Communication Driver SAGE

Driver for communication using SAGE HMI using IEC-60870-5-101 protocol in Slave mode.

Index

1 Introduction

The SAGE driver enables communication between Studio system and SAGE systems that implement IEC-60870-5-101 master protocol, in accordance with the characteristics covered in this document.

This document contains 8 parts, as follows:

- **Introduction**: Provides an overview of the driver documentation.
- **General characteristics**: Provides information necessary to identify all the required components (hardware and software) necessary to implement the communication and global characteristics about the communication.
- **Installation**: Explains the procedures that must be followed to install the software and hardware required for the communication.
- **Driver configuration**: Provides the required information to configure the communication driver such as the different permutations for configuration and its default values.
- **Execution**: Explain the steps to test whether the driver was correctly installed and configured.
- **Troubleshooting**: Supplies a list of the most common error codes for this protocol and the procedures to fix them.
- **Application Sample**: Provides a sample application for testing the configuration the driver.
- **History of versions**: Provides a log of all the modifications done in driver.

✍ **Note:** This document presumes that the user has read the chapter *Driver Configuration* of the Studio's Technical reference manual.

2 General Characteristics

2.1 Device Characteristics

- **Manufacturer**:
- **Compatible Equipment**:
  - SAGE HMI

Tip: Refers to section 2.4 to see the Equipment used in the standard conformance tests for this driver.

2.2 Link Characteristics

- **TCP/IP communication port**: Selectable
- **Physical protocol**: Ethernet/Serial
- **Logic protocol**: IEC-60870-5-101
- **Specific PC Board**: Ethernet board in case of Ethernet physical protocol

2.3 Driver Characteristics

- **Operating System**:
  - Windows 9x
  - Windows 2000
  - Windows NT

Tip: Please refer to section 2.4 to see the Operating System used in the conformance tests for this driver.

The driver is composed of the following files:
- **SAGE.INI**: Internal file of the driver, it should not be modified by the user.
- **SAGE.MSG**: Contains the error messages for each error code. It is an internal file of the driver; the user should not modify it.
- **SAGE.PDF**: Provides detailed documentation about the driver (this document).
- **SAGE.DLL**: Compiled library for the driver.

Note: All the files above must to be in the subdirectory /DRV of the Studio's installation directory.

- **Supported Registers:**

Register Type	Length	Write	Read	Bit	Integer	Float
Single Point	1 Bit	•	•	•	–	–
Double Point	4 Bits	•	•	–	•	–
Normalized Value	2 Bytes	•	•	–	•	–
Bitstring Value	4 Bytes	•	•	–	•	–
Floating Point Number	4 Bytes	•	•	–	–	•

✍ **Note: SAGE** is a SLAVE driver. By this way, the MASTER side must start the reading and writing operations. However, the SAGE driver writes values to the MASTER using spontaneous commands.

2.4 Information about conformance testing

- **Equipment**: PC running SAGE software under UNIX operating system
- **Configuration:**

- Baud Rate: 9600
- Protocol: IEC-60870-5-101
- Data Bits: 8
- Stop Bits: 1
- Parity: None
- COM port: COM1

- **Operating System (development)**: Windows 2000 professional edition + Service pack 1
- **Operating System (target)**: Windows 2000 professional edition + Service pack 1;
- **Studio Version**: 4.4
- **Driver version**: 1.00

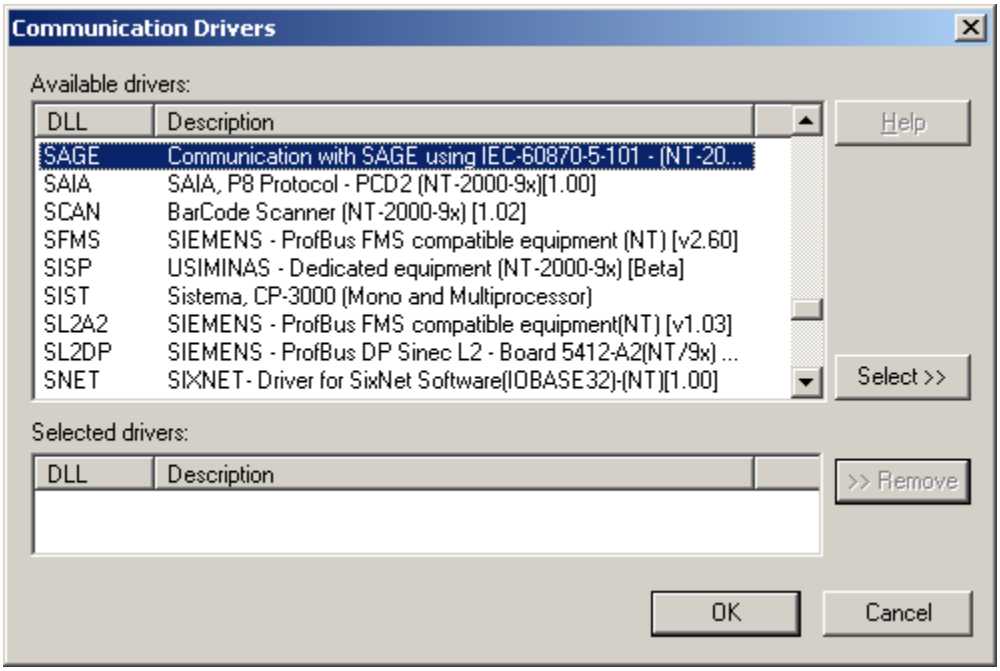
3 Installation

3.1 Installing the Driver

When you install the Studio, the communication drivers are already installed. You need now to select the driver at the applications where it will be used.

The steps to select the driver inside an application are:

1. Execute the Studio and select the proper application.
2. Select the menu *Insert + Driver...*
3. In the column **Available Drivers**, select the **SAGE Driver** and push the button **Select >>** (the driver SAGE must appear in the box **Selected Drivers**).
4. Press **OK**.



3.2 Other software requirements

It is not necessary to install any other software in the PC to enable the communication between the Studio and the Device. However, to enable the driver communication using TCP/IP, you need to enable the Operating System TCP/IP protocol in the computer where Studio is running. Please see the Operating System documentation for further details.

➲**Attention:** Special precautions must be taken when installing the physical hardware. Refer to the hardware manufacturer documentation for specific instructions in this area.

4 Driver Configuration

After the driver is installed and selected in the Studio (see section 3.1), you should proceed to the driver configuration.

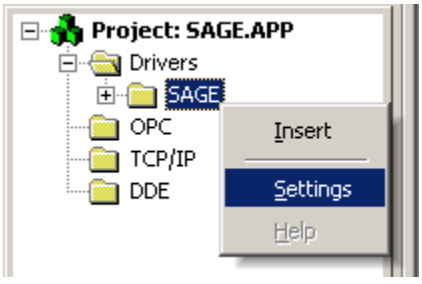
The driver configuration is two parts:

- The Settings or Communication parameters, it is only one configuration to the whole driver;
- The communication tables or Driver Worksheets, where the communication tags are defined. There are two types of communication tables: **Standard Tables** and **MAIN DRIVER SHEET**. This driver implements only Standard Tables.

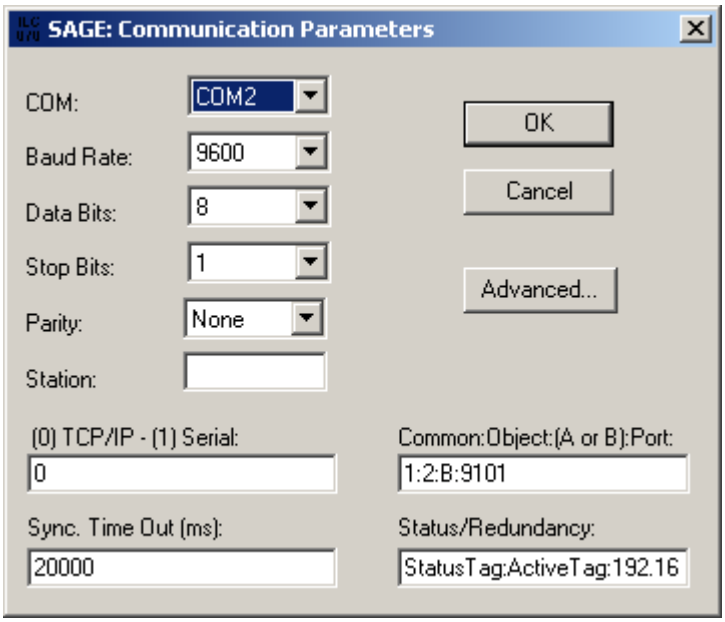
4.1 Settings - Communication Parameters

These parameters are valid for all driver worksheets configured in the system. To open the window for configuring the **Communication parameters**, follow these steps:

1. In the **Workspace** of the Studio environment, select the **Comm** table.
2. Expand the folder **Drivers** and select the subfolder **SAGE**.
3. Right click on the **SAGE** subfolder and select the option **Settings**.



When selecting the Settings, there is the following dialog to configure:



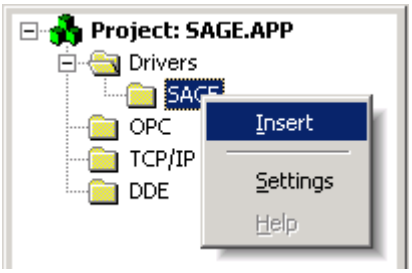
Parameter	Default Value	Valid values	Description
Station	0	1-255	Studio address
(0) TCP/IP – (1) Serial	0	0-1	Specifies if TCP/IP will be used or not
Sync. Time Out (ms)	20000	>=0	Clock syncronization time out
Common:Object:(A or B):Port	1:2:B	(1 or 2):(2 or 3):(A or B):(0-65565)	The first field specifies the Common Address of ASDU size. The second specifies the Information Object Address size. The third one specifies if the Station is A or B and the last one is the port number used for TCP/IP communication. For further details see the IEC-60870-5-101 document from IEC.
Status/Redundancy	StatusTag:Active Tag:192.168.2.1	StatusTag and Active Tag must be an existent tag. The IP address is the IP of the redundant station	StatusTag is not an optional parameter. It will hold the link level status, since this driver does not use the communication worksheets status field. The Active and IP fields are used only the redundancy is needed and it is not possible for both station to share the same transmission medium. Active is a tag that determines if the station is activated or not and the IP is the redundant machine address that will receive notification about events sent to sage from the active station.

✍ **Note:** The Common Address of ASDU, the Information Object and the TCP/IP port number must me the same in Studio and in SAGE. The Active tag must never be enabled in both redundant stations. The Station type must be different between SAGE and Studio (e.g.: Studio=B, SAGE=A) and the same for redundant stations.

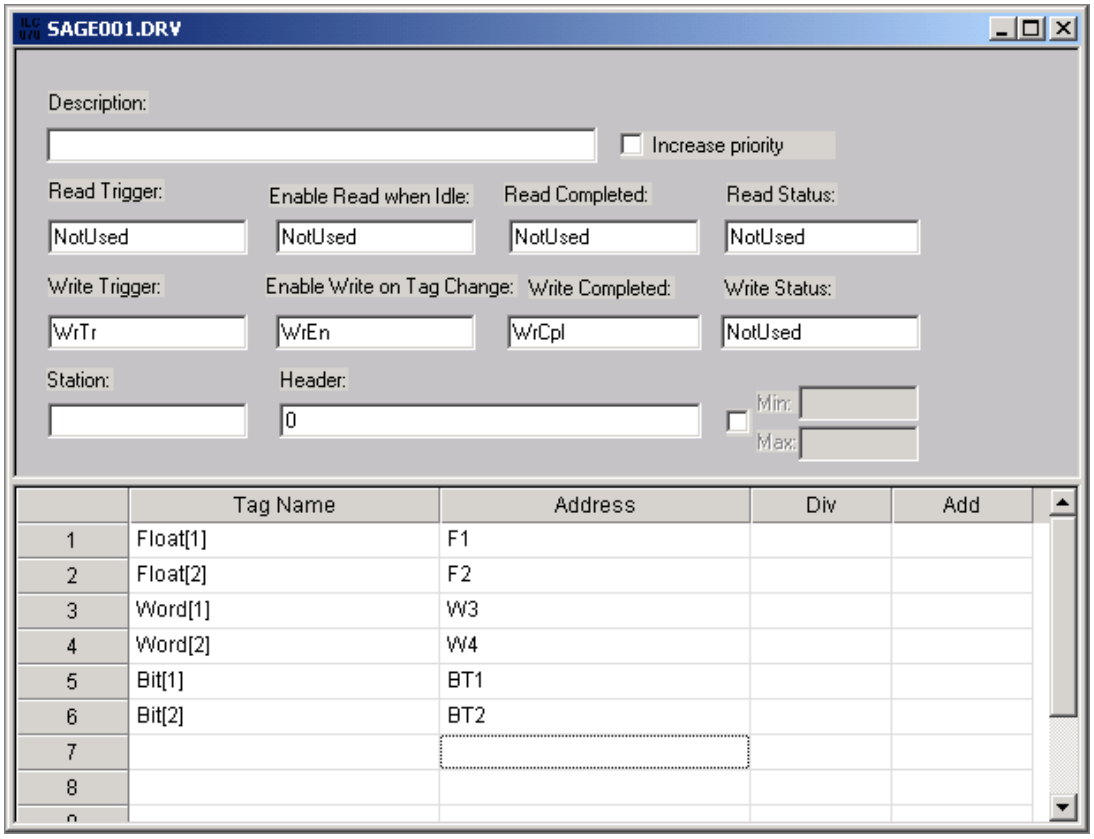
4.2 Standard Driver Worksheet

It is possible to configure many driver worksheets; each one will be composed of a Header and Body. To create a new driver worksheet, follow these steps:

1. In the **Workspace** of the Studio environment, select the table **Comm**.
2. Expand the folder **Drivers** and select the subfolder **SAGE**.
3. Right click on the **SAGE** subfolder and select the option **Insert**.



All entries at the Driver Worksheet, exception by the **Station**, **Header** and **Address** are standard to all communication drivers. You should refer to Studio Technical Reference Manual about the configuration of the standard fields. This document describes the Station, Header and Address fields, which are specific to each communication driver.



4.3 Station and Header configuration

Parameter	Default Value	Valid values	Description
Station	-	-	Not used for this communication driver
Header	0	See next table	Defines the variables address reference or the group

The parameter **Header** defines the offset or the group for the variables configured on the Worksheet body. It complies with the following syntax:

- To offset:
  <AddressReference> - Integer number (e.g.: 100);

- To Groups:
  G<GroupNumber> (e.g.: G01)

After editing the field **Header**, the system will check if it is valid or not. If the syntax is incorrect, the default value (0) will be automatically placed in this field.

You can type string Tag between curly brackets into this field, but be sure that the Tag's value is correct, with the right syntax, or you will get the Invalid Header error.

The group field is used for SAGE interrogation command. Since SAGE SCADA implements only General Interrogation, all the groups are read when the command is received. The amount of variables you can have in each group is in the table below:

Register Type	Amount
Single Point	120
Double Point	120
Normalized Value	78
Bitstring Value	47
Floating Point Number	47
Total	412

✍ **Note:** The amount of points for each register type is calculated subtracting the lowest address from highest address configured in the worksheet. For instance if you have 2 Single Points with address 2 and 70 configured in the driver worksheet the amount of points calculated is 69 (70-2+1).

If your variable should be initialized when the communication starts you will need to create a group worksheet for it. The worksheets configured with address reference can hold up to 100 address each and the variables can be of any type. See the section 4.4 for configuration samples.

4.4 Address Configuration

The body of the driver worksheet allows you to associate each tag to its respective address in the device. In the column **Tag Name,** you must type the tag from your application database. This tag will be read or written by the Master according with the specified address. The address cells complies to the following syntax:

<Format>[Timestamp]<AddressNumber> (e.g.: F10)

- Format*:* B for boolean (single point) values, D for double points, W for word values, S for Bitstring and F for float values.
- Timestamp: This is an optional field, it should be filled with **T** the if the information is sent with Timestamp. Group worksheets should not be configured with timestamp values.
- AddressNumber*:* Object address to the configured object. The final object address is calculated adding the address specified in the Header field. If the worksheet is a group worksheet (header field configured to Gxx) the entire address must be configured. If the worksheet is not a group worksheet the AddressNumber must be configured with values between 0-99 and the rest must be and the Header field.

Sample of Addressing Configuration		
Address on MASTER	**Header Field**	**Address Field**
Bitstring 1	0	S1
Bitstring 1 with timestamp	0	ST1
Double point 1025 with Timestamp	1000	DT25
Double point 1025 for Group	G00	D1025
Normalized value 348	300	W48
Normalized value 348 for Group	G1	W348
Float point 525	500	F25
Float point 525 for Group	G30	F525

4.5 Main Driver Sheet (MDS)

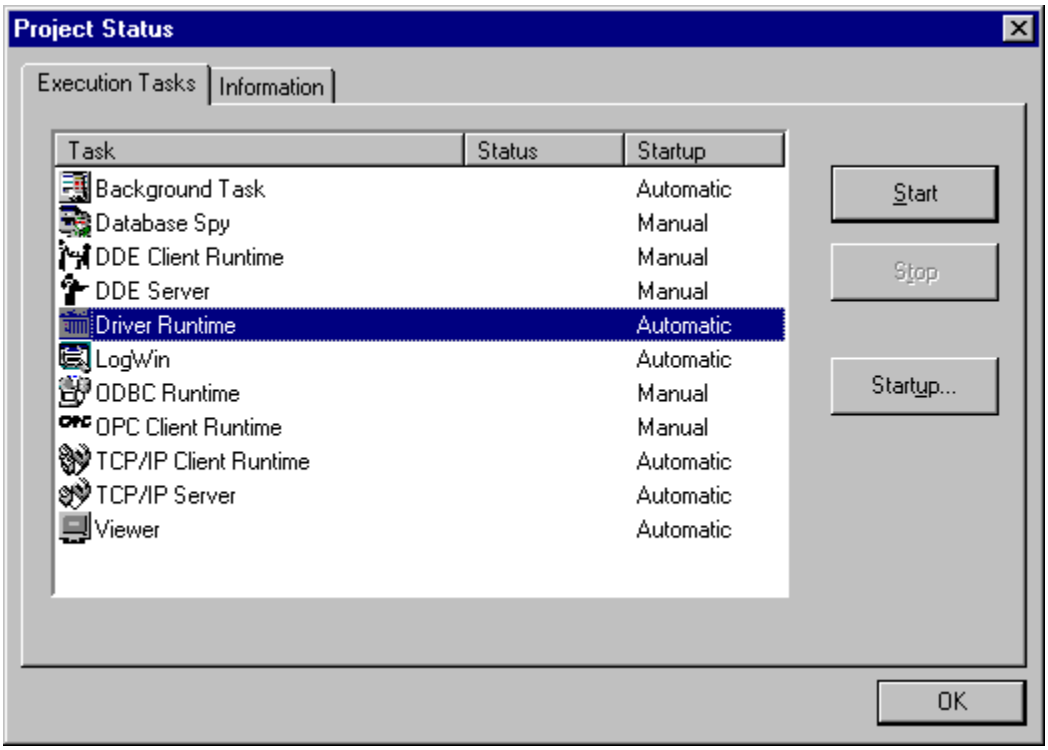
The Main driver sheet is not implemented for this communication driver.

4.6 Device Configuration

The device must run the IEC-60870-5-101 protocol like MASTER (controlling station).

5 Execution

When installing the driver, it is automatically selected to execute when you start-up the Runtime Environment. To verify the if the driver is correctly enabled to start, use the menu option **Project** + **Status…,** and verify the task **Driver Runtime**



6 Troubleshooting

After each attempt to communicate using this driver, the tag configured **Write Status** will receive the error code regarding the kind of failure that occurred. The error messages are:

Error Code	Description	Possible causes	Procedure to solve
0	OK	Communication without problems	None
1	Invalid Header	Wrong Header was configured in the worksheet Header field	Change the worksheet Header field to a valid value
2	Invalid Address	The address or addresses configured on worksheet address fields are not valid	Change the invalid addresses to valid addresses according with this document
3	Invalid Station	Wrong Station was configured in the worksheet Station field	Change the worksheet Station field to a valid value
20	Invalid command	The MASTER send an invalid command	Verify MASTER settings
21	Invalid block size	The addresses configured on the driver worksheet exceed the maximum protocol frame size	Create another worksheet putting the address separated to reduce the frame size
22	Fail to allocate memory	The drive could not allocate memory its initialization	Verify the Operation System resources
200	Error start server socket	The TCP/IP port 2404 is already in use by another software	Close the software and start the driver again
202	There is no master connected	The MASTER has not sent the STARTDT command and the communication cannot start	Verify MASTER settings
-15	Timeout waiting start a message.	- Disconnected cables - PLC turned off, or in Stop or error mode - Wrong Station number - Wrong RTS/CTS control settings.	- Check the cable wiring - Check the PLC state. It must be RUN - Check the station number. - Check the right configuration. See on the section 2.2 the different RTS/CTS valid configurations.
-17	Timeout between rx char.	- PLC in stop or error mode - Wrong station number - Wrong parity - Wrong RTS/CTS configuration settings	- Check the cable wiring - Check the PLC state. It must be RUN - Check the station number. - Check the right configuration. See on the section 2.2 the different RTS/CTS valid configurations.

Tip: The communication status can be verified by the **output** Window of the Studio's environment or by the **LogWin** module. To set a log of events for **Field Read Commands**, **Field Write Commands** and **Serial Communication** click with the right button of the mouse on the output window and chose the option setting to select these log events. When testing under a Windows CE target, you can enable the log at the unit (Tools/Logwin) and verify the file celog.txt created at the target unit.

When testing the communication with the Studio, you should first use the application sample described at item 7 (if it's available), instead of the new application that you are creating.

If is required to contact technical support, please have the following information available:

- Operating System (type and version): To find this information use the Tools/System Information option
- Project information: It is displayed using the option Project/Status from the Studio menu
- Driver version and communication log: Available from Studio Output when running the driver
- Device model and boards: please refer to hardware manufacture's documentation

7 Application Sample

The Studio contains a configured project to test the driver. It is strongly recommended to do some tests with this application before beginning the configuration of the customized project, for the follow reasons:

- To understand better the information covered in section 4 of this document.
- To verify that your configuration is working.
- To certify that the hardware used in the test (device + adapter + cable + PC) is in working conditions before beginning the configuration of the applications.

Note: The Application Sample is not available for all drivers.

The Studio application is in the directory: /COMMUNICATION EXAMPLES/I870T

To perform the test, you need to follow these steps:

- Configure the device communication parameters using manufacturer programmer software.
- Open the application /COMMUNICATION EXAMPLES/ I870T
- Execute the application
- To display the following screen with some information about the communication, please execute the Viewer module in the Studio.

Tip: The application for testing may be used like a maintenance screen for the custom application.

8 Appendix A - Interoperability

This section was extracted from IEC-60870-101 interoperability document. It should be used to verify the interoperability between the Studio driver and other IEC implementations.

Extracted from 60870-5-101 © IEC:1995, page 171

8.1 Network configuration

(network-specific parameter)

- ☒ Point-to-point
- ☐ Multiple point-to-point
- ☐ Multipoint-party line
- ☐ Multipoint-star

8.2 Physical Layer

(network-specific parameter)

Transmission speed (control direction)

Unbalanced interchange circuit V.24/V.28 Standard	Unbalanced interchange circuit V.24/V.28 Recommended if >1 200 bit/s	Balanced interchange circuit X.24/X.27	
☐ 100 bit/s	☐ 2400 bit/s	☒ 2400 bit/s	☐ 56000 bit/s
☐ 200 bit/s	☐ 4800 bit/s	☒ 4800 bit/s	☐ 64000 bit/s
☐ 300 bit/s	☐ 9600 bit/s	☒ 9600 bit/s	
☐ 600 bit/s		☒ 19200 bit/s	
☐ 1200 bit/s		☒ 38400 bit/s	

Transmission speed (monitor direction)

Unbalanced interchange circuit V.24/V.28 Standard	Unbalanced interchange circuit V.24/V.28 Recommended if >1 200 bit/s	Balanced interchange circuit X.24/X.27	
☐ 100 bit/s	☐ 2400 bit/s	☒ 2400 bit/s	☐ 56000 bit/s
☐ 200 bit/s	☐ 4800 bit/s	☒ 4800 bit/s	☐ 64000 bit/s
☐ 300 bit/s	☐ 9600 bit/s	☒ 9600 bit/s	
☐ 600 bit/s		☒ 19200 bit/s	
☐ 1200 bit/s		☒ 38400 bit/s	

Extracted from 60870-5-101 © IEC:1995, page 173

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

Frame length

☐ Structured

255 Maximum length L (number of octets)

☒ Unstructured

8.4 Application Layer

Transmission mode for application data

Mode 1 (Least significant octet first), as defined in clause 4.10 of IEC 870-5-4, 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 ☐ structured

☒ Two octets ☒ unstructured

☒ Three octets

Cause of transmission
(system-specific parameter)

☒ One octet ☐ Two octets (with originator address)

Extracted from 60870-5-101 © IEC:1995, pages 175–177, updated per Addendum 1

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

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 bit	C_BO_NA_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_NB_1
☐ <105> := Reset process command	C_RP_NC_1
☐ <106> := Delay acquisition command	C_CD_NA_1

Parameter in control direction
(station-specific parameter)

☐ <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

Extracted from 60870-5-101 © IEC:1995, page 179

8.5 Basic application functions

Station initialization
(station-specific parameter)

☐ Remote initialization

General Interrogation
(system- or station-specific parameter)

☒ 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 l4
☒ group 15
☒ group 16

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

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

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

Transmission of Integrated totals
(station- or object-specific parameter)

☐ Counter request
☐ 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

Addresses per group have to be defined

Extracted from 60870-5-101 © IEC:1995, page 181

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

9 History of Versions

Version	By	Date	Description of changes
1.00	Lourenco	04-Sep-2001	▪ First driver version
1.00	Lourenco	13-Dec-2001	▪ Included the interoperability section in the documentation
1.1	Eduardo Castro	02-Dec-2016	▪ Fixed driver type in INI file