
IEC 60870-5-101/104 Slave Protocols

Documentation for Cybectec part numbers P-SSPR-0101 and P-SSPR-0103

The information in this document is subject to change without notice.

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3	2008-05-08	Mathieu Harvey, Jr. Eng.	Added support of serial radios.
2	2007-02-27	Johanne Lavallée	Cooper integration, no major changes for version 4.
1	2006-01-20	Rémi Dutil	No major changes with respect to version 2.0.

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1. Introduction

This manual provides the information required to install and set up an IEC 60870-5-101/104 slave protocol in a Cybectec SMP Gateway.

The IEC 60870-5-101/104 slave protocol components are used to retrieve data from any device compatible with the IEC 60870-5-101/104 protocol definition. They can also be used to control such devices.

1.1 References

You need to be familiar with the SMP Gateway environment, slave protocol concepts, the IEC 60870-5-101/104 protocol specification, and the CSV file format before proceeding with this document. You can get this information by reading the following documents:

- *IEC 60870-5-1, Telecontrol Equipment and Systems - Part 5, Transmission Protocols - Section 1: Transmission frame formats, 1990.*
- *IEC 60870-5-2, Telecontrol Equipment and Systems - Part 5, Transmission Protocols - Section 2: Link transmission procedures, 1992.*
- *IEC 60870-5-3, Telecontrol Equipment and Systems - Part 5, Transmission Protocols - Section 3: General structure of application data, 1992.*
- *IEC 60870-5-4, Telecontrol Equipment and Systems - Part 5, Transmission Protocols - Section 4: Definition and coding of application information elements, 1993.*
- *IEC 60870-5-5, Telecontrol Equipment and Systems - Part 5, Transmission Protocols - Section 5: Basic application functions, 1995.*
- *IEC 60870-5-101, Telecontrol Equipment and Systems - Part 5, Transmission Protocols - Section 101: Companion standard for basic telecontrol tasks, 1995.*
- *IEC 60870-5-104, Telecontrol Equipment and Systems - Part 5, Transmission Protocols - Section 104: Network access for IEC 60870-5-101 using standard transport profiles, 2000.*
- *SMP Config CSV Format Definition, Cooper Power Systems.*

1.2 Document Overview

Chapter	Definition
2	This chapter deals with the IEC 60870-5 device profile and interoperability with other IEC 60870-5 devices.
3	This chapter documents the configuration settings associated with the IEC 60870-5 slave component.
4	This chapter describes the operations performed by the IEC 60870-5 slave protocol component, including interactions with the RTDX.
5	This chapter describes the diagnostics information produced by the IEC 60870-5 slave protocol component.

1.3 Glossary

IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
RTDX	Real-Time Data Exchange
RTU	Remote Terminal Unit
UTC	Universal Time Coordinated

2. Features

2.1 IEC IEC60870-5-101 Communications

The following communication features are available when connecting IEC 60870-5-101 master stations to the SMP Gateway:

Feature	Comment
Serial Port	The IEC 60870-5-101 protocol component supports RS-232, RS-422 and RS-485 interfaces at bit rates up to 115200 bps.
Multidrop	This protocol component can be used over a multidrop link, if its device address is different than the one of other devices sharing the link.
Modem	This protocol component supports modem connections, in either permanent or switched mode.
Serial Radios	The IEC 60870-5-101 protocol component supports asynchronous communications using serial radios.
Link Redundancy	This protocol component can be configured to use two different communication links to communicate with the same device.

Table 2-1 IEC 60870-5-101 Communications Features

2.2 IEC 60870-5-104 Communications

The following communication features are available when connecting IEC 60870-5-104 master stations to the SMP Gateway:

Feature	Comment
TCP/IP	The IEC 60870-5-104 protocol component supports TCP/IP communication.
Link Redundancy	This protocol component can be configured to use two different communication links to communicate with the same device.

Table 2-2 IEC 60870-5-104 Communications Features

2.3 Interoperability

The purpose of this chapter is to describe how the IEC 60870-5-101 and IEC 60870-5-104 protocols are implemented in Cybectec SMP Gateway.

This chapter, in conjunction with chapter 4 and the IEC interoperability sheets, provides complete information on how to communicate with the IEC 60870-5 slave component via the IEC 60870-5-101 or the IEC 60870-5-104 protocols.

2.3.1 Implementation Restrictions and Warnings

The following protocol and/or implementation restrictions apply:

- Each instance of the IEC 60870-5 protocol implements data points associated with a single *Common ASDU address*. Therefore, all data points defined for this address must have a unique *Information Object Address*.
- The data reported by an IEC 60870-5 slave component is updated internally as fast as the Real-Time Data Exchange component receives it from the various data producer components. The freshness of the data a master station receives depends on the master station's configuration (polling cycle/report by exception) as well as on the polling cycle of the components producing the data.

2.3.2 IEC 60870-5-101 Interoperability Sheet

The following table provides a "Device Profile Document" in the standard format defined in the IEC 60870-5-101 document.

<p>8 Interoperability Sheet</p> <p>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 crossed in the white boxes (simply replace "□" with "☒").</p>															
<p>8.1 Network configuration (network-specific parameter)</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;"><input checked="" type="checkbox"/> Point-to-point</td> <td style="width: 50%;"><input checked="" type="checkbox"/> Multipoint-party line</td> </tr> <tr> <td><input type="checkbox"/> Multiple point-to-point</td> <td><input type="checkbox"/> Multipoint-star</td> </tr> </table>	<input checked="" type="checkbox"/> Point-to-point	<input checked="" type="checkbox"/> Multipoint-party line	<input type="checkbox"/> Multiple point-to-point	<input type="checkbox"/> Multipoint-star											
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<p>8.2 Physical layer (network-specific parameter)</p> <p><u>Transmission speed (control direction)</u></p> <table style="width: 100%; border: none;"> <thead> <tr> <th style="width: 33%;">Unbalanced interchange V.24/V.28 Standard</th> <th style="width: 33%;">Unbalanced interchange circuit V.24/V.28 Recommended if >1 200 bit/s</th> <th style="width: 33%;">Balanced interchange circuit circuit X.24/X.27</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/> 100 bit/s</td> <td><input checked="" type="checkbox"/> 2400 bit/s</td> <td><input type="checkbox"/> 2400 bit/s</td> </tr> <tr> <td><input checked="" type="checkbox"/> 200 bit/s</td> <td><input checked="" type="checkbox"/> 4800 bit/s</td> <td><input type="checkbox"/> 4800 bit/s</td> </tr> <tr> <td><input checked="" type="checkbox"/> 300 bit/s</td> <td><input checked="" type="checkbox"/> 9600 bit/s</td> <td><input type="checkbox"/> 9600 bit/s</td> </tr> <tr> <td><input checked="" type="checkbox"/> 600 bit/s</td> <td><input checked="" type="checkbox"/> 19200 bit/s</td> <td><input type="checkbox"/> 19200 bit/s</td> </tr> </tbody> </table>	Unbalanced interchange V.24/V.28 Standard	Unbalanced interchange circuit V.24/V.28 Recommended if >1 200 bit/s	Balanced interchange circuit circuit X.24/X.27	<input checked="" type="checkbox"/> 100 bit/s	<input checked="" type="checkbox"/> 2400 bit/s	<input type="checkbox"/> 2400 bit/s	<input checked="" type="checkbox"/> 200 bit/s	<input checked="" type="checkbox"/> 4800 bit/s	<input type="checkbox"/> 4800 bit/s	<input checked="" type="checkbox"/> 300 bit/s	<input checked="" type="checkbox"/> 9600 bit/s	<input type="checkbox"/> 9600 bit/s	<input checked="" type="checkbox"/> 600 bit/s	<input checked="" type="checkbox"/> 19200 bit/s	<input type="checkbox"/> 19200 bit/s
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<input checked="" type="checkbox"/> 600 bit/s	<input checked="" type="checkbox"/> 19200 bit/s	<input type="checkbox"/> 19200 bit/s													

1200 bit/s

38400 bit/s

56000 bit/s

64000 bit/s

Transmission speed (monitor direction)

Unbalanced interchange
V.24/V.28
Standard

Unbalanced interchange
circuit V.24/V.28
Recommended if >1 200 bit/s

Balanced interchange circuit
circuit X.24/X.27

100 bit/s

2400 bit/s

2400 bit/s

200 bit/s

4800 bit/s

4800 bit/s

300 bit/s

9600 bit/s

9600 bit/s

600 bit/s

19200 bit/s

19200 bit/s

1200 bit/s

38400 bit/s

56000 bit/s

64000 bit/s

8.3 *Link Layer*

(network-specific parameter)

Frame format FT 1.2, single character 1 and the fixed time out interval are used exclusively in this companion standard.

Link transmission procedure

Balanced transmission

Unbalanced transmission

Address field of link

Not present
(balanced transmission only)

One octet

Two octets

Structured

Unstructured

Frame length

Maximum length L (number of octets)

8.4 *Application Layer*

Transmission mode for application data

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

Common address of ASDU

(system-specific parameter)

One octet

Two octets

Information object address

(system-specific parameter)

- One octet
- Two octets
- Three octets
- structured
- unstructured

Cause of transmission
(system-specific parameter)

- One octet
- Two octets (with originator address)

Selection of standard ASDUs

Process information in monitor direction
(station-specific parameter)

- <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 bits M_BO_NA_1
- <8> := Bitstring of 32 bits with time tag M_BO_TA_1
- <9> := Measured value, normalized value M_ME_NA_1
- <10> := Measured value, normalized value with time tag M_ME_TA_1
- <11> := Measured value, scaled value M_ME_NB_1
- <12> := Measured value, scaled value with time tag M_ME_TB_1
- <13> := Measured value, short floating point value M_ME_NC_I
- <14> := Measured value, short floating point value with time tag M_ME_TC_1
- <15> := Integrated totals M_IT_NA_1
- <16> := Integrated totals with time tag M_IT_TA_1
- <17> := Event of protection equipment with time tag M_EP_TA_1
- <18> := Packed start events of protection equipment with time tag M_EP_TB_1
- <19> := Packed output circuit information of protection equipment with time tag M_EP_TC_1
- <20> := Packed single-point information with status change detection M_PS_NA_1
- <21> := Measured value, normalized value without quality descriptor M_ME_ND_1
- <30> := Single-point information with time tag CP56Time2a M_SP_TB_1
- <31> := Double-point information with time tag CP56Time2A M_DP_TB_1

<input checked="" type="checkbox"/> <32> := Step position information with time tag CP56Time2A	M_ST_TB_1
<input checked="" type="checkbox"/> <33> := Bitstring of 32 bits with time tag CP56Time2A	M_BO_TB_1
<input checked="" type="checkbox"/> <34> := Measured value, normalized value with time tag CP56Time2A	M_ME_TD_1
<input checked="" type="checkbox"/> <35> := Measured value, scaled value with time tag CP56Time2A	M_ME_TE_1
<input checked="" type="checkbox"/> <36> := Measured value, short floating point value with time tag CP56Time2A	M_ME_TF_1
<input checked="" type="checkbox"/> <37> := Integrated totals with time tag CP56Time2A	M_IT_TB_1
<input type="checkbox"/> <38> := Event of protection equipment with time tag CP56Time2A	M_EP_TD_1
<input type="checkbox"/> <39> := Packed start events of protection equipment with time tag CP56time2A	M_EP_TE_1
<input type="checkbox"/> <40> := Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

Process information in control direction

(station-specific parameter)

<input checked="" type="checkbox"/> <45>:= Single command	C_SC_NA_1
<input checked="" type="checkbox"/> <46>:= Double command	C_DC_NA_1
<input checked="" type="checkbox"/> <47>:= Regulating step command	C_RC_NA_1
<input checked="" type="checkbox"/> <48>:= Set point command, normalized value	C_SE_NA_1
<input checked="" type="checkbox"/> <49>:= Set point command, scaled value	C_SE_NB_1
<input checked="" type="checkbox"/> <50>:= Set point command, short floating point value	C_SE_NC_1
<input checked="" type="checkbox"/> <51>:= Bitstring of 32 bits	C_BO_NA_1

System information in monitor direction

(station-specific parameter)

<input checked="" type="checkbox"/> <70> := End of initialization	M_EI_NA_1
---	-----------

System information in control direction

(station-specific parameter)

<input checked="" type="checkbox"/> <100> := Interrogation command	C_IC_NA_1
<input checked="" type="checkbox"/> <101> := Counter interrogation command	C_CI_NA_1
<input checked="" type="checkbox"/> <102> := Read command	C_RD_NA_1
<input checked="" type="checkbox"/> <103> := Clock synchronization command	C_CS_NA_1
<input checked="" type="checkbox"/> <104> := Test command	C_TS_NA_1
<input checked="" type="checkbox"/> <105> := Reset process command	C_RP_NA_1
<input checked="" type="checkbox"/> <106> := Delay acquisition command	C_CD_NA_1

Parameter in control direction

(station-specific parameter)

- <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)

- <120> := File ready F_FR_NA_1
- <121> := Section ready F_SR_NA_1
- <122> := Call directory, select file, call file, call section F_SC_NA_1
- <123> := Last section, last segment F_LS_NA_1
- <124> := Ack file, ack section F_AF_NA_1
- <125> := Segment F_SG_NA_1
- <126> := Directory F_DR_TA_1

8.5 Basic application functions

Station initialization

(station-specific parameter)

- Remote initialization

General Interrogation

(system- or station-specific parameter)

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

Addresses per group have to be defined

Clock synchronization

(station-specific parameter)

- Clock synchronization

Command transmission

(object-specific parameter)

- Direct command transmission Select and execute command
- Direct set point command transmission Select and execute set point command
- No additional definition C_SE_ACTTERM used

- Short pulse duration (duration determined by a system parameter in the outstation)
- Long pulse duration (duration determined by a system parameter in the outstation)
- Persistent output

Transmission of Integrated totals

(station- or object-specific parameter)

- | | |
|--|---|
| <input checked="" type="checkbox"/> Counter request | <input checked="" type="checkbox"/> General request counter |
| <input checked="" type="checkbox"/> Counter freeze without reset | <input checked="" type="checkbox"/> Request counter group 1 |
| <input checked="" type="checkbox"/> Counter freeze with reset | <input checked="" type="checkbox"/> Request counter group 2 |
| <input checked="" type="checkbox"/> Counter reset | <input checked="" type="checkbox"/> Request counter group 3 |
| | <input checked="" type="checkbox"/> Request counter group 4 |

Addresses per group have to be defined

Parameter loading

(object-specific parameter)

- Threshold value
- Smoothing factor
- Low limit for transmission of measured value
- High limit for transmission of measured value

Parameter activation

(object-specific parameter)

- Act/deact of persistent cyclic or periodic transmission of the addressed object

File transfer

(station-specific parameter)

- File transfer in monitor direction
- File transfer in control direction

2.3.3 IEC 60870-5-104 Interoperability Sheet

The following table provides a "Device Profile Document" in the standard format defined in the IEC 60870-5-104 document.

8 Interoperability Sheet

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 crossed in the white boxes (simply replace "" with ""). The black boxes ("") show parameters not available in 870-5-104.

8.1 Network configuration

(not topical in IEC 60870-5-104)

8.2 Physical layer

(not topical in IEC 60870-5-104)

8.3 Link layer

(not topical in IEC 60870-5-104)

8.4 Application Layer

Transmission mode for application data

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

Common address of ASDU

(system-specific parameter)

- | | |
|------------------------------------|--|
| <input type="checkbox"/> One octet | <input checked="" type="checkbox"/> Two octets |
|------------------------------------|--|

Information object address

(system-specific parameter)

- | | |
|--|--|
| <input type="checkbox"/> One octet | <input checked="" type="checkbox"/> Structured |
| <input type="checkbox"/> Two octets | <input checked="" type="checkbox"/> Unstructured |
| <input checked="" type="checkbox"/> Three octets | |

Cause of transmission

(system-specific parameter)

- | | |
|------------------------------------|--|
| <input type="checkbox"/> One octet | <input checked="" type="checkbox"/> Two octets (with originator address) |
|------------------------------------|--|

Selection of standard ASDUs

Process information in monitor direction (station-specific parameter)

<input checked="" type="checkbox"/> <1> := Single-point information	M_SP_NA_1
<input checked="" type="checkbox"/> <2> := Single-point information with time tag	M_SP_TA_1
<input checked="" type="checkbox"/> <3> := Double-point information	M_DP_NA_1
<input checked="" type="checkbox"/> <4> := Double-point information with time tag	M_DP_TA_1
<input checked="" type="checkbox"/> <5> := Step position information	M_ST_NA_1
<input checked="" type="checkbox"/> <6> := Step position information with time tag	M_ST_TA_1
<input checked="" type="checkbox"/> <7> := Bitstring of 32 bits	M_BO_NA_1
<input checked="" type="checkbox"/> <8> := Bitstring of 32 bits with time tag	M_BO_TA_1
<input checked="" type="checkbox"/> <9> := Measured value, normalized value	M_ME_NA_1
<input checked="" type="checkbox"/> <10> := Measured value, normalized value with time tag	M_ME_TA_1
<input checked="" type="checkbox"/> <11> := Measured value, scaled value	M_ME_NB_1
<input checked="" type="checkbox"/> <12> := Measured value, scaled value with time tag	M_ME_TB_1
<input checked="" type="checkbox"/> <13> := Measured value, short floating point value	M_ME_NC_I
<input checked="" type="checkbox"/> <14> := Measured value, short floating point value with time tag	M_ME_TC_1
<input checked="" type="checkbox"/> <15> := Integrated totals	M_IT_NA_1
<input checked="" type="checkbox"/> <16> := Integrated totals with time tag	M_IT_TA_1
<input checked="" type="checkbox"/> <17> := Event of protection equipment with time tag	M_EP_TA_1
<input checked="" type="checkbox"/> <18> := Packed start events of protection equipment with time tag	M_EP_TB_1
<input checked="" type="checkbox"/> <19> := Packed output circuit information of protection equipment with time tag	M_EP_TC_1
<input type="checkbox"/> <20> := Packed single-point information with status change detection	M_PS_NA_1
<input type="checkbox"/> <21> := Measured value, normalized value without quality descriptor	M_ME_ND_1
<input checked="" type="checkbox"/> <30> := Single-point information with time tag CP56Time2a	M_SP_TB_1
<input checked="" type="checkbox"/> <31> := Double-point information with time tag CP56Time2A	M_DP_TB_1
<input checked="" type="checkbox"/> <32> := Step position information with time tag CP56Time2A	M_ST_TB_1
<input checked="" type="checkbox"/> <33> := Bitstring of 32 bits with time tag CP56Time2A	M_BO_TB_1
<input checked="" type="checkbox"/> <34> := Measured value, normalized value with time tag CP56Time2AM_ME_TD_1	
<input checked="" type="checkbox"/> <35> := Measured value, scaled value with time tag CP56Time2A	M_ME_TE_1
<input checked="" type="checkbox"/> <36> := Measured value, short floating point value with time tag CP56Time2A	M_ME_TF_1
<input checked="" type="checkbox"/> <37> := Integrated totals with time tag CP56Time2A	M_IT_TB_1
<input type="checkbox"/> <38> := Event of protection equipment with time tag CP56Time2A	M_EP_TD_1

- <39> := Packed start events of protection equipment with time tag CP56Time2A M_EP_TE_1
- <40> := Packed output circuit information of protection equipment with time tag CP56Time2a M_EP_TF_1

Process information in control direction
(station-specific parameter)

- <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 bits 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
- <64> := Bitstring of 32 bits with time tag CP56Time2A C_BO_TA_1

System information in monitor direction
(station-specific parameter)

- <70> := End of initialization M_EI_NA_1

System information in control direction
(station-specific parameter)

- <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)

- | | | |
|---|--|-----------|
| <input checked="" type="checkbox"/> <110> | := Parameter of measured value, normalized value | P_ME_NA_1 |
| <input checked="" type="checkbox"/> <111> | := Parameter of measured value, scaled value | P_ME_NB_1 |
| <input checked="" type="checkbox"/> <112> | := Parameter of measured value, short floating point value | P_ME_NC_1 |
| <input checked="" type="checkbox"/> <113> | := Parameter activation | P_AC_NA_1 |

File transfer

(station-specific parameter)

- | | | |
|--------------------------------|---|-----------|
| <input type="checkbox"/> <120> | := File ready | F_FR_NA_1 |
| <input type="checkbox"/> <121> | := Section ready | F_SR_NA_1 |
| <input type="checkbox"/> <122> | := Call directory, select file, call file, call section | F_SC_NA_1 |
| <input type="checkbox"/> <123> | := Last section, last segment | F_LS_NA_1 |
| <input type="checkbox"/> <124> | := Ack file, ack section | F_AF_NA_1 |
| <input type="checkbox"/> <125> | := Segment | F_SG_NA_1 |
| <input type="checkbox"/> <126> | := Directory | F_DR_TA_1 |

8.5 Basic application functions

Station initialization

(station-specific parameter)

- Remote initialization

General Interrogation

(system- or station-specific parameter)

- | | | |
|---|--|--|
| <input checked="" type="checkbox"/> global | | |
| <input checked="" type="checkbox"/> group 1 | <input checked="" type="checkbox"/> group 7 | <input checked="" type="checkbox"/> group 13 |
| <input checked="" type="checkbox"/> group 2 | <input checked="" type="checkbox"/> group 8 | <input checked="" type="checkbox"/> group 14 |
| <input checked="" type="checkbox"/> group 3 | <input checked="" type="checkbox"/> group 9 | <input checked="" type="checkbox"/> group 15 |
| <input checked="" type="checkbox"/> group 4 | <input checked="" type="checkbox"/> group 10 | <input checked="" type="checkbox"/> group 16 |
| <input checked="" type="checkbox"/> group 5 | <input checked="" type="checkbox"/> group 11 | |
| <input checked="" type="checkbox"/> group 6 | <input checked="" type="checkbox"/> group 12 | |

Addresses per group have to be defined

Clock synchronization

(station-specific parameter)

- Clock synchronization

Command transmission

(object-specific parameter)

- Direct command transmission
- Direct set point command transmission
- No additional definition
- Short pulse duration (duration determined by a system parameter in the outstation)
- Long pulse duration (duration determined by a system parameter in the outstation)
- Persistent output
- Select and execute command
- Select and execute set point command
- C_SE_ACTTERM used

Transmission of Integrated totals

(station- or object-specific parameter)

- Counter request
- Counter freeze without reset
- Counter freeze with reset
- Counter reset
- Request counter group 4
- General request counter
- Request counter group 1
- Request counter group 2
- Request counter group 3

Addresses per group have to be defined

Parameter loading

(object-specific parameter)

- Threshold value
- Smoothing factor
- Low limit for transmission of measured value
- High limit for transmission of measured value

Parameter activation

(object-specific parameter)

- Act/deact of persistent cyclic or periodic transmission of the addressed object

File transfer

(station-specific parameter)

- File transfer in monitor direction
- File transfer in control direction

Definition of time outs

Parameter	Default value	Remarks	Selected value
t_0	30s	Time out of connection establishment	(can be changed)
t_1	15s	Time out of send or test APDUs	(can be changed)
t_2	10s	Time out for acknowledge in case of no data messages $t_2 < t_1$	
t_3	20s	Time out for sending test frames in case of along idle state	(can be changed)

Maximum number of outstanding I format APDUs k and latest acknowledge

Parameter	Default value	Remarks	Selected value
K	12 APDUs	Maximum difference for the receive number to send state variable	(can be changed)
w	8 APDUs	Latest acknowledge after receiving w I-format APDUs	(can be changed)

Maximum range of values k: 1 to 32767 (215 – 1) APDUs, accuracy 1 APDU

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

Port number

Parameter	Value	Remarks
Portnumber	2404	Should not be changed but it is possible to do so.

3. Configuration Settings

This chapter enumerates the configuration settings to be specified for each IEC 60870-5 slave protocol instance. The **SMP Config** software is generally used to define these settings.

3.1 General Settings

General settings define the configuration and general behavior of the slave component. One instance of these settings is required per component instance, except when link redundancy is enabled. In that case, one instance of these settings is required per link.

Setting	Description
Device Prefix	A name identifying the component instance. When a device prefix is specified, certain logical binary points are generated by the IEC 870-5 slave component (see section 6.8.5 - Generated Binary Inputs).
Command Enable	A checkmark enables control operations by the master component on binary output points. Range: checkmark / no checkmark Default value: no checkmark
BO Mode	Indicates the binary output command mode used by the master to perform control operations on binary output points. Allowed values: Select/Execute Direct Execute Default value: Select/Execute
AO Mode	Indicates the analog output command mode used by the master to perform control operations on analog output points. Allowed values: Select/Execute Direct Execute Default value: Select/Execute
Inactivity Timeout	The number of seconds that the component will wait after the last valid data link layer frame is received before resetting the communication link. If set to 0, the inactivity timeout is disabled. Range: 0 to 1,000,000 secs Default value: 60 secs
Unavailability Timeout	The number of seconds that the component will wait after the last valid data link layer frame or the last connection request from the control station is received, before declaring the link unavailable. If set to 0, the unavailability timeout is disabled. The link availability state is published using the ___ <i>LinkAvailable</i> logical point (see section 6.8.5). Range: 0 to 1,000,000 secs Default value: 60 secs

Setting	Description
Selection Timeout	<p>The time interval, in milliseconds, following a SELECT command, during which an EXECUTE command must be received before the selection times out.</p> <p>In the case of IEC 60870-5-104, this interval also indicates the maximum time difference allowed between a time-tagged command and the local time. If the offset between the two time sources is greater than this difference, the incoming command is refused.</p> <p>Note: A value of 0 causes an immediate timeout.</p> <p>Range: 0 to 2,147,483,647 ms</p> <p>Default value: 30,000 ms</p>
Sel. Conf. Timeout	<p>The number of milliseconds to wait for the confirmation of a SELECT command sent through the RTDX.</p> <p>Range: 500 to 2,147,483,647 ms</p> <p>Default value: 1,000 ms</p>
Exec. Conf. Timeout	<p>The number of milliseconds to wait for the confirmation of an EXECUTE command sent through the RTDX.</p> <p>Range: 500 to 2,147,483,647 ms</p> <p>Default value: 10,000 ms</p>
Client Time Zone	<p>The time zone at which the master's clock is set.</p> <p>Some masters may expect to receive data changes that are timestamped using local time information, rather than UTC time. Therefore, if the master's clock is adjusted to the local time zone setting, the slave's configuration must be set accordingly so it can adjust the timestamps to the local time. If the slave is configured to accept clock synchronization request, the same time zone setting will be used to convert the master's local time information to UTC time.</p> <p>If the master's clock is adjusted for daylight savings, the Auto Adjust DST setting must also be enabled (see below).</p> <p>By default, SMP Config assumes that the master's clock is set to use UTC time, which corresponds to the GMT time zone modifier setting.</p>
Auto Adjust DST	<p>Indicates that the master's clock is adjusted for daylight savings.</p> <p>This setting is used in conjunction with the Device Time Zone setting, to convert timestamps to transmit from UTC to local time.</p> <p>It is also used on the reception of clock synchronization request, to convert the master's local time information to UTC time.</p>

Setting	Description
Clock Sync	<p>Specifies whether clock synchronization requests information will be used to adjust the SMP Gateway's clock, or not.</p> <p>Range: checkmark / no checkmark</p> <p>Default value: checkmark</p>
Clock Sync Cycle	<p>The time interval, in milliseconds, at which the control station sends clock synchronization requests to synchronize the slave component.</p> <p>Set this value to 0 if no clock synchronization is required. In this case, clock synchronization commands will be rejected.</p> <p>Range: 0 to 2,147,483,647 ms</p> <p>Default value: 1,800,000 ms (30 mins)</p>
Report Cycle	<p>Sets the background scan cycle, in milliseconds. During a background scan, acquisition objects configured to be periodically scanned are reported to the control station.</p> <p>Set the background scan to 0 to disable background scanning.</p> <p>Range: 0 to 2,147,483,647 ms</p> <p>Default value: 300,000 ms (5 mins)</p>
Short Pulse Dur.	<p>The activation time, in milliseconds, for a short pulse command.</p> <p>Range: 0 to 2,147,483,647 ms</p> <p>Default value: 500 ms</p>
Long Pulse Dur.	<p>The activation time, in milliseconds, for a long pulse command.</p> <p>Range: 0 to 2,147,483,647 ms</p> <p>Default value: 1,000 ms</p>
Restart Enable	<p>A checkmark allows the C_RP_NA_1 command to restart the SMP Gateway.</p> <p>Range: checkmark / no checkmark</p> <p>Default value: no checkmark</p>
Queue Length	<p>The number of information objects in the transmission queues (Class 1 and Class 2). Care must be taken to ensure that all objects can be stored in the queue at least once. It is strongly recommended that this size be set to twice the number of acquisition objects (analog and binary). If IEC 60870-5 queue overflow errors are generated, this value should be increased accordingly.</p> <p>Range: 64 to 32,768</p> <p>Default value: 256</p>

Setting	Description
Not Topical Support	<p>A checkmark allows the slave component to bypass the <i>wait for master component initial general interrogation scan completed</i> notification before allowing connections from the control station at startup.</p> <p>If the control station interrogates the slave component while the initial general interrogation scan is being performed, the latter returns analog and binary inputs flagged with the <i>Not Topical</i> status bits.</p> <p>Range: checkmark / no checkmark</p> <p>Default value: no checkmark</p>
Max Connection Delay	<p>Maximum number of seconds, that the slave component will wait for the master component's <i>initial general interrogation scan completed</i> notification before allowing incoming connections.</p> <p>This allows slave components to wait before allowing connections from the control center until master components (those configured to do so) complete their first general interrogation scan, or time out if the communication cannot be established. Following an SMP Gateway reboot, this prevents the control station from seeing any useless transitions resulting from system initialization.</p> <p>You should specify a value of 0 when <i>Not Topical Support</i> contains a checkmark.</p> <p>Range: 0 to 86,400 secs</p> <p>Default value: 0</p>
Hot-Standby Support	<p>Indicates the startup status of the slave on the standby SMP Gateway.</p> <p>Allowed values: Disabled Slave not started Acquisition Slave started, no control allowed Acquisition and Control Slave started, control allowed</p> <p>Default value: Disabled</p>

Table 3-3 General Settings

3.2 Common IEC 60870-5 Settings

Common IEC 60870-5 settings are common to both the IEC 60870-5-101 and IEC 60870-5-104 protocols. One instance of these settings is required per component instance, except when link redundancy is enabled, in which case, one instance of these settings is required per link.

Setting	Description
Emitter Address	<p>Emitter address for outgoing frames.</p> <p>Range: 0 to 254</p>

Setting	Description
	Default value: 0
ASDU Address	Remote IED common ASDU address. This address is used in all IEC 60870-5 application transactions. The IEC 60870-5 master checks that all incoming objects have this address. Range: 1 to 254 if <i>CAA Size</i> = 1 1 to 65,534 if <i>CAA Size</i> = 2 Default value: 1
Max Frame Size	Maximum frame length, in bytes. Range: 35 to 261 IEC 60870-5-101 35 to 255 IEC 60870-5-104 Default value: 261 IEC 60870-5-101 255 IEC 60870-5-104

Table 3-4 Common IEC 60870-5 Settings

3.3 IEC 60870-5-101 Specific Settings

One instance of these settings is required per component instance, except when link redundancy is enabled, in which case, one instance of these settings is required per link.

Setting	Description
Link Address	Link address of the component. Range: 1 to 254 if <i>LA Size</i> = 1 1 to 65,534 if <i>LA Size</i> = 2 Default value: 1
LA Size	Size (number of bytes) of the link address. Allowed values: 1 or 2 Default value: 1
COT Size	Size (number of bytes) of the cause of transmission field. This field includes the emitter address. Allowed values: 1 or 2 Default value: 1
CAA Size	Size (number of bytes) of the common ASDU address. Allowed values: 1 or 2 Default value: 1
IOA Size	Size (number of bytes) of the information objects' address. Allowed values: 1, 2 or 3 Default value: 2
CP56Time2a	A checkmark specifies that 7-byte time tags will be used, rather than 3-byte time tags.

Setting	Description
	Range: checkmark / no checkmark Default value: no checkmark
Use Single Control Character	A checkmark allows the slave component to answer with the single control character E5 to the class 2 request when there is no class 2 data and no access demand for class 1 data (ACD = 1). Range: checkmark / no checkmark Default value: no checkmark
Use Sequential Addressing	A checkmark allows the slave component to answer with sequential addressing (SQ = 1). Range: checkmark / no checkmark Default value: no checkmark
No Terminations	A checkmark specifies that the slave component should not transmit command and setpoint terminations (ACTTERM), but rather command and setpoint confirmations (ACTCON). Range: checkmark / no checkmark Default value: no checkmark

Table 3-5 IEC 60870-5-101 Specific Settings

3.4 IEC 60870-5-104 Specific Settings

Only one instance of IEC 60870-5-104 specific settings is required per component instance.

Setting	Description
T0	Timeout for the establishment of a connection. Range: 1 to 255 secs Default value: 30 secs
T1	Timeout for receiving acknowledges to an I or U APDU (data frames). Range: 1 to 255 secs Default value: 15 secs
T2	Timeout for sending a S-ACK APDU if no data acknowledges are received. Range: 1 to 255 secs, T2 < T1 Default value: 10 secs
T3	Timeout for the establishment of a connection (in seconds). Range: 1 to 255 secs, T3 > T1 Default value: 30 secs
K	Maximum number of unacknowledged frames allowed to be in transit at any moment.

Setting	Description
	Range: 1 to 32,767 Default value: 12
W	Maximum number of frames to wait before acknowledging, if no data acknowledges are received. Recommendation: W should not exceed 2/3 of K. Range: 1 to 32,767 Default value: 8

Table 3-6 IEC 60870-5-104 Specific Settings

3.5 Counter Group Settings

Counter group interrogation settings determine how counters will be polled. Five instances of these settings are required per component instance: one for each group.

Setting	Description
Group	Group number of the group to which the point belongs. The general group consists of all the counters. Allowed values: 0 general group 1 to 4 group number
Mode	Indicates how freeze and request commands are carried out. Allowed values: <ul style="list-style-type: none"> Remote FRZ & RQT Freeze and request commands are issued by the master station. Remote FRZ - Spont RQT Freeze commands are issued by master station, and frozen values are reported spontaneously. Local FRZ - Remote RQT Freeze operations are performed locally in a cyclic fashion. Request commands are issued by control centers. Local FRZ - Spont RQT Freeze operations are performed locally, and frozen values are reported spontaneously. Default value: Remote FRZ & RQT
Freeze Cycle	In the case of a local freeze, indicates the cycle, in milliseconds, at which the local freeze operations will be performed. Range: 0 to 2,147,483,647 secs Default value: 300,000 secs (5 mins)
Reset	In case of a local freeze, the counter is also reset if you put a checkmark in this box.

Setting	Description
	Range: checkmark / no checkmark
	Default value: no checkmark

Table 3-7 Counter Group Settings

3.6 Parameter Loading Settings

One instance of these settings is required for each parameter object that can be modified by the master station. The IEC 60870-5 slave creates these points in the RTDX. Their purpose is to allow master stations to modify analog input behavior.

Setting	Description
Name	The name that identifies the point. This name must be unique for each parameter point.
Address	IEC 60870-5-101 or IEC 60870-5-104 information object address of the parameter object. This address must be unique for all I/O points of the IEC 60870-5 slave. Range: 1 to 16,777,216 Default value: 1
AI Address	Information object address of the analog input whose behavior is affected by this setting. Range: 1 to 16,777,216 Default value: 1
Type	This setting is read-only. A drop-down list shows all the values supported by the EIC 60870-5-101/104 slave protocol but in fact, the only value supported by the system is <i>Threshold</i> . Thus, you are defining a threshold parameter. Values listed: Threshold Smoothing factor Low limit High limit Default value: Threshold (only value allowed)
Group	Group number of the group to which the point belongs. When a request for a specific group is received, only points belonging to this group are reported. There is no general group for parameter objects. Allowed values: 0 no group 1 to 16 group number Default value: 0
Units	The type of units. This setting is optional and is used by certain SMP Tools . A list of units is automatically provided by SMP Config . Allowed values: As shown in the drop-down list.

Setting	Description
	Default value: Undefined
Description	An optional point description. Although recommended, this description is not mandatory as it is only used by the various SMP Tools . Range: 1 to 63 chars Default value: none

Table 3-8 Parameter Loading Settings

3.7 Analog Input Settings

Each instance of the slave protocol component may contain several analog input points to be reported to the master station. Analog input settings tell the component how to map analog inputs from the RTDX to protocol addresses. The following table shows the analog input settings for the IEC 60870-5 slave protocol.

Setting	Description
Name	The name that identifies the point. This name must be unique for each analog input point.
Address	IEC 60870-5-101 or IEC 60870-5-104 information object address. Range: 1 to 16,777,216 Default value: 1
Format	Format used to report the analog input value. See section 6.8.2 - Analog Inputs, for details on translation rules from the RTDX to reported values. Allowed values: Normalized Scaled Floating-point Step position Bitstring Default value: Normalized
Class (IEC 60870-5-101)	Selection of the class assignment. Class 1 is generally used for high-priority data. Allowed values: Class 1 Class 2 Default value: Class 1
Time Tagged	Indicates that time tags will be used for spontaneous or cyclic reporting. Values reported following group interrogation requests are never time tagged. Range: checkmark / no checkmark Default value: checkmark
Group	Group number of the group to which the point belongs. When a

Setting	Description
	<p>request for a specific group is received, only points belonging to this group are reported. The general group consists of all the points.</p> <p>Allowed values: 0 no group 1 to 16 group number</p> <p>Default value: 0</p>
Cyclic	<p>A checkmark enables cyclic reporting. The master station can change the cyclic reporting attribute at run time through the <i>Cyclic activation</i> setting. This setting is restored for each analog input point each time the communication is lost.</p> <p>Range: checkmark / no checkmark</p> <p>Default value: no checkmark</p>
Force Float	<p>A checkmark specifies that when RAW and FLOAT RTDX values are available, the FLOAT value will be used for the translation. If there is no checkmark, the RAW value will be used.</p> <p>Range: checkmark / no checkmark</p> <p>Default value: checkmark</p>

Table 3-9 Analog Input Settings

3.8 Binary Input Settings

Each instance of the slave protocol component may contain several binary input points to be reported to the master station. Binary input settings tell the component how to map binary inputs from the RTDX to protocol addresses. The following table shows the binary input settings for the IEC 60870-5 slave protocol.

Setting	Description
Name	The name that identifies the point. This name must be unique for each binary input point.
Address	<p>IEC 60870-5-101 or IEC 60870-5-104 information object address.</p> <p>Range: 1 to 16,777,216</p> <p>Default value: 1</p>
Format	<p>Indicates whether the binary input is a single point or a double point. If it is a double point, two binary input points must be configured, with the same <i>Address</i> but with different bits.</p> <p>Allowed values: Single point Double point (0) bit 0 Double point (1) bit 1</p> <p>Default value: Single point</p>
Class (IEC 60870-5-101)	<p>Selection of the class assignment.</p> <p>Class 1 is generally used for high-priority data.</p> <p>Allowed values: Class 1</p>

Setting	Description
	Class 2 Default value: Class 1
Time Tagged	A checkmark specifies that time tags will be used for spontaneous or cyclic reporting. Values reported following group interrogation requests are never time tagged. Range: checkmark / no checkmark Default value: checkmark
Group	Group number of the group to which the point belongs. When a request for a specific group is received, only points belonging to this group are reported. The general group consists of all the points. Allowed values: 0 no group 1 to 16 group number Default value: 0

Table 3-10 Binary Input Settings

3.9 Counter Input Settings

Each instance of the slave protocol component may contain several counter input points to be reported to the master station. Counter input settings tell the component how to map counter inputs from the RTDX to protocol addresses.

The IEC 60870-5 slave component automatically creates a frozen counter point associated with each configured counter input point. On reception of a freeze command for a given counter input point, the current value of the point is stored in the associated frozen counter point, and can be reported to the master station. The freeze command can be issued from the master station or locally (see section 3.5 - Counter Group Settings).

The following table shows the counter input settings for the IEC 60870-5 slave protocol.

Setting	Description
Name	The name that identifies the point. This name must be unique for each counter input point.
Address	IEC 60870-5-101 or IEC 60870-5-104 information object address. Range: 1 to 16,777,216 Default value: 1
Time Tagged	A checkmark specifies that time tags will be used when reporting a value. Range: checkmark / no checkmark Default value: checkmark
Group	Group number of the group to which the point belongs. When a request for a specific counter group is received, only counters belonging to this group are affected. The general counter group consists of all the counters. Allowed values: 0 no group

Setting	Description
	1 to 4 group number
	Default value: 0

Table 3-11 Counter Input Settings

3.10 Analog Output Settings

Each instance of the slave protocol component may contain several analog output points to be reported to or controlled by a master station. Analog output settings tell the component how to map analog outputs from the RTDX to protocol addresses. The following table shows the analog output settings for the IEC 60870-5 slave protocol.

Setting	Description
Name	The name that identifies the point. This name must be unique for each analog output point.
Address	IEC 60870-5-101 or IEC 60870-5-104 information object address. Range: 1 to 16,777,216 Default value: 1
Simulated Control Confirmation	Indicates whether or not a simulated confirmation is required for control requests sent to the master component. Simulated confirmations differ from real confirmations in that they are simply a basic validation of the control request by the master. Real confirmations represent the result of the interaction between the master and the end device, and are only sent once the specified operation has been performed and confirmed by the end device. Note: DIRECT EXECUTE commands are processed in the same way as are EXECUTE commands. Allowed values: None SELECT only EXECUTE only SELECT and EXECUTE Default value: SELECT only

Table 3-12 Analog Output Settings

3.11 Binary Output Settings

Each instance of the slave protocol component may contain several binary output points to be reported to or controlled by a master station. Binary output settings tell the component how to map binary outputs from the RTDX to protocol addresses. The following table shows the binary output settings for the IEC 60870-5 slave protocol.

Setting	Description
Name	The name that identifies the point. This name must be unique for each binary output point.
Address	IEC 60870-5-101 or IEC 60870-5-104 information object address.

Setting	Description
	Range: 1 to 16,777,216 Default value: 1
Simulated Control Confirmation	<p>Indicates whether or not a simulated confirmation is required for control requests sent to the master component.</p> <p>Simulated confirmations differ from real confirmations in that they are simply a basic validation of the control request by the master. Real confirmations represent the result of the interaction between the master and the end device, and are only sent once the specified operation has been performed and confirmed by the end device.</p> <p>NOTE: DIRECT EXECUTE commands are processed in the same way as are EXECUTE commands.</p> <p>Allowed values: None SELECT only EXECUTE only SELECT and EXECUTE</p> <p>Default value: SELECT only</p>
Default Action	<p>The action that is to be performed when a command with a DEFAULT qualifier is received. This setting can be used with or without the <i>Points Pairing</i> setting, since any command received with a DEFAULT command qualifier will see its operation type change to any of the allowed values before being processed by the <i>Point Pairing</i> algorithm.</p> <p>Allowed values: Latch Short Pulse Long Pulse</p> <p>Default value: Latch</p>
Point Pairing	<p>Indicates how IEC 60870-5-101 and IEC 60870-5-104 operations using two PULSE points are supported for this point. If supported, the next index is reserved and is used to define the second point of the pair, which will handle the complementary operation.</p> <p>See sections 6.6.4 - Binary Output Specific Operations and 6.6.4.1 - OPEN/CLOSE operations using two points, for details.</p> <p>Allowed values: None Dual Point Open/Close, Open First Dual Point Open/Close, Close First</p> <p>Default value: None</p>

Table 3-13 Binary Output Settings

3.12 Comma-Separated Values File Format

Using **SMP Config**, you can import or export a CSV (Comma-Separated Values) file containing your SMP Gateway configuration.

Refer to the document entitled *SMP Config CSV Format Definition*, where you will find a description of the format to be used in defining the various IEC 60870-5 slave protocol settings.

4. Multiple Instances

There is no practical limit to the number of IEC 60870-5-101 slave component instances that can simultaneously be loaded on the SMP Gateway. Multiple instances may be connected to individual serial links, or grouped together on multidrop links in any combination.

5. Link Redundancy

When link redundancy is enabled for an IEC 60870-5-101 slave component instance, two different connections must be assigned to the protocol instance in the *Connection Usage* view. Two instances should appear instead of one, each followed by a suffix (" (1)" for the main link, "(2)" for the redundant one). The main link will use the settings configured in the *General* view, while the redundant link will use the settings configured in the *Redundancy* view.

The same conditions apply for an IEC 60870-5-104 slave component instance configured for link redundancy, except that the same connection can be used as the main and redundant link. In this case, both *General* and *Redundancy* link-related settings must have the same values.

6. Operations

The IEC 60870-5 slave protocol component interacts with an IEC 60870-5 master station device by receiving requests and sending responses to these requests.

The IEC 60870-5-101 implementation does not allow the sending of unsolicited responses or events. The IEC 60870-5-104 implementation does, however, transmit unsolicited responses or events as they are received. Operations performed through the IEC 60870-5 task cycle are described in this chapter.

6.1 Startup Sequence

The IEC 60870-5 slave protocol component is loaded by the SMP Gateway application. The startup sequence of the component begins when the SMP Gateway initializes the component, giving it a handle to the configured communication link specified in the configuration file.

The step-by-step procedure required to initialize the IEC 60870-5 slave component is described below:

- Register with the Time Component* services.
- Register with the Trace Component* services.
- Register with the Statistics Component* services.
- Register with the Logs Component* services.
- Validate the configuration block received from the main application.
- Create the real-time database, which subscribes to all the data points specified in the configuration file, via the RTDX Component*.
- Initialize the communication link.

* All these components are part of the SMP Gateway application.

All the above steps must be carried out successfully for the operation cycle to begin. Once initialized, the component waits for the main application to give the start command.

6.2 IEC 60870-5 Task Management

Interactions between the IEC 60870-5 slave component and the master station are handled by the IEC 60870-5 task. The operation cycle begins when the SMP Gateway application sends the START command to the component. At that moment, the component is configured properly and is ready to enter normal operation mode. The operations performed during an IEC 60870-5 task cycle are briefly described below. The details of all these steps exceed the goal of this document and will not be described here.

- Collect new data from the communication link.
- Process the new data link frames received.
- Transmit any data link confirm frames, if needed.
- Process new application layer requests, if any.
- Generate unsolicited response, if events are pending.
- Transmit new data link frames, if any.
- Sleep for a cycle time and go to step 1.

6.3 Clock Synchronization

If clock synchronization is disabled, the slave will reject the clock synchronization command.

When clock synchronization is enabled, the control center must periodically ensure that the slave is synchronized by issuing clock synchronization commands. When such a command is not received during the time specified by the *Sync Cycle* setting (see section 3.1 - General Settings), the time tags for all new objects to be transmitted will have their *invalid* field set to indicate potentially doubtful time information.

When the master station sends a clock synchronization request to the slave, the component forwards the received time to the SMP Gateway's TIME component, which sets the new time on the SMP Gateway's Real-Time Clock. The clock synchronization operation lasts three seconds. During this time, already buffered objects will be transmitted with the previous time. Newly buffered objects will have their "invalid" field set to indicate potentially doubtful time information. After the three seconds have elapsed, the slave will issue a clock synchronization confirmation and new objects will be time tagged with the new time and with their "invalid" field cleared.

In IEC 60870-5-101, the *delay acquisition* part of clock synchronization is supported for compatibility reasons only. The results are not taken into account therefore clock synchronization is not very precise. In IEC 60870-5-104 the *delay acquisition command* does not exist at all. The precision obtained depends on the network conditions at the moment of command transmission.

Note that the LOCAL time mode is not supported on the SMP Gateway platform. The IEC 60870-5-101/104 Slave must therefore be configured in UTC and the master station must send clock synchronization commands using UTC time. Time tags reported by the slave will also be in UTC time.

6.4 Event Queuing

Event queuing applies to the IEC 60870-5-101 slave only. It is not supported by IEC 60870-5-104. When a connection is lost and restored, the queue is emptied.

At system startup, new data point updates received from the RTDX are not added to the event queues until an *active* connection is established with the master station. An active connection begins once a valid data link layer frame is received. This mechanism ensures that if an active communication is established long after system startup, the master station will not receive all the change events that occurred since system startup. Unexpected event queue overflows are also avoided by this mechanism.

The same behavior applies when a communication loss occurs. The *Inactivity Timeout* setting controls how long the link will remain active if no link frames are received. If this timer expires, the event queues are emptied and new events are discarded, in the same way as during system startup. New events will be queued again once an active connection has been established with the master station.

If the communication is lost before the *Inactivity Timeout* expires, the events will still be available to the master station.

6.5 Parameter Loading Operations

IEC 60870-5 protocols allow the loading of certain settings into the slave. The master can load some of these settings using P_ME_XX_1 frames. The format (NA, NB, NC) must be the same as the one used to report the analog input. The loaded settings are maintained until they are changed or the SMP Gateway restarted. When the SMP Gateway is restarted, a value of 0 is restored for each setting.

Only the THRESHOLD setting can be set by the user. Each analog input has its own threshold, and this threshold must be set for each point. The threshold is the minimum change, compared to the last reported value, that will cause a new value to be reported. Note that measured values configured for cyclic reporting are never reported spontaneously, unless the status bits have changed.

6.6 Output Control Operations

Output control operations on analog or binary output points are initiated by the master station, which sends a control request on the communication link, and then waits for a confirmation of this operation.

When the IEC 60870-5 slave component receives such a request, before forwarding it to a data master component, it first carries out a number of verifications to ensure that nothing will prevent the operation from succeeding. If it encounters a problem, the command is rejected.

Control output operations can be refused for the following reasons:

- The command message is erroneous, or contains unexpected settings.
- The command is inhibited (locally, remotely, etc.).
- The requested operation applies to an unknown or non-configured (disabled) point.
- The requested output point is currently controlled by another slave component.
- The requested output point is not in a valid operational state, i.e. at least one invalid status bit is set.

Once the verifications have been carried out and no problems encountered, the control request is forwarded to the master component that handles output control operations on the specified point. A confirmation is sent back to the slave component, indicating whether the operation was successfully completed or not, or simply refused. The IEC 60870-5 slave component then waits for the master component to send back a reply, indicating whether the operation was successful or not. The IEC 60870-5 slave component then transmits the confirmation to the master station, completing the control operation.

The sequence of each control operation is recorded in the Command log (see section 7.1 - Log Entries).

6.6.1 Command Confirmations: real and simulated

Depending on the configuration of output points, the IEC 60870-5 slave component asks the concerned master to send the reply message before (simulated) or after the request has been forwarded to the end device (real).

Simulated confirmations should be used when a quick response is required from the master component. This can be the case if the control operation is to be performed by a RTU that requires a lot of time to complete the operation.

6.6.2 IEC 60870-5-104 Specific Operations

IEC 60870-5-104 supports time tagged control operations. These commands, issued by the master station, contain the time at which the command was sent over the network. When such a command is received by the slave component, the command time tag is compared to the SMP Gateway time. If there is more than a 10 second difference, or if the synchronization is not valid, the incoming command will be automatically rejected.

6.6.3 Analog Output Specific Operations

Analog output control operations are quite simple, only a value and a format are required to build a command message destined to a master component.

In addition to the basic verifications performed on all output points, an additional check is made to ensure that for a given EXECUTE request, the value and format are the same as those specified in the SELECT request. If this is not the case, the request is refused.

The format of the value to apply depends on the analog output object variation, which is taken directly from the application layer control request received from the master station. The master component may have to convert the value to a format that the end device can handle.

6.6.4 Binary Output Specific Operations

To perform binary output control operations on a given output point, the master station must specify a control function among those defined by in the IEC 60870-5-101 and IEC 60870-5-104 protocols. These operations can be one of the following (with the command qualifier set to DEFAULT, SHORT PULSE, LONG PULSE or LATCH):

- Single point commands (ON/OFF);
- Double point commands (ON/OFF);
- Regulating step commands (RAISE/LOWER).

In the RTDX, the control functions (called execute types) are normalized as OPEN/CLOSE and PULSE. Consequently, it is the slave component's responsibility to translate the IEC 60870-5-101 and IEC 60870-5-104 control functions to execute types defined by the RTDX. The following translation table is used:

Command Qualifier	Command Type	Translation into the RTDX
SHORT PULSE	Single point command ON	CLOSE with duration equal to <i>Short Pulse Dur.</i>
	Double point command ON	
	Regulating step command RAISE	
	Single point command OFF	OPEN with duration equal to <i>Short Pulse Dur.</i>
	Double point command OFF	
	Regulating step command LOWER	
LONG PULSE	Single point command ON	CLOSE with duration equal to <i>Long Pulse Dur.</i>
	Double point command ON	
	Regulating step command RAISE	
	Single point command OFF	OPEN with duration equal to <i>Long Pulse Dur.</i>
	Double point command OFF	
	Regulating step command LOWER	

Command Qualifier	Command Type	Translation into the RTDX
LATCH	Single point command ON	CLOSE with duration equal to 0.
	Double point command ON	
	Regulating step command RAISE	
	Single point command OFF	OPEN with duration equal to 0.
	Double point command OFF	
	Regulating step command LOWER	
DEFAULT	Single point command ON	CLOSE with duration set according to the <i>Default Action</i> setting.
	Double point command ON	
	Regulating step command RAISE	
	Single point command OFF	OPEN with duration set according to the <i>Default Action</i> setting.
	Double point command OFF	
	Regulating step command LOWER	

Table 6-1 Default translation table for binary outputs

Master components are also responsible for translating RTDX execute types to protocol-specific operations. Thanks to this mechanism, the control center can control output points, regardless of the protocol.

For binary output control operations, two additional checks are added to the basic verifications performed on all output points. The first is to ensure that for a given request, the resulting execute type is supported by the specified output point in the master component configuration. The second check ensures that for a given EXECUTE request, the control function is the same as those specified in the SELECT request.

6.6.4.1 OPEN/CLOSE operations using two points

The IEC 60870-5 slave component provides a mechanism by means of which the master station can operate a single master component open/close point using two slave component PULSE points.

For a given binary output point, this mechanism is activated when the *Point Pairing* setting of the point configuration is set to *Dual Point Open/Close, Open First*, or *Dual Point Open/Close, Close First*. The IEC 60870-5 slave component creates a point at the next information object address, which will handle the complementary operation. If the point is configured as *Dual Point Open/Close, Open First*, it handles OPEN operations, and the complementary point handles CLOSE operations. On the other hand, if the point is configured as *Dual Point Open/Close, Close First*, it handles CLOSE operations, and the complementary point handles OPEN operations. Consequently, the information object address of the complementary point is reserved and cannot be used for another point.

It is important to note that this mechanism is meaningful only when PULSE qualifiers are received. When a LATCH qualifier is received, the command state requested is translated directly in the RTDX.

From the master station point of view, two output points are available on which control output operations can be performed. These two points can be operated using any control function, which will be translated to an OPEN or CLOSE execute type on the configured output point. The following table shows the translation matrix.

Command Qualifier	Pair Point Operated	Command Type	Translation into the RTDX
SHORT PULSE	Close	Single point command ON	CLOSE with duration equal to <i>Short Pulse Dur.</i> on the data provider point associated to the pair.
		Double point command ON	
		Regulating step command RAISE	
		Single point command OFF	
		Double point command OFF	
		Regulating step command LOWER	
	Open	Single point command ON	OPEN with duration equal to <i>Short Pulse Dur.</i> on the data provider point associated to the pair.
		Double point command ON	
		Regulating step command RAISE	
		Single point command OFF	
		Double point command OFF	
		Regulating step command LOWER	
LONG PULSE	Close	Single point command ON	CLOSE with duration equal to <i>Long Pulse Dur.</i> set for the master protocol point associated with the pair.
		Double point command ON	
		Regulating step command RAISE	
		Single point command OFF	
		Double point command OFF	
		Regulating step command LOWER	
	Open	Single point command ON	OPEN with duration equal to <i>Long Pulse Dur.</i> set for the
		Double point command ON	

Command Qualifier	Pair Point Operated	Command Type	Translation into the RTDX
		Regulating step command RAISE	master protocol point associated with the pair.
		Single point command OFF	
		Double point command OFF	
		Regulating step command LOWER	
LATCH	Close	Single point command ON	CLOSE with duration equal to 0 on the data provider point associated to the pair.
		Double point command ON	
		Regulating step command RAISE	
		Single point command OFF	OPEN with duration equal to 0 on the data provider point associated to the pair.
		Double point command OFF	
		Regulating step command LOWER	
	Open	Single point command ON	OPEN with duration equal to 0 on the data provider point associated to the pair.
		Double point command ON	
		Regulating step command RAISE	
		Single point command OFF	CLOSE with duration equal to 0 on the data provider point associated to the pair.
		Double point command OFF	
		Regulating step command LOWER	
DEFAULT	Close	Single point command ON	The <i>Default Action</i> specified in the settings will be used. This will activate SHORT PULSE, LONG PULSE or LATCH behavior as stated above.
		Double point command ON	
		Regulating step command RAISE	
		Single point command OFF	
		Double point command OFF	
		Regulating step command LOWER	
	Open	Single point command ON	
		Double point command ON	

Command Qualifier	Pair Point Operated	Command Type	Translation into the RTDX
		Regulating step command RAISE	
		Single point command OFF	
		Double point command OFF	
		Regulating step command LOWER	

Table 6-2 Point pairing translation table for binary outputs

6.7 Cold Restart

Upon receiving the *Reset Process* application request, the IEC 60870-5 component sends a positive confirmation to the master station if the *Restart Enable* (General settings) setting is set. Otherwise, a negative confirmation is issued.

After issuing the positive confirmation, the IEC 60870-5 component waits 5 seconds and the gateway is then restarted. This means that all data providers/consumers are restarted, with their original configurations. Any changes that the master station may have made (event class assignment, analog reporting dead band, etc.) are lost. **It is very important to note that the master station should use this request only if the purpose is to restart the gateway.**

6.8 Data Object Management

One of the main tasks of the IEC 60870-5 slave component is to get the information on all of its configured I/O points from the RTDX component, and to translate this information into IEC format. This enables it to respond to master station requests with the most up-to-date information available.

The following sections describe in detail how each object received from the RTDX component is translated into IEC format.

6.8.1 Time Tagging

All objects received from the RTDX component have a time-tag field that indicates the time at which the objects were last updated. However, objects may be reported with or without time tags. When an acquisition object is marked to be time tagged in its configuration, every spontaneous or cyclic change is marked with a time tag. Requested values, such as values reported following a C_IC_NA_1 or C_RD_NA_1 request are not time tagged.

When using IEC 60870-5-101 protocols, it is possible to use extended 7 byte time tags instead of the standard 3 byte time tags. The two formats cannot be used simultaneously.

6.8.2 Analog Inputs

Analog input objects received from the RTDX component contain the following information:

- A raw value, stored as a signed 32 bits value, with an indication of how many significant bits are used.
- A floating-point value, which is computed using the object's raw value and the scaling factors.

- A time tag (see section 6.8.1);
- A status bit field that contains various information on the current object status.

Internally, the IEC 60870-5 component maintains the same information, but not in the same format. The raw and floating values, and time tag are stored in the same way as they are in the RTDX object. However, the status bit field must be translated into IEC 60870-5 flags. The following table describes how each bit of the RTDX status is translated into IEC 60870-5 flags.

RTDX Status Bit	Translation to IEC 60870-5 flags
Bad Reference	Mapped into the <i>IV (Invalid)</i> flag.
Communications Failure	Mapped into the <i>IV (Invalid)</i> flag or into the <i>NT (Not Topical)</i> flag when "Not Topical Support" is specified in the general settings.
Hardware Failure	Mapped into the <i>IV (Invalid)</i> flag.
Forced	Mapped directly to the <i>SB (Substituted)</i> flag.
Over Range	Mapped directly to the <i>OV (Overflow)</i> flag.

Table 6-3 Translation of RTDX status bits to IEC 60870-5 flags for analog inputs

The following table shows the translation of RTDX analog inputs to IEC 60870-5 information objects.

IEC 60870-5 Report Format	Values received in the RTDX	Translation
Normalized value	RAW only	The RAW value is used to set the 16 bits of information of the Normalized value object. If the RAW value exceeds 32767 or is smaller than -32768, the maximum/minimum values will be used and the OV flag will be set. NOTE: If this translation is used, the master component of the point being set must produce a RAW value that is compatible with the IEC 60870-5 protocol. In the IEC 60870-5 protocol, a value incremented by 1 is equal to 1/32768. An integer value of 5 would therefore be reported as 5/32768=0.0002, which may not be the value wanted.
	FLOAT only	The 16 bits of information of the Normalized value object is obtained by multiplying the FLOAT value by 32768.0. If the resulting value exceeds 32767 or is smaller than -32768, the maximum/minimum values will be used and the OV flag will be set. This means that the allowed range for floating values is -1 to +1.
	Both	If the <i>Force Float</i> setting (Analog input settings) is set, the translation is the same as for FLOAT only. Otherwise, the translation is the same as for RAW only.

IEC 60870-5 Report Format	Values received in the RTDX	Translation
Scaled value	RAW only	The RAW value is used to set the 16 bits of information of the Scaled value object. If the RAW value exceeds 32767 or is smaller than -32768, the maximum/minimum values will be used and the OV flag will be set.
	FLOAT only	The 16 bits of information of the Scaled value object is obtained by truncating the FLOAT value. If the resulting value exceeds 32767 or is smaller than -32768, the maximum/minimum values will be used and the OV flag will be set. This means that the allowed range for floating values is -32768 to +32767.
	Both	If the <i>Force Float</i> setting is set, the translation is the same as FLOAT only. Otherwise, the translation is the same as RAW only.
Floating point value	RAW only	The value of the floating-point value object is obtained by converting the RAW value to a FLOAT value.
	FLOAT only	The FLOAT value is used for the floating-point value object.
	Both	If the <i>Force Float</i> setting is set, the translation is the same as for FLOAT only. Otherwise, the translation is the same as RAW only.
Step position information	RAW only	The RAW value is used to set the 7 bits of information of the Step position information object. If the RAW value exceeds 63 or is smaller than -64, the maximum/minimum values will be used and the OV flag will be set.
	FLOAT only	The 7 bits of information of the Step position information object is obtained by truncating the FLOAT value. If the resulting value exceeds 63 or is smaller than -64, the maximum/minimum values will be used and the OV flag will be set. This means that allowed range for floating values is -64 to +63.
	Both	If the <i>Force Float</i> setting is set, the translation is the same as for FLOAT only. Otherwise, the translation is the same as for RAW only.

Table 6-4 Translation of RTDX values to IEC 60870-5 values for analog inputs

6.8.2.1 Analog Input Event Generation

Analog input events can be generated when new information is received from the RTDX. Events are generated for a given analog input point if at least one of the following conditions is met:

- The IEC 60870-5 flags have changed.

- The offset between the last reported value and the current value exceeds the dead band value.

6.8.2.2 Analog Input Reporting Deadband

When the master station sends a parameter loading request for setting the dead band value (Threshold) for a given point, it must send the new value in the same format that the analog input object is reported (Normalized, Scaled or Floating point).

6.8.3 Binary Inputs

Binary input objects received from the RTDX component contain the following information:

- A binary state.
- A time tag (see section 6.8.1).
- A status bit field that contains various information on the current object status.

Internally, the IEC 60870-5 component maintains the same information, but not in the same format. The state and the time tag are stored in the same way as they are in the RTDX object. However, the status bit field must be translated into IEC 60870-5 flags. The following table describes how each bit of the RTDX status is translated into IEC 60870-5 flags.

RTDX Status Bit	Translation to IEC 60870-5 flags
Bad Reference	Not used.
Communications Failure	Mapped into the <i>IV (Invalid)</i> flag or into the <i>NT (Not Topical)</i> flag when "Not Topical Support" is specified in the general settings.
Hardware Failure	Mapped into the <i>IV (Invalid)</i> flag.
Forced	Mapped directly to the <i>SB (Substituted)</i> flag.
Overrange	Not used.

Table 6-5 Translations of RTDX status bits to IEC 60870-5 flags for binary inputs

6.8.3.1 Binary Input Event Generation

Binary input events are generated when new information is received from the RTDX. No special conditions need to be met for binary events to be generated. Each binary transition or change of status causes an event to be generated.

6.8.3.2 Double-Point Binary Inputs

Binary inputs reported as double-point information are made up of two single RTDX binary input points. The double input status bits are derived by combining the status bits of both binary inputs. Thus, as soon as one of the two inputs becomes INVALID, the double-point object is reported as invalid. It will not be reported as VALID until both binary inputs are VALID again.

6.8.4 Counter Inputs

Counter input objects are stored as analog input objects in the RTDX component. The following information is available for each object:

- A raw value, stored as a signed 32-bit value, with an indication of how many significant bits are used.

- A floating-point value, which is not used in this case since counter objects can only be reported using 16-bit or 32-bit variations.
- A time tag (see section 6.8.1).
- A status bit field that contains various information about the current object status.

Internally, the IEC 60870-5 component maintains the same information, but not in the same format. The raw value is transformed to an unsigned 32-bit value. The time tag is stored in the same format as it is in the RTDX object. The status bit field must be translated into IEC 60870-5 flags. The following table describes how each bit of the RTDX status is translated into IEC 60870-5 flags.

RTDX Status Bit	Translation to IEC 60870-5 flags
Bad Reference	Not used
Communications Failure	Mapped into the <i>IV (Invalid)</i> flag
Hardware Failure	Mapped into the <i>IV (Invalid)</i> flag
Forced	Not used
Over Range	Mapped directly to the <i>IV (Invalid)</i> flag

Table 6-6 Translations of RTDX status bits to IEC 60870-5 flags for counter inputs

The *SQ (Sequence)* field of the IEC 60870-5 counter input objects is always set to 0. The *CA (Counter Adjusted)* flag of the IEC 60870-5 counter input objects is clear after reporting a value and set each time the counter increments.

When performing incremental counter acquisition, the *CY (Carry)* flag is set when the value has incremented by more than 2^{32} since the last report. Otherwise, it is set when the counter value wraps from 0xFFFFFFFF to 0. This flag is cleared when a counter RESET operation is performed (either locally or remotely).

6.8.4.1 Counter Input Event Generation

Counter input events may be generated when new information is received from the RTDX. Events are generated for a given counter input point only if the IEC 60870-5 IV flags have changed. Otherwise, counter inputs are generated through freeze operations only.

6.8.4.2 Frozen Counter Input Event Generation

Counter input values are frozen according to the conditions listed in the counter group settings. Two events can result in a freeze counter operation: a counter FREEZE command received or local FREEZE timer expiration. When a counter is FROZEN, its value and status bits are also frozen. The FREEZE operation may also contain a RESET operation that is performed on the counter after the freeze has occurred.

6.8.5 Generated Binary Inputs

The IEC 60870-5 slave component generates two logical binary inputs:

Name	Description
<u> </u> LinkActive	Indicates whether or not the link configured for this protocol instance shows signs of activity.

Name	Description
___LinkAvailable	Indicates whether or not the link configured for this protocol instance is operational.

Table 6-7 Generated Binary Inputs

When link redundancy is enabled, two sets of these points are produced. They share the same device prefix and point name, but are followed by a suffix that indicates which link they are attached to ("_(X)", where 'X' is 1 for the main link and 2 for the redundant link).

Ex. S104___LinkActive_(1), S104___LinkActive_(2), S104___LinkAvailable_(1) and S104___LinkAvailable_(2).

7. Diagnostics

Diagnostic information is produced by the IEC 60870-5 slave component so that the end-user can follow the activities that are going on between the component and the master station. This information is divided in 3 categories: logs, statistic tables and real-time traces.

7.1 Log Entries

The IEC 60870-5 slave component maintains at least the following special log entries (logs other than those that all master/slave components must support by default):

Log	Entries made by the IEC 60870-5 protocol component
Startup	Illegal headers and/or versions for information found in the configuration files. The number of I/O points of each category that should have been configured but that were ignored because of errors in the configuration file. Problems encountered when establishing links with the various SMP Gateway interfaces. Any other initialization problem. An indication that initialization was completed successfully, if such is the case.
Command	All detailed command processing related activities, along with a success or failure status for each individual step.
Protocol	Various abnormalities or errors that are detected when communicating with the control center. This log shows, for instance, the reasons an IEC 60870-5 control direction request was refused.
Reset	All cold restart commands received from the control center, before forcing the system to restart.

Table 7-1 Log Entries

7.2 Statistics Tables

The IEC 60870-5 slave component maintains various statistics fields that can be viewed using standard SMP Tools. Most of the information in this table is directly received/sent from/to the control center, or taken from the configuration file.

Component statistics are divided into 2 pages. The fields are described in the tables below, for each page.

7.2.1 Page 1 – Configuration and Operation Statistics

Name	Description
Configuration	
Instance Name	Name of the IEC 60870-5 component.
Protocol	See section 3.2 – Common IEC 60870-5 Settings.
Link Address Size	See section 3.3 – IEC 60870-5-101 Specific Settings.

Name	Description
Cause of Transmission Size	See section 3.2 – Common IEC 60870-5 Settings.
Common ASDU Address Size	See section 3.2 – Common IEC 60870-5 Settings.
Information Object Address Size	See section 3.2 – Common IEC 60870-5 Settings.
Maximum Frame Size	See section 3.2 – Common IEC 60870-5 Settings.
Link Address	See section 3.3 – IEC 60870-5-101 Specific Settings.
Common ASDU Address	See section 3.2 – Common IEC 60870-5 Settings.
Scan process info	
Current Scan Status	Indicates the current state of the scan task.
Communication Status	Indicates the current state of the communication.
Command enabled	Indicates that commands are enabled.
Qty Open Session	The number of times a connection was established with the master.

Table 7-2 Configuration and Operation Statistics Page

7.2.2 Page 2 - Protocol Layer Statistics

Name	Description
General	
Instance Name	Name of the IEC 60870-5 component.
Protocol	See section 3.2 – Common IEC 60870-5 Settings.
Application Layer – Monitor Direction	
End of initialization	Number of M_EI_NA_1 frames sent.
Single point information	Number of M_SP_NA_1 and M_SP_TA_1 and M_SP_TB_1 sent.
Double point information	Number of M_DP_NA_1 and M_DP_TA_1 and M_DP_TB_1 sent.
Step position information	Number of M_ST_NA_1 and M_ST_TA_1 and M_ST_TB_1 sent.
Bitstring point information	Number of M_BO_NA_1 and M_BO_TA_1 and M_BO_TB_1 sent.
Measured values	Number of M_ME_NA_1 and M_ME_NB_1 and M_ME_NC_1 and M_ME_TA_1 and M_ME_TB_1 and M_ME_TC_1 and M_ME_TD_1 and M_ME_TE_1 and M_ME_TF_1 sent.

Name	Description
Counter	Number of M_IT_NA_1 and M_IT_TA_1 and M_IT_TB_1 sent.
Application Layer – Control Direction	
Group Interrogation	Number of C_IC_NA_1 received.
Group Counter Interrogation	Number of C_CI_NA_1 received.
Clock Synchronization	Number of C_CS_NA_1 received.
Test	Number of C_TS_NA_1 and C_TS_TA_1 received.
Single Point Command	Number of C_SC_NA_1 and C_SC_TA_1 received.
Double Point Command	Number of C_DC_NA_1 and C_DC_TA_1 received.
Regulating Step Command	Number of C_RC_NA_1 and C_RC_TA_1 received.
Set Point Command	Number of C_SE_NA_1 and C_SE_NB_1 and C_SE_NC_1 and C_SE_TA_1 and C_SE_TB_1 and C_SE_TC_1 and received.
Bitstring Command	Number of C_BO_NA_1 and C_BO_TA_1 received
Parameter Loading	Number of P_ME_NA_1 and P_ME_NB_1 and P_ME_NC_1 received.
Cyclic Activation	Number of P_AC_NA_1 received.
IEC 60870-5-2 Link Layer	
Rx Frame	Number of link frames received.
Tx Frame	Number of link frames transmitted.
Rx Error	Number of link reception errors.
Tx Error	Number of link transmission errors.
Rx Timeout	Number of link reception timeouts.
Rx: Send User Data	Number of User Data frames received.
Rx: Send/No Reply User Data	Number of User Data frames (that require no response) frames received.
Rx: Reset of Link	Number of Reset of Link frames received.
Rx Request Status of Link	Number of Request Status of Link frames received.
Rx: Class 1 Request	Number of Class 1 Request frames received.
Rx: Class 2 Request	Number of Class 2 Request frames received.
Rx: Unknown frame	Number of Unknown frames received.

Name	Description
Tx: User Data	Number of User Data frames transmitted.
Tx: ACK	Number of ACK frames transmitted.
Tx: Nack (Link Busy)	Number of Nack (Link Busy) frames transmitted.
Tx: Nack (Data Not Available)	Number of Nack (Data Not Available) frames transmitted.
Tx: Status of Link	Number of Status of Link frames transmitted.
IEC 60870-5-104 Layer	
Rx APDU	Number of APDUs received.
Tx APDU	Number of APDUs transmitted.
Rx Error	Number of reception errors.
Tx Error	Number of transmission errors.
Rx ACK	Number of ACKs received.
DT-ACK Timeout	Number of timeouts on ACK transmitted.
FCT-CON Timeout (T1)	Number of timeouts on U APDU transmitted.
Tx TEST_FR-ACT (T3)	Number of TEST_FR-ACT U APDU transmitted.
Rx TEST_FR-ACT	Number of TEST_FR-ACT U APDU received.
Conn Err	Number of connection errors.
Conn Timeout (T0)	Number of connection timeouts.

Table 7-3 Protocol Layer Statistics Page

All the fields in the operations and protocol layer statistic pages can be cleared, except the fields in the general section.

7.3 Real-Time Traces

The IEC 60870-5 slave component produces trace messages for the IEC 60870-5 protocol. These, combined with the communication component traces (in hexadecimal characters) and System/Real Time Data Exchange traces, can be used to monitor all the activities of a component. All available trace message categories are described in the following table.

Trace Name	Contents
Scan	Displays information on the scan process, such as task stats, session opening, communication errors, etc.
IEC 60870-5 Objects	Displays all IEC 60870-5 objects received or transmitted on the connection.
Link Layer	Displays the link layer traces (IEC 60870-5-2 or IEC 60870-5-104)

Table 7-4 Trace Messages