Electrical network protection

# Sepam
# IEC 60870-5-103
# communication

For Sepam series 20/40/60/80

## User's manual
## 03/2011

Schneider Electric

# Safety instructions

## Safety symbols and messages

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, service or maintain it. The following special messages may appear throughout this bulletin or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

### Risk of electric shock

*ANSI symbol.*    *IEC symbol.*

The addition of either symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

### Safety alert

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

### Safety messages

| ⚠ DANGER |
|---|
| **DANGER** indicates an imminently hazardous situation which, if not avoided, **will result in** death or serious injury. |

| ⚠ WARNING |
|---|
| **WARNING** indicates a potentially hazardous situation which, if not avoided, **can result in** death or serious injury. |

| ⚠ CAUTION |
|---|
| **CAUTION** indicates a potentially hazardous situation which, if not avoided, **can result in** minor or moderate injury. |

| CAUTION |
|---|
| **CAUTION**, used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, **can result in** equipment damages. |

## Important notes

### Restricted liability

Electrical equipment should be serviced and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this manual. This document is not intended as an instruction manual for untrained persons.
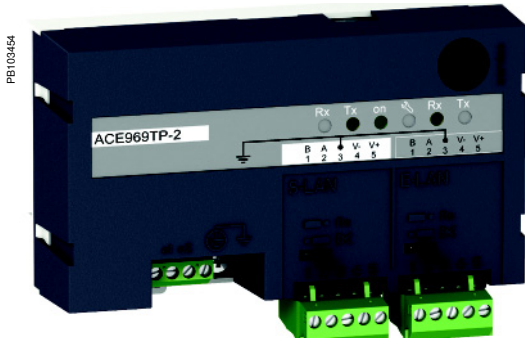
### Device operation

The user is responsible for checking that the rated characteristics of the device are suitable for its application. The user is responsible for reading and following the device's operating and installation instructions before attempting to commission or maintain it. Failure to follow these instructions can affect device operation and constitute a hazard for people and property.
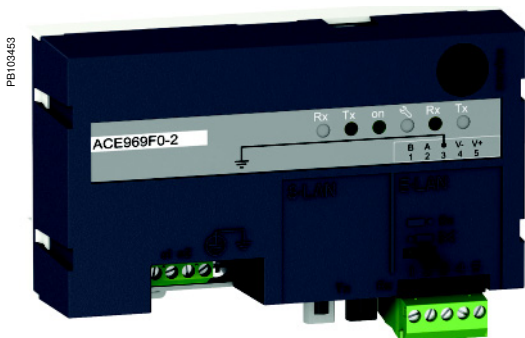
### Protective grounding

The user is responsible for compliance with all the existing international and national electrical codes concerning protective grounding of any device.

*IEC 60870-5-103
communication*

# Content

*ACE969TP-2 communication interface.*



*ACE969FO-2 communication interface.*

## General

IEC 60870-5-103 communication enables Sepam units to be connected to a supervisor or other device featuring an IEC 60870-5-103 communication channel. Communication is based on the master/slave principle:
■ Sepam is always a slave station.
■ The master is the supervisor or another device.

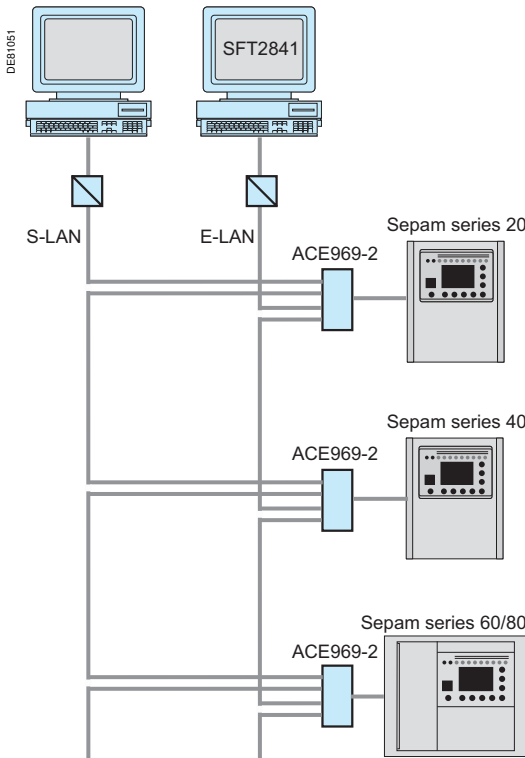IEC 60870-5-103 communication is available via the ACE969-2 communication interface.

ACE969-2 is a multiprotocol communication interface with two independent communication ports:
■ The S-LAN (Supervisory-Local Area Network) port is used to connect Sepam to a communication network dedicated to supervision.
■ The E-LAN (Engineering-Local Area Network) port is reserved for specific Sepam setup, operating and adjustment functions. This port is connected to the SFT2841 software tool.

The ACE969-2 interface is available in two versions, linked to the physical interface of the S-LAN supervision port:
■ ACE969TP-2 (Twisted Pair) for an S-LAN network, 2-wire RS 485 serial link
■ ACE969FO-2 (Fiber Optic) for a fiber-optic star or ring S-LAN

The E-LAN engineering port is always a 2-wire RS 485 type port.

## Accessible data

IEC 60870-5-103 communication via the S-LAN port provides access to a great deal of information, in particular:
■ Reading of metering information
■ Reading of status conditions and time-tagged events
■ Transfer of files including disturbance records and tripping contexts
■ Time-setting and synchronization
■ Transmission of remote controls

The actual list depends on the application, the type of Sepam, the enabled functions, and the ACE969-2 interface parameter settings.

Connecting the SFT2841 tool to the E-LAN port also provides access to all Sepam function parameters and operating data:
■ Hardware configuration parameters
■ Remote settings for protection functions
■ Switching on/off of protection functions
■ Retrieval of disturbance records
■ Display of metering and diagnosis information
■ Display of logic states
■ Display of alarms



*Two independent networks:*
*S-LAN: IEC 60870-5-103 supervision*
*E-LAN: For SFT2841 operating functions.*

# IEC 60870-5-103 protocol

| | |
|---|---|
| Selected application functions of IEC 60870-5-5 | User process |
| Selected application service data units of IEC 60870-5-3 | Application layer |
| Selected application information elements of IEC 60870-5-4 | (Layer 7) |
| Selected link transmission procedures of IEC 60870-5-2 | Link layer |
| Selected transmission frame formats of IEC 60870-5-1 | (Layer 2) |
| Fiber-optic system based on IEC 60874-2 or IEC 60874-10 and IEC 60794-1 and IEC 60794-2 or copper-wire-based system according to EIA RS-485 | Physical layer (Layer 1) |

*IEC 60870-5-103 communication profile.*

## Presentation

**The IEC 60870-5-103 protocol is a companion standard for the informative interface of protection equipment.**
Standard IEC 60870-5-103 was prepared by IEC technical committee 57 (Power system control and associated communications).
It is a companion standard for the basic standards in series IEC 60870-5.

As a companion standard, it adds semantics to the definitions and functional profiles specified in the basic standards:
■ Definition of the particular uses for information objects
■ Definition of specialist information objects
■ Definition of service procedures or additional parameters in respect of the basic standards

Standard IEC 60870-5-103 defines communication between protection equipment and devices of a control system (supervisor or RTU) in a substation.

Standard IEC 60870-5-103 can be obtained in full from the International Electrotechnical Commission: http://www.iec.ch.

## Protocol principle

### General
Standard IEC 60870-5-103 defines a multipoint communication protocol via which information can be exchanged between a control system (supervisor or RTU) and one or more protection devices. The control system is the master and the protection devices are the slaves. Each slave is identified by a unique address between 1 and 254. Address 255 is reserved for broadcast frames.

Standard IEC 60870-5-103 defines two different methods for exchanging information:
■ The first is based on the use of predefined data structures (ASDU - Application Service Data Units) and application procedures supporting the transmission of standardized information.
■ The other uses generic services supporting the transmission of any type of information.
Sepam does not use generic services.

The protocol distinguishes between:
■ The Monitoring direction for the transmission of ASDUs sent by a protection device (slave device) to the control system (master device).
■ The Control direction for ASDUs sent by the control system to a protection device.

### Monitoring direction
Communication is based on the cyclic transmission of link-layer polling requests by the master in order to invite the slave to send its data.
■ Class 1 data polling is usually used for event transmission.
■ Class 2 data polling is used for the cyclic transmission of metering information.

### Control direction
The master can send:
■ General commands (enable/disable functions: protection, recloser, etc.)
■ A general interrogation request to obtain the current value of slave equipment status conditions and indications
■ A transmission request for disturbance records
■ Time synchronization commands
■ Commands to reset the communication interface

### Communication initialization
The slave communication interface only becomes operational once an initialization request sent by the master device has been received.
The absence of polling by the master is detected by the slave and this stops communication. To re-establish communication, the master device must send a reset request.

### Information characteristics
All information exchanged between the control system and the protection equipment features:
■ A function number
■ An information number
■ The ASDU number used to transmit the information
■ The cause of the transmission

# IEC 60870-5-103 protocol
## Access to Sepam data

*Sepam is a multifunctional digital relay, which supplies a great deal of information. Sepam data is categorized on the basis of function. Compliant with the data model defined in IEC 60870-5-103, all data is identified by a function number (FUN) and an information number (INF).*

*A detailed description of the Sepam data table, including function number and information number, appears in the Sepam data table section.*

### List of IEC 60870-5-103 standard functions

Sepam supports the subset of standard functions shown below.
Sepam uses the standard FUN and INF numbers for these functions.

| FUN | Function name |
|-----|---------------|
| 255 | System |
| 160 | Overcurrent protection |

### List of Sepam-specific functions

Sepam uses private FUN and INF numbers for these functions.

| FUN | Function name |
|-----|---------------|
| **States and indications** | |
| 20 | Sepam supervision |
| 21 | Switchgear and network |
| 22 | Logic equations |
| 31 | Logic inputs (MES no. 1) |
| 32 | Logic inputs (MES no. 2) |
| 33 | Logic inputs (MES no. 3) |
| 41 | Logipam group 1 |
| 42 | Logipam group 2 |
| 43 | Logipam group 3 |
| **Protections** | |
| 100 | Overcurrent protections |
| 101 | Directional current protections |
| 102 | Voltage protections |
| 103 | Frequency protections |
| 104 | Motor/generator protections |
| 105 | Miscellaneous protections |
| 106 | Thermal protections |
| 107 | Power protections |
| 108 | Differential protections |
| 109 | Speed protection |
| **Measurements** | |
| 10 | Temperature measurements |
| 11 | Additional measurements 1 |
| 12 | Additional measurements 2 |

### List of standard ASDUs

Sepam supports the subset of standard ASDUs shown below.

| ASDU | Function | Monitor direction | Control direction |
|------|----------|-------------------|-------------------|
| 1 | Time-tagged message | ■ | |
| 2 | Time-tagged message with relative time | ■ | |
| 5 | Identification message | ■ | |
| 6 | Time synchronization | ■ | ■ |
| 7 | General interrogation | | ■ |
| 8 | End of general interrogation | ■ | |
| 9 | Measurands II | ■ | |
| 20 | General command | | ■ |

### List of private ASDUs

In addition to the functions and standard ASDU, Sepam supports a File transfer function, which uses private ASDUs.
This function can be used to retrieve:
■ Tripping contexts (Sepam series 60, Sepam series 80 only)
■ Disturbance records
Disturbance records are supplied in COMTRADE format.

| ASDU | Function | Monitoring direction | Control direction |
|------|----------|----------------------|-------------------|
| 254 | Transfer command | | ■ |
| 255 | Transfer response | ■ | |

*The Sepam communication profile defines how the options of standard IEC 60870-5-103 are implemented by Sepam.*
*The presentation format and numbering used in this section are intentionally based on clause "8. Interoperability" of standard IEC 60870-5-103.*

☑ *Indicates that Sepam supports the option from the standard.*
☐ *Indicates that Sepam does not support the option.*

# 8. Interoperability

## 8.1 Physical layer

### 8.1.1 Electrical interface
☑ EIA RS-485.
☑ Number of loads .......1.............. for one protection device.

**Nota :** *EIA RS-485 standard defines unit loads so that 32 of them can be operated on one line. For detailed information refer to clause 3 of EIA RS-485 standard.*

### 8.1.2 Optical interface
☑ Glass fiber.
☐ Plastic fiber.

☐ F-SMA type connector.
☑ BFOC/2.5 type connector.

### 8.1.3 Transmission speed
☑ 9,600 bps.
☑ 19,200 bps.

## 8.2 Link layer
There are no choices for the link layer.

## 8.3 Application layer

### 8.3.1 Transmission mode for application data
Mode 1 (least significant byte first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

### 8.3.2 COMMON ADDRESS OF ASDU
☑ One COMMON ADDRESS OF ASDU (identical to station address)
☐ More than one COMMON ADDRESS OF ASDU

### 8.3.3 Selection of standard information numbers in monitoring direction

**8.3.3.1 System functions in monitoring direction**

| | INF | Semantics |
|---|---|---|
| ☑ | <0> | End of general interrogation |
| ☑ | <0> | Time synchronization |
| ☑ | <2> | Reset FCB |
| ☑ | <3> | Reset CU |
| ☑ | <4> | Start/restart |
| ☐ | <5> | Power on |

**8.3.3.2 Status indications in monitoring direction**

| INF | Semantics |
|---|---|
| ☑ <16> | Auto-recloser active |
| ☐ <17> | Teleprotection active |
| ☐ <18> | Protection active |
| ☑ <19> | LED reset |
| ☑ <20> | Monitoring direction blocked |
| ☐ <21> | Test mode |
| ☐ <22> | Local parameter setting |
| ☑ <23> | Characteristic 1 |
| ☑ <24> | Characteristic 2 |
| ☐ <25> | Characteristic 3 |
| ☐ <26> | Characteristic 4 |
| ☐ <27> | Auxiliary input 1 |
| ☐ <28> | Auxiliary input 2 |
| ☐ <29> | Auxiliary input 3 |
| ☐ <30> | Auxiliary input 4 |

**8.3.3.3 Supervision indications in monitoring direction**

| INF | Semantics |
|---|---|
| ☑ <32> | Measurand supervision I |
| ☑ <33> | Measurand supervision V |
| ☑ <35> | Phase sequence supervision |
| ☑ <36> | Trip circuit supervision |
| ☐ <37> | I>> back-up operation |
| ☐ <38> | VT fuse failure |
| ☐ <39> | Teleprotection disturbed |
| ☐ <46> | Group warning |
| ☐ <47> | Group alarm |

**8.3.3.4 Earth fault indications in monitoring direction**

| INF | Semantics |
|---|---|
| ☐ <48> | Earth fault L1 |
| ☐ <49> | Earth fault L2 |
| ☐ <50> | Earth fault L3 |
| ☐ <51> | Earth fault forward, i.e. line |
| ☐ <52> | Earth fault reverse, i.e. busbar |

### 8.3.3.5 Fault indications in monitoring direction

| INF | Semantics |
|---|---|
| ☐ <64> | Start/pick-up L1 |
| ☐ <65> | Start/pick-up L2 |
| ☐ <66> | Start/pick-up L3 |
| ☐ <67> | Start/pick-up N |
| ☑ <68> | General trip |
| ☐ <69> | Trip L1 |
| ☐ <70> | Trip L2 |
| ☐ <71> | Trip L3 |
| ☐ <72> | Trip I>> (back-up operation) |
| ☐ <73> | Fault location X in ohms |
| ☐ <74> | Fault forward/line |
| ☐ <75> | Fault reverse/busbar |
| ☐ <76> | Teleprotection signal transmitted |
| ☐ <77> | Teleprotection signal received |
| ☐ <78> | Zone 1 |
| ☐ <79> | Zone 2 |
| ☐ <80> | Zone 3 |
| ☐ <81> | Zone 4 |
| ☐ <82> | Zone 5 |
| ☐ <83> | Zone 6 |
| ☐ <84> | General start/pick-up |
| ☑ <85> | Breaker failure |
| ☐ <86> | Trip measuring system L1 |
| ☐ <87> | Trip measuring system L2 |
| ☐ <88> | Trip measuring system L3 |
| ☐ <89> | Trip measuring system E |
| ☑ <90> | Trip I> |
| ☑ <91> | Trip I>> |
| ☑ <92> | Trip IN> |
| ☑ <93> | Trip IN>> |

### 8.3.3.6 Auto-reclosure indications in monitoring direction

| INF | Semantics |
|---|---|
| ☑ <128> | CB 'on' by AR |
| ☐ <129> | CB 'on' by delayed AR |
| ☐ <130> | AR blocked |

### 8.3.3.7 Measurands in monitoring direction

| INF | Semantics |
|---|---|
| ☐ <144> | Measurand |
| ☐ <145> | Measurands I, V |
| ☐ <146> | Measurands I, V, P, Q |
| ☐ <147> | Measurands IN, VEN |
| ☑ <148> | Measurands IL1, 2, 3, VL1, 2, 3, P, Q, f |

### 8.3.3.8 Generic functions in monitoring direction

| INF | Semantics |
|---|---|
| ☐ <240> | Read headings of all defined groups |
| ☐ <241> | Read values or attributes of all entries of one group |
| ☐ <243> | Read directory of a single entry |
| ☐ <244> | Read value or attribute of a single entry |
| ☐ <245> | End of general interrogation of generic data |
| ☐ <249> | Write entry with confirmation |
| ☐ <250> | Write entry with execution |
| ☐ <251> | Write entry aborted |

### 8.3.4 Selection of standard information numbers in control direction

**8.3.4.1 System functions in control direction**

| INF | Semantics |
|---|---|
| ☑ <0> | Initiation of general interrogation |
| ☑ <0> | Time synchronization |

**8.3.4.2 General commands in control direction**

| INF | Semantics |
|---|---|
| ☑ <16> | Auto-recloser on/off |
| ☐ <17> | Teleprotection on/off |
| ☐ <18> | Protection on/off |
| ☑ <19> | LED reset |
| ☑ <23> | Activate characteristic 1 |
| ☑ <24> | Activate characteristic 2 |
| ☐ <25> | Activate characteristic 3 |
| ☐ <26> | Activate characteristic 4 |

**8.3.4.3 Generic functions in control direction**

| INF | Semantics |
|---|---|
| ☐ <240> | Read headings of all defined groups |
| ☐ <241> | Read values or attributes of all entries of one group |
| ☐ <243> | Read directory of a single entry |
| ☐ <244> | Read value or attribute of a single entry |
| ☐ <245> | General interrogation of generic data |
| ☐ <248> | Write entry |
| ☐ <249> | Write entry with confirmation |
| ☐ <250> | Write entry with execution |
| ☐ <251> | Write entry aborted |

### 8.3.5 Basic application functions

☐ Test mode
☑ Blocking of monitoring direction
☐ Disturbance data
☐ Generic services
☑ Private data

### 8.3.6 Miscellaneous

Measurands are transmitted with ASDU 3 as well as with ASDU 9. As defined in 7.2.6.8, the maximum MVAL can either be 1.2 or 2.4 times the rated value. No different rating shall be used in ASDU 3 and ASDU 9, i.e. for each measurand there is only one choice.

| Measurand | Max. MVAL = rated value times | | |
|---|---|---|---|
| | 1.2 | or | 2.4 |
| Current L1 | ☑ | | ☐ |
| Current L2 | ☑ | | ☐ |
| Current L3 | ☑ | | ☐ |
| Voltage L1-E | ☑ | | ☐ |
| Voltage L2-E | ☑ | | ☐ |
| Voltage L3-E | ☑ | | ☐ |
| Active power P | ☑ | | ☐ |
| Reactive power Q | ☑ | | ☐ |
| Frequency f | ☑ | | ☐ |
| Voltage L1 - L2 | ☑ | | ☐ |

*■ The monitoring direction data table, which lists all Sepam data to be transmitted to the supervisor.*

*■ The control direction data table, which lists all supervisor data to be transmitted to Sepam.*

## Description of the Sepam data table

The following information is provided for each data item:
■ The ASDU (Application Service Data Unit) number
■ The value of the FUN (Function) and INF (Information) identifiers
■ The value of the COT (Cause Of Transmission) field
■ A GI (General Interrogation) marker
■ The Sepam data semantic
■ The Sepam series for which the data is available
For Sepam series 20, Sepam B2X (dedicated to voltage applications) are distinct from Sepam S20, T20 and M20 (dedicated to current applications).
The effective availability of a Sepam data item also depends on the Sepam type and function parameter settings.

### ASDU: Application Service Data Unit

The ASDU number identifies the standard data structure used by Sepam for data transmission.

### FUN and INF: Function number and information number

Each Sepam data item is identified by:
■ The number of the function to which the data belongs: FUN
■ The information number of the basic data: INF

### COT: Cause Of Transmission

The COT value shows the cause of transmission of the data.

**Monitoring direction**

In the monitoring direction, Sepam uses the following COT values:

| COT | Label | |
| --- | --- | --- |
| 1 | Spontaneous | Information produced spontaneously following a change of state (date-tagged event) |
| 2 | Cyclic | Information produced cyclically by Sepam (measurements) |
| 3 | Reset (FCB) | Response to command to reset the frame count bit (FCB) |
| 4 | Reset (CU) | Response to command to reset the communication unit (CU) |
| 5 | Start/restart | Response to command to initialize the communication interface |
| 8 | Time synchronization | Acknowledgment of time synchronization command |
| 9 | General interrogation | Information produced in response to a general interrogation command |
| 10 | End of general interrogation | Termination message of a general interrogation cycle |
| 12 | Remote operation | Change of state resulting from a supervisor command |
| 20 | Positive acknowledgement | Positive acknowledgment of command |
| 21 | Negative acknowledgement | Negative acknowledgment of command |

**Control direction**

In the control direction, Sepam supports the following COT values:

| COT | Label | |
| --- | --- | --- |
| 8 | Time synchronization | Time synchronization command |
| 9 | General interrogation | Initialization of a general interrogation cycle |
| 20 | General command | Command from the supervisor such as open/close breaker, enable/disable a function, etc. |

### GI: General Interrogation

The GI marker indicates whether the data is produced in response to a general interrogation request. For this data, each change of state ("OFF" to "ON" and "ON" to "OFF") is also transmitted spontaneously.

# IEC 60870-5-103 protocol
## Sepam data table - Monitoring direction

| ASDU | FUN | INF | COT | GI | IEC 60870-5-103 semantic | Sepam series 20 B2X | Sepam series 20 Other | Sepam series 40 | Sepam series 60 | Sepam series 80 |
|---|---|---|---|---|---|---|---|---|---|---|
| | **255** | | | | **System functions** | | | | | |
| 8 | 255 | 0 | 10 | | End of general interrogation | ■ | ■ | ■ | ■ | ■ |
| 6 | 255 | 0 | 8 | | Time synchronization | ■ | ■ | ■ | ■ | ■ |
| 5 | 255 | 2 | 3 | | Reset frame count bit (FCB) | ■ | ■ | ■ | ■ | ■ |
| 5 | 255 | 3 | 4 | | Reset communication unit (CU) | ■ | ■ | ■ | ■ | ■ |
| 5 | 255 | 4 | 5 | | Start/restart | ■ | ■ | ■ | ■ | ■ |

| ASDU | FUN | INF | COT | GI | IEC 60870-5-103 semantic | Sepam semantic | Sepam series 20 B2X | Sepam series 20 Other | Sepam series 40 | Sepam series 60 | Sepam series 80 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **160** | | | | **Maximum overcurrent protection (IEC 60870-5-103 standard function)** | | | | | | |
| 1 | 160 | 16 | 1, 9, 12, 20, 21 | ■ | Auto-recloser active | Recloser on | | ■ | ■ | ■ | ■ |
| 1 | 160 | 19 | 1, 12, 20, 21 | | LED reset | Sepam reset after fault | ■ | ■ | ■ | ■ | ■ |
| 1 | 160 | 20 | 9, 11 | ■ | Monitoring direction blocked | Monitoring direction blocked | ■ | ■ | ■ | ■ | ■ |
| 1 | 160 | 23 | 1, 9, 12, 20, 21 | ■ | Characteristic 1 | Setting group A in service | | ■ | ■ | ■ | ■ |
| 1 | 160 | 24 | 1, 9, 12, 20, 21 | ■ | Characteristic 2 | Setting group B in service | | ■ | ■ | ■ | ■ |
| 1 | 160 | 32 | 1, 9 | ■ | Measurand supervision I | Phase-CT fault | | | ■ | ■ | ■ |
| 1 | 160 | 33 | 1, 9 | ■ | Measurand supervision V | Phase-VT fault | | | ■ | ■ | ■ |
| 1 | 160 | 35 | 1, 9 | ■ | Phase sequence supervision | Main-phase reverse rotation | | | ■ | ■ | ■ |
| 1 | 160 | 36 | 1, 9 | ■ | Trip circuit supervision | Matching fault or Trip Circuit Supervision | ■ | ■ | ■ | ■ | ■ |
| 2 | 160 | 68 | 1 | | General trip | Trip | ■ | ■ | ■ | ■ | ■ |
| 2 | 160 | 85 | 1 | | Breaker failure | Protection 50BF | | ■ | ■ | ■ | ■ |
| 2 | 160 | 90 | 1 | | Trip I> | Protection 50/51 unit 1 | | ■ (unit 1 group A) | ■ | ■ | ■ |
| 2 | 160 | 91 | 1 | | Trip I>> | Protection 50/51 unit 2 | | ■ (unit 2 group A) | ■ | ■ | ■ |
| 2 | 160 | 92 | 1 | | Trip IN> | Protection 50N/51N unit 1 | | ■ (unit 1 group A) | ■ | ■ | ■ |
| 2 | 160 | 93 | 1 | | Trip IN>> | Protection 50N/51N unit 2 | | ■ (unit 2 group A) | ■ | ■ | ■ |
| 1 | 160 | 128 | 1 | | CB 'on' by Auto-recloser | Recloser: reclosing successful | | ■ | ■ | ■ | ■ |

| ASDU | FUN | INF | COT | GI | Sepam semantic | Sepam series 20 B2X | Sepam series 20 Other | Sepam series 40 | Sepam series 60 | Sepam series 80 |
|---|---|---|---|---|---|---|---|---|---|---|
| | **20** | | **Sepam supervision** | | | | | | | |
| 1 | 20 | 1 | 1, 9 | ■ | Sepam partial fault | ■ | ■ | ■ | ■ | ■ |
| 1 | 20 | 2 | 1, 9 | ■ | Sepam major fault | ■ | ■ | ■ | ■ | ■ |
| 1 | 20 | 3 | 1, 9 | ■ | MET 148-1 module sensor fault | | ■ | ■ | ■ | ■ |
| 1 | 20 | 4 | 1, 9 | ■ | MET 148-2 module sensor fault | | | ■ | ■ | ■ |
| 1 | 20 | 5 | 1, 9 | ■ | Control fault | ■ | ■ | ■ | ■ | ■ |
| 1 | 20 | 6 | 1, 9 | ■ | Residual VT fault | | | ■ | ■ | ■ |
| 1 | 20 | 7 | 1, 9 | ■ | Additional phase CT fault | | | | | ■ |
| 1 | 20 | 8 | 1, 9 | ■ | Additional phase VT fault | | | | | ■ |
| 1 | 20 | 9 | 1, 9 | ■ | Additional residual VT fault | | | | | ■ |
| 1 | 20 | 10 | 1 | | Min. V_aux | | | | ■ | ■ |
| 1 | 20 | 11 | 1 | | Max. V_aux | | | | ■ | ■ |
| 1 | 20 | 12 | 1 | | Battery low or absent | | | | ■ | ■ |
| 1 | 20 | 13 | 1, 9 | ■ | Test mode | | | | ■ | ■ |
| 1 | 20 | 14 | 1, 9, 12, 20, 21 | ■ | S-LAN communication monitoring active | ■ | ■ | ■ | | |
| 1 | 20 | 15 | 1 | | Ethernet communication fault | | | | ■ | ■ |
| | **21** | | **Switchgear and network** | | | | | | | |
| 1 | 21 | 1 | 1, 9, 12, 20, 21 | ■ | Device closed | | | | ■ | ■ |
| 1 | 21 | 2 | 1, 9 | ■ | Device racked out | | | | ■ | ■ |
| 1 | 21 | 3 | 1 | | SF6 alarm | | | ■ | ■ | ■ |
| 1 | 21 | 4 | 1, 9 | ■ | Earthing switch closed | | | | ■ | ■ |
| 1 | 21 | 5 | 1 | | Thermistor alarm | | | ■ | ■ | ■ |
| 1 | 21 | 6 | 1 | | Thermistor tripping | | | ■ | ■ | ■ |
| 1 | 21 | 7 | 1 | | Buchholz alarm | | | ■ | ■ | ■ |
| 1 | 21 | 8 | 1 | | Buchholz tripping | | | ■ | ■ | ■ |
| 1 | 21 | 9 | 1 | | Thermostat alarm | | | ■ | ■ | ■ |
| 1 | 21 | 10 | 1 | | Thermostat tripping | | | ■ | ■ | ■ |
| 1 | 21 | 11 | 1 | | Pressure alarm | | | ■ | ■ | ■ |
| 1 | 21 | 12 | 1 | | Pressure tripping | | | ■ | ■ | ■ |
| 1 | 21 | 13 | 1 | | External tripping 1 | | | ■ | ■ | ■ |
| 1 | 21 | 14 | 1 | | External tripping 2 | | | ■ | ■ | ■ |
| 1 | 21 | 15 | 1 | | External tripping 3 | | | ■ | ■ | ■ |
| 1 | 21 | 16 | 1 | | Load shedding | | | | ■ | ■ |
| 1 | 21 | 17 | 1 | | Restart | | | | ■ | ■ |
| 1 | 21 | 18 | 1, 9 | ■ | Additional phase reverse rotation | | | | ■ | ■ |
| 1 | 21 | 19 | 1, 9 | ■ | Recloser ready | | | ■ | ■ | ■ |
| 1 | 21 | 20 | 1 | | Recloser: final trip | | ■ | ■ | ■ | ■ |
| 1 | 21 | 21 | 1 | | Send blocking signal 1 | | ■ | ■ | ■ | ■ |
| 1 | 21 | 22 | 1 | | Send blocking signal 2 | | | ■ | ■ | ■ |
| 1 | 21 | 23 | 1, 9 | ■ | Closing circuit supervision | | | | ■ | ■ |
| 1 | 21 | 24 | 1 | | Request for synchro-checked closing | | | | ■ | ■ |
| 1 | 21 | 25 | 1 | | Synchronization stop | | | | ■ | ■ |
| 1 | 21 | 26 | 1 | | Synchronization failure | | | | ■ | ■ |
| 1 | 21 | 27 | 1 | | Synchronization successful | | | | ■ | ■ |
| 1 | 21 | 28 | 1 | | dU synchronization failure | | | | ■ | ■ |
| 1 | 21 | 29 | 1 | | dPhi synchronization failure | | | | ■ | ■ |
| 1 | 21 | 30 | 1 | | dF synchronization failure | | | | ■ | ■ |
| 1 | 21 | 31 | 1 | | Manual capacitor step control | | | | | ■ |
| 1 | 21 | 32 | 1 | | Automatic capacitor step control | | | | | ■ |
| 1 | 21 | 33 | 1 | | Capacitor step 1 matching fault | | | | | ■ |
| 1 | 21 | 34 | 1 | | Capacitor step 2 matching fault | | | | | ■ |
| 1 | 21 | 35 | 1 | | Capacitor step 3 matching fault | | | | | ■ |
| 1 | 21 | 36 | 1 | | Capacitor step 4 matching fault | | | | | ■ |
| 1 | 21 | 37 | 1 | | Coupling closing order | | | | ■ | ■ |
| 1 | 21 | 38 | 1 | | Coupling synchronization failure | | | | ■ | ■ |
| 1 | 21 | 39 | 1 | | Tripping by automatic transfer (AT) | | | | | ■ |
| 1 | 21 | 40 | 1 | | Cumulative breaking current monitoring | | | | ■ | ■ |
| 1 | 21 | 102 | 20, 21 | | Ack. of command Priority group shutdown | | | | ■ | ■ |
| 1 | 21 | 103 | 20, 21 | | Ack. of command Enable/Disable synchro-check | | | | ■ | ■ |
| 1 | 21 | 104 | 20, 21 | | Ack. of command Enable/Disable voltage check | | | | ■ | ■ |
| 1 | 21 | 105 | 20, 21 | | Ack. of command Close/Open capacitor step 1 | | | | | ■ |
| 1 | 21 | 106 | 20, 21 | | Ack. of command Close/Open capacitor step 2 | | | | | ■ |
| 1 | 21 | 107 | 20, 21 | | Ack. of command Close/Open capacitor step 3 | | | | | ■ |
| 1 | 21 | 108 | 20, 21 | | Ack. of command Close/Open capacitor step 4 | | | | | ■ |

# IEC 60870-5-103 protocol
Sepam data table - Monitoring direction

| ASDU | FUN | INF | COT | GI | Sepam semantic | Sepam series 20 | | Sepam series 40 | Sepam series 60 | Sepam series 80 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | B2X | Other | | | |
| | **22** | | **Logic equations** | | | | | | | |
| 1 | 22 | 1 | 1, 9 | ■ | V1 | | | ■ | ■ | ■ |
| 1 | 22 | 2 | 1, 9 | ■ | V2 | | | ■ | ■ | ■ |
| 1 | 22 | 3 | 1, 9 | ■ | V3 | | | ■ | ■ | ■ |
| 1 | 22 | 4 | 1, 9 | ■ | V4 | | | ■ | ■ | ■ |
| 1 | 22 | 5 | 1, 9 | ■ | V5 | | | ■ | ■ | ■ |
| 1 | 22 | 6 | 1, 9 | ■ | V6 | | | ■ | ■ | ■ |
| 1 | 22 | 7 | 1, 9 | ■ | V7 | | | ■ | ■ | ■ |
| 1 | 22 | 8 | 1, 9 | ■ | V8 | | | ■ | ■ | ■ |
| 1 | 22 | 9 | 1, 9 | ■ | V9 | | | ■ | ■ | ■ |
| 1 | 22 | 10 | 1, 9 | ■ | V10 | | | ■ | ■ | ■ |
| 1 | 22 | 11 | 1, 9 | ■ | V11 | | | | ■ | ■ |
| 1 | 22 | 12 | 1, 9 | ■ | V12 | | | | ■ | ■ |
| 1 | 22 | 13 | 1, 9 | ■ | V13 | | | | ■ | ■ |
| 1 | 22 | 14 | 1, 9 | ■ | V14 | | | | ■ | ■ |
| 1 | 22 | 15 | 1, 9 | ■ | V15 | | | | ■ | ■ |
| 1 | 22 | 16 | 1, 9 | ■ | V16 | | | | ■ | ■ |
| 1 | 22 | 17 | 1, 9 | ■ | V17 | | | | ■ | ■ |
| 1 | 22 | 18 | 1, 9 | ■ | V18 | | | | ■ | ■ |
| 1 | 22 | 19 | 1, 9 | ■ | V19 | | | | ■ | ■ |
| 1 | 22 | 20 | 1, 9 | ■ | V20 | | | | ■ | ■ |
| 1 | 22 | 21 | 1, 9 | ■ | V_FLAGREC | | | ■ | ■ | ■ |
| 1 | 22 | 22 | 1, 9 | ■ | V_TRIPCB | | | ■ | ■ | ■ |
| 1 | 22 | 23 | 1, 9 | ■ | V_CLOSECB | | | ■ | ■ | ■ |
| 1 | 22 | 24 | 1, 9 | ■ | V_INHIBCLOSE | | | ■ | ■ | ■ |
| 1 | 22 | 25 | 1, 9 | ■ | V_RESET | | | | ■ | ■ |
| 1 | 22 | 26 | 1, 9 | ■ | V_CLEAR | | | | ■ | ■ |
| 1 | 22 | 27 | 1, 9 | ■ | V_INHIBIT_RESET_LOCAL | | | | ■ | ■ |
| 1 | 22 | 28 | 1, 9 | ■ | V_SHUTDOWN | | | | ■ | ■ |
| 1 | 22 | 29 | 1, 9 | ■ | V_DE-EXCITATION | | | | ■ | ■ |
| 1 | 22 | 30 | 1, 9 | ■ | V_CLOSE_NOCTRL | | | | ■ | ■ |
| 1 | 22 | 31 | 1, 9 | ■ | V_TRIP_STP1 | | | | ■ | ■ |
| 1 | 22 | 32 | 1, 9 | ■ | V_TRIP_STP2 | | | | ■ | ■ |
| 1 | 22 | 33 | 1, 9 | ■ | V_TRIP_STP3 | | | | ■ | ■ |
| 1 | 22 | 34 | 1, 9 | ■ | V_TRIP_STP4 | | | | ■ | ■ |
| 1 | 22 | 35 | 1, 9 | ■ | V_CLOSE_STP1 | | | | ■ | ■ |
| 1 | 22 | 36 | 1, 9 | ■ | V_CLOSE_STP2 | | | | ■ | ■ |
| 1 | 22 | 37 | 1, 9 | ■ | V_CLOSE_STP3 | | | | ■ | ■ |
| 1 | 22 | 38 | 1, 9 | ■ | V_CLOSE_STP4 | | | | ■ | ■ |
| 1 | 22 | 39 | 1, 9 | ■ | V_TRANS_ON_FLT | | | | ■ | ■ |
| 1 | 22 | 40 | 1, 9 | ■ | V_TRANS_STOP | | | | ■ | ■ |
| 1 | 22 | 41 | 1, 9 | ■ | V_MIMIC_IN_1 | | | | ■ | ■ |
| 1 | 22 | 42 | 1, 9 | ■ | V_MIMIC_IN_2 | | | | ■ | ■ |
| 1 | 22 | 43 | 1, 9 | ■ | V_MIMIC_IN_3 | | | | ■ | ■ |
| 1 | 22 | 44 | 1, 9 | ■ | V_MIMIC_IN_4 | | | | ■ | ■ |
| 1 | 22 | 45 | 1, 9 | ■ | V_MIMIC_IN_5 | | | | ■ | ■ |
| 1 | 22 | 46 | 1, 9 | ■ | V_MIMIC_IN_6 | | | | ■ | ■ |
| 1 | 22 | 47 | 1, 9 | ■ | V_MIMIC_IN_7 | | | | ■ | ■ |
| 1 | 22 | 48 | 1, 9 | ■ | V_MIMIC_IN_8 | | | | ■ | ■ |
| 1 | 22 | 49 | 1, 9 | ■ | V_MIMIC_IN_9 | | | | ■ | ■ |
| 1 | 22 | 50 | 1, 9 | ■ | V_MIMIC_IN_10 | | | | ■ | ■ |
| 1 | 22 | 51 | 1, 9 | ■ | V_MIMIC_IN_11 | | | | ■ | ■ |
| 1 | 22 | 52 | 1, 9 | ■ | V_MIMIC_IN_12 | | | | ■ | ■ |
| 1 | 22 | 53 | 1, 9 | ■ | V_MIMIC_IN_13 | | | | ■ | ■ |
| 1 | 22 | 54 | 1, 9 | ■ | V_MIMIC_IN_14 | | | | ■ | ■ |
| 1 | 22 | 55 | 1, 9 | ■ | V_MIMIC_IN_15 | | | | ■ | ■ |
| 1 | 22 | 56 | 1, 9 | ■ | V_MIMIC_IN_16 | | | | ■ | ■ |

| ASDU | FUN | INF | COT | GI | Sepam semantic | Sepam series 20 | | Sepam series 40 | Sepam series 60 | Sepam series 80 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | B2X | Other | | | |
| | **31** | **Logic inputs (MES no. 1)** | | | | | | | | |
| 1 | 31 | 1 | 1, 9 | ■ | Logic input | I11 | I11 | I11 | I101 | I101 |
| 1 | 31 | 2 | 1, 9 | ■ | Logic input | I12 | I12 | I12 | I102 | I102 |
| 1 | 31 | 3 | 1, 9 | ■ | Logic input | I13 | I13 | I13 | I103 | I103 |
| 1 | 31 | 4 | 1, 9 | ■ | Logic input | I14 | I14 | I14 | I104 | I104 |
| 1 | 31 | 5 | 1, 9 | ■ | Logic input | I21 | I21 | I21 | I105 | I105 |
| 1 | 31 | 6 | 1, 9 | ■ | Logic input | I22 | I22 | I22 | I106 | I106 |
| 1 | 31 | 7 | 1, 9 | ■ | Logic input | I23 | I23 | I23 | I107 | I107 |
| 1 | 31 | 8 | 1, 9 | ■ | Logic input | I24 | I24 | I24 | I108 | I108 |
| 1 | 31 | 9 | 1, 9 | ■ | Logic input | I25 | I25 | I25 | I109 | I109 |
| 1 | 31 | 10 | 1, 9 | ■ | Logic input | I26 | I26 | I26 | I110 | I110 |
| 1 | 31 | 11 | 1, 9 | ■ | Logic input | | | | I111 | I111 |
| 1 | 31 | 12 | 1, 9 | ■ | Logic input | | | | I112 | I112 |
| 1 | 31 | 13 | 1, 9 | ■ | Logic input | | | | I113 | I113 |
| 1 | 31 | 14 | 1, 9 | ■ | Logic input | | | | I114 | I114 |
| | **32** | **Logic inputs (MES no. 2)** | | | | | | | | |
| 1 | 32 | 1 to 14 | 1, 9 | ■ | Logic inputs I201 to I214 | | | | ■ | ■ |
| | **33** | **Logic inputs (MES no. 3)** | | | | | | | | |
| 1 | 3 | 1 to 14 | 1, 9 | ■ | Logic inputs I301 to I314 | | | | | ■ |
| | **41** | **Logipam group 1 (Sepam series 80 option)** | | | | | | | | |
| 1 | 41 | 16 to 31 | 1, 9 | ■ | TS16 to TS31 | | | | | ■ |
| 1 | 41 | 106 | 20, 21 | | Ack. of command TC6 | | | | | ■ |
| 1 | 41 | 107 | 20, 21 | | Ack. of command TC7 | | | | | ■ |
| 1 | 41 | 110 to 117 | 20, 21 | | Ack. of command TC10 to Ack. of command TC17 | | | | | ■ |
| | **42** | **Logipam group 2 (Sepam series 80 option)** | | | | | | | | |
| 1 | 42 | 33 to 48 | 1, 9 | ■ | TS33 to TS48 | | | | | ■ |
| 1 | 42 | 121 to 129 | 20, 21 | | Ack. of command TC21 to Ack. of command TC29 | | | | | ■ |
| | **43** | **Logipam group 3 (Sepam series 80 option)** | | | | | | | | |
| 1 | 43 | 52 to 64 | 1, 9 | ■ | TS52 to TS64 | | | | | ■ |
| 1 | 43 | 149 to 164 | 20, 21 | | Ack. of command TC49 to Ack. of command TC64 | | | | | ■ |

| ASDU | FUN | INF | COT | GI | Sepam semantic | Sepam series 20 B2X | Sepam series 20 Other | Sepam series 40 | Sepam series 60 | Sepam series 80 |
|---|---|---|---|---|---|---|---|---|---|---|
| | **100** | | | | **Overcurrent protections** | | | | | |
| 2 | 100 | 1 | 1 | | Protection 50/51 unit 3 | | ■ (unit 1 group B) | ■ | ■ | ■ |
| 2 | 100 | 2 | 1 | | Protection 50/51 unit 4 | | ■ (unit 2 group B) | ■ | ■ | ■ |
| 2 | 100 | 3 | 1 | | Protection 50/51 unit 5 | | | | | ■ |
| 2 | 100 | 4 | 1 | | Protection 50/51 unit 6 | | | | | ■ |
| 2 | 100 | 5 | 1 | | Protection 50/51 unit 7 | | | | | ■ |
| 2 | 100 | 6 | 1 | | Protection 50/51 unit 8 | | | | | ■ |
| 2 | 100 | 7 | 1 | | Protection 50N/51N unit 3 | | ■ (unit 1 group B) | ■ | ■ | ■ |
| 2 | 100 | 8 | 1 | | Protection 50N/51N unit 4 | | ■ (unit 2 group B) | ■ | ■ | ■ |
| 2 | 100 | 9 | 1 | | Protection 50N/51N unit 5 | | | | | ■ |
| 2 | 100 | 10 | 1 | | Protection 50N/51N unit 6 | | | | | ■ |
| 2 | 100 | 11 | 1 | | Protection 50N/51N unit 7 | | | | | ■ |
| 2 | 100 | 12 | 1 | | Protection 50N/51N unit 8 | | | | | ■ |
| 2 | 100 | 13 | 1 | | Protection 51V unit 1 | | | ■ | ■ | ■ |
| 2 | 100 | 14 | 1 | | Protection 51V unit 2 | | | | | ■ |
| | **101** | | | | **Directional current protections** | | | | | |
| 2 | 101 | 1 | 1 | | Protection 67 unit 1 | | | ■ | ■ | ■ |
| 2 | 101 | 2 | 1 | | Protection 67 unit 2 | | | ■ | ■ | ■ |
| 2 | 101 | 3 | 1 | | Protection 67N unit 1 | | | ■ | ■ | ■ |
| 2 | 101 | 4 | 1 | | Protection 67N unit 2 | | | ■ | ■ | ■ |
| | **102** | | | | **Voltage protections** | | | | | |
| 2 | 102 | 1 | 1 | | Protection 27/27S unit 1 | ■ | | ■ | ■ | ■ |
| 2 | 102 | 2 | 1 | | Protection 27/27S unit 2 | ■ | | ■ | ■ | ■ |
| 2 | 102 | 3 | 1 | | Protection 27/27S unit 3 | | | | | ■ |
| 2 | 102 | 4 | 1 | | Protection 27/27S unit 4 | | | | | ■ |
| 2 | 102 | 5 | 1 | | Protection 27D unit 1 | ■ | | ■ | ■ | ■ |
| 2 | 102 | 6 | 1 | | Protection 27D unit 2 | ■ | | ■ | ■ | ■ |
| 2 | 102 | 7 | 1 | | Protection 27R unit 1 | ■ | | ■ | ■ | ■ |
| 2 | 102 | 8 | 1 | | Protection 27R unit 2 | | | ■ | ■ | ■ |
| 2 | 102 | 11 | 1 | | Protection 59 unit 1 | ■ | | ■ | ■ | ■ |
| 2 | 102 | 12 | 1 | | Protection 59 unit 2 | ■ | | ■ | ■ | ■ |
| 2 | 102 | 13 | 1 | | Protection 59 unit 3 | | | | | ■ |
| 2 | 102 | 14 | 1 | | Protection 59 unit 4 | | | | | ■ |
| 2 | 102 | 21 | 1 | | Protection 59N unit 1 | ■ | | ■ | ■ | ■ |
| 2 | 102 | 22 | 1 | | Protection 59N unit 2 | ■ | | ■ | ■ | ■ |
| 2 | 102 | 31 | 1 | | Protection 27S phase 1 | ■ | | | | |
| 2 | 102 | 32 | 1 | | Protection 27S phase 2 | ■ | | | | |
| 2 | 102 | 33 | 1 | | Protection 27S phase 3 | ■ | | | | |

| ASDU | FUN | INF | COT | GI | Sepam semantic | Sepam series 20 | | Sepam series 40 | Sepam series 60 | Sepam series 80 |
|------|-----|-----|-----|-----|----------------|-----|-----|-----|-----|-----|
| | | | | | | B2X | Other | | | |
| | **103** | | **Frequency protections** | | | | | | | |
| 2 | 103 | 1 | 1 | | Protection 81H unit 1 | ■ | | ■ | ■ | ■ |
| 2 | 103 | 2 | 1 | | Protection 81H unit 2 | | | ■ | ■ | ■ |
| 2 | 103 | 11 | 1 | | Protection 81L unit 1 | ■ | | ■ | ■ | ■ |
| 2 | 103 | 12 | 1 | | Protection 81L unit 2 | ■ | | ■ | ■ | ■ |
| 2 | 103 | 13 | 1 | | Protection 81L unit 3 | | | ■ | ■ | ■ |
| 2 | 103 | 14 | 1 | | Protection 81L unit 4 | | | ■ | ■ | ■ |
| 2 | 103 | 21 | 1 | | Protection 81R unit 1 | ■ | | | ■ | ■ |
| 2 | 103 | 22 | 1 | | Protection 81R unit 2 | | | | ■ | ■ |
| | **104** | | **Motor/generator protections** | | | | | | | |
| 2 | 104 | 1 | 1 | | Protection 48/51LR (locked rotor) | | ■ | ■ | ■ | ■ |
| 2 | 104 | 2 | 1 | | Protection 48/51LR (locked rotor at start-up) | | ■ | ■ | ■ | ■ |
| 2 | 104 | 3 | 1 | | Protection 48/51LR (excessive starting time) | | ■ | ■ | ■ | ■ |
| 1 | 104 | 4 | 1, 9 | ■ | Protection 66 | | ■ | ■ | ■ | ■ |
| 2 | 104 | 5 | 1 | | Protection 21B | | | | | ■ |
| 2 | 104 | 6 | 1 | | Protection 50/27 | | | | | ■ |
| 2 | 104 | 7 | 1 | | Protection 64G2/27TN unit 1 | | | | | ■ |
| 2 | 104 | 8 | 1 | | Protection 64G2/27TN unit 2 | | | | | ■ |
| 2 | 104 | 9 | 1 | | Protection 78PS | | | | | ■ |
| 2 | 104 | 10 | 1 | | Protection 24 unit 1 | | | | | ■ |
| 2 | 104 | 11 | 1 | | Protection 24 unit 2 | | | | | ■ |
| 2 | 104 | 12 | 1 | | Protection 40 | | | | ■ | ■ |
| | **105** | | **Miscellaneous protections** | | | | | | | |
| 2 | 105 | 1 | 1 | | Protection 46 unit 1 | | ■ | ■ | ■ | ■ |
| 2 | 105 | 2 | 1 | | Protection 46 unit 2 | | | ■ | ■ | ■ |
| 2 | 105 | 3 | 1 | | Protection 46BC | | | ■ | | |
| 2 | 105 | 11 | 1 | | Protection 47 unit 1 | | | ■ | ■ | ■ |
| 2 | 105 | 12 | 1 | | Protection 47 unit 2 | | | | ■ | ■ |
| 2 | 105 | 20 | 1 | | Protection 37 | | ■ | ■ | ■ | ■ |
| 2 | 105 | 31 | 1 | | Protection 51C unit 1 (capacitor step 1) | | | | | ■ |
| 2 | 105 | 32 | 1 | | Protection 51C unit 2 (capacitor step 1) | | | | | ■ |
| 2 | 105 | 33 | 1 | | Protection 51C unit 3 (capacitor step 2) | | | | | ■ |
| 2 | 105 | 34 | 1 | | Protection 51C unit 4 (capacitor step 2) | | | | | ■ |
| 2 | 105 | 35 | 1 | | Protection 51C unit 5 (capacitor step 3) | | | | | ■ |
| 2 | 105 | 36 | 1 | | Protection 51C unit 6 (capacitor step 3) | | | | | ■ |
| 2 | 105 | 37 | 1 | | Protection 51C unit 7 (capacitor step 4) | | | | | ■ |
| 2 | 105 | 38 | 1 | | Protection 51C unit 8 (capacitor step 4) | | | | | ■ |
| 1 | 105 | 101 | 20, 21 | | Ack. of command Reset undercurrent protection | | | ■ | ■ | ■ |

| ASDU | FUN | INF | COT | GI | Sepam semantic | Sepam series 20 | | Sepam series 40 | Sepam series 60 | Sepam series 80 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | B2X | Other | | | |
| | **106** | | **Thermal protections** | | | | | | | |
| 1 | 106 | 1 | 1 | | Protection 49 RMS alarm set point | | ■ | ■ | ■ | ■ |
| 1 | 106 | 2 | 1 | | Protection 49 RMS tripping set point | | ■ | ■ | ■ | ■ |
| 1 | 106 | 3 | 1, 9, 12, 20, 21 | ■ | Thermal protection tripping inhibited | | ■ | ■ | ■ | ■ |
| 1 | 106 | 11 | 1 | | Protection 38/49T tripping sensor 1 module 1 | | ■ | ■ | ■ | ■ |
| 1 | 106 | 12 | 1 | | Protection 38/49T tripping sensor 2 module 1 | | ■ | ■ | ■ | ■ |
| 1 | 106 | 13 | 1 | | Protection 38/49T tripping sensor 3 module 1 | | ■ | ■ | ■ | ■ |
| 1 | 106 | 14 | 1 | | Protection 38/49T tripping sensor 4 module 1 | | ■ | ■ | ■ | ■ |
| 1 | 106 | 15 | 1 | | Protection 38/49T tripping sensor 5 module 1 | | ■ | ■ | ■ | ■ |
| 1 | 106 | 16 | 1 | | Protection 38/49T tripping sensor 6 module 1 | | ■ | ■ | ■ | ■ |
| 1 | 106 | 17 | 1 | | Protection 38/49T tripping sensor 7 module 1 | | ■ | ■ | ■ | ■ |
| 1 | 106 | 18 | 1 | | Protection 38/49T tripping sensor 8 module 1 | | ■ | ■ | ■ | ■ |
| 1 | 106 | 21 | 1 | | Protection 38/49T tripping sensor 1 module 2 | | | ■ | ■ | ■ |
| 1 | 106 | 22 | 1 | | Protection 38/49T tripping sensor 2 module 2 | | | ■ | ■ | ■ |
| 1 | 106 | 23 | 1 | | Protection 38/49T tripping sensor 3 module 2 | | | ■ | ■ | ■ |
| 1 | 106 | 24 | 1 | | Protection 38/49T tripping sensor 4 module 2 | | | ■ | ■ | ■ |
| 1 | 106 | 25 | 1 | | Protection 38/49T tripping sensor 5 module 2 | | | ■ | ■ | ■ |
| 1 | 106 | 26 | 1 | | Protection 38/49T tripping sensor 6 module 2 | | | ■ | ■ | ■ |
| 1 | 106 | 27 | 1 | | Protection 38/49T tripping sensor 7 module 2 | | | ■ | ■ | ■ |
| 1 | 106 | 28 | 1 | | Protection 38/49T tripping sensor 8 module 2 | | | ■ | ■ | ■ |
| 1 | 106 | 31 | 1 | | Protection 38/49T alarm sensor 1 module 1 | ■ | ■ | ■ | ■ | ■ |
| 1 | 106 | 32 | 1 | | Protection 38/49T alarm sensor 2 module 1 | ■ | ■ | ■ | ■ | ■ |
| 1 | 106 | 33 | 1 | | Protection 38/49T alarm sensor 3 module 1 | ■ | ■ | ■ | ■ | ■ |
| 1 | 106 | 34 | 1 | | Protection 38/49T alarm sensor 4 module 1 | ■ | ■ | ■ | ■ | ■ |
| 1 | 106 | 35 | 1 | | Protection 38/49T alarm sensor 5 module 1 | ■ | ■ | ■ | ■ | ■ |
| 1 | 106 | 36 | 1 | | Protection 38/49T alarm sensor 6 module 1 | ■ | ■ | ■ | ■ | ■ |
| 1 | 106 | 37 | 1 | | Protection 38/49T alarm sensor 7 module 1 | ■ | ■ | ■ | ■ | ■ |
| 1 | 106 | 38 | 1 | | Protection 38/49T alarm sensor 8 module 1 | ■ | ■ | ■ | ■ | ■ |
| 1 | 106 | 41 | 1 | | Protection 38/49T alarm sensor 1 module 2 | | | ■ | ■ | ■ |
| 1 | 106 | 42 | 1 | | Protection 38/49T alarm sensor 2 module 2 | | | ■ | ■ | ■ |
| 1 | 106 | 43 | 1 | | Protection 38/49T alarm sensor 3 module 2 | | | ■ | ■ | ■ |
| 1 | 106 | 44 | 1 | | Protection 38/49T alarm sensor 4 module 2 | | | ■ | ■ | ■ |
| 1 | 106 | 45 | 1 | | Protection 38/49T alarm sensor 5 module 2 | | | ■ | ■ | ■ |
| 1 | 106 | 46 | 1 | | Protection 38/49T alarm sensor 6 module 2 | | | ■ | ■ | ■ |
| 1 | 106 | 47 | 1 | | Protection 38/49T alarm sensor 7 module 2 | | | ■ | ■ | ■ |
| 1 | 106 | 48 | 1 | | Protection 38/49T alarm sensor 8 module 2 | | | ■ | ■ | ■ |
| | **107** | | **Power protections** | | | | | | | |
| 2 | 107 | 1 | 1 | | Protection 32P unit 1 | | | ■ | ■ | ■ |
| 2 | 107 | 2 | 1 | | Protection 32P unit 2 | | | | ■ | ■ |
| 2 | 107 | 3 | 1 | | Protection 32Q | | | ■ | ■ | ■ |
| 2 | 107 | 11 | 1 | | Protection 37P unit 1 | | | | ■ | ■ |
| 2 | 107 | 12 | 1 | | Protection 37P unit 2 | | | | ■ | ■ |
| | **108** | | **Differential protections** | | | | | | | |
| 2 | 108 | 1 | 1 | | Protection 64REF unit 1 | | | | ■ | ■ |
| 2 | 108 | 2 | 1 | | Protection 64REF unit 2 | | | | ■ | ■ |
| 2 | 108 | 10 | 1 | | Protection 87T2 | | | | | ■ |
| 2 | 108 | 11 | 1 | | Protection 87M/87G | | | | | ■ |
| | **109** | | **Speed protections** | | | | | | | |
| 1 | 109 | 1 | 1 | | Protection 12 unit 1 | | | | ■ | ■ |
| 1 | 109 | 2 | 1 | | Protection 12 unit 2 | | | | ■ | ■ |
| 1 | 109 | 3 | 1 | | Protection 14 unit 1 | | | | ■ | ■ |
| 1 | 109 | 4 | 1 | | Protection 14 unit 2 | | | | ■ | ■ |

# IEC 60870-5-103 protocol
Sepam data table - Monitoring direction

| ASDU | FUN | INF | COT | GI | Sepam semantic | Sepam series 20 B2X | Sepam series 20 Other | Sepam series 40 | Sepam series 60 | Sepam series 80 |
|---|---|---|---|---|---|---|---|---|---|---|
| | **160** | | **Standard measurements** | | | | | | | |
| 9 | 160 | 148 | 2 | | 9 information elements MEA1 to MEA9 | | | | | |
| | | | | | MEA1: Phase current I1 | | ■ | ■ | ■ | ■ |
| | | | | | MEA2: Phase current I2 | | ■ | ■ | ■ | ■ |
| | | | | | MEA3: Phase current I3 | | ■ | ■ | ■ | ■ |
| | | | | | MEA4: Phase-to-neutral voltage V1 | ■ | | ■ | ■ | ■ |
| | | | | | MEA5: Phase-to-neutral voltage V2 | ■ | | ■ | ■ | ■ |
| | | | | | MEA6: Phase-to-neutral voltage V3 | ■ | | ■ | ■ | ■ |
| | | | | | MEA7: Active power P | | | ■ | ■ | ■ |
| | | | | | MEA8: Reactive power Q | | | ■ | ■ | ■ |
| | | | | | MEA9: Frequency f | ■ | | ■ | ■ | ■ |
| | **10** | | **Temperature measurements** | | | | | | | |
| 9 | 10 | 1 | 2 | | 16 information elements: 16 temperatures MEA1 to MEA16, as a % of full scale (i.e. 200°C) | | | | | |
| | | | | | MEA1: Temperature sensor 1 module 1 | | ■ | ■ | ■ | ■ |
| | | | | | MEA2: Temperature sensor 2 module 1 | | ■ | ■ | ■ | ■ |
| | | | | | MEA3: Temperature sensor 3 module 1 | | ■ | ■ | ■ | ■ |
| | | | | | MEA4: Temperature sensor 4 module 1 | | ■ | ■ | ■ | ■ |
| | | | | | MEA5: Temperature sensor 5 module 1 | | ■ | ■ | ■ | ■ |
| | | | | | MEA6: Temperature sensor 6 module 1 | | ■ | ■ | ■ | ■ |
| | | | | | MEA7: Temperature sensor 7 module 1 | | ■ | ■ | ■ | ■ |
| | | | | | MEA8: Temperature sensor 8 module 1 | | ■ | ■ | ■ | ■ |
| | | | | | MEA9: Temperature sensor 1 module 2 | | | ■ | ■ | ■ |
| | | | | | MEA10: Temperature sensor 2 module 2 | | | ■ | ■ | ■ |
| | | | | | MEA11: Temperature sensor 3 module 2 | | | ■ | ■ | ■ |
| | | | | | MEA12: Temperature sensor 4 module 2 | | | ■ | ■ | ■ |
| | | | | | MEA13: Temperature sensor 5 module 2 | | | ■ | ■ | ■ |
| | | | | | MEA14: Temperature sensor 6 module 2 | | | ■ | ■ | ■ |
| | | | | | MEA15: Temperature sensor 7 module 2 | | | ■ | ■ | ■ |
| | | | | | MEA16: Temperature sensor 8 module 2 | | | ■ | ■ | ■ |
| | **11** | | **Additional measurements 1** | | | | | | | |
| 9 | 11 | 1 | 2 | | 13 information elements MEA1 to MEA13 | | | | | |
| | | | | | MEA1: Residual current I0Σ | | ■ (I0Σ or I0) | ■ | ■ | ■ |
| | | | | | MEA2: Residual current I0 | | ■ (I0Σ or I0) | ■ | ■ | ■ |
| | | | | | MEA3: Negative sequence / unbalance T | | ■ | ■ | ■ | ■ |
| | | | | | MEA4: Phase-to-phase voltage U21 | ■ | | ■ | ■ | ■ |
| | | | | | MEA5: Phase-to-phase voltage U32 | ■ | | ■ | ■ | ■ |
| | | | | | MEA6: Phase-to-phase voltage U13 | ■ | | ■ | ■ | ■ |
| | | | | | MEA7: Residual voltage V0 | ■ | | ■ | ■ | ■ |
| | | | | | MEA8: Positive sequence voltage Vd | ■ | | ■ | ■ | ■ |
| | | | | | MEA9: Negative-sequence voltage Vi | | | ■ | ■ | ■ |
| | | | | | MEA10: Power factor Cos Phi | | | ■ | ■ | ■ |
| | | | | | MEA11: Neutral-point voltage Vnt | | | | ■ | ■ |
| | | | | | MEA12: Total harmonic distortion Uthd | | | | ■ | ■ |
| | | | | | MEA13: Total harmonic distortion Ithd | | | | ■ | ■ |
| | **12** | | **Additional measurements 2** | | | | | | | |
| 9 | 12 | 1 | 2 | | 16 information elements MEA1 to MEA16 | | | | | |
| | | | | | MEA1: Phase current I'1 | | | | | ■ |
| | | | | | MEA2: Phase current I'2 | | | | | ■ |
| | | | | | MEA3: Phase current I'3 | | | | | ■ |
| | | | | | MEA4: Residual current I'0Σ | | | | | ■ |
| | | | | | MEA5: Residual current I'0 | | | | | ■ |
| | | | | | MEA6: Phase-to-phase voltage U'21 | | | | | ■ |
| | | | | | MEA7: Phase-to-phase voltage U'32 | | | | | ■ |
| | | | | | MEA8: Phase-to-phase voltage U'13 | | | | | ■ |
| | | | | | MEA9: Phase-to-neutral voltage V'1 | | | | | ■ |
| | | | | | MEA10: Phase-to-neutral voltage V'2 | | | | | ■ |
| | | | | | MEA11: Phase-to-neutral voltage V'3 | | | | | ■ |
| | | | | | MEA12: Residual voltage V'0 | | | | | ■ |
| | | | | | MEA13: Positive sequence voltage V'd | | | | | ■ |
| | | | | | MEA14: Negative-sequence voltage V'i | | | | | ■ |
| | | | | | MEA15: Frequency f' | | | | | ■ |
| | | | | | MEA16: Negative sequence / unbalance T' | | | | | ■ |

Schneider Electric

# IEC 60870-5-103 protocol
## Sepam data table - Control direction

| ASDU | FUN | INF | COT | GI | Sepam semantic | Sepam series 20 B2X | Sepam series 20 Other | Sepam series 40 | Sepam series 60 | Sepam series 80 |
|---|---|---|---|---|---|---|---|---|---|---|
| | **255** | | **System functions** | | | | | | | |
| 7 | 255 | 0 | 9 | | Initiation of general interrogation | ■ | ■ | ■ | ■ | ■ |
| 6 | 255 | 0 | 8 | | Time synchronization | ■ | ■ | ■ | ■ | ■ |
| | **160** | | **General commands** | | | | | | | |
| 20 | 160 | 16 | 20 | | Enable recloser (ON) | | ■ | ■ | ■ | ■ |
| 20 | | | | | Disable recloser (OFF) | | | | | |
| 20 | 160 | 19 | 20 | | Sepam reset (ON) | ■ | ■ | ■ | ■ | ■ |
| 20 | 160 | 23 | 20 | | Switching to setting group A (ON) | | ■ | ■ | ■ | ■ |
| 20 | 160 | 24 | 20 | | Switching to setting group B (ON) | | ■ | ■ | ■ | ■ |
| | **20** | | **Sepam monitoring** | | | | | | | |
| 20 | 20 | 14 | 20 | | S-LAN communication monitoring (re)activation (ON) | ■ | ■ | ■ | | |
| | | | | | S-LAN communication monitoring inhibition (OFF) | | | | | |
| | **21** | | **Switchgear and network commands** | | | | | | | |
| 20 | 21 | 1 | 20 | | Closing (ON) | ■ | ■ | ■ | ■ | ■ |
| | | | | | Trip/open (OFF) | | | | | |
| 20 | 21 | 102 | 20 | | Priority group shutdown (ON) | | | | ■ | ■ |
| | | | | | Cancel priority group shutdown (OFF) | | | | | |
| 20 | 21 | 103 | 20 | | Enable synchro-check (ON) | | | | ■ | ■ |
| | | | | | Disable synchro-check (OFF) | | | | | |
| 20 | 21 | 104 | 20 | | Enable voltage check (ON) | | | | ■ | ■ |
| | | | | | Disable voltage check (OFF) | | | | | |
| 20 | 21 | 105 | 20 | | Close capacitor step 1 (ON) | | | | | ■ |
| | | | | | Open capacitor step 1 (OFF) | | | | | |
| 20 | 21 | 106 | 20 | | Close capacitor step 2 (ON) | | | | | ■ |
| | | | | | Open capacitor step 2 (OFF) | | | | | |
| 20 | 21 | 107 | 20 | | Close capacitor step 3 (ON) | | | | | ■ |
| | | | | | Open capacitor step 3 (OFF) | | | | | |
| 20 | 21 | 108 | 20 | | Close capacitor step 4 (ON) | | | | | ■ |
| | | | | | Open capacitor step 4 (OFF) | | | | | |
| | | | **Other commands** | | | | | | | |
| 20 | 105 | 101 | 20 | | Reset undercurrent protection (ON) | | | ■ | ■ | ■ |
| 20 | 106 | 3 | 20 | | Inhibit thermal protection (ON) | | ■ | ■ | ■ | ■ |
| | | | | | Confirm thermal protection (OFF) | | | | | |
| | **41** | | **Logipam group 1 (Sepam series 80 option) TC available for the user** | | | | | | | |
| 20 | 41 | 106 | 20 | | TC6 | | | | | ■ |
| 20 | 41 | 107 | 20 | | TC7 | | | | | ■ |
| 20 | 41 | 110 to 117 | 20 | | TC10 to TC17 | | | | | ■ |
| | **42** | | **Logipam group 2 (Sepam series 80 option) TC available for the user** | | | | | | | |
| 20 | 42 | 121 to 129 | 20 | | TC21 to TC29 | | | | | ■ |
| | **43** | | **Logipam group 3 (Sepam series 80 option) TC available for the user** | | | | | | | |
| 20 | 43 | 149 to 164 | 20 | | TC49 to TC64 | | | | | ■ |

## Presentation

The Sepam communication interfaces must be configured using SFT2841 software.

The IEC 60870-5-103 protocol is available with the ACE969TP-2 or ACE969FO-2 communication interfaces.
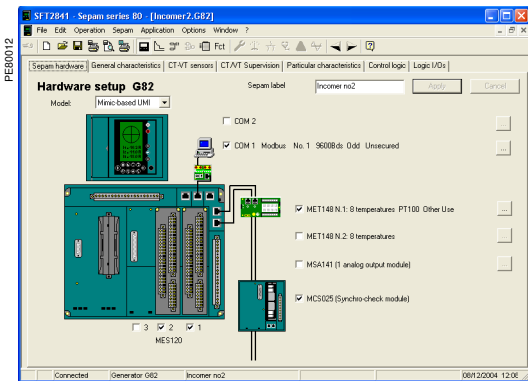Several parameter categories have to be configured once the interface has been selected:
■ The configuration parameters for the physical layer of the E-LAN port
■ The configuration parameters for the physical layer of the S-LAN port
■ The configuration parameters for functions specific to the
IEC 60870-5-103 protocol (advanced S-LAN port parameters)

## Access to configuration parameters

*SFT2841: Sepam series 80 hardware configuration.*

These parameters can be accessed from the **Communication configuration** window in the SFT2841 software.

To access this window:
■ Display the **Sepam configuration** screen in SFT2841. This screen will vary according to the type of Sepam used.
■ Select the **Communication** option.
■ Click [ ... ] : the **Communication configuration** window appears.

■ Select the type of interface used (ACE969TP-2 or ACE969FO-2).
■ Select the IEC103 communication protocol (S-LAN port).

## Configuration of the E-LAN port

*Configuration of the physical layer of the E-LAN port on an ACE969TP.*

### Configuration of the physical layer
The E-LAN port on the ACE969TP-2 and ACE969FO-2 communication interfaces is a 2-wire RS 485 port.
The configuration parameters for the physical layer of the E-LAN port are:
■ Sepam address
■ Transmission speed
■ Parity check type

| Parameters | Authorized values | Default value |
|---|---|---|
| Sepam address | 1 to 247 | 1 |
| Speed | 4800, 9600, 19200 or 38400 bps | 38400 bps |
| Parity | No parity, Even or Odd | Odd |

### Configuration tips
■ The Sepam address MUST be assigned before Sepam is connected to the E-LAN communication network.
■ You are also strongly advised to set the other physical layer configuration parameters before connecting to the communication network.
■ Modifying the configuration parameters during normal operation will not disturb Sepam but will reset the E-LAN communication port. If SFT2841 is connected to Sepam via the E-LAN network, any communication between Sepam and SFT2841 will be interrupted.
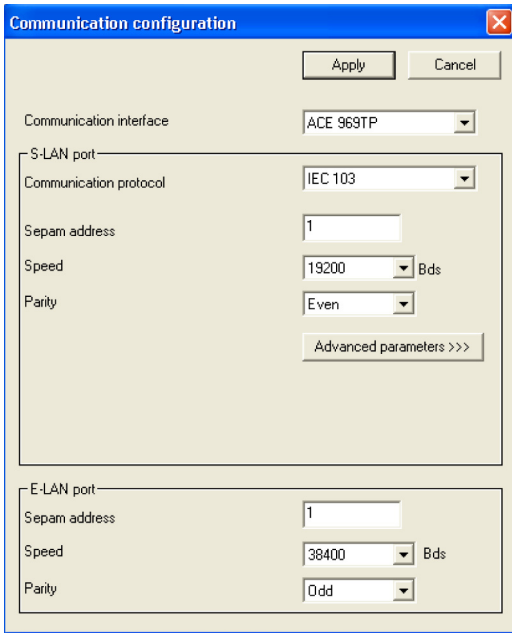
*Configuration of the physical layer of the S-LAN port on an ACE969TP.*

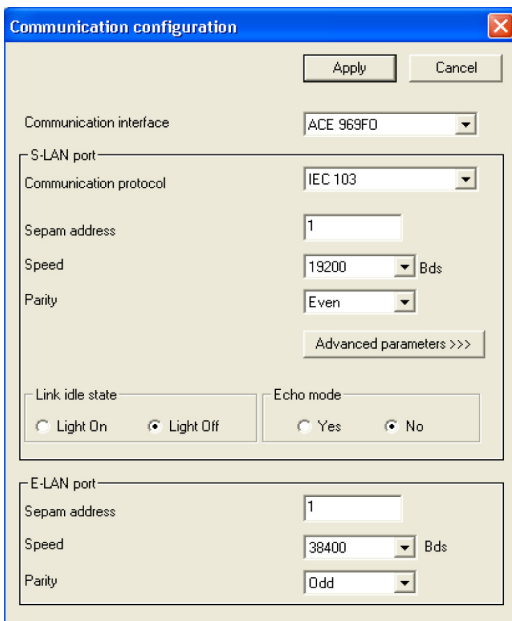## Configuration of the S-LAN port: Physical layer

The configuration parameters will vary depending on the communication interface selected: ACE969TP or ACE969FO.

### ACE969TP: 2-wire RS 485 S-LAN port

The configuration parameters for the physical layer of the S-LAN port on the ACE969TP are:
■ Sepam address
■ Transmission speed
■ Parity check type

| Parameters | Authorized values | Default value |
|---|---|---|
| Sepam address | 0 to 254 | 1 |
| Speed | 4800, 9600, 19200 or 38400 bps | 19200 bps |
| Parity | No parity, Even or Odd | Even |

### ACE969FO: Fiber-optic S-LAN port

The configuration parameters for the physical layer of the S-LAN port on the ACE969FO-2 are:
■ Sepam address
■ Transmission speed
■ Parity check type
■ Link idle state: Light On or Light Off
■ Echo mode: Yes or No
Echo mode must be activated when the Sepam is connected to an optical ring communication network.

| Parameters | Authorized values | Default value |
|---|---|---|
| Sepam address | 0 to 254 | 1 |
| Speed | 4800, 9600, 19200 or 38400 bps | 19200 bps |
| Parity | No parity, Even or Odd | Even |
| Link idle state | Light Off or Light On | Light Off |
| Echo mode | Yes (optical ring) or No (optical star) | No |



*Configuration of the physical layer of the S-LAN port on an ACE969FO.*

### Configuration tips

■ The Sepam address MUST be assigned before Sepam is connected to the S-LAN communication network.
■ You are also strongly advised to set the other physical layer configuration parameters before connecting to the communication network.
■ Modifying the configuration parameters during normal operation will not disturb Sepam but will reset the S-LAN communication port.

# Configuration of the S-LAN port: IEC 60870-5-103 protocol

## Configuration of the IEC 60870-5-103 protocol functions
The configuration of the IEC 60870-5-103 protocol functions is identical whether the ACE969TP-2 interface or the ACE969FO-2 interface is used.

Click the Advanced parameters button in the ACE969-2 configuration windows to open the **IEC 103 Protocol parameters** window, in which the following can be configured:
■ The standard parameters as defined by standard IEC 60870-5-103
■ The Sepam private data to be exchanged with the supervisor

## Configuration of the standard parameters
The standard IEC 60870-5-103 protocol parameters are as follows:
■ Cyclic ASDU period
■ Inactivity timer
■ Time synchronization period
■ Blocking of monitoring direction

### Cyclic ASDU period
Period during which cyclic data, such as measurement information, is generated and updated by Sepam.
This parameter, which is expressed in seconds, must be set consistently with the interval at which this data is polled by the supervisor.

### Inactivity timer
In normal operation, the supervisor sends polling requests to the Sepam units at regular intervals. Each Sepam monitors the activity of the supervisor by checking that polling requests are being received regularly.
If a Sepam fails to receive requests during a configurable period (the inactivity time delay), it will lock its communication port and cease to respond to requests sent subsequently by the supervisor.
To re-establish communication with a locked Sepam, the supervisor must initiate a reset.
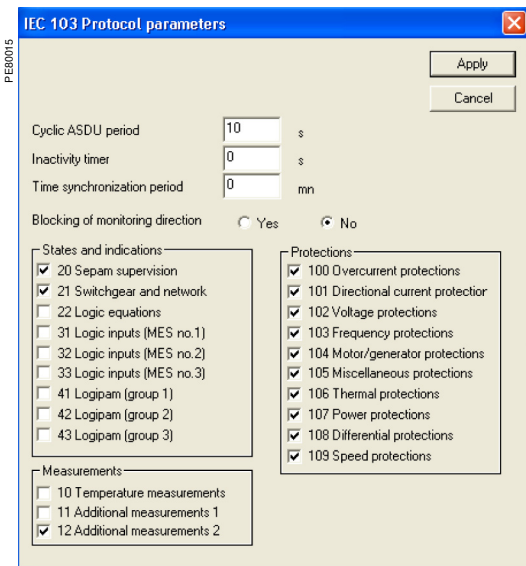
### Time synchronization period
Time synchronization is transmitted via ASDU 6.
If this ASDU has not been received at the end of time T (time synchronization period), Sepam will assume that its clock setting may be inaccurate and will assign the information "Invalid time" to time-tagged data.

### Blocking of monitoring direction
Sepam can suspend the transmission of data in the monitoring direction, in accordance with the procedure specified by IEC 60870-5-103.

| Parameters | Authorized values | Default value |
|---|---|---|
| Cyclic ASDU period | 0 to 60 seconds | 10 seconds |
| Inactivity timer | 0 to 60000 seconds | 0 (infinite) |
| Time synchronization period | 0 to 60000 minutes | 0 |
| Blocking of monitoring direction | No or Yes | No |



*Configuration of the IEC 60870-5-103 protocol.*

## Selection of the data to be exchanged

Sepam private data is categorized in three subsets:
- States and indications
- Protections
- Measurements

In each subset, the data is organized into functional groups. A functional group is identified by a function number (FUN).

The data groups to be exchanged with the supervisor can be selected in the configuration window.
Only the data groups required for the application should be selected, in order to avoid overloading communication unnecessarily (in particular in the event of a general interrogation on the part of the supervisor).
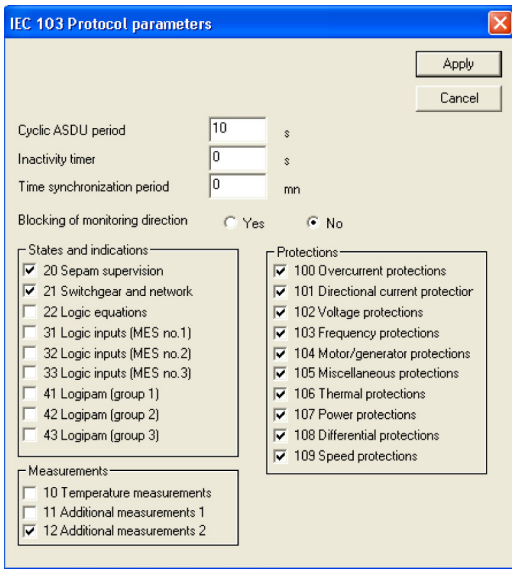


*Configuration of the IEC 60870-5-103 protocol.*

| FUN | Function | Sepam series 20 | | Sepam series 40 | Sepam series 60 | Sepam series 80 |
|---|---|---|---|---|---|---|
| | | B2X | Other | | | |
| | **States and indications** | | | | | |
| 20 | Sepam supervision | ■ | ■ | ■ | ■ | ■ |
| 21 | Switchgear and network | NA | ■ | ■ | ■ | ■ |
| 22 | Logic equations | NA | NA | □ | □ | □ |
| 31 | Logic inputs (MES no. 1) | □ | □ | □ | □ | □ |
| 32 | Logic inputs (MES no. 2) | NA | NA | NA | □ | □ |
| 33 | Logic inputs (MES no. 3) | NA | NA | NA | NA | □ |
| 41 | Logipam (group 1) | NA | NA | NA | NA | □ |
| 42 | Logipam (group 2) | NA | NA | NA | NA | □ |
| 43 | Logipam (group 3) | NA | NA | NA | NA | □ |
| | **Protections** | | | | | |
| 100 | Overcurrent protections | NA | ■ | ■ | ■ | ■ |
| 101 | Directional current protections | NA | NA | ■ | ■ | ■ |
| 102 | Voltage protections | ■ | NA | ■ | ■ | ■ |
| 103 | Frequency protections | ■ | NA | ■ | ■ | ■ |
| 104 | Motor/generator protections | NA | ■ | ■ | ■ | ■ |
| 105 | Miscellaneous protections | NA | ■ | ■ | ■ | ■ |
| 106 | Thermal protections | NA | ■ | ■ | ■ | ■ |
| 107 | Power protections | NA | NA | ■ | ■ | ■ |
| 108 | Differential protections | NA | NA | NA | ■ | ■ |
| 109 | Speed protections | NA | NA | NA | ■ | ■ |
| | **Measurements** | | | | | |
| 10 | Temperature measurements | NA | □ | □ | □ | □ |
| 11 | Additional measurements 1 | ■ | ■ | ■ | ■ | ■ |
| 12 | Additional measurements 2 | NA | NA | NA | NA | □ |

■ *Function available and selected by default*
□ *Function available and not selected by default*
*NA (Not Applicable): Function not available for a Sepam series, not displayed in the IEC103 Protocol parameters window*

## ⚠ DANGER

**HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS**
■ Only qualified personnel should install this equipement. Such work should be performed only after reading this entire set of instrucions and checking the technical characteristics of the device.
■ NEVER work alone.
■ Turn off all power supplying this equipement before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
■ Always use a properly rated voltage sensing device to confirm that all power is off.
■ Start by connecting the device to the protective earth and to the functional earth.
■ Screw tight all terminals, even those not in use.
**Failure to follow these instructions will result in death or serious injury.**

# Installation and operating instructions for Sepam

The communication interfaces must be installed and connected in accordance with the instructions in each Sepam user's and operation manual.
■ Sepam series 20 user's manual, reference PCRED301005EN,
■ Sepam series 40 user's manual, reference PCRED301006EN,
■ Sepam series 60 user's manual, reference PCRED310017EN,
■ Sepam series 80 operation manual, reference SEPED303003EN,

# Preliminary checks

The following preliminary checks must be made:
■ Check the CCA612 cord connection between the ACE969-2 interface and the Sepam base unit.
■ Check the auxiliary power supply connection to the ACE969-2.
■ Check the connection between the S-LAN communication port and the ACE969-2.
■ Check the complete configuration of the ACE969-2.

# Checking the operation of the ACE969-2 interface

You can use the following to check that the ACE969-2 interface is operating correctly:
■ The indicator LEDs on the front panel of the ACE969-2
■ The information provided by the SFT2841 software connected to Sepam:
□ On the Diagnosis screen
□ On the Communication configuration screens

### Indicator LEDs on the ACE969-2
■ Green "on" LED: ACE969-2 energized
■ Red "key" LED: ACE969-2 interface status
□ LED off: ACE969-2 configured and communication operational
□ LED flashing: ACE969-2 configuration error or ACE969-2 not configured
□ LED on: ACE969-2 error
■ S-LAN and E-LAN Tx / Rx LEDs:
□ S-LAN Tx LED flashing: Sepam transmitting
□ S-LAN Rx LED flashing: Sepam receiving
□ Tx and Rx off: RS 485 communication is idle
□ Tx or Rx LED is "on" while the RS 485 communication network is idle: the idle voltage state of the RS 485 network is incorrect
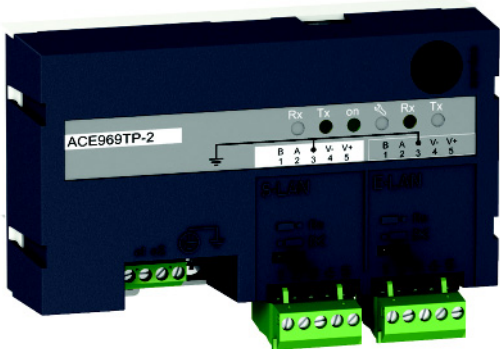


*ACE969TP-2 communication interface.*
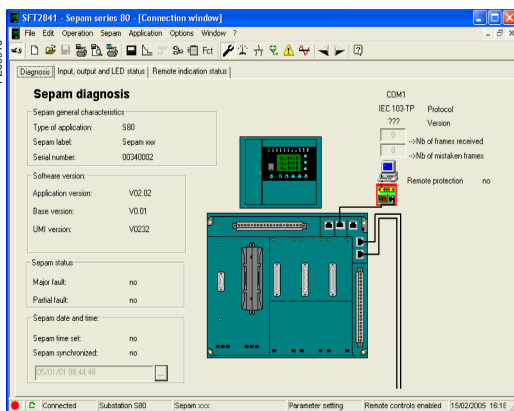


*SFT2841: Sepam series 80 diagnosis screen.*

## Diagnosis using SFT2841 software

**Sepam diagnosis screen**
When connected to Sepam, the SFT2841 software informs the operator of the general Sepam status and of the Sepam communication status in particular.
All Sepam status information appears on the Sepam diagnosis screen.

**Sepam communication diagnosis**
The operator is provided with the following information to assist with identifying and resolving communication problems:
■ Name of the protocol configured
■ IEC 60870-5-103 interface version number
■ Number of frames received
■ Number of mistaken frames received
These two counters are reset to zero if:
■ The maximum value (65535) is reached
■ The Sepam auxiliary power supply is lost
■ The communication parameters are modified

## Troubleshooting assistance

The following diagnosis information indicates whether Sepam and a supervisor are communicating correctly using the IEC 60870-5-103 protocol:

■ Indicator LEDs on the front panel of the ACE969-2:
□ Green "on" LED on
□ Red "key" LED off
□ S-LAN Rx and Tx LEDs flashing
■ Sepam diagnosis screen:
□ Name of the protocol configured: IEC 60870-5-103
□ IEC 60870-5-103 interface version number displayed
□ Number of frames received increasing at regular intervals
□ Number of mistaken frames received not increasing

Deviations from the above indicate that communication between Sepam and the supervisor has failed. The table below lists the possible causes of communication failures, along with the associated course of action to be taken in each case.

| Symptoms | | Possible cause | Action/Remedy |
|---|---|---|---|
| **ACE969-2 LEDs** | **SFT2841 diagnosis** | | |
| "On" LED off | Protocol = ???? and/or Version = ???? | No power supply to ACE969-2 | Check the auxiliary power supply to the ACE969-2. |
| "Key" LED on | Protocol = ???? and/or Version = ???? | ACE969-2 failed | Replace the ACE969-2. |
| "Key" LED flashing | Protocol = ???? and/or Version = ???? | ACE969-2 not configured | Configure the ACE969-2 using SFT2841. |
| | | ACE969-2 is not connected to Sepam. | Check the ACE969-2 connection to Sepam. |
| | | The ACE969-2 configuration is incorrect. | Use SFT2841 to check the interface selected: ACE969TP-2 or ACE969FO-2. |
| S-LAN Rx LED flashing | Increase in mistaken frame counter value | The ACE969-2 physical layer configuration is incorrect. | Use SFT2841 to check the following parameters: ■ Transmission speed ■ Parity |
| | | The communication protocol selected is incorrect. | Check the communication protocol selected. |
| | | The S-LAN network is not properly connected. | Check the connection of the S-LAN network and the RS 485 remote power supply. |
| S-LAN Rx LED flashing | The frame counter values are not increasing. | The supervisor is not sending frames to Sepam. | Use SFT2841 to check the Sepam address parameter and check that the supervisor is sending frames to Sepam. |
| | | The communication protocol selected is incorrect. | Check the communication protocol selected. |
| S-LAN Rx LED off | | The supervisor is not sending frames on the network. | Check that the supervisor is operating correctly. |
| | | The S-LAN network is not properly connected. | Check the connection of the S-LAN network and the RS 485 remote power supply. |
| Tx or Rx LED is "on" while the RS 485 communication network is idle. | | The idle voltage state of the RS 485 network is incorrect. | ■ Check that the pull-up and pull-down bias resistors are correctly installed on the RS 485 network. ■ Check that the 2 load resistors are correctly installed at each end of the RS 485 network. |

## Presentation

The Monitoring and Control data managed by Sepam is coded in accordance with the structure of standard ASDUs as specified in standard IEC 60870-5-103.

| ASDU | COT | Monitoring direction | Control direction | Description |
|------|-----|----------------------|-------------------|-------------|
| 1 | 1 | ■ | | Changes of state |
| 1 | 9 | ■ | | States in response to general interrogation |
| 2 | 1 | ■ | | Protection equipment tripping indication |
| 5 | 3,4,5 | ■ | | Identification |
| 9 | 2 | ■ | | Measurements |
| 20 | 20 | | ■ | Commands |

## Status information coding: ASDU 1 and ASDU 2

Information on Sepam states and indications is coded using ASDU 1 and ASDU 2. It is obtained via requests to scan class 1 data.

### ASDU 1

| Bytes | | Description |
|-------|--------------|-------------|
| 1 | 1 | *ASDU number* |
| 2 | 81h | *Structure qualifier* |
| 3 | 1 or 9 | *COT: 1 (spontaneous) or 9 (General Interrog. resp.)* |
| 4 | @ | *ASDU common address: Sepam address* |
| 5 | FUN | *FUN: function number* |
| 6 | INF | *INF: information number* |
| 7 | DPI | *DPI (Double Point Information): 1=OFF - 2=ON* |
| 8 | | *Milliseconds (least significant byte)* |
| 9 | Time-tagged label | *Milliseconds (most significant byte)* |
| 10 | | *Minutes + invalidity bit (most significant bit)* |
| 11 | | *Hours + Summer time bit (most significant bit)* |
| 12 | | *Additional information: 0 if COT=1* |
| | | *General interrogation number if COT=9* |

### ASDU 2

| Bytes | | Description |
|-------|--------------|-------------|
| 1 | 2 | *ASDU number* |
| 2 | 81h | *Structure qualifier* |
| 3 | 1 | *COT: 1 (spontaneous)* |
| 4 | @ | *ASDU common address: Sepam address* |
| 5 | FUN | *FUN: function number* |
| 6 | INF | *INF: information number* |
| 7 | DPI | *DPI (Double Point Information): 1=OFF - 2=ON* |
| 8 | 0 | *REL: Relative time elapsed between appearance of the fault and tripping (not managed by Sepam)* |
| 9 | 0 | |
| 10 | 0 | *FAN: Fault number (not managed by Sepam)* |
| 11 | 0 | |
| 12 | | *Milliseconds (least significant byte)* |
| 13 | Time-tagged label | *Milliseconds (most significant byte)* |
| 14 | | *Minutes + invalidity bit (most significant bit)* |
| 15 | | *Minutes + Summer time bit (most significant bit)* |
| 16 | | *Additional information: 0 if COT=1* |
| | | *General interrogation number if COT=9* |

## Sepam identification: ASDU 5

ASDU 5 is generated by Sepam in response to initialization commands sent by the master:

■ Reset CU (Communication Unit)
■ Reset FCB (Frame Count Bit)

IEC 60870-5-103 communication is only operational after initialization by the master station. In response to this initialization request, Sepam generates two successive ASDU 5 type messages.

### ASDU 5 in response to Reset CU

| | |
|---|---|
| First ASDU 5 message: | COT = 4 (Reset CU) and INF = 3 |
| Second ASDU 5 message: | COT = 5 (Start/restart) and INF = 4 |

### ASDU 5 in response to Reset FCB

| | |
|---|---|
| First ASDU 5 message: | COT = 3 (Reset FCB) and INF = 2 |
| Second ASDU 5 message: | COT = 5 (Start/restart) and INF = 4 |

Once communication has been established, if the master sends a new initialization request, only the first ASDU 5 message is generated.

### ASDU 5

| Bytes | | Description |
|---|---|---|
| 1 | 5 | *ASDU number* |
| 2 | 81h | *Structure qualifier* |
| 3 | COT | *COT: 3, 4 or 5* |
| 4 | @ | *ASDU common address: Sepam address* |
| 5 | FUN | *FUN: function number* |
| 6 | INF | *INF: information number 2, 3 or 4* |
| 7 | 2 | *Compatibility level* |
| 8 | "S" | *(level 2: Sepam does not support IEC 60870-5-103 generic services)* |
| 9 | "E" | |
| 10 | " " | |
| 11 | "S" | *Manufacturer identification (8 ASCII characters) "SE SEPAM"* |
| 12 | "E" | |
| 13 | "P" | |
| 14 | "A" | |
| 15 | "M" | |
| 16 | "G" | *Application software identification (4 ASCII characters)* |
| 17 | "4" | *For example, "G40 " for Sepam series 40 Generator application* |
| 18 | "0" | |
| 19 | " " | |

## Measurement coding: ASDU 9

Sepam measurements are coded using ASDU 9.
They are obtained via requests to scan class 2 data.

The size of ASDU 9 depends on the number of measurements provided.
The number of measurements is shown in the Structure qualifier field.

### ASDU 9

| Bytes | | Description |
|---|---|---|
| 1 | 9 | ASDU number |
| 2 | n | Number of measurements coded in ASDU |
| 3 | 2 | COT: 2 (cyclical) |
| 4 | @ | ASDU common address: Sepam address |
| 5 | FUN | FUN: function number |
| 6 | INF | INF: information number |
| 7 | MES 1 | Measurement 1 (least significant byte) |
| 8 | | Measurement 1 (most significant byte) |
| .. | ... | |
| .. | .. | |
| .. | MES n | Measurement n (least significant byte) |
| Zz | | Measurement n (most significant byte) |

Where Zz = 8 + 2 x (n - 1)

Each measurement is coded on 2 bytes.
The value provided is a value standardized by IEC 60870-5-103 which is coded as a 13-bit 2's complement value (bits 3 to 15). It is expressed in relation to a reference value.
Bit 0 is the overflow bit (OV: Overflow)
Bit 1 is the error bit (ERR)
Bit 2 is a reserved bit (RES); it is always 0

| Most significant byte | | | | | | | | Least significant byte | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Signed IEC standardized value on 13 bits | | | | | | | | | | | | | RES | ERR | OV |

The actual value measured by Sepam is obtained from the IEC standardized value using the following formula:

$$\text{Measured value} = \text{Reference value} \times \frac{\text{Standardized value CEI} + 1}{2^{12}}$$

Sepam provides different types of measurements for which the reference values are:

| Measurement types | Reference value | Dynamic |
|---|---|---|
| Currents | 1.2 x Rated current | 120% |
| Voltages | 1.2 x Rated voltage | 120% |
| Powers (P, Q) | 1.2 x U x I x $\sqrt{3}$ | 120% |
| Frequencies | 1.2 x Rated frequency | 120% |
| Negative sequence/ unbalance, total harmonic distortion, etc. | 1.2 | 120% |
| Cos Phi | 1 | 100% |
| Temperature | 200°C | 100% |

For example, if the rated current on Sepam is set to 630 A, the current value coded as 3251 represents a measured current equal to 600 A.
The value 3251 (0CB3h) is coded:

| Most significant byte | | | | | | | | Least significant byte | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Signed IEC standardized value on 13 bits | | | | | | | | | | | | | RES | ERR | OV |
| 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | C | | | | B | | | | 3 | | | | 0 | 0 | 0 |

## Command coding: ASDU 20

Commands are sent to Sepam (enable/disable functions, open/close, remote controls, etc.) via ASDU 20.

A command is always confirmed by Sepam through generation of an acknowledgement message by return using ASDU 1 (COT 20).
The General Command ASDU includes an identification number (Return Information Identifier, from 0 to 255), selected arbitrarily by the master. This number is copied as is by Sepam into the Command Acknowledgement ASDU so that a link can be established with the Command ASDU.
The value of the command is coded in the DCI (Double Command Information) byte; the authorized values are OFF (1) and ON (2).

### ASDU 20

| Bytes | | Description |
|---|---|---|
| 1 | 20 | *ASDU number* |
| 2 | 81h | *Structure qualifier* |
| 3 | 20 | *COT: 20 (general command)* |
| 4 | @ | *ASDU common address: Sepam address* |
| 5 | FUN | *FUN: function number* |
| 6 | INF | *INF: information number* |
| 7 | DCI | *DCI (Double Command Information): 1=OFF - 2=ON* |
| 8 | RII | *RII: Return Information Identifier* |

## Presentation

Sepam records information, in the form of files, produced by the following functions:
■ Disturbance records
■ Tripping contexts (for Sepam series 60 and Sepam series 80 only)
These files can be retrieved using a file transfer procedure based on private ASDUs 254 and 255.

## Types of file to be transferred

### Definitions

The files that can be transferred from Sepam to the supervisor are:
■ 1 DR (Disturbance Records) directory file, which contains the information required for transferring disturbance record files saved in Sepam
■ 1 TR (Tripping Records) directory file, which contains the information required for transferring Tripping context files saved in Sepam
■ Disturbance record files, which contain data saved in Sepam on events via the Disturbance recording function
■ Tripping context files, which contain data saved by Sepam on tripping

### File names

Each file is identified by a name coded in ASCII-character.

| File | File name | Size of file name (in bytes) |
|---|---|---|
| DR directory | DR | 2 |
| Disturbance records | yyyy-mm-dd-hh-mn-sssss | 22 |
| TR directory | TR | 2 |
| Tripping contexts | yyyy-mm-dd-hh-mn-sssss | 22 |

The name of Disturbance record and Tripping context files is encoded with the date the file is saved by Sepam:
■ yyyy: year coded on 4 ASCII characters
■ mm: month coded on 2 ASCII characters, from 01 to 12
■ dd: day coded on 2 ASCII characters, from 01 to 31
■ hh: hour coded on 2 ASCII characters, from 00 to 23
■ mn: minutes coded on 2 ASCII characters, from 00 to 59
■ sssss: milliseconds coded on 5 ASCII characters, from 00000 to 59999

## Transfer principle

A Disturbance record file is transferred from Sepam to the supervisor in three stages:
**1.** The DR directory file is read by the supervisor
**2.** The contents of the DR file is interpreted by the supervisor, to identify the Disturbance record file to be transferred
**3.** The selected Disturbance record file is read

A Tripping context file is transferred from Sepam to the supervisor in the same way, using the TR directory file.

## Reading a file

### Procedure

The same procedure applies for reading all files (directory files and data files). This consists of an exchange of requests/responses between the supervisor and Sepam:
■ The supervisor sends requests based on ASDU 254 (private ASDU).
■ Responses from Sepam are retrieved by the supervisor via requests to scan class 1 data. Responses from Sepam are based on ASDU 255 (private ASDU).

A file is read in three stages:
**1.** The file to be transferred is opened via an Open request/response
**2.** Data is transferred from the file through a succession of Read Block requests/responses
**3.** The file is closed via a Close request/response

### Notes

■ Only one file can be open at any one time: the directory must therefore be closed after reading, in order to be able to read one of the files in this directory.
■ For an open file, only one transfer is permitted at any one time.
■ A data block contains a maximum of 238 bytes. The number of Read Block requests necessary to transfer a file depends on its size.

### ASDU requests and responses

| ASDU | FUN | Control direction | Monitoring direction | Description |
|------|-----|-------------------|----------------------|-------------|
| 254 | 105 | ■ | | Open request |
| 255 | 105 | | ■ | Open response |
| 254 | 101 | ■ | | Read Block request |
| 255 | 101 | | ■ | Read Block positive response |
| 255 | 103 | | ■ | Read Block negative response |
| 254 | 106 | ■ | | Close request |
| 255 | 106 | | ■ | Close response |

### Checking and processing errors
Sepam performs a series of checks to ensure that a file is read correctly.
Any error that occurs whilst a file is being read causes the file to be closed automatically by Sepam.

**Block number sequence check**
Data blocks are numbered starting at 0. Blocks must be read in ascending order.
It is possible to reread the same block i several times, as long as no request has been made for the next block i+1 to be read.
A sequence error in the block number requested in a Read Block request generates a negative Read Block response (status = incorrect block number).

**Data integrity check**
A Disturbance record file or Tripping context file in Sepam can be overwritten at any time by a new record if a new event occurs. If a file is in the process of being read, then data obtained by the supervisor will be corrupt. Sepam signals this error in the Close response (status = corrupt file).

**Inactivity check: aborting a read operation**
Sepam manages an inactivity time delay when a file read operation has been initialized, and throughout the entire course of the read operation. If there is more than 60 seconds between two Read Block requests or between the last Read Block request and the Close request, Sepam automatically closes the file. A spontaneous Close response is generated by Sepam (status = file closed on detection of inactivity).

### Execution reports
Responses from Sepam contain an execution report coded in the Status field of ASDU 255.
The values possible in the Status field are listed in the table below:

| Status | Description |
| --- | --- |
| 0 | OK |
| 3 | Open error response: file does not exist |
| 5 | Open error response: file already open |
| 6 | Read Block negative response and Close error response: file identifier incorrect |
| 16 | Read Block negative response and Close error response: file not open |
| 17 | Spontaneous Close response: file closed on detection of inactivity |
| 19 | Close error response: file corrupted |
| 20 | Read Block negative response: block number incorrect |

## Presentation

ASDU 254 and 255 are used to perform the 3 steps necessary for reading a file:
■ Open the file
■ Read the data blocks
■ Close the file
Coding of the request from the supervisor (ASDU 254) and coding of the response from Sepam (ASDU 255) is given for each step.

## Opening a file

### Open request

| Field | Size (bytes) | Description |
|---|---|---|
| 254 | 1 | ASDU number |
| 105 | 1 | FUN function number |
| X | 1 | Request number, selected arbitrarily by the supervisor |
| n | 1 | Length of the file name to be opened |
| Byte 1 ... Byte n | n | Name of the file to be opened |

### Open response

| Field | Size (bytes) | Description |
|---|---|---|
| 255 | 1 | ASDU number |
| 105 | 1 | FUN function number |
| X | 1 | Number of the corresponding Open req. |
| Status | 1 | Execution report |
| Least significant ... Most significant | 4 | File identifier *This identifier must be used in Read Block and Close requests* |
| Least significant ... Most significant | 4 | File size in bytes *(value on 32 bits)* |

## Reading a data block

### Read Block request

| Field | Size (bytes) | Description |
|---|---|---|
| 254 | 1 | *ASDU number* |
| 101 | 1 | *FUN function number* |
| | 4 | *Open file identifier (provided by Sepam in the Open response)* |
| | 4 | *Block number to be read* |

### Read Block positive response

| Field | Size (bytes) | Description |
|---|---|---|
| 255 | 1 | *ASDU number* |
| 101 | 1 | *FUN function number* |
| | 4 | *Open file identifier* |
| | 4 | *Block number read (most-significant bit at 1 if last block)* |
| n | 1 | *Block size in bytes* |
| Byte 1 ... Byte n | n | *Block data* |

For the last block, the most significant bit in the Block number field is set to 1 by Sepam.

### Read Block negative response

| Field | Size (bytes) | Description |
|---|---|---|
| 255 | 1 | *ASDU number* |
| 103 | 1 | *FUN function number* |
| | 4 | *Open file identifier* |
| Status | 1 | *Error report* |

## Closing a file

### Close request

| Field | Size (bytes) | Description |
|---|---|---|
| 254 | 1 | *ASDU number* |
| 106 | 1 | *FUN function number* |
| X | 1 | *Request number, selected arbitrarily by the supervisor* |
| | 4 | *Open file identifier (provided by Sepam in the Open response)* |

### Close response

| Field | Size (bytes) | Description |
|---|---|---|
| 255 | 1 | *ASDU number* |
| 106 | 1 | *FUN function number* |
| X | 1 | *Number of the corresponding Close req.* |
| | 4 | *Open file identifier (provided by Sepam in the Open response)* |
| Status | 1 | *Execution report* |

## Example 1: Complete read operation with no errors

| | Control system | | Protection equipment | |
|---|---|---|---|---|
| | Application layer | IEC103 link layer | IEC103 link layer | Application layer |

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| Control system Application layer | IEC103 link layer | IEC103 link layer | Protection equipment Application layer |
|---|---|---|---|
| Start reading: Open file Open request | SEND ASDU 254 FUN 105 | | |
| | | CONFIRM | |
| Scan class 1 data | REQUEST CLASS 1 | | |
| | | RESPOND ASDU 255 FUN 105 | Open response |
| Read first block Read Block (0) req. | SEND ASDU 254 FUN 101 | | |
| | | CONFIRM | |
| Scan class 1 data | REQUEST CLASS 1 | | |
| | | RESPOND ASDU 255 FUN 101 | Read Block response |
| Read block Read Block (1) req. | SEND ASDU 254 FUN 101 | | |
| | | CONFIRM | |
| Scan class 1 data | REQUEST CLASS 1 | | |
| | | RESPOND ASDU 255 FUN 101 | Read Block (1) response |
| ... | ... | ... | ... |
| Read last block Read Block (n) req. | SEND ASDU 254 FUN 101 | | |
| | | CONFIRM | |
| Scan class 1 data | REQUEST CLASS 1 | | |
| | | RESPOND ASDU 255 FUN 101 | Read Block (n) response (last block) |
| Close file Close request | SEND ASDU 254 FUN 106 | | |
| | | CONFIRM | |
| Scan class 1 data | REQUEST CLASS 1 | | |
| | | RESPOND ASDU 255 FUN 105 | Close response |
| End of file reading | | | |

## Example 2: Read operation interrupted on error (Read Block negative response)
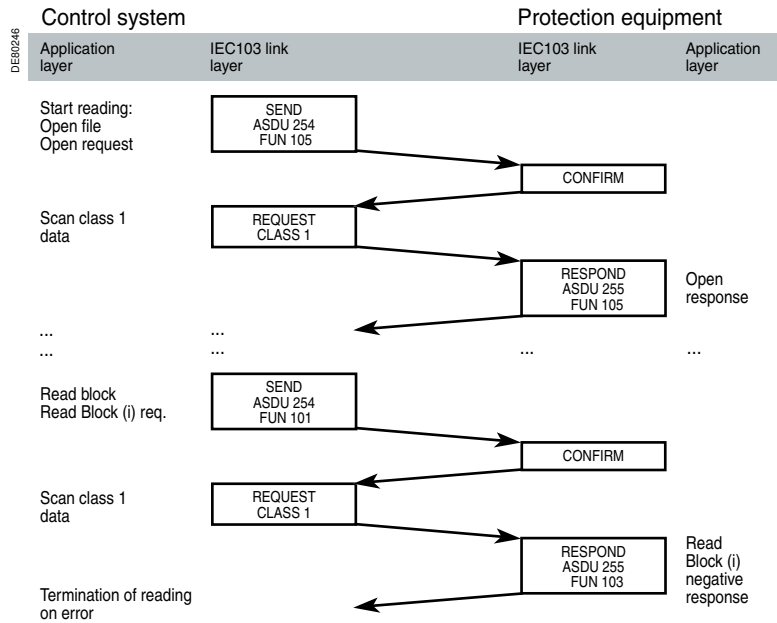


If an error occurs on a Read Block request, Sepam returns a negative Read Block response. The open file is automatically closed by Sepam.
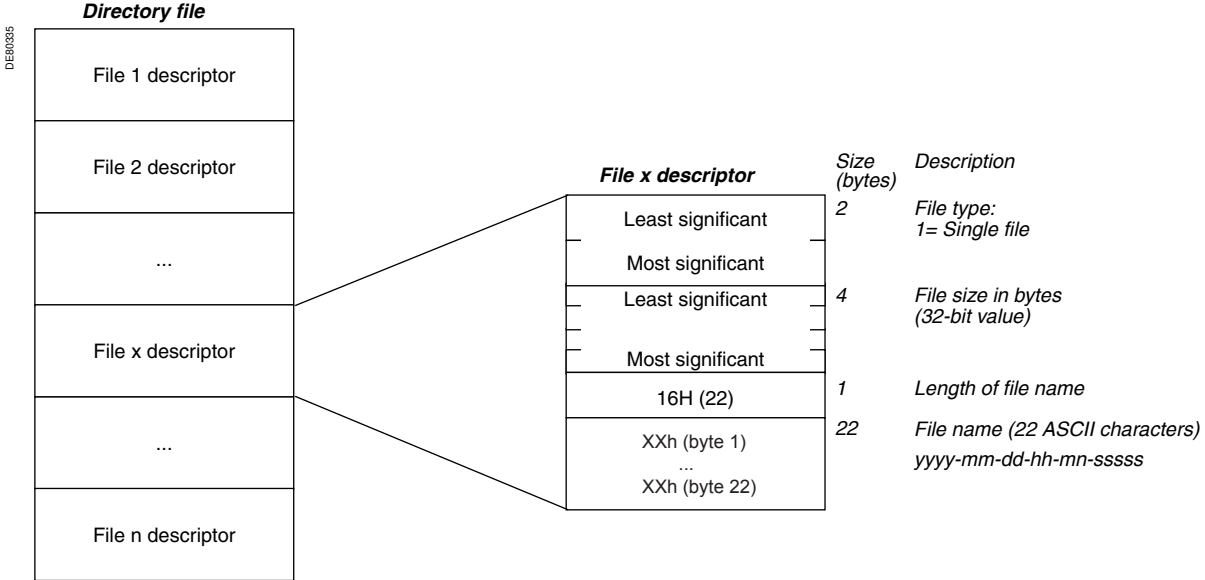
## Example 3: Read operation interrupted on Sepam abort (spontaneous Close response)
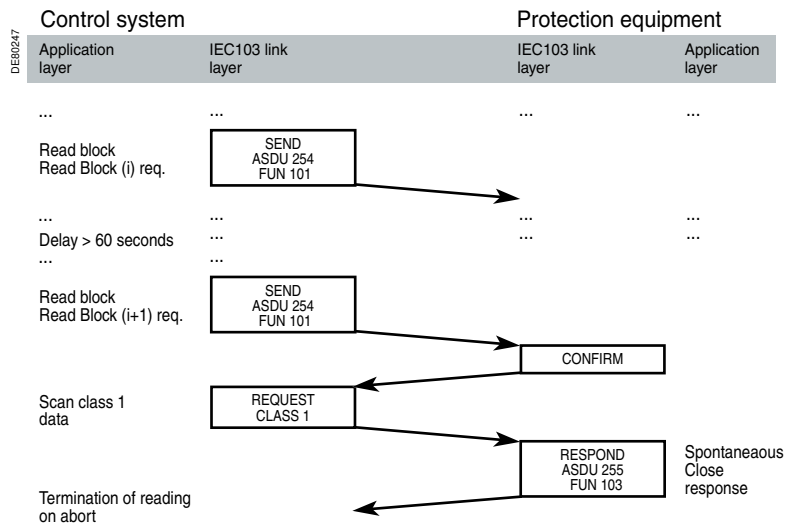


If more than 60 seconds elapses between two Read Block requests or between the last Read Block request and the Close request, Sepam automatically closes the file. A spontaneous Close response is generated by Sepam (status = file closed on detection of inactivity).

## DR or TR directory files

A directory file is a list of file descriptors.

*Directory file*

| Directory file |
|---|
| File 1 descriptor |
| File 2 descriptor |
| ... |
| File x descriptor |
| ... |
| File n descriptor |

| File x descriptor | Size (bytes) | Description |
|---|---|---|
| Least significant | 2 | File type: 1= Single file |
| Most significant | | |
| Least significant | 4 | File size in bytes (32-bit value) |
| Most significant | | |
| 16H (22) | 1 | Length of file name |
| XXh (byte 1) ... XXh (byte 22) | 22 | File name (22 ASCII characters) *yyyy-mm-dd-hh-mn-sssss* |

## Disturbance record file
## DR\yyyy-mm-dd-hh-mn-sssss

Disturbance records produced by Sepam are coded in COMTRADE format. This format is also the one used in the IEC 60870-5-103 standard (only the file reading procedure is different from the one defined by IEC 60870-5-103).

A COMTRADE disturbance record consists of two standard files:
■ A .CFG file, which includes the record configuration parameters (definition of analog and digital channels recorded, definition of sampling characteristics)
■ A .DAT file, which includes the sampled values recorded for each channel

The disturbance record files are stored in Sepam in the directory DR. The name of each file gives the date and time of its production. It is coded yyyy-mm-dd-hh-mn-sssss

A disturbance record file produced by Sepam is structured in such a way that the COMTRADE.CFG and .DAT files can be easily obtained.

**Structure of a Sepam disturbance record file**

| | Size (bytes) | Description |
|---|---|---|
| Low byte | 2 | Size in bytes (n) of the .CFG configuration data zone (16-bit value) |
| High byte | | |
| .CFG zone | n | Configuration parameters (.CFG file, ASCII format) |
| .DAT zone | X | Samples values (.DAT file, binary format) |

## Tripping context files
## TR\yyyy-mm-dd-hh-mn-sssss

The tripping context files are stored in Sepam in the directory TR. The name of each file gives the date and time of its production. It is coded yyyy-mm-dd-hh-mn-sssss

A tripping context file contains a set of measurements recorded by Sepam when a protection function trips.
It consists of two parts:
■ Date of the context, coded on 8 bytes
■ List of measurements, with each measurement coded on 32 bits (4 bytes)

**Structure of a Sepam tripping context file**

| | *Size (bytes)* | *Description* |
|---|---|---|
| Date | *8* | *Context date* |
| Measurement 1 | *4* | *List of 44 measurements* *Each measurement is a 32-bit numeric value coded on 4 bytes, from the most significant to the least significant.* |
| ... ... ... ... | | *...* |
| Measurement 44 | *4* | |

The tripping context date is coded on 8 bytes

| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | Reserved | | | | | *Reserved value, always 0* |
| 2 | | | | Year | | | | | *Year from 0 to 99* |
| 3 | 0 | 0 | 0 | 0 | | Month | | | *Month from 1 to 12* |
| 4 | 0 | 0 | 0 | | Day | | | | *Day from 1 to 31* |
| 5 | 0 | 0 | 0 | | Hours | | | | *Hours from 0 to 24* |
| 6 | 0 | 0 | | Minutes | | | | | *Minutes from 0 to 59* |
| 7 | | | Milliseconds (most significant) | | | | | | *Milliseconds from 0 to 59999* |
| 8 | | | Milliseconds (least significant) | | | | | | |

The tripping context comprises the 44 measurements listed in the table below.

| No. | Information | Format | Unit |
|-----|-------------|--------|------|
| 1 | Tripping current phase 1 Itrip1 | 32NS | 0.1 A |
| 2 | Tripping current phase 2 Itrip2 | 32NS | 0.1 A |
| 3 | Tripping current phase 3 Itrip3 | 32NS | 0.1 A |
| 4 | Residual current I0Σ | 32NS | 0.1 A |
| 5 | Residual current I0 | 32NS | 0.1 A |
| 6 | Negative-sequence current Ii | 32NS | 0.1 A |
| 7 | Phase-to-phase voltage U21 | 32NS | 1 V |
| 8 | Phase-to-phase voltage U32 | 32NS | 1 V |
| 9 | Phase-to-phase voltage U13 | 32NS | 1 V |
| 10 | Phase-to-neutral voltage V1 | 32NS | 1 V |
| 11 | Phase-to-neutral voltage V2 | 32NS | 1 V |
| 12 | Phase-to-neutral voltage V3 | 32NS | 1 V |
| 13 | Residual voltage V0 | 32NS | 1 V |
| 14 | Positive sequence voltage Vd | 32NS | 1 V |
| 15 | Negative-sequence voltage Vi | 32NS | 1 V |
| 16 | Frequency f | 32NS | 0.01 Hz |
| 17 | Active power P | 32S | 1 kW |
| 18 | Reactive power Q | 32S | 1 kvar |
| 19 | Apparent power S | 32S | 1 kVA |
| 20 | Additional tripping current I'trip1 | 32NS | 0.1 A |
| 21 | Additional tripping current I'trip2 | 32NS | 0.1 A |
| 22 | Additional tripping current I'trip3 | 32NS | 0.1 A |
| 23 | Additional residual current I'0Σ | 32NS | 0.1 A |
| 24 | Additional residual current I'0 | 32NS | 0.1 A |
| 25 | Additional negative-sequence current I'i | 32NS | 0.1 A |
| 26 | Phase-to-phase voltage U'21 | 32NS | 1 V |
| 27 | Phase-to-phase voltage U'32 | 32NS | 1 V |
| 28 | Phase-to-phase voltage U'13 | 32NS | 1 V |
| 29 | Phase-to-neutral voltage V'1 | 32NS | 1 V |
| 30 | Phase-to-neutral voltage V'2 | 32NS | 1 V |
| 31 | Phase-to-neutral voltage V'3 | 32NS | 1 V |
| 32 | Residual voltage V'0 | 32NS | 1 V |
| 33 | Positive sequence voltage V'd | 32NS | 1 V |
| 34 | Negative-sequence voltage V'i | 32NS | 1 V |
| 35 | Frequency f' | 32NS | 0.01 Hz |
| 36 | Neutral-point voltage Vnt | 32NS | 1 V |
| 37 | H3 neutral-point voltage V3nt | 32NS | 0.1% |
| 38 | H3 residual voltage V3r | 32NS | 0.1% |
| 39 | Differential current Id1 | 32NS | 0.1 A |
| 40 | Differential current Id2 | 32NS | 0.1 A |
| 41 | Differential current Id3 | 32NS | 0.1 A |
| 42 | Through current It1 | 32NS | 0.1 A |
| 43 | Through current It2 | 32NS | 0.1 A |
| 44 | Through current It3 | 32NS | 0.1 A |

The tripping context measurements are 32-bit numeric values coded on 4 bytes, from the most significant to the least significant.
The following formats are used:
- 32 NS: 32-bit non-signed value
- 32 S: 32-bit signed 2's complement value

As standards, specifications and designs change from time to time, please ask for confirmation of the information given in this publication.

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