Electrical network protection

Sepam series 80
Modbus communication

User's manual
10/2009

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.

ANSI symbol.

IEC symbol.

Risk of electric shock

The addition of either symbol to a “Danger” or “Warning” safety label on a device indicates that an electrical hazard exists, which will result in death or 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 and prompt you to consult the manual. Obey all safety instructions that follow this symbol in the manual to avoid possible injury or death.

Safety messages

⚠ DANGER

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

⚠ WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, **could result in** death, serious injury or property damage.

⚠ CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, **could result in** minor or moderate injury or property damage.

CAUTION

CAUTION, used without the safety alerts symbol, indicates a potentially hazardous situation which, if not avoided, **could result in** property damage.

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.

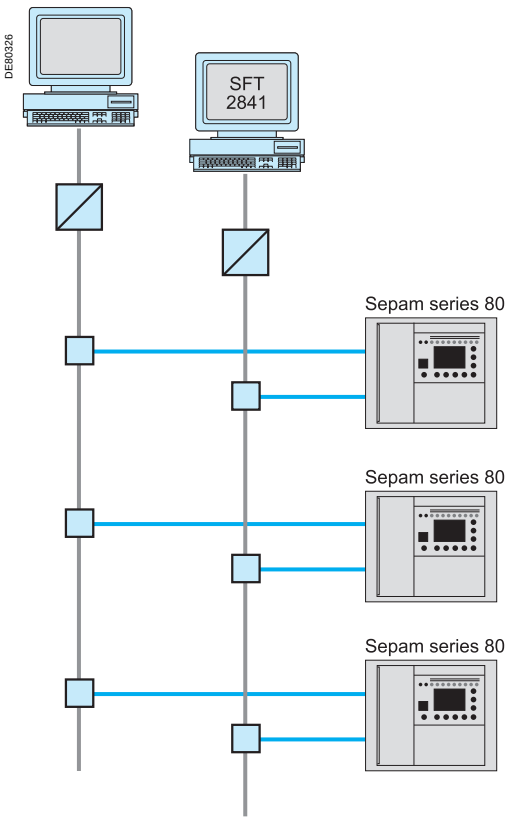
Device operation

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.

Content



Sepam series 80 - two ports for communication and remote operation by SFT2841.

General

Modbus communication allows Sepam to be connected to a supervisor or any other device with a master Modbus communication channel.
Sepam is always a slave station.
Sepam series 80 has 2 identical and independent serial communication ports, COM1 and COM2. Sepam series 80 can also be fitted with an optional Ethernet communication interface. Use of COM2 port and Ethernet interface are mutually exclusive.

Sepam is connected to a Modbus communication network via a communication interface.
There is a choice of 3 types of communication interface:
- communication interfaces to connect Sepam to a single serial network:
  - ACE949-2, for connection to a 2-wire RS 485 network
  - ACE959, for connection to a 4-wire RS 485 network
  - ACE937, for connection to a fiber-optic star network
- communication interfaces to connect Sepam to 2 serial networks:
  - ACE969TP-2, for connection to:
    - one 2-wire RS 485 Modbus S-LAN supervision communication network
    - one 2-wire RS 485 E-LAN engineering communication network
  - ACE969FO-2, for connection to:
    - one fiber-optic Modbus S-LAN supervision communication network
    - one 2-wire RS 485 E-LAN engineering communication network
- communication interfaces to connect Sepam to an Ethernet network:
  - ACE850TP for electrical connection to the network
  - ACE850FO for optical connection to the network.

Accessing Sepam data

Data available

Modbus communication provides access to many different functions, including:
- reading of metering and diagnosis information
- reading of status conditions and remote indications
- transfer of time-tagged events
- transfer of disturbance-recording data
- viewing of protection settings
- reading of Sepam configuration and identification
- remote control of the analog output
- time-setting and synchronization.

The actual list depends on the application, the type of Sepam and the enabled functions.

Modbus communication also offers a number of additional functions (when enabled):
- transmission of remote controls
- modification of protection settings.

A password may be set up to protect access to these two functions.

Access modes

Depending on the data, two access modes are used:
- direct access - the data may be accessed directly in a single read or write operation
- indirect access - access requires a number of read and write operations, using a protocol that is specific to the data accessed.

Customized table

With Sepam series 80, it is possible to set up for each Modbus port a customized sub-group of data for quick reading of the most significant information on the user application.

Compatibility with Sepam 2000

Even though Sepam series 80 offers many additional functions, it remains compatible with Sepam 2000 addresses and formats for most information.

Protocol operation

Modbus is used to exchange information between a master and one or more slave units, identified by a number. It implements request-reply dialog, where requests are always initiated by the master. Modbus exists in ASCII and binary (RTU mode) formats.

Data is exchanged in the form of 16-bit words (also called registers) or simply bits. Each piece of information (bit or register) has a 16-bit address.

A detailed description of the protocol is provided in the appendix. It may also be found at **www.modbus.org**.

Modbus functions

The Modbus protocol used by Sepam series 80 is a compatible sub-group of the RTU Modbus protocol.
The functions listed below are handled by Sepam series 80:
- basic functions (data access):
  - function 1: reading of n output or internal bits
  - function 2: reading of n input bits
  - function 3: reading of n output or internal words
  - function 4: reading of n input words
  - function 5: writing of 1 bit
  - function 7: high-speed reading of 8 bits
  - function 15: writing of n bits
  - function 16: writing of n words.
- communication-management functions:
  - function 8: Modbus diagnosis
  - function 11: reading of Modbus event counter
  - function 43: sub-function 14: reading of identification.
- enhanced functions:
  - function 102: secure access.

The following exception codes are supported:
- 1: unknown function code
- 2: incorrect address
- 3: incorrect data
- 4: not ready (cannot process request)
- 7: not acknowledged (remote reading and setting in particular).

Multi-master operation

Serial line Modbus operation

When Sepam units are connected via a gateway to a multiple-access network (Ethernet, Modbus+, etc.), a number of masters may address the same unit via the same communication port.
The serial line Modbus protocol cannot manage this type of architecture. The network designer is responsible for avoiding collisions.
- For direct-access data, in general, no particular precautions must be taken.
- For indirect-access data, Sepam provides two exchange zones on each port, making possible two simultaneous, independent accesses by two different masters.

Modbus over TCP/IP operation

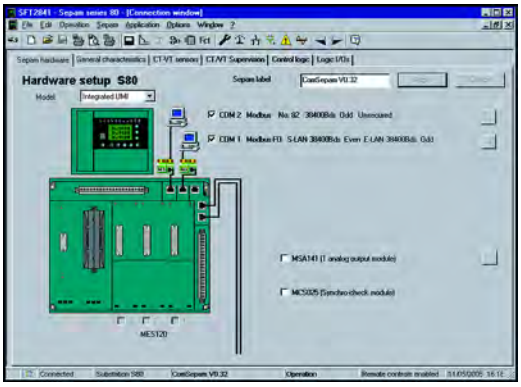
The ACE850 accepts up to 8 simultaneous Modbus/TCP connections.
Sepam accepts the Unit-Id 255 or any value in the range 1-247.
If several clients are accessing indirect-access data, they must make proper use of the two exchange zones provided. No access synchronization is provided by Sepam units.

Performance

The typical response time (time between the end of request reception and sending the reply) is less than 10 milliseconds for 90% of exchanges.
It may occasionally be longer, but not exceed 150 ms.
In indirect mode, the time needed between the request (or an acknowledgment) and the availability of the corresponding data is linked to the Sepam low-priority cycle time and may vary from a few dozen to several hundred milliseconds.

Configuring the communication interfaces
Serial line communication

PE50557



SFT2841: Sepam configuration screen.

Access to configuration parameters

The Sepam communication interfaces must be configured using SFT2841 software. The configuration parameters can be accessed from the Communication configuration window in the SFT2841 software.
To access this window:
- open the **Sepam configuration** window in SFT2841
- select the communication port you are going to configure, by checking the COM1 or COM2 box
- click on the relevant button ...: the **Communication configuration** window appears
- select the type of interface used: ACE949/ACE959/ACE937, ACE969TP or ACE969FO
- select the Modbus communication protocol.

The configuration parameters will vary depending on the communication interface selected: ACE949/ACE959/ACE937, ACE969TP or ACE969FO. The table below specifies the parameters to be configured depending on the communication interface chosen.

Parameters to be configured	ACE949 ACE959 ACE937	ACE969TP	ACE969FO
Physical layer parameters	■	■	■
Fiber-optic parameters			■
Advanced Modbus parameters	■	■	■
E-LAN parameters		■	■

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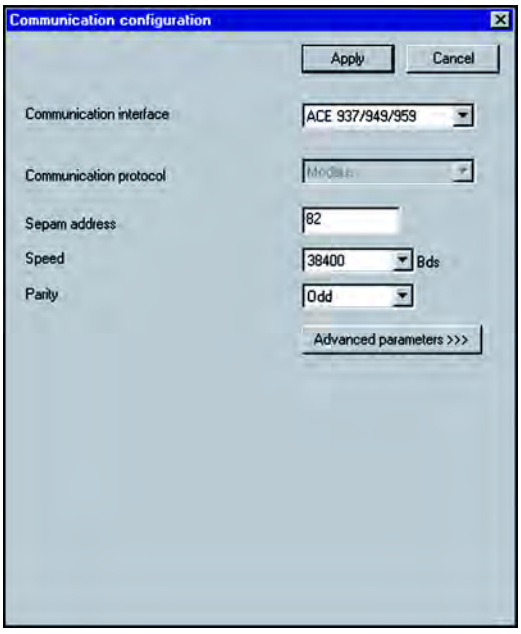

SFT2841: communication configuration window for ACE949.

Configuring the physical layer of the Modbus port

Asynchronous serial transmission is used with the following character format:
- 1 start bit
- 8 data bits
- 1 stop bit
- parity according to parameter setting.

The number of stop bits is always fixed at 1.
If a configuration with parity has been selected, each character will contain 11 bits: 1 start bit + 8 data bits + 1 parity bit + 1 stop bit.
If a no parity configuration has been selected, each character will contain 10 bits: 1 start bit + 8 data bits + 1 stop bit.

The configuration parameters for the physical layer of the Modbus port are as follows:
- slave number (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	19200 bps
Parity	No parity, even or odd	Even

Configuring the ACE969FO-2 fiber-optic port

The configuration for the physical layer of the ACE969FO-2 fiber-optic port is completed with the following 2 parameters:
- link idle state: light-on or light-off
- echo mode: with or without.

Fiber-optic parameters	Authorized values	Default value
Link idle state	Light Off or Light On	Light Off
Echo mode	Yes (fiber-optic ring) or No (fiber-optic star)	No

Note: *in echo mode, the Modbus master will receive the echo of its own request before the slave's reply. The Modbus master must be able to disregard this echo. Otherwise, it is impossible to create a Modbus fiber-optic ring.*

Configuring the communication interfaces
Serial line communication

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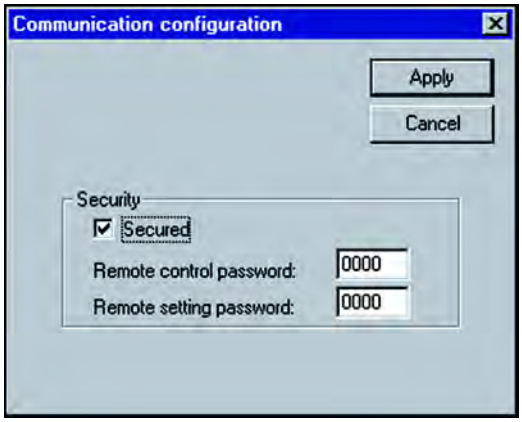

Modbus Advanced parameters window.

Configuring Modbus advanced parameters

With Sepam series 80, remote controls and remote settings can be protected by a password.
Advanced parameters can be used to configure the security function by:
- activating the function
- entering the password for the remote controls
- entering the password for the remote settings.

Advanced parameters	Authorized values	Default value
Security function	On/Off	Off
Remote controls password	4-digit code	0000
Remote settings password	4-digit code	0000

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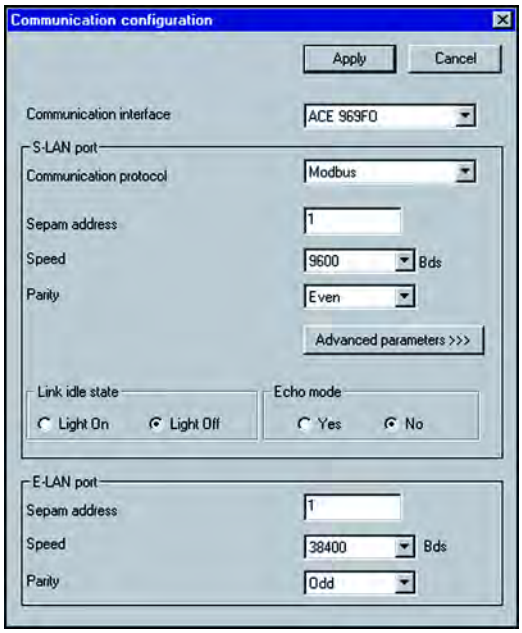

Communication configuration window for ACE969FO.

Configuring the physical layer of the ACE969-2 E-LAN port

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.

The number of stop bits is always fixed at 1.
If a configuration with parity has been selected, each character will contain 11 bits: 1 start bit + 8 data bits + 1 parity bit + 1 stop bit.
If a no parity configuration has been selected, each character will contain 10 bits: 1 start bit + 8 data bits + 1 stop bit.

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 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 communication port.

Configuring the communication interfaces
Ethernet communication

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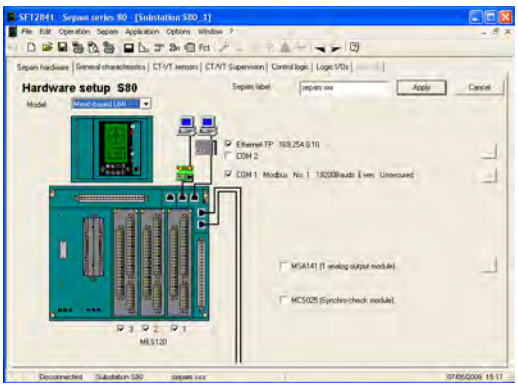

SFT2841: Sepam configuration screen.

Access to configuration parameters

The Sepam communication interfaces must be configured using SFT2841 software. The configuration parameters can be accessed from the Communication configuration window in the SFT2841 software.
To access this window:
- open the **Sepam configuration** window in SFT2841
- select the Ethernet communication port
- click on the relevant button ... : the **Communication configuration** window appears
- select the type of interface used: ACE850TP or ACE850FO.

Configuring an ACE850 involves:
- configuring the standard Ethernet parameters (mandatory)
- configuring one or more of the following sets of advanced optional parameters:
  - SNMP: Ethernet network management
  - SNTP: time synchronization
  - IP filtering: access control
  - RSTP: Ethernet ring management
  - User accounts: access control.

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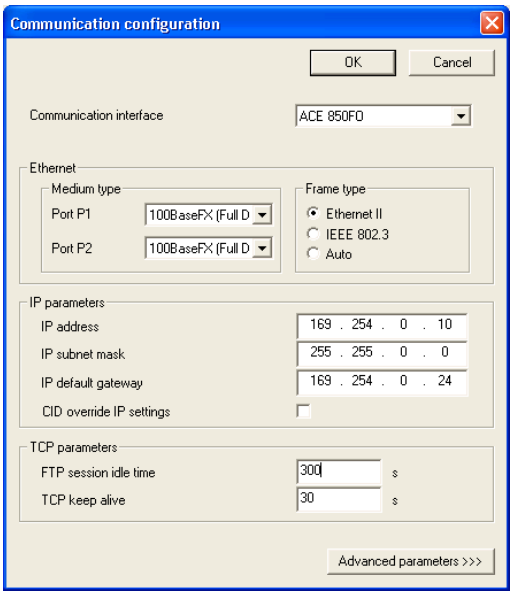


Ethernet and TCP/IP configuration

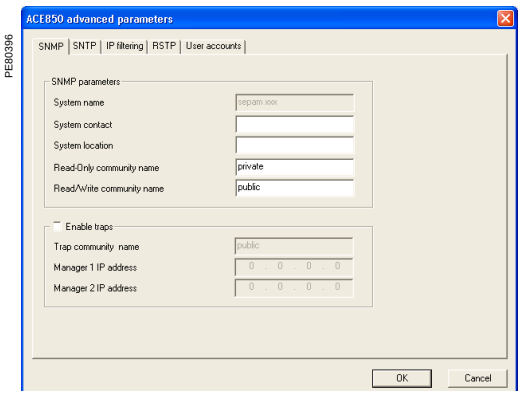
Before configuring the ACE850, obtain a unique static IP address, subnet mask, and default gateway address from the network administrator. See the section on IP address and parameter guidelines, page 9.

Parameters	Description	Authorized values
Frame format	Used to select the format for data sent over an Ethernet connection.	Ethernet II, 802.3, Auto **Default**: Ethernet II
Media type	Used to define the physical Ethernet connection.	ACE850TP ■ 10T/100Tx Auto ■ 10BaseT-HD ■ 10BaseT-FD ■ 100BaseTX-HD ■ 100BaseTX-FD **Default**: 10T/100Tx Auto
		ACE850FO ■ 100BaseFX-HD ■ 100BaseFX-FD **Default**: 100BaseFX-FD
IP address	Used to enter the static IP address of the ACE850.	0.0.0.0 to 255.255.255.255 **Default**: 169.254.0.10
Subnet mask	Used to enter the subnet mask of your network.	0.0.0.0 to 255.255.255.255 **Default**: 255.255.0.0
Default gateway	Used to enter the default gateway (router) IP address used for wide area network (WAN) communications.	0.0.0.0 to 255.255.255.255 **Default**: 0.0.0.0
Allow CID file to override IP parameters	This option is irrelevant when only Modbus communication is used.	**Default**: not checked
Keep alive	Timeout value used to test for session disconnection.	1 to 60 seconds **Default**: 30 seconds
FTP session inactivity timeout	Timeout value used to force disconnection of an inactive FTP session	30 to 900 seconds **Default**: 30 seconds

Duplicate IP address detection

The ACE850 IP address must be unique in the network. If it is not unique, the Status LED repeats a four blink-pause pattern and a new IP address must be assigned to the ACE850 or to the conflicting device.

Configuring the communication interfaces
Ethernet communication



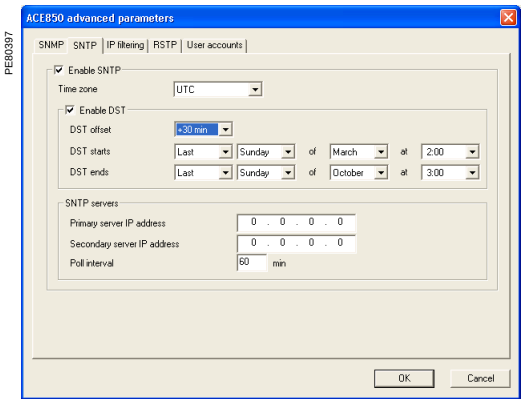
SFT2841: SNMP configuration.

SNMP configuration

The ACE850 supports SNMP V1, allowing a network administrator to remotely access it with an SNMP manager and view the network status and diagnostics in the MIB2 format (only a subset of MIB2 is implemented).
Additionally, the ACE850 may be configured to send SNMP traps in the following cases:

- ACE850 start/restart
- Link up
- Link down
- Authentication failure.

Parameters	Description	Authorized values
System Name	This parameter is the same as the Sepam label.	Not modifiable from this screen.
System Contact	Name of the administrative contact	String (< 16 characters) **Default**: empty string
System Location	Location of the Sepam/ACE850	String (< 16 characters) **Default**: empty string
Read-only Community Name	SNMP community that has read-only access to the MIB. Acts as a password.	String (< 16 characters) **Default**: "public"
Read-write Community Name	SNMP community that has read-write access to the MIB. Acts as a password.	String (< 16 characters) **Default**: "private"
Enable traps	Checking this check box enables SNMP to send traps.	**Default**: "not checked"
Traps Community Name	SNMP community that is used with traps.	String (< 16 characters) **Default**: "public"
Manager 1 IP address	IP address of the SNMP manager to which traps are sent.	0.0.0.0 to 255.255.255.255 **Default**: 0.0.0.0
Manager 2 IP address	IP address of a second SNMP manager to which traps are sent.	0.0.0.0 to 255.255.255.255 **Default**: 0.0.0.0



SFT2841: SNTP configuration.

SNTP configuration

SNTP is a time synchronization protocol that can be used to synchronize the Sepam. SNTP is used in mode 3-4 (unicast mode).

- If SNTP is used, the synchronization source for Sepam must be defined as Ethernet.
- If SNTP is not used, the Sepam synchronization must be ensured by other means (Modbus frames, synchronization tops).

Parameters	Description	Authorized values
Enable SNTP	Enables the time and date of the Sepam to be set by the Simple Network Time Protocol (SNTP) server.	**Default**: not enabled
Time Zone Offset	Determines the difference between local time and Coordinated Universal Time (UTC) (same as GMT).	UTC-12 to UTC+14 **Default**: UTC
Enable Daylight Saving Time	Enables the use of Daylight Saving Time (Summer time).	**Default**: not enabled
DST offset	Difference between standard time and Daylight Saving Time.	+ 30 or + 60 minutes **Default**: + 60 minutes
DST starts	If enabled, DST starts on the selected date.	**Default**: last Sunday of March
DST ends	If enabled, DST ends on the selected date.	**Default**: last Sunday of October
Primary Server IP Address	The IP address of the SNTP server the ACE850 contacts to get the time message.	0.0.0.0 to 255.255.255.255 **Default**: 0.0.0.0
Secondary Server IP Address	The IP address of another SNTP server the ACE850 contacts in case the primary server is down.	0.0.0.0 to 255.255.255.255 **Default**: 0.0.0.0
Poll Interval	Controls how often the ACE850 contacts the SNTP server for the correct time.	1 to 300 minutes **Default**: 60 minutes

Configuring the communication interfaces
Ethernet communication

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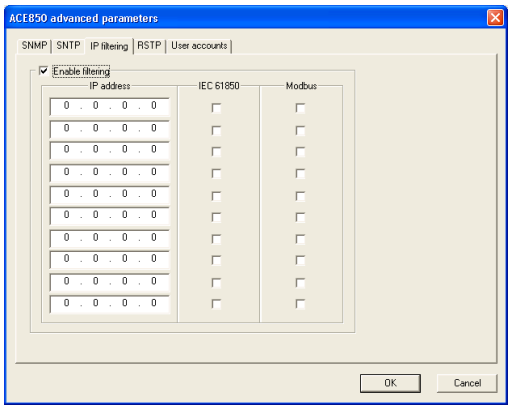

SFT2841: IP filtering configuration.

IP filtering configuration

The IP filtering function allows the administrator to specify which Modbus/TCP clients and which IEC 61850 clients have access to the ACE850 services.

Note: *if IP filtering is enabled, access is forbidden to any client not in the filtered list.*

Parameters	Description	Authorized values
Enable filtering	Check this box to activate filtering based on IP addresses.	**Default**: not enabled
IP address	The IP address of a client for which filtering options are defined.	0.0.0.0 to 255.255.255.255 **Default**: 0.0.0.0
IEC 61850	Check this box to grant IEC 61850 access to the given IP address.	**Default**: not checked
Modbus	Check this box to grant Modbus/TCP access to the given IP address.	**Default**: not checked

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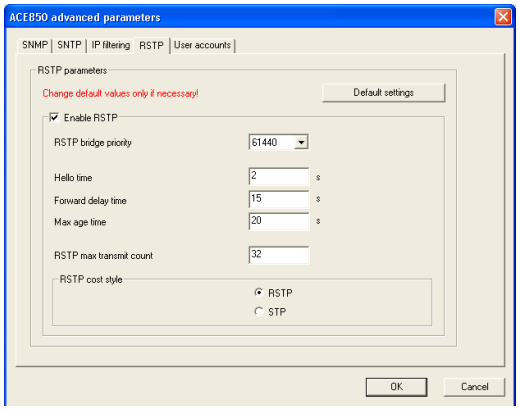


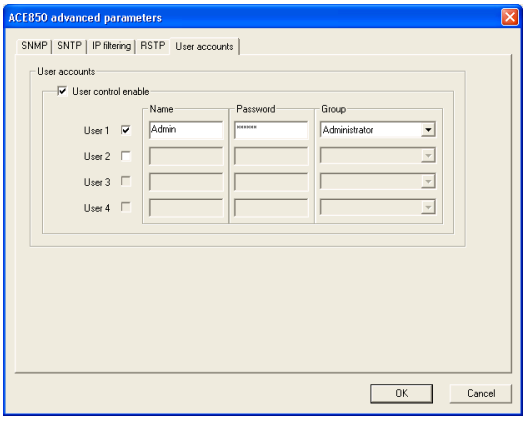
SFT2841: RSTP configuration.

RSTP configuration

The RSTP protocol enables the use of redundant Ethernet architectures such as rings.
It must be enabled each time the ACE850 is included in a loop. It may be disabled in other cases.
Changing the default settings is normally not required and should be performed with extreme care as it could jeopardize the stability of the Ethernet network.
If in doubt, it is always possible to revert to the default values using the Default settings button.

Parameters	Description	Authorized values
Enable RSTP	Check this box to activate the use of the RSTP protocol.	**Default**: enabled
Bridge priority	Priority of the bridge. The bridge with the lowest priority becomes root.	0 - 61440, by steps of 4096 **Default**: 61440
Hello time	Amount of time between the transmission of configuration messages	1 to 10 seconds **Default**: 2 seconds
Forward delay time	Time value to control how fast a port changes its spanning state when moving towards the forwarding state	4 to 30 seconds **Default**: 21 seconds
Max age time	Valid duration of configuration message once sent by the root bridge	6 to 40 seconds **Default**: 40 seconds
Max transmit count	Maximum BPDUs that can be transmitted by the Port Transmit state machine in any Hello time. This value limits the maximum transmission rate.	3 to 100 **Default**: 32
Cost style	RSTP (32 bits) or STP (16 bits) cost style selection	**Default**: RSTP

Note: *RSTP parameters must verify the following relationships:*
- *2 x (Forward_delay_time - 1 second) ⩾ Max_age_time*
- *Max_age_time ⩾ 2 x (Hello_time + 1 second).*



SFT2841: User accounts configuration.

User accounts configuration

ACE850 users are assigned usernames and passwords used to gain access to the FTP or WEB servers. Each user belongs to a group which determines the user's access rights:

- Administrator: read-write access to the FTP server, access to the WEB server
- Operator: read-only access to the FTP server, access to the WEB server
- Guest: no access to the FTP server, access to the WEB server

Up to 4 user accounts can be defined.

Parameters	Description	Authorized values
User control enable	Check this box to enable the configuration of users account. Currently, the ACE850 will not operate if this box is not checked. Ensure that this box is always checked.	**Default**: enabled
User n	Check this box to create this user account. Uncheck it to delete the account (only the last account in the list can be deleted).	**Default**: user 1 enabled Users 2 to 4 disabled
Name	User name	String (1 to 8 characters)
Password	User password	String (4 to 8 characters)
Group	Group to which the user belongs	Administrator, Operator, Guest

The following account is always created by default as user 1:

- Name: Admin
- Password: ACE850
- Group: Administrator

IP address and parameter guidelines

IP addresses

Several configuration parameters are IP addresses. These addresses must follow precise rules which are enforced by SFT2841 and ACE850. These rules are:

- Every IP address is made of 4 fields separated by dots: x . y . z . t
- Each field is a decimal value coded on 8 bits (range [0..255]).
- The first field (x) must be in the range [1..224] but must not be 127.
- Intermediate fields can cover the full range [0..255].
- The last field must not be 0 (range [1..255]).

IP subnet mask

The IP subnet mask is also made of 4 dot separated fields:

- The binary representation of the subnet mask is made of a set of 8 to 30 contiguous ones in the most significant part, followed by a set of contiguous zeroes (255.0.0.0 to 255.255.255.252).
- For a class A IP address ($x \leqslant 126$), the number of ones in the subnet mask must be at least 8 (255.y.z.t).
- For a class B IP address ($128 \leqslant x \leqslant 191$), the number of ones in the subnet mask must be at least 16 (255.255.z.t).
- For a class C IP address ($192 \leqslant x \leqslant 223$), the number of ones in the subnet mask must be at least 24 (255.255.255.t).
- The subnet part of the device IP address, obtained when applying the subnet mask, must not be 0.

IP default gateway

- An IP address of 0.0.0.0 means no gateway.
- If a gateway is defined, it must belong to the same subnet as the device.

Installing the communication network

Preliminary study

According to the installation characteristics and constraints, a technical study must first determine the communication network requirements, including:
- the type of medium (electrical or fiber optic)
- the number of Sepam units per network
- the transmission speed
- the ACE interfaces configuration
- the Sepam parameter settings.

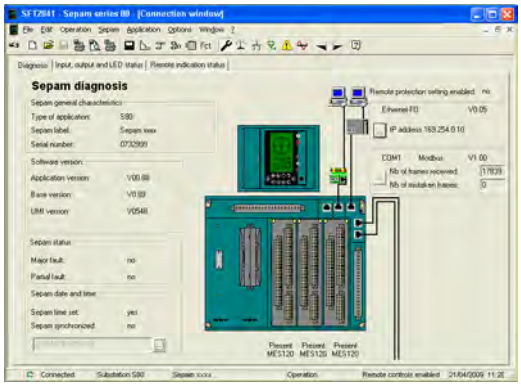
Sepam operating instructions

Communication interfaces must be installed and connected in accordance with the Sepam series 80 installation and operation manual instructions, reference SEPED303003EN.

Preliminary checks

Perform the following:
- check the CCA612 cord connection between the ACE interface and the Sepam base unit
- check the ACE Modbus communication port connection
- check the complete configuration of the ACE
- for the ACE969, check the auxiliary power supply connection.

PE80416



SFT2841: Sepam series 80 diagnosis screen.

Checking the operation of the ACE interface

You can use the following to check that an ACE interface is operating correctly:
- the indicator LEDs on the front panel of the ACE
- the information provided by the SFT2841 software connected to Sepam:
  - on the Diagnosis screen
  - on the Communication configuration screens.

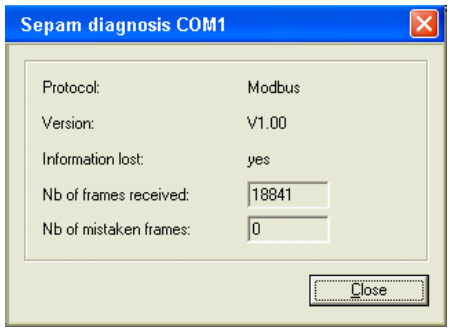
Link activity LED for ACE949-2, ACE959 and ACE937

The link activity LED for ACE949-2, ACE959 and ACE937 interfaces flashes when Sepam transmission or reception is active.

Indicator LEDs on the ACE969

- green "on" LED: ACE969 energized
- red "key" LED: ACE969 interface status:
  - LED off: ACE969 configured and communication operational
  - LED flashing: ACE969 configuration error or ACE969 not configured
  - LED on: ACE969 error
- S-LAN and E-LAN Tx/Rx LEDs:
  - Tx flashing: Sepam transmitting
  - Rx flashing: Sepam receiving
  - Tx and Rx off: RS 485 communication is idle
  - Tx or Rx LED on while the RS485 communication network is idle: the idle state voltage of the RS485 network is incorrect.

PE80417



SFT2841: Communication diagnosis.

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.
The Sepam diagnosis screen displays Sepam status information. You can get detailed status information about each communication channel using buttons on the 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
- Modbus interface version number
- number of valid frames received (CPT9)
- number of invalid (mistaken) frames received (CPT2).

Link activity LED

The ACE interface link activity LEDs are activated by variations in the signal on the Modbus network. When the supervisor communicates with Sepam (during transmission or reception), these LEDs flash.
After wiring, check the information given by the link activity LEDs when the supervisor operates.

Note: *flashing indicates that there is traffic passing to or from Sepam; it does not mean that the exchanges are valid.*

Functional test

If there is any doubt about correct operation of the link:
- run read/write cycles in the test zone
- use Modbus diagnosis function 8 (sub-code 0, echo mode).

The Modbus frames below, transmitted or received by a supervisor, are an example of a test performed when communication is implemented.

Test zone		
Read	Transmission	01 03 0C00 0002 C75B
	Reception	01 03 04 0000 0000 FA33
Write	Transmission	01 10 0C00 0001 02 1234 6727
	Reception	01 10 0C00 0001 0299
Read	Transmission	01 03 0C00 0001 B75A
	Reception	01 03 02 1234 B539
Function 8 - Modbus diagnosis, echo mode		
Transmission		01 08 0000 1234 ED7C
Reception		01 08 0000 1234 ED7C

Even in echo mode, Sepam recalculates and checks the CRC sent by the master:
- if the CRC received is valid, Sepam replies
- if the CRC received is invalid, Sepam does not reply.

Modbus diagnosis counters

Counter definition

Sepam manages the Modbus diagnosis counters. These are:
- **CPT1**: Number of valid frames received, whether the slave is involved or not
- **CPT2**: Number of frames received with a CRC error or physical error (frames with more than 255 bytes, frames received with at least one parity, overrun, framing or line-break error)
- **CPT3**: Number of exception responses generated (even if not transmitted, due to receipt of a broadcast request)
- **CPT4**: Number of frames specifically addressed to the station (excluding broadcasting)
- **CPT5**: Number of valid broadcast frames received
- **CPT6**: Not significant
- **CPT7**: Not significant
- **CPT8**: Number of frames received with at least one character having a physical error (parity, overrun, framing or line break)
- **CPT9**: Number of valid requests received and correctly executed.

Counter reset

The counters are reset to 0:
- when they reach the maximum value FFFFh (65535)
- when they are reset by a Modbus command (function 8)
- when Sepam auxiliary power is lost
- when communication parameters are modified.

Using the counters

Modbus diagnosis counters help to detect and resolve communications problems. They can be accessed by the dedicated read functions (Modbus protocol functions 8 and 11).
The CPT2 and CPT9 counters can be displayed on SFT2841
("Sepam Diagnosis" screen).
An incorrect speed (or parity) increments CPT2.
Non-reception is signaled by the lack of change on CPT9.

Operating anomalies

It is advisable to connect the Sepam units to the Modbus network one by one. Make sure that the supervisor is sending frames to the relevant Sepam by checking the activity on the RS 232 - RS 485 converter or the fiber-optic converter if there is one, and on the ACE module.

RS 485 network
- check the wiring on each ACE module
- check the tightness of the screw terminals on each ACE module
- check the connection of the CCA612 cord linking the ACE module to the Sepam base unit
- check that polarization is only at one point and that impedance matching is at both ends of the RS 485 network
- check the auxiliary power supply connection to the ACE969TP-2
- check that the ACE909-2 or ACE919 converter used is connected, powered and set up correctly.

Fiber-optic network
- check the connections on the ACE module
- check the connection of the CCA612 cord linking the ACE module to the Sepam base unit
- check the auxiliary power supply connection to the ACE969FO-2
- check that the converter or fiber-optic star used is correctly connected, powered and configured
- for a fiber-optic ring, check that the Modbus master can correctly handle the echo of its requests.

In all cases
- check all the ACE configuration parameters on SFT2841
- check the CPT2 and CPT9 diagnostic counters on SFT2841
("Sepam Diagnosis" screen).

Installing the Ethernet network

Preliminary study

According to the installation characteristics and constraints, a technical study must first determine the Ethernet network requirements, including:
- the network topology
- the various subnets (if any) and their interconnections
- the IP addressing scheme

Sepam operating instructions

Communication interfaces must be installed and connected in accordance with the Sepam series 80 installation and operation manual instructions, reference SEPED303003EN.

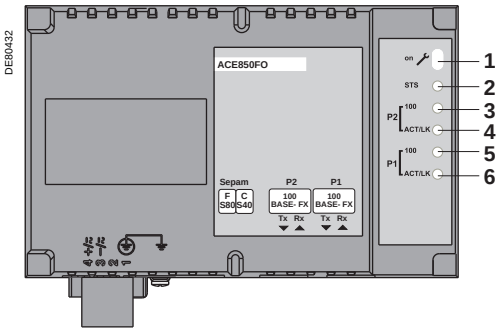
Preliminary checks

Perform the following actions:
- check the CCA614 cord connection between the ACE850 interface and the Sepam base unit
- check the connection of the ACE850 to the Ethernet network
- check the auxiliary power supply connection
- check the complete configuration of the ACE850.

Checking the operation of the ACE interface

You can use the following to check that an ACE850 interface is operating correctly:
- the indicator LEDs on the front panel of the ACE850
- the information provided by the SFT2841 software connected to Sepam
- the Web pages embedded inside the ACE850.

Basic diagnostics



ACE850 communication interface.

Diagnosis using indicator LEDs on the ACE850

1 On/fault indicator. This indicator has the following states:
- Off: the ACE850 interface is not powered
- steady red: the ACE850 is initializing or is faulty
- blinking red: the ACE850 is unable to establish communication with the Sepam base unit, or the ACE850 is not properly configured
- steady green: the ACE850 is operating correctly
- fast blinking green: indicates a transient state which occurs at startup when IEC 61850 communication is also used
- steady green and blinking red: communication with the base unit has been lost. This can indicate a normal situation due to a restart of the Sepam after parameters have been downloaded. The ACE850 automatically resumes normal operation in a few seconds.

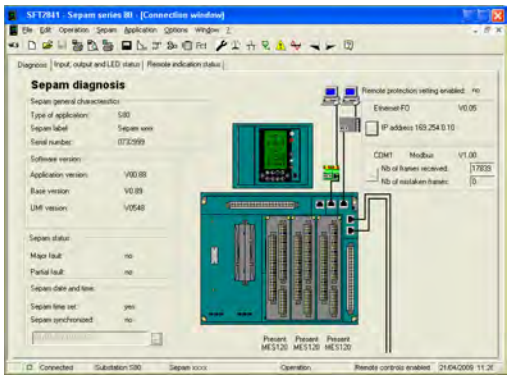
This status can also indicate an error condition, in which case, ACE850 restarts automatically within 15 seconds and try to re-establish connection.

2 Status indicator. This indicator has the following states:
- Off: the Ethernet communication is not started
- steady green: the Ethernet communication is correctly operating
- three blinks pattern: no logical Ethernet link
- four blinks pattern: duplicate IP address
- six blinks pattern: invalid IP configuration.

3 and **5** Speed indicators. These indicators have the following states:
- Off: the corresponding physical link is down or the port speed is 10Mbps
- On: the corresponding port operates at 100Mbps.

4 and **6** Link/Activity indicators. These indicators have the following states:
- Off: the corresponding physical link is not established
- On: the corresponding physical link is established
- blinking: the indicator blinks with the activity on the link.

PE80401

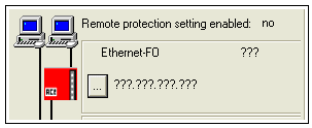


SFT2841: Sepam diagnosis screen.

Diagnosis using SFT2841 software

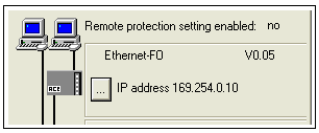
When connected to Sepam, the SFT2841 software informs the operator of the general Sepam status and of the Sepam communication status in particular.
Sepam status information appears on the Sepam diagnosis screen on which buttons can be used to obtain detailed status information on each communication channel.
The Sepam diagnosis screen can be used to check that the Sepam base unit and the ACE850 interface are correctly connected:

PE80405



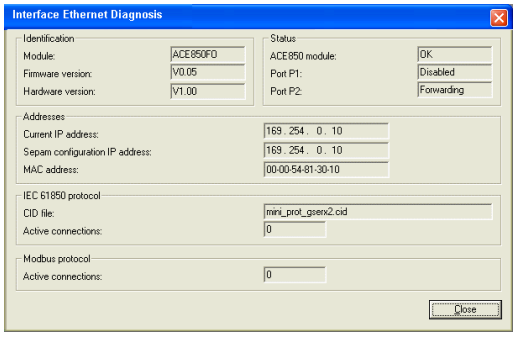
Diagnosis screen detail:
ACE850 not or improperly connected.

PE80406



Diagnosis screen detail:
ACE850 connected properly.

PE80402



SFT2841: Ethernet diagnosis screen.

The Ethernet diagnosis screen can be used to check:
- the ACE850 module status. The ACE850 status is OK if the ACE850 validates its configuration.
- the communication ports status
- the current ACE850 IP address. If the current IP address is different from the one configured, this could mean that the configured address is not valid, unless the IEC 61850 protocol is also being used.

Advanced diagnostics using the embedded Web server

The advanced diagnostics feature is only available when it is possible to establish an Ethernet connection with the ACE850. If not, the basic diagnostics must be used to solve the problems.

PE80403

ACE850 home page.

Accessing the ACE850 Web server

1. Start your web browser (Internet explorer 6.0 or higher, Mozilla Firefox for example).
2. In the address text box, type the address of the ACE850 (`169.254.0.10` is the default), then press **Enter**.
3. In the login window, type your username and password (default is `Admin`, `ACE850`).
4. From the left side menu, choose the language for the current session.
5. From the menu, click **Diagnostics** to access the diagnostics menu.

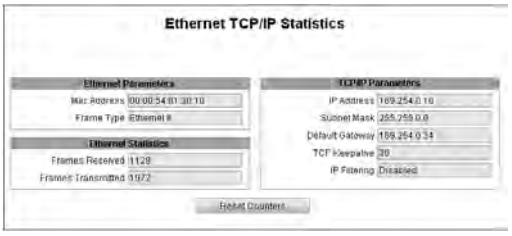
Diagnostics Web pages

There are two general diagnostics pages dealing with Ethernet operation:
- Ethernet global statistics
- Ethernet port statistics

There is also a set of protocol dedicated diagnostic pages:
- Modbus statistics
- IEC 61850 statistics (not covered in this manual)
- SNMP statistics
- SNTP statistics
- RSTP statistics

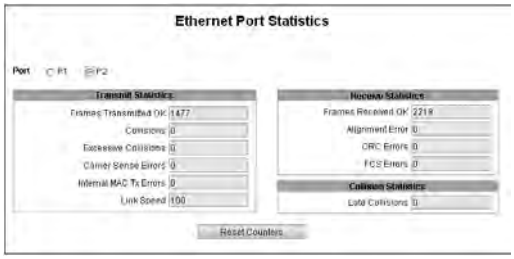
Diagnostic pages are automatically refreshed every 5 seconds (approximately).

PE80404



ACE850 Ethernet TCP/IP statistics.

PE80407



ACE850 Ethernet port statistics.

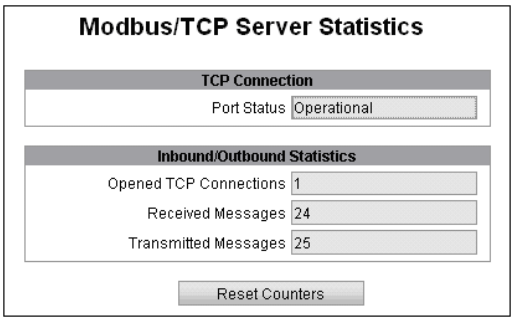
Ethernet TCP/IP statistics

Item	Description
Mac address	Unique Ethernet hardware address of the ACE850
Frame type	Value of the frame type configured with SFT2841
TCP/IP parameters	Parameter values configured with SFT2841
Frames received	Total number of received Ethernet frames, regardless of port or protocol
Frames transmitted	Total number of transmitted Ethernet frames, regardless of port or protocol
Reset Counters button	Button to reset the Ethernet counters

Ethernet port statistics

Item	Description
Port P1/P2 buttons	Selection of the port of which statistics are displayed
Frames transmitted OK	A counter that increments each time a frame is successfully transmitted.
Collisions	A counter that increments each time a frame is retransmitted due to collision detection.
Excessive collisions	A counter that increments each time a frame cannot be sent because it has reached the maximum collision status based on the Truncated Binary Exponential Backoff algorithm.
Carrier sense errors	A counter that increments each time there is a collision because carrier sense is disabled.
Internal MAC Tx errors	A counter that increments for every transmission error that is not caused by late, excessive, or carrier sense collisions.
Link speed	Actual link speed
Frames received OK	A counter that increments each time a frame is successfully received.
Alignment errors	A counter that increments each time a received frame has an FCS error and does not end on an 8-bit frame boundary.
CRC errors	A counter that increments each time a received frame has a CRC or an alignment error.
FCS errors	A counter that increments each time a received frame has a FCS or an alignment error.
Late collisions	A counter that increments each time a collision occurs after the slot time (512 bits starting at the preamble).
Reset counters button	Button to reset the port counters

PE80408



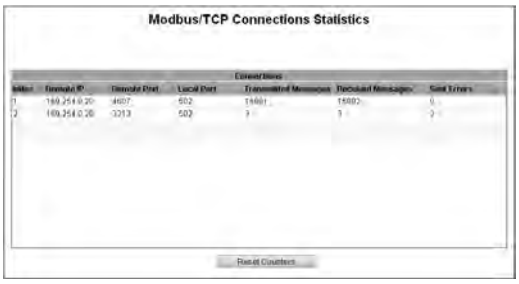
ACE850 Modbus/TCP server statistics.

Modbus/TCP server statistics

Item	Description
Port status	Modbus port status
Opened TCP connections	Number of Modbus clients currently connected
Received messages	Total number of Modbus requests
Transmitted messages	Total number of Modbus responses
Reset counters button	Button to reset the messages counters

Note: *the Web interface uses one Modbus connection to operate.*

PPE80409

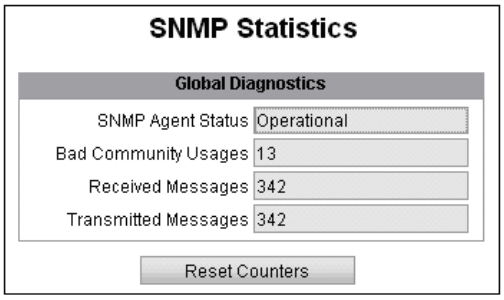


ACE850 Modbus/TCP connections statistics.

Modbus/TCP connections statistics

Item	Description
Index	Connection number
Remote IP	IP address of the Modbus client
Remote port	TCP port number on the client side
Local port	TCP port number on the server side
Transmitted messages	Number of Modbus requests for this connection
Received messages	Number of Modbus normal responses for this connection
Sent errors	Number of Modbus exception responses for this connection
Reset counters button	Button to reset the messages counters

PE80410

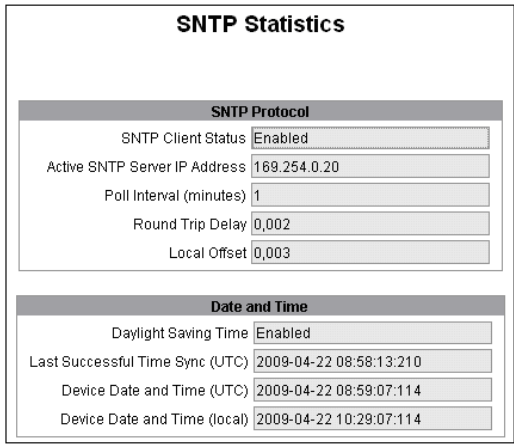


ACE850 SNMP statistics.

SNMP statistics

Item	Description
SNMP agent status	Status of the SNMP agent
Bad Community usages	Number of requests with invalid community
Received messages	Total number of SNMP requests
Transmitted messages	Total number of SNMP responses
Reset counters button	Button to reset the messages counters

PE80411

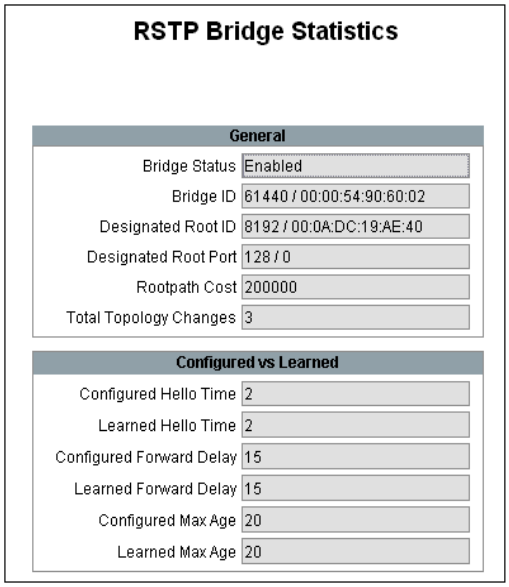


ACE850 SNTP statistics.

SNTP statistics

Item	Description
SNTP Client status	Value configured for the parameter in SFT2841
Active SNTP server IP address	Address of the server currently answering SNTP requests (0.0.0.0 if no server answer)
Poll interval	Value configured for the parameter in SFT2841
Round trip delay	Total time for SNMP request and response messages
Local offset	Difference between SNTP time and ACE time
Daylight saving time	Value configured for the parameter in SFT2841
Last Successful Time Synchronization (UTC)	Last time the ACE850 successfully contacted the SNTP server (UTC time)
Device Date and Time (UTC)	Current time and date of the ACE850 (UTC time)
Device Date and Time (local)	Current time and date of the ACE850 (local time)

PE80412

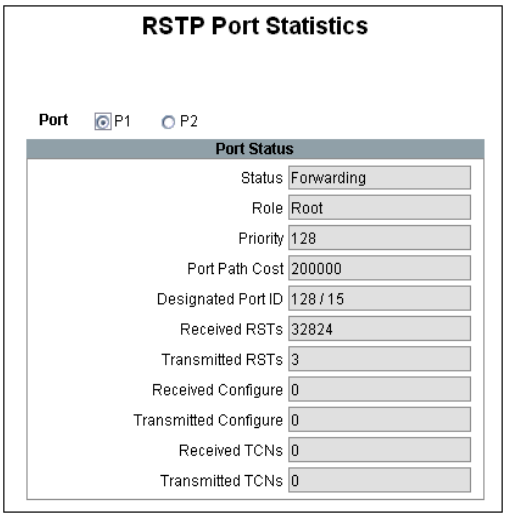


ACE850 RSTP bridge statistics.

RSTP bridge statistics

Item	Description
Bridge status	RSTP status of the bridge
Bridge ID	Bridge vector (Bridge priority/Bridge Mac address)
Designated Root ID	Bridge vector of the RSTP root bridge
Designated Root Port	Identifier of the root port (priority/number)
Rootpath cost	Path cost to the root
Total topology changes	Topology change counter (as defined by 802.1D-2004)
Configured hello time	Value of the configured hello time
Learned hello time	Operational value for hello time
Configured forward delay	Reminder of the configured forward delay
Learned forward delay	Operational value for forward delay
Configured max age	Value of the configured max age
Learned max age	Operational value for max age

PE80413



ACE850 RSTP port statistics.

RSTP port statistics

Item	Description
Port P1 / P2 buttons	Selection of the port of which statistics are displayed
Status	RSTP status for the selected port
Role	RSTP role for the selected port
Priority	Port priority
Port path cost	Port contribution to root path cost
Designated port ID	Identifier of the link partner port (priority/number)
Received RSTs	Number of RST BPDUs received (RSTP)
Transmitted RSTs	Number of RST BPDUs sent (RSTP)
Received configure	Number of Configuration BPDUs received (STP)
Transmitted configure	Number of Configuration BPDUs sent (STP)
Received TCNs	Number of Topology change BPDUs received (STP)
Transmitted TCNs	Number of Topology change BPDUs sent (STP)

Data addresses and coding

Presentation

Word addresses

All Sepam information accessible via Modbus communication is organized in 16-bit words. Each word is identified by its address coded on 16 bits, i.e. from 0 to 65535 (FFFFh).
However, to remain compatible with older equipment, the essential information has addresses coded from 0 to 9999 (270Fh).
In the following pages of this document, all addresses are expressed in hexadecimal (xxxxh).
Data which is similar from the control-monitoring application and the coding viewpoint is grouped in adjacent address zones.

Bit addresses

Some information is also available in bit form. The bit address is derived from the word address, where:
bit address = (word address x 16) + bit rank (0 to 15).
Example: word 0C00 bit 0 = C000, word 0C00 bit 14 = C00E.

Non-defined addresses

Only the addresses defined in this document should be used.
If other addresses are used, Sepam may return an exception message or data that is not significant.

Direct-access data

This data is permanently identified by its Modbus address. It may be accessed by a single read or write operation, addressing a part of or the entire zone in question.

Indirect-access data

In this case, the Modbus addresses indicated make up an exchange zone occupied by different data, depending on the context. At least two operations are required for each exchange. The necessary protocol is indicated for each zone.

Data coding

Except where mentioned in the text, Sepam data is coded in one of the formats below:
- 32S: 32-bit signed 2's complement value
- 32NS: 32-bit non-signed value
- 16S: 16-bit signed 2's complement value
- 16NS: 16-bit non-signed value
- 16O: 16-bit signed value, coded with a shift of 8000h (-32768 is coded 0, 0 is coded 8000h, 32767 is coded FFFFh)
- B: bit or set of bits
- IEC: time coding format using four words as per IEC 60870-5-4:

Bit	*15*	*14*	*13*	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Word 1	reserved									year (0 to 99)						
Word 2	0	0	0	0	month (1 to 12)				0	0	0	day (1 to 31)				
Word 3	0	0	0	hour (0 to 23)					0	0	minute (0 to 59)					
Word 4	millisecond (0 to 59999)															

Bits set to 0 correspond to format fields not used by Sepam. They are always read as 0 and are not taken into account during writing.
The reserved field is read as 0 and may receive different values during writing.

- ASCII: character string in ASCII code, the number of characters is indicated. When ASCII strings do not completely fill the field, zero bytes are added. The order of characters in Modbus words is the following:
  - character n in the LSB position
  - character n+1 in the MSB position
- MMmm: coding of a version number on 16 bits (major index in the MSB position, minor index in LSB position)

For 16 and 32 bits values, the following letter may follow the format code:
- A: an out of range or not computable value is indicated by 7FFFh (16-bit) or 00007FFFh (32-bit)
- B: an out of range or not computable value is indicated by 7FFFFFFFh (32-bit)

32-bit formats
For these data, the most-significant word is sent first.
Saturation
In all formats, if a datum overruns the maximum permissible value for the related format, the value read for the datum is the maximum permissible value for the format.
The maximum value can also indicate a non-calculable value.

List of address zones

	Starting address	Ending address	Access mode	Access type
Time management and Sepam (compatible with Sepam 2000)				
Synchronization zone	0002	0005	direct	word
Identification zone	0006	000F	direct	word
Event table (first table compatible with Sepam 2000)				
First table	0040	0060	indirect	word
Second table	0070	0090	indirect	word
Application management				
Application zone	0180	01BF	direct	word
Metering and diagnosis				
32-bit metering and diagnosis	0200	02B1	direct	word
16-bit metering and diagnosis	0300	0339	direct	word
Directories				
Disturbance recordings	0400	044F	direct	word
Tripping context	0480	0497	direct	word
Out-of-sync context	0500	0507	direct	word
Test				
Test zone	0C00	0C0F	direct	word / bit
Status conditions and controls (compatible with Sepam 2000)				
Logic inputs and logic equations	0C10	0C16	direct	word / bit
Logic outputs	0C20	0C23	direct	word / bit
Analog-output control	0C30	0C30	direct	word
Logipam counters	0C40	0C57	direct	word
Remote-control orders	0C84	0C8B	direct	word / bit
Remote indications	0C8F	0C9E	direct	word / bit
First access zone to settings				
Read settings	2000	207C	indirect	word
Read request	2080	2080	indirect	word
Remote setting	2100	217A	indirect	word
First zone for recording-data transfer				
Selection	2200	2203	indirect	word
Read	2300	237C	indirect	word
Customized table				
Data table	2600	267C	direct	word
Configuration table	2680	26FC	direct	word
Second access zone to settings (compatible with Sepam 2000)				
Read settings	D000	D07C	indirect	word
Read request	D080	D080	indirect	word
Remote setting	D100	D17A	indirect	word
Second zone for recording-data transfer (compatible with Sepam 2000)				
Selection	D200	D203	indirect	word
Read	D300	D37C	indirect	word
Metering and miscellaneous for Sepam 2000 compatibility				
Disturb. rec. identification zone	D204	D210	direct	word
Measurements x 1	FA00	FA2F	direct	word
Measurements x 10	FB00	FB24	direct	word
Compact zone	FB80	FB8F	direct	word
Configuration zone	FC00	FC03	direct	word

CAUTION

RISK OF DATA CORRUPTION

When using an ACE850 communication interface with IEC 61850 communication enabled, do not use the following address zones for Modbus/TCP (see the list address zone table):

- first access zone to settings
- first zone for recording-data transfer

Failure to follow these instructions can result in equipment damage.

Addresses in direct-access mode

Presentation

For each zone, the following data is provided:
- each Modbus address for the zone
- the Modbus function codes available for reading
- the Modbus function codes available for writing
- data formats, values and units
- whether the data can be included in a customized table ("config").

The indicated addresses are always word addresses. For bit access, the bit address must be used (see above).

Synchronization zone

The synchronization zone is a data structure containing the absolute data and time used by Sepam to time-tag its various recordings (events, disturbance recording, etc.).

The zone should be written in a single block containing 4 words, using function 16 (write word).

Synchronization zone	Address	Read	Write	Format	Config.
Absolute time (year)	0002	3	16	IEC	-
Absolute time (month + day)	0003	3	16	IEC	-
Absolute time (hours + minutes)	0004	3	16	IEC	-
Absolute time (milliseconds)	0005	3	16	IEC	-

Identification zone

The identification zone contains system information pertaining to the identification of the Sepam equipment.

Synchronization zone		Address	Read	Write	Value/ Format	Config.
Manufacturer identification		0006	3	-	0100	-
Equipment identification		0007	3	-	0	-
Marking + equipment type		0008	3	-	1200	-
Modbus version		0009	3	-	MMmm	-
Application	technical level	000A	3	-	1 to n	-
	version	000B	3	-	MMmm	-
Sepam check-word		000C	3	-	idem 0C8F	-
Summary zone		000D	3	-	0 (not mngd)	-
Command		000E	3	16	0 (not mngd)	-
Extension address		000F	3	-	180	-

This zone is provided to ensure compatibility with existing equipment. A more complete description is available starting at address 0180 in the application zone or using the identification read function.

Application zone

The application zone contains a set of information on the contents of Sepam series 80. Some of the information is reserved.

Application zone	Address	Read	Write	Format	Config.
Reserved	0180	3	-	-	-
Reserved	0181	3	-	-	-
Reserved	0182	3	-	-	-
Application abbreviation	0183/0185	3	-	ASCII 6c	-
Application name	0186/018F	3	-	ASCII 20c	-
Sepam marking	0190/0199	3	-	ASCII 20c	-
Application version	019A/019C	3	-	ASCII 6c	-
Local-language name	019D/01A6	3	-	ASCII 12c	-
Technical level	01A7	3	-	16NS	-
UV number	01A8	3	-	16NS	-
Reserved	01A9	3	-	-	-
Reserved	01AA	3	-	-	-
Reserved	01AB	3	-	-	-
Reserved	01AC	3	-	-	-
Reserved	01AD	3	-	-	-
Reserved	01AE	3	-	-	-
Local-language version	01AF	3	-	MMmm	-
English-language version	01B0	3	-	MMmm	-
Boot version	01B1	3	-	MMmm	-
Base version	01B2	3	-	MMmm	-
Communication version	01B3	3	-	MMmm	-
DSM-module version	01B4/01B6	3	-	ASCII 6c	-
MET148-2 n° 1 module version	01B7/01B9	3	-	ASCII 6c	-
MET148-2 n° 2 module version	01BA/01BC	3	-	ASCII 6c	-
MSA141 module version	01BD/01BF	3	-	ASCII 6c	-
Reserved	01C0/01C2	3	-	ASCII 6c	-
Mimic-based UMI version	01C3/01C5	3	-	ASCII 6c	-
MCS025 module version	01C6/01C8	3	-	ASCII 6c	-
ACE969 COM1 module version	01C9/01CB	3	-	ASCII 6c	-
ACE969 COM2 module version	01CC/01CE	3	-	ASCII 6c	-
ACE850 module version	01CF/01D1	3	-	ASCII 6c	-

32-bit metering and diagnosis zone

This zone contains all Sepam metering and diagnosis information, coded on 32 bits. Zone size exceeds the capacity of a frame, i.e. at least two requests are required to read it in full. Depending on the application and the parameter settings, some information is not significant.

32-bit metering and diagnosis zone	Address	Read	Write	Format	Unit	Config.
Phase current I1	0200/0201	3, 4	-	32NS	0.1 A	yes
Phase current I2	0202/0203	3, 4	-	32NS	0.1 A	yes
Phase current I3	0204/0205	3, 4	-	32NS	0.1 A	yes
Residual current I0Σ	0206/0207	3, 4	-	32NS	0.1 A	yes
Residual current I0	0208/0209	3, 4	-	32NS	0.1 A	yes
Demand current Im1	020A/020B	3, 4	-	32NS	0.1 A	yes
Demand current Im2	020C/020D	3, 4	-	32NS	0.1 A	yes
Demand current Im3	020E/020F	3, 4	-	32NS	0.1 A	yes
Peak demand current IM1	0210/0211	3, 4	-	32NS	0.1 A	yes
Peak demand current IM2	0212/0213	3, 4	-	32NS	0.1 A	yes
Peak demand current IM3	0214/0215	3, 4	-	32NS	0.1 A	yes
Phase-to-phase voltage U21	0216/0217	3, 4	-	32NS	1 V	yes
Phase-to-phase voltage U32	0218/0219	3, 4	-	32NS	1 V	yes
Phase-to-phase voltage U13	021A/021B	3, 4	-	32NS	1 V	yes
Phase-to-neutral voltage V1	021C/021D	3, 4	-	32NS	1 V	yes
Phase-to-neutral voltage V2	021E/021F	3, 4	-	32NS	1 V	yes
Phase-to-neutral voltage V3	0220/0221	3, 4	-	32NS	1 V	yes
Residual voltage V0	0222/0223	3, 4	-	32NS	1 V	yes
Positive sequence voltage Vd	0224/0225	3, 4	-	32NS	1 V	yes
Negative-sequence voltage Vi	0226/0227	3, 4	-	32NS	1 V	yes
Frequency f	0228/0229	3, 4	-	32NSA	0.01 Hz	yes
Active power P	022A/022B	3, 4	-	32SB	0.1 kW	yes
Reactive power Q	022C/022D	3, 4	-	32SB	0.1 kvar	yes
Apparent power S	022E/022F	3, 4	-	32SB	0.1 kVA	yes
Power factor cos φ	0230/0231	3, 4	-	32SA	0.01	yes
Peak demand active power PM	0232/0233	3, 4	-	32S	0.1 kW	yes
Peak demand reactive power QM	0234/0235	3, 4	-	32S	0.1 kvar	yes
Active power P phase 1	0236/0237	3, 4	-	32SB	0.1 kW	yes
Active power P phase 2	0238/0239	3, 4	-	32SB	0.1 kW	yes
Active power P phase 3	023A/023B	3, 4	-	32SB	0.1 kW	yes
Reactive power Q phase 1	023C/023D	3, 4	-	32SB	0.1 kvar	yes
Reactive power Q phase 2	023E/023F	3, 4	-	32SB	0.1 kvar	yes
Reactive power Q phase 3	0240/0241	3, 4	-	32SB	0.1 kvar	yes
Apparent power S phase 1	0242/0243	3, 4	-	32SB	0.1 kVA	yes
Apparent power S phase 2	0244/0245	3, 4	-	32SB	0.1 kVA	yes
Apparent power S phase 3	0246/0247	3, 4	-	32SB	0.1 kVA	yes
Positive active energy Ea+	0248/0249	3, 4	-	32NS	100 kWh	yes
Negative active energy Ea-	024A/024B	3, 4	-	32NS	100 kWh	yes
Positive reactive energy Er+	024C/024D	3, 4	-	32NS	100 kvarh	yes
Negative reactive energy Er-	024E/024F	3, 4	-	32NS	100 kvarh	yes
Ext. positive active energy Ea+	0250/0251	3, 4	-	32NS	100 kWh	yes
Ext. negative active energy Ea-	0252/0253	3, 4	-	32NS	100 kWh	yes
Ext. positive reactive energy Ea+	0254/0255	3, 4	-	32NS	100 kvarh	yes
Ext. negative reactive energy Ea-	0256/0257	3, 4	-	32NS	100 kvarh	yes
Neutral-point voltage Vnt	0258/0259	3, 4	-	32NS	1 V	yes
H3 neutral-point voltage V3nt	025A/025B	3, 4	-	32NS	1 V	yes
H3 residual voltage V3r	025C/025D	3, 4	-	32NS	1 V	yes

32-bit metering and diagnosis zone (cont.)

32-bit metering and diagnosis zone	Address	Read	Write	Format	Unit	Config.
Phase current I'1	025E/025F	3, 4	-	32NS	0.1 A	yes
Phase current I'2	0260/0261	3, 4	-	32NS	0.1 A	yes
Phase current I'3	0262/0263	3, 4	-	32NS	0.1 A	yes
Residual current I'0Σ	0264/0265	3, 4	-	32NS	0.1 A	yes
Residual current I'0	0266/0267	3, 4	-	32NS	0.1 A	yes
Number of operations	0268/0269	3, 4	-	32NS	1	yes
Tripping current phase 1 Itrip1	026A/026B	3, 4	-	32NS	0.1 A	yes
Tripping current phase 2 Itrip2	026C/026D	3, 4	-	32NS	0.1 A	yes
Tripping current phase 3 Itrip3	026E/026F	3, 4	-	32NS	0.1 A	yes
Tripping current calculated I0 Itrip0	0270/0271	3, 4	-	32NS	0.1 A	yes
Reserved	0272/0273	3, 4	-	-	-	yes
Reserved	0274/0275	3, 4	-	-	-	yes
Reserved	0276/0277	3, 4	-	-	-	yes
Reserved	0278/0279	3, 4	-	-	-	yes
Reserved	027A/027B	3, 4	-	-	-	yes
Number of operations	027C/027D	3, 4	-	32NS	1	yes
Differential current Id1	027E/027F	3, 4	-	32NSB	0.1 A	yes
Differential current Id2	0280/0281	3, 4	-	32NSB	0.1 A	yes
Differential current Id3	0282/0283	3, 4	-	32NSB	0.1 A	yes
Through current It1	0284/0285	3, 4	-	32NSB	0.1 A	yes
Through current It2	0286/0287	3, 4	-	32NSB	0.1 A	yes
Through current It3	0288/0289	3, 4	-	32NSB	0.1 A	yes
Impedance Zd	028A/028B	3, 4	-	32NSB	1 mΩ	yes
Impedance Z21	028C/028D	3, 4	-	32NSB	1 mΩ	yes
Impedance Z32	028E/028F	3, 4	-	32NSB	1 mΩ	yes
Impedance Z13	0290/0291	3, 4	-	32NSB	1 mΩ	yes
Phase-to-phase voltage U'21	0292/0293	3, 4	-	32NS	1 V	yes
Phase-to-phase voltage U'32	0294/0295	3, 4	-	32NS	1 V	yes
Phase-to-phase voltage U'13	0296/0297	3, 4	-	32NS	1 V	yes
Phase-to-neutral voltage V'1	0298/0299	3, 4	-	32NS	1 V	yes
Phase-to-neutral voltage V'2	029A/029B	3, 4	-	32NS	1 V	yes
Phase-to-neutral voltage V'3	029C/029D	3, 4	-	32NS	1 V	yes
Residual voltage V'0	029E/029F	3, 4	-	32NS	1 V	yes
Positive sequence voltage V'd	02A0/02A1	3, 4	-	32NS	1 V	yes
Negative sequence voltage V'i	02A2/02A3	3, 4	-	32NS	1 V	yes
Frequency f'	02A4/02A5	3, 4	-	32NSA	0.01 Hz	yes
Voltage difference dU (synchro-check)	02A6/02A7	3, 4	-	32NSB	1 V	yes
Frequency difference df (synchro-check)	02A8/02A9	3, 4	-	32NSA	0.01 Hz	yes
Phase difference dPhi (synchro-check)	02AA/02AB	3, 4	-	32NSA	0.1°	yes
Capacitor capacitance C1 (or C21)	02AC/02AD	3, 4	-	32NSB	0.1 µF	yes
Capacitor capacitance C2 (or C32)	02AE/02AF	3, 4	-	32NSB	0.1 µF	yes
Capacitor capacitance C3 (or C13)	02B0/02B1	3, 4	-	32NSB	0.1 µF	yes
Reserved	02B2/02FF		-			

16-bit metering and diagnosis zone

This zone contains all Sepam metering and diagnosis information, coded on 16 bits. Depending on the application and the parameter settings, some information is not significant.

16-bit metering and diagnosis zone	Address	Read	Write	Format	Unit	Config.
Temperature 1 MET148-2 n° 1	0300	3, 4	-	16SA	1°C	yes
Temperature 2 MET148-2 n° 1	0301	3, 4	-	16SA	1°C	yes
Temperature 3 MET148-2 n° 1	0302	3, 4	-	16SA	1°C	yes
Temperature 4 MET148-2 n° 1	0303	3, 4	-	16SA	1°C	yes
Temperature 5 MET148-2 n° 1	0304	3, 4	-	16SA	1°C	yes
Temperature 6 MET148-2 n° 1	0305	3, 4	-	16SA	1°C	yes
Temperature 7 MET148-2 n° 1	0306	3, 4	-	16SA	1°C	yes
Temperature 8 MET148-2 n° 1	0307	3, 4	-	16SA	1°C	yes
Temperature 1 MET148-2 n° 2	0308	3, 4	-	16SA	1°C	yes
Temperature 2 MET148-2 n° 2	0309	3, 4	-	16SA	1°C	yes
Temperature 3 MET148-2 n° 2	030A	3, 4	-	16SA	1°C	yes
Temperature 4 MET148-2 n° 2	030B	3, 4	-	16SA	1°C	yes
Temperature 5 MET148-2 n° 2	030C	3, 4	-	16SA	1°C	yes
Temperature 6 MET148-2 n° 2	030D	3, 4	-	16SA	1°C	yes
Temperature 7 MET148-2 n° 2	030E	3, 4	-	16SA	1°C	yes
Temperature 8 MET148-2 n° 2	030F	3, 4	-	16SA	1°C	yes
Total harmonic distortion Uthd	0310	3, 4	-	16NS	0.1%	yes
Total harmonic distortion Ithd	0311	3, 4	-	16NS	0.1%	yes
Angle φ0Σ	0312	3, 4	-	16NSA	1°	yes
Reserved	0313	3, 4	-	-	-	yes
Angle φ0	0314	3, 4	-	16NSA	1°	yes
Angle φ'0	0315	3, 4	-	16NSA	1°	yes
Angle φ1	0316	3, 4	-	16NSA	1°	yes
Angle φ2	0317	3, 4	-	16NSA	1°	yes
Angle φ3	0318	3, 4	-	16NSA	1°	yes
Negative sequence / unbalance	0319	3, 4	-	16NS	% Ib	yes
Negative sequence / unbalance '	031A	3, 4	-	16NS	% Ib'	yes
Machine rotation speed	031B	3, 4	-	16NS	rpm	yes
Thermal capacity used	031C	3, 4	-	16NS	%	yes
Running hours counter	031D	3, 4	-	16NS	1 hr	yes
Time before tripping	031E	3, 4	-	16NS	1 min	yes
Time before closing	031F	3, 4	-	16NS	1 min	yes
Starting time / overload	0320	3, 4	-	16NS	0.01 s	yes
Start inhibit time	0321	3, 4	-	16NS	1 min	yes
Number of starts allowed	0322	3, 4	-	16NS	1	yes
Learnt cooling time constant T2 (49 RMS) thermal rate 1	0323	3, 4	-	16NS	1 min	yes
Learnt cooling time constant T2 (49 RMS) thermal rate 2	0324	3, 4	-	16NS	1 min	yes
Total cumulative breaking current	0325	3, 4	-	16NS	1(kA)²	yes
Cumulative breaking current (0 < I < 2 In)	0326	3, 4	-	16NS	1(kA)²	yes
Cum. breaking current (2 In < I < 5 In)	0327	3, 4	-	16NS	1(kA)²	yes
Cum. breaking current (5 In < I< 10 In)	0328	3, 4	-	16NS	1(kA)²	yes
Cum. breaking current (10 In < I < 40 In)	0329	3, 4	-	16NS	1(kA)²	yes
Cumulative breaking current (I > 40 In)	032A	3, 4	-	16NS	1(kA)²	yes
Initial value of cumulative breaking current	032B	3, 4	-	16NS	1(kA)²	yes
Starting/overload current	032C	3, 4	-	16NS	1 A	yes
Operating time	032D	3, 4	-	16NS	1 ms	yes
Charging time	032E	3, 4	-	16NSA	1 s	yes
Number of racking out operations	032F	3, 4	-	16NS	1	yes
Auxiliary voltage	0330	3, 4	-	16NS	0.1 V	yes
Number of trips on phase current	0331	3, 4	-	16NS	1	yes
Number of trips on earth-fault current	0332	3, 4	-	16NS	1	yes
Angle I1 / I'1	0333	3, 4	-	16NSA	1°	yes
Angle I2 / I'2	0334	3, 4	-	16NSA	1°	yes
Angle I3 / I'3	0335	3, 4	-	16NSA	1°	yes
Operating time capacitor step 1	0336	3, 4	-	16NS	1 hr	yes
Operating time capacitor step 2	0337	3, 4	-	16NS	1 hr	yes
Operating time capacitor step 3	0338	3, 4	-	16NS	1 hr	yes
Operating time capacitor step 4	0339	3, 4	-	16NS	1 hr	yes

Directory zones

These zones indicate the recordings available in Sepam series 80 for the given data category. They have a similar structure.

Disturbance-recording directory

Disturbance-recording directory	Address	Read	Write	Format	Unit	Config.
Size of set-up files	0400	3	-	16NS	bytes	-
Size of data files	0401/0402	3	-	32NS	bytes	-
Number of records available	0403	3	-	16NS	1	-
Date of record 1 (most recent)	0404/0407	3	-	IEC	-	-
Date of record 2	0408/040B	3	-	IEC	-	-
...	...	...		...		
Date of record 19 (least recent)	044C/044F	3	-	IEC	-	-

Tripping-context directory

Context directory	Address	Read	Write	Format	Unit	Config.
Context size	0480	3	-	16NS	bytes	-
Not used	0481/0482	3	-	-	-	-
Number of records available	0483	3	-	16NS	1	-
Date of record 1 (most recent)	0484/0487	3	-	IEC	-	-
Date of record 2	0488/048B	3	-	IEC	-	-
...	...	...		...		
Date of record 5 (least recent)	0494/0497	3	-	IEC	-	-

Out-of-sync context directory

Context directory	Address	Read	Write	Format	Unit	Config.
Context size	0500	3	-	16NS	bytes	-
Not used	0501/0502	3	-	-	-	-
Number of records available	0503	3	-	16NS	1	-
Date of record	0504	3	-	IEC	-	-

Test zone

The test zone is a 16-word zone that may be accessed via the communication link by all functions, in both read and write modes, to facilitate communication testing at the time of commissioning or to test the link.
These words are set to zero when Sepam starts.

Test zone	Address	Bit addresses	Read	Write	Config.
Test word 1	0C00	C000/C00F	1, 2, 3, 4	5, 6, 15, 16	-
Test word 2	0C01	C010/C01F	1, 2, 3, 4	5, 6, 15, 16	-
...	...	...	...	...	
Test word 16	0C0F	C0F0/C0FF	1, 2, 3, 4	5, 6, 15, 16	-

Logipam counter zone

Counters used by the Logipam program.

Logipam counter zone	Address	Read	Write	Config.
C1	0C40	3	-	yes
C2	0C41	3	-	yes
C3	0C42	3	-	yes
C4	0C43	3	-	yes
C5	0C44	3	-	yes
C6	0C45	3	-	yes
C7	0C46	3	-	yes
C8	0C47	3	-	yes
C9	0C48	3	-	yes
C10	0C49	3	-	yes
C11	0C4A	3	-	yes
C12	0C4B	3	-	yes
C13	0C4C	3	-	yes
C14	0C4D	3	-	yes
C15	0C4E	3	-	yes
C16	0C4F	3	-	yes
C17	0C50	3	-	yes
C18	0C51	3	-	yes
C19	0C52	3	-	yes
C20	0C53	3	-	yes
C21	0C54	3	-	yes
C22	0C55	3	-	yes
C23	0C56	3	-	yes
C24	0C57	3	-	yes

Status-condition and control zones

Logic input / logic equation zone

Input / equation zone	Address	Bit addresses	Read	Write	Format	Config.
Logic inputs I101 to I114 (MES120 n° 1)	0C10	C100/C10F	1, 2, 3, 4	-	B	yes
Logic inputs I201 to I214 (MES120 n° 2)	0C11	C110/C11F	1, 2, 3, 4	-	B	yes
Logic inputs I301 to I314 (MES120 n° 3)	0C12	C120/C12F	1, 2, 3, 4	-	B	yes
Logic equation bits (1st word)	0C13	C130/C13F	1, 2, 3, 4	-	B	yes
Logic equation bits (2nd word)	0C14	C140/C14F	1, 2, 3, 4	-	B	yes
Logic equation bits (3rd word)	0C15	C150/C15F	1, 2, 3, 4	-	B	yes
Logic equation bits (4th word)	0C16	C160/C16F	1, 2, 3, 4	-	B	yes

Layout of logic inputs

Bit	*15*	*14*	*13*	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Input	-	-	14	13	12	11	10	09	08	07	06	05	04	03	02	01

Logic equation bits

	1st word 0C13	2nd word 0C14	3rd word 0C15	4th word 0C16
Bit 00	V1	V17	V_TRIP_STP3	V_MIMIC_IN_9
Bit 01	V2	V18	V_TRIP_STP4	V_MIMIC_IN_10
Bit 02	V3	V19	V_CLOSE_STP1	V_MIMIC_IN_11
Bit 03	V4	V20	V_CLOSE_STP2	V_MIMIC_IN_12
Bit 04	V5	V_FLAGREC	V_CLOSE_STP3	V_MIMIC_IN_13
Bit 05	V6	V_TRIPCB	V_CLOSE_STP4	V_MIMIC_IN_14
Bit 06	V7	V_CLOSECB	V_TRANS_ON_FLT	V_MIMIC_IN_15
Bit 07	V8	V_INHIBCLOSE	V_TRANS_STOP	V_MIMIC_IN_16
Bit 08	V9	V_RESET	V_MIMIC_IN_1	Reserved
Bit 09	V10	V_CLEAR	V_MIMIC_IN_2	Reserved
Bit 10	V11	V_INHIBIT_RESET_LOCAL	V_MIMIC_IN_3	Reserved
Bit 11	V12	V_SHUTDOWN	V_MIMIC_IN_4	Reserved
Bit 12	V13	V_DE-EXCITATION	V_MIMIC_IN_5	Reserved
Bit 13	V14	V_CLOSE_NOCTRL	V_MIMIC_IN_6	Reserved
Bit 14	V15	V_TRIP_STP1	V_MIMIC_IN_7	Reserved
Bit 15	V16	V_TRIP_STP2	V_MIMIC_IN_8	Reserved

Addresses in direct-access mode

Logic-output zone

This zone indicates the status of the logic outputs and the LEDs on the front panel.

Logic-output zone	Address	Bit addresses	Read	Write	Format	Config.
Logic outputs O1 to O5 (base)	0C20	C200/C10F	1, 2, 3, 4	-	B	yes
Logic outputs O101 to O106 (MES120 n° 1)	0C21	C210/C21F	1, 2, 3, 4	-	B	yes
Logic outputs O201 to O206 (MES120 n° 2)	0C22	C220/C22F	1, 2, 3, 4	-	B	yes
Logic outputs O301 to O306 (MES120 n° 3)	0C23	C230/C23F	1, 2, 3, 4	-	B	yes
LED status	0C24	C240/C24F	1, 2, 3, 4	-	B	yes

Layout of logic outputs

Bit	*15*	*14*	*13*	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Output	-	-	-	-	-	-	-	-	-	-	06	05	04	03	02	01

Layout of LEDs

Bit	*15*	*14*	*13*	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
LED	-	-	-	-	-	-	L9	L8	L7	L6	L5	L4	L3	L2	L1	LD

LD: red "Sepam unavailable" LED.

Analog-output control zone

Analog-output zone	Address	Read	Write	Format	Config.
MSA141	0C30	3	6, 16	16S/16NS (1)	-

(1) *As per MSA141 parameter settings (option).*

Remote control of the analog output

The analog output of the MSA141 module may be set up for remote control via the Modbus communication link. The usable range of the numerical value transmitted is defined by the "min. value" and "max. value" settings of the analog output (SFT2841).

Addresses in direct-access mode

Remote-control zone

Remote-control zone	Address	Bit addresses	Read	Write	Format	Config.
TCM1 to TCM16	0C80	C800/C80F	1, 2, 3, 4	5, 6, 15, 16	B	-
TCM17 to TCM32	0C81	C810/C81F	1, 2, 3, 4	5, 6, 15, 16	B	-
STC1 to STC16	0C84	C840/C84F	1, 2, 3, 4	5, 6, 15, 16	B	-
STC17 to STC32	0C85	C850/C85F	1, 2, 3, 4	5, 6, 15, 16	B	-
STC33 to STC48	0C86	C860/C86F	1, 2, 3, 4	5, 6, 15, 16	B	-
STC49 to STC64	0C87	C870/C87F	1, 2, 3, 4	5, 6, 15, 16	B	-
TC1 to TC16	0C88	C880/C88F	1, 2, 3, 4	5, 6, 15, 16	B	-
TC17 to TC32	0C89	C890/C89F	1, 2, 3, 4	5, 6, 15, 16	B	-
TC33 to TC48	0C8A	C8A0/C8AF	1, 2, 3, 4	5, 6, 15, 16	B	-
TC49 to TC64	0C8B	C8B0/C8BF	1, 2, 3, 4	5, 6, 15, 16	B	-

Use of remote-control orders

Remote-control orders can be transmitted to Sepam by:
- 32 bits of maintained remote-control orders (TCM)
- 64 bits of pulse-type remote-control orders (TC)

Pulse-type remote-control orders can be executed in either of the following modes, selected by parameter setting:
- direct mode
- confirmed SBO (Select Before Operate) mode

Maintained remote-control orders (TCM)

Maintained remote-control orders (TCM1 to TCM32) work like bistables. They continuously maintain the value of the last state ordered. They can be used only by the Logipam program. They are reset to zero if Sepam auxiliary power is lost.

Pulse-type remote control orders (TC) in direct mode

The remote-control order is executed when it is written in the remote-control word. The program logic resets it to zero after the remote-control order is acknowledged.

Pulse-type remote control orders (TC) in confirmed SBO mode

Remote-control orders involve two steps:
- selection by the master of the order to be sent by writing the bit in the STC word and checking of the selection by rereading the word
- execution of the order to be sent by writing the bit in the TC word.

The remote-control order is executed if the bit in the STC word and the bit in the associated TC word are set. The program logic resets the STC and TC bits to zero after the remote-control order is acknowledged.

Deselection of the STC bit takes place:
- if the master deselects it by writing in the STC word
- if the master selects (write bit) a bit other than the one already selected
- if the master sets a bit in the TC word which does not match the selection. In this case, no remote-control order is executed.
- if the related order is not given within 30 seconds.

The choice between direct mode or confirmed SBO mode for remote control orders is made in the Sepam General characteristics configuration screen. This is a global parameter that applies to:
- *both Sepam communication ports, COM1 and COM2*
- *Ethernet communication port.*

Inhibiting predefined remote control orders

Predefined processing of remote-control orders may be inhibited, except for the tripping remote-control order TC1 which may be activated at any time:
- by choosing Local or Test control mode via the key-switch on Sepam relays with mimic-based UMIs
- by assigning a logic input to the "Inhibit remote control" function.

The parameter setting of the logic input may be done in two modes:
- inhibition if the input is set to 1
- inhibition if the input is set to 0 (negative input).

In all cases, the remote-control orders remain available in Logipam which may be used to define a specific inhibition logic.

Security

It is possible to protect the remote-control zone against writing, see the section on security.

Remote-control zone (cont'd)

Pulse-type remote-control orders not used by the Logipam program are pre-assigned to protection, control and metering functions.
The assignment of the remote-control orders is given in the tables below.
Depending on the applications and functions in operation, certain remote-control orders may not be applicable and will produce no effect.
if the switchgear function is enabled (or running), the following remote-control orders are acknowledged:

- device tripping and closing
- recloser enabling and disabling.

The corresponding value for Sepam 2000 is indicated. This value corresponds to the address, not the role (roles are not static in Sepam 2000).
When a remote-control order (TC) is used by the Logipam program, it is no longer assigned to a predefined function.

Word 0C88: TC1 to TC16		**Sepam 2000**
Bit 00: TC1	Trip / open	KTC33
Bit 01: TC2	Closing	KTC34
Bit 02: TC3	Sepam reset	KTC35
Bit 03: TC4	Peak demand current reset	KTC36
Bit 04: TC5	Peak demand power reset	KTC37
Bit 05: TC6	Reserved	KTC38
Bit 06: TC7	Reserved	KTC39
Bit 07: TC8	Enable recloser	KTC40
Bit 08: TC9	Disable recloser	KTC41
Bit 09: TC10	Free	KTC42
Bit 10: TC11	Free	KTC43
Bit 11: TC12	Free	KTC44
Bit 12: TC13	Free	KTC45
Bit 13: TC14	Free	KTC46
Bit 14: TC15	Free	KTC47
Bit 15: TC16	Free	KTC48
Word 0C89: TC17 to TC32		**Sepam 2000**
Bit 00: TC17	Reserved	KTC49
Bit 01: TC18	Inhibit disturbance-recording triggering (OPG)	KTC50
Bit 02: TC19	Confirm disturbance-recording triggering (OPG)	KTC51
Bit 03: TC20	Manual disturbance-recording triggering (OPG)	KTC52
Bit 04: TC21	Free	KTC53
to		
Bit 12: TC29	Free	KTC61
Bit 13: TC30	Inhibit thermal protection	KTC62
Bit 14: TC31	Confirm thermal protection	KTC63
Bit 15: TC32	Reset undercurrent protection	KTC64
Word 0C8A: TC33 to TC48		**Sepam 2000**
Bit 00: TC33	Switching to setting group A	-
Bit 01: TC34	Switching to setting group B	-
Bit 02: TC35	Priority group shutdown	-
Bit 03: TC36	Cancel priority group shutdown	
Bit 04: TC37	Enable synchro-check	-
Bit 05: TC38	Disable synchro-check	-
Bit 06: TC39	Enable voltage check	-
Bit 07: TC40	Disable voltage check	-
Bit 08: TC41	Open capacitor step 1	-
Bit 09: TC42	Open capacitor step 2	-
Bit 10: TC43	Open capacitor step 3	-
Bit 11: TC44	Open capacitor step 4	-
Bit 12: TC45	Close capacitor step 1	-
Bit 13: TC46	Close capacitor step 2	-
Bit 14: TC47	Close capacitor step 3	-
Bit 15: TC48	Close capacitor step 4	-
Word 0C8B: TC49 to TC64		**Sepam 2000**
Bit 00: TC49	Free	-
to		
Bit 15: TC64	Free	-

Remote-indications zone

Remote-indications zone	Address	Bit addresses	Read	Write	Format	Config.
Sepam check-word	0C8F	C8F0/C8FF	1, 2, 3, 4	-	B	yes
TS1-TS16	0C90	C900/C90F	1, 2, 3, 4	-	B	yes
TS17-TS32	0C91	C910/C91F	1, 2, 3, 4	-	B	yes
TS33-TS48	0C92	C920/C92F	1, 2, 3, 4	-	B	yes
TS49-TS64	0C93	C930/C93F	1, 2, 3, 4	-	B	yes
TS65-TS80	0C94	C940/C94F	1, 2, 3, 4	-	B	yes
TS81-TS96	0C95	C950/C95F	1, 2, 3, 4	-	B	yes
TS97-TS112	0C96	C960/C96F	1, 2, 3, 4	-	B	yes
TS113-TS128	0C97	C970/C97F	1, 2, 3, 4	-	B	yes
TS129-TS144	0C98	C980/C98F	1, 2, 3, 4	-	B	yes
TS145-TS160	0C99	C990/C99F	1, 2, 3, 4	-	B	yes
TS161-TS176	0C9A	C9A0/C9AF	1, 2, 3, 4	-	B	yes
TS177-TS192	0C9B	C9B0/C9BF	1, 2, 3, 4	-	B	yes
TS193-TS208	0C9C	C9C0/C9CF	1, 2, 3, 4	-	B	yes
TS209-TS224	0C9D	C9D0/C9DF	1, 2, 3, 4	-	B	yes
TS225-TS240	0C9E	C9E0/C9EF	1, 2, 3, 4	-	B	yes

The check work comprises a set of information on Sepam status.
The "high-speed reading" function (function 7) is used to access the most-significant byte in the check word (bits 15 to 8).

Word 0C8F: Sepam check-word		Notes
Bit 00	Reserved	
Bit 01	Modbus Security function enabled	
Bit 02	Reserved	
Bit 03	Sepam in “data loss” status in 2nd event zone	(1) (2)
Bit 04	Event in 2nd event zone	(1)
Bit 05	Setting group A in service	(2)
Bit 06	Setting group B in service	(2)
Bit 07	Sepam time not correct	(2)
Bit 08	Sepam partial fault	(2)
Bit 09	Sepam major fault	
Bit 10	Sepam in parameter setting mode	(2)
Bit 11	Remote setting inhibited	
Bit 12	Inductive network (1)/capacitive (0)	
Bit 13	Sepam not synchronous	(2)
Bit 14	Sepam in “data loss” status in 1st event zone	(1) (2)
Bit 15	Event in 1st event zone	(1)

(1) *This information is specific to each communication port.*
(2) *Status changes of bits 3, 5, 6, 7, 8, 10, 13, 14 trigger sending of a time-tagged event (see the section on time-tagged events).*

Remote-indication bits (TS) are pre-assigned to protection, control and metering functions.
The tables below present each remote-indication bit. Depending on the applications and functions in operation, certain remote-indication bits may not be applicable.
The corresponding value for Sepam 2000 is indicated. This value corresponds to the address, not the meaning (meanings are not static in Sepam 2000).
When a remote-indication order is used by the Logipam program, it is no longer assigned to a predefined function and the meaning is determined by the Logipam program.

Word 0C90: TS1 to TS16		Sepam 2000
Bit 00: TS1	Matching fault or Trip Circuit Supervision	KTS1
Bit 01: TS2	Control fault	KTS2
Bit 02: TS3	TC / position discrepancy	KTS3
Bit 03: TS4	External tripping 1	KTS4
Bit 04: TS5	Sepam not reset after fault	KTS5
Bit 05: TS6	External tripping 2	KTS6
Bit 06: TS7	External tripping 3	KTS7
Bit 07: TS8	Cos φ inductive	KTS8
Bit 08: TS9	Cos φ capacitive	KTS9
Bit 09: TS10	Closed position	KTS10
Bit 10: TS11	Device racked out	KTS11
Bit 11: TS12	SF6 alarm	KTS12
Bit 12: TS13	Earthing switch closed	KTS13
Bit 13: TS14	Remote-control enabled	KTS14
Bit 14: TS15	Overcurrent protection (summary)	KTS15
Bit 15: TS16	Free	KTS16

Word 0C91: TS17 to TS32		**Sepam 2000**
Bit 00: TS17	Free	KTS17
to		
Bit 14: TS31	Free	KTS31
Bit 15: TS32	Send blocking signal 1	KTS32
Word 0C92: TS33 to TS48		**Sepam 2000**
Bit 00: TS33	Free	KTS33
to		
Bit 15: TS48	Free	KTS48
Word 0C93: TS49 to TS64		**Sepam 2000**
Bit 00: TS49	Disturbance recording stored	KTS49
Bit 01: TS50	Disturbance recording inhibited	KTS50
Bit 02: TS51	Remote setting inhibited	KTS51
Bit 03: TS52	Free	KTS52
to		
Bit 15: TS64	Free	KTS64
Word 0C94: TS65 to TS80		
Bit 00: TS65	Protection 50/51 unit 1	
Bit 01: TS66	Protection 50/51 unit 2	
Bit 02: TS67	Protection 50/51 unit 3	
Bit 03: TS68	Protection 50/51 unit 4	
Bit 04: TS69	Protection 50/51 unit 5	
Bit 05: TS70	Protection 50/51 unit 6	
Bit 06: TS71	Protection 50/51 unit 7	
Bit 07: TS72	Protection 50/51 unit 8	
Bit 08: TS73	Protection 50N/51N unit 1	
Bit 09: TS74	Protection 50N/51N unit 2	
Bit 10: TS75	Protection 50N/51N unit 3	
Bit 11: TS76	Protection 50N/51N unit 4	
Bit 12: TS77	Protection 50N/51N unit 5	
Bit 13: TS78	Protection 50N/51N unit 6	
Bit 14: TS79	Protection 50N/51N unit 7	
Bit 15: TS80	Protection 50N/51N unit 8	
Word 0C95: TS81 to TS96		
Bit 00: TS81	Protection 27/27S unit 1	
Bit 01: TS82	Protection 27/27S unit 2	
Bit 02: TS83	Protection 27/27S unit 3	
Bit 03: TS84	Protection 27/27S unit 4	
Bit 04: TS85	Protection 27D unit 1	
Bit 05: TS86	Protection 27D unit 2	
Bit 06: TS87	Protection 27R unit 1	
Bit 07: TS88	Protection 27R unit 2	
Bit 08: TS89	Protection 59 unit 1	
Bit 09: TS90	Protection 59 unit 2	
Bit 10: TS91	Protection 59 unit 3	
Bit 11: TS92	Protection 59 unit 4	
Bit 12: TS93	Protection 59N unit 1	
Bit 13: TS94	Protection 59N unit 2	
Bit 14: TS95	Protection 51V unit 1	
Bit 15: TS96	Protection 51V unit 2	
Word 0C96: TS97 to TS112		
Bit 00: TS97	Protection 67 unit 1	
Bit 01: TS98	Protection 67 unit 2	
Bit 02: TS99	Protection 67N unit 1	
Bit 03: TS100	Protection 67N unit 2	
Bit 04: TS101	Protection 46 unit 1	
Bit 05: TS102	Protection 46 unit 2	
Bit 06: TS103	Protection 47 unit 1	
Bit 07: TS104	Protection 47 unit 2	
Bit 08: TS105	Protection 32P unit 1	
Bit 09: TS106	Protection 32P unit 2	
Bit 10: TS107	Protection 32Q	
Bit 11: TS108	Protection 37	
Bit 12: TS109	Protection 37P unit 1	
Bit 13: TS110	Protection 37P unit 2	
Bit 14: TS111	Protection 40	
Bit 15: TS112	Protection 50BF	

Word 0C97: TS113 to TS128	
Bit 00: TS113	Protection 49RMS – alarm set point
Bit 01: TS114	Protection 49RMS – tripping set point
Bit 02: TS115	Protection 48/51LR (locked rotor)
Bit 03: TS116	Protection 48/51LR (locked rotor at start-up)
Bit 04: TS117	Protection 48/51LR (excessive starting time)
Bit 05: TS118	Protection 66
Bit 06: TS119	Protection 21B
Bit 07: TS120	Protection 50/27
Bit 08: TS121	Protection 64G2/27TN unit 1
Bit 09: TS122	Protection 64G2/27TN unit 2
Bit 10: TS123	Protection 78PS
Bit 11: TS124	Protection 64REF unit 1
Bit 12: TS125	Protection 64REF unit 2
Bit 13: TS126	Protection 87T2
Bit 14: TS127	Protection 87M/87G
Bit 15: TS128	Reserved
Word 0C98: TS129 to TS144	
Bit 00: TS129	Protection 81H unit 1
Bit 01: TS130	Protection 81H unit 2
Bit 02: TS131	Protection 81L unit 1
Bit 03: TS132	Protection 81L unit 2
Bit 04: TS133	Protection 81L unit 3
Bit 05: TS134	Protection 81L unit 4
Bit 06: TS135	Protection 81R unit 1
Bit 07: TS136	Protection 81R unit 2
Bit 08: TS137	Protection 12 unit 1
Bit 09: TS138	Protection 12 unit 2
Bit 10: TS139	Protection 14 unit 1
Bit 11: TS140	Protection 14 unit 2
Bit 12: TS141	Protection 24 unit 1
Bit 13: TS142	Protection 24 unit 2
Bit 14: TS143	Reserved
Bit 15: TS144	Reserved
Word 0C99: TS145 to TS160	
Bit 00: TS145	Protection 38/49T alarm sensor 1 MET148 n° 1
Bit 01: TS146	Protection 38/49T tripping sensor 1 MET148 n° 1
Bit 02: TS147	Protection 38/49T alarm sensor 2 MET148 n° 1
Bit 03: TS148	Protection 38/49T tripping sensor 2 MET148 n° 1
Bit 04: TS149	Protection 38/49T alarm sensor 3 MET148 n° 1
Bit 05: TS150	Protection 38/49T tripping sensor 3 MET148 n° 1
Bit 06: TS151	Protection 38/49T alarm sensor 4 MET148 n° 1
Bit 07: TS152	Protection 38/49T tripping sensor 4 MET148 n° 1
Bit 08: TS153	Protection 38/49T alarm sensor 5 MET148 n° 1
Bit 09: TS154	Protection 38/49T tripping sensor 5 MET148 n° 1
Bit 10: TS155	Protection 38/49T alarm sensor 6 MET148 n° 1
Bit 11: TS156	Protection 38/49T tripping sensor 6 MET148 n° 1
Bit 12: TS157	Protection 38/49T alarm sensor 7 MET148 n° 1
Bit 13: TS158	Protection 38/49T tripping sensor 7 MET148 n° 1
Bit 14: TS159	Protection 38/49T alarm sensor 8 MET148 n° 1
Bit 15: TS160	Protection 38/49T tripping sensor 8 MET148 n° 1
Word 0C9A: TS161 to TS176	
Bit 00: TS161	Protection 38/49T alarm sensor 1 MET148 n° 2
Bit 01: TS162	Protection 38/49T tripping sensor 1 MET148 n° 2
Bit 02: TS163	Protection 38/49T alarm sensor 2 MET148 n° 2
Bit 03: TS164	Protection 38/49T tripping sensor 2 MET148 n° 2
Bit 04: TS165	Protection 38/49T alarm sensor 3 MET148 n° 2
Bit 05: TS166	Protection 38/49T tripping sensor 3 MET148 n° 2
Bit 06: TS167	Protection 38/49T alarm sensor 4 MET148 n° 2
Bit 07: TS168	Protection 38/49T tripping sensor 4 MET148 n° 2
Bit 08: TS169	Protection 38/49T alarm sensor 5 MET148 n° 2
Bit 09: TS170	Protection 38/49T tripping sensor 5 MET148 n° 2
Bit 10: TS171	Protection 38/49T alarm sensor 6 MET148 n° 2
Bit 11: TS172	Protection 38/49T tripping sensor 6 MET148 n° 2
Bit 12: TS173	Protection 38/49T alarm sensor 7 MET148 n° 2
Bit 13: TS174	Protection 38/49T tripping sensor 7 MET148 n° 2
Bit 14: TS175	Protection 38/49T alarm sensor 8 MET148 n° 2
Bit 15: TS176	Protection 38/49T tripping sensor 8 MET148 n° 2

Word 0C9B: TS177 to TS192	
Bit 00: TS177	Protection 51C unit 1 (capacitor step 1)
Bit 01: TS178	Protection 51C unit 2 (capacitor step 1)
Bit 02: TS179	Protection 51C unit 3 (capacitor step 2)
Bit 03: TS180	Protection 51C unit 4 (capacitor step 2)
Bit 04: TS181	Protection 51C unit 5 (capacitor step 3)
Bit 05: TS182	Protection 51C unit 6 (capacitor step 3)
Bit 06: TS183	Protection 51C unit 7 (capacitor step 4)
Bit 07: TS184	Protection 51C unit 8 (capacitor step 4)
Bit 08: TS185	Thermistor alarm
Bit 09: TS186	Thermistor tripping
Bit 10: TS187	Buchholz alarm
Bit 11: TS188	Buchholz tripping
Bit 12: TS189	Thermostat alarm
Bit 13: TS190	Thermostat tripping
Bit 14: TS191	Pressure alarm
Bit 15: TS192	Pressure tripping
Word 0C9C: TS193 to TS208	
Bit 00: TS193	MET148-1 module sensor fault
Bit 01: TS194	MET148-2 module sensor fault
Bit 02: TS195	Inhibit thermal protection tripping
Bit 03: TS196	Main-phase reverse rotation
Bit 04: TS197	Additional-phase reverse rotation
Bit 05: TS198	Send blocking signal 2
Bit 06: TS199	Recloser: On
Bit 07: TS200	Recloser: ready
Bit 08: TS201	Recloser: final trip
Bit 09: TS202	Recloser: reclosing successful
Bit 10: TS203	Recloser: cycle 1 in progress
Bit 11: TS204	Recloser: cycle 2 in progress
Bit 12: TS205	Recloser: cycle 3 in progress
Bit 13: TS206	Recloser: cycle 4 in progress
Bit 14: TS207	Recloser: closing by recloser
Bit 15: TS208	Test mode
Word 0C9D: TS209 to TS224	
Bit 00: TS209	Phase CT fault
Bit 01: TS210	Phase VT fault
Bit 02: TS211	Residual VT fault
Bit 03: TS212	Additional phase CT fault
Bit 04: TS213	Additional phase VT fault
Bit 05: TS214	Additional residual VT fault
Bit 06: TS215	Load shedding
Bit 07: TS216	Restart
Bit 08: TS217	Min. V_aux
Bit 09: TS218	Max. V_aux
Bit 10: TS219	Battery low or absent
Bit 11: TS220	Request for synchro-checked closing
Bit 12: TS221	dU synchronization failure
Bit 13: TS222	dPhi synchronization failure
Bit 14: TS223	dF synchronization failure
Bit 15: TS224	Synchronization stop
Word 0C9E: TS225 to TS240	
Bit 00: TS225	Synchronization failure
Bit 01: TS226	Synchronization succesful
Bit 02: TS227	Manual capacitor step control
Bit 03: TS228	Automatic capacitor step control
Bit 04: TS229	Capacitor step 1 matching fault
Bit 05: TS230	Capacitor step 2 matching fault
Bit 06: TS231	Capacitor step 3 matching fault
Bit 07: TS232	Capacitor step 4 matching fault
Bit 08: TS233	Tripping
Bit 09: TS234	Closing coil monitoring
Bit 10: TS235	Cumulative breaking current monitoring
Bit 11: TS236	Coupling closing order
Bit 12: TS237	Coupling synchronization failure
Bit 13: TS238	Tripping by automatic transfer (AT)
Bit 14: TS239	Reserved
Bit 15: TS240	Ethernet communication fault

If data files are larger than 64 Kbytes, the number of records is forced to zero. Only the last two records are provided.

Zones for Sepam 2000 compatibility

Disturb. rec. identification zone

This zone exists exclusively for address and format compatibility with Sepam 2000. When compatibility is not required, use the directory zone (address 400).

Disturb. rec. identification zone	Address	Read	Write	Format	Unit	Config.
Reserved	D204	3	-	-	-	-
Reserved	D205	3	-	-	-	-
Size of set-up files	D206	3	-	16NS	bytes	-
Size of data files	D207	3	-	16NS	bytes	-
Number of records available	D208	3	-	16NS	1	-
Date of record 1 (most recent)	D209/D20C	3	-	IEC		-
Date of record 2	D20D/D210	3	-	IEC		-

Configuration zone

This zone exists exclusively for address and format compatibility with Sepam 2000. It is static and does not depend on the real configuration of the Sepam series 80 relay.

Configuration zone	Address	Read	Write	Value	Config.
Not used	FC00	3	-	0	-
Sepam series 80	FC01	3	-	1200 h	-
Not managed	FC02	3	-	0	-
Not managed	FC03	3	-	0	-

Residual current

On Sepam 2000, measured and calculated residual currents are exclusive, i.e. they have the same Modbus address. On Sepam series 80, the two values may both exist: the compatible address is used for the calculated value and the new address is used for the measured value.

Number of starts / Inhibit time

On Sepam 2000, these two values are exclusive and use the same Modbus address. They are differentiated by the sign. On Sepam series 80, the two values may both exist, the compatible address is used for the number of starts and the new address is used for the inhibit time.

Metering zone x 1

Metering zone x 1	Address	Read	Write	Format	Unit	Config.
Phase current I1	FA00	3, 4	-	16NS	0.1 A	yes
Phase current I2	FA01	3, 4	-	16NS	0.1 A	yes
Phase current I3	FA02	3, 4	-	16NS	0.1 A	yes
Peak demand current IM1	FA03	3, 4	-	16NS	0.1 A	yes
Peak demand current IM2	FA04	3, 4	-	16NS	0.1 A	yes
Peak demand current IM3	FA05	3, 4	-	16NS	0.1 A	yes
Phase-to-phase voltage U21	FA06	3, 4	-	16NS	1 V	yes
Phase-to-phase voltage U32	FA07	3, 4	-	16NS	1 V	yes
Phase-to-phase voltage U13	FA08	3, 4	-	16NS	1 V	yes
Frequency f	FA09	3, 4	-	16NS	0.01 Hz	yes
Active power P	FA0A	3, 4	-	16O	1 kW	yes
Reactive power Q	FA0B	3, 4	-	16O	1 kvar	yes
Power factor cos φ	FA0C	3, 4	-	16O	0.01	yes
Peak demand active power PM	FA0D	3, 4	-	16NS	1 kW	yes
Peak demand reactive power QM	FA0E	3, 4	-	16NS	1 kvar	yes
Residual current I0Σ	FA0F	3, 4	-	16NS	0.1 A	yes
T1: temperature 1 MET n° 1	FA10	3, 4	-	16O	1°C	yes
T2: temperature 2 MET n° 1	FA11	3, 4	-	16O	1°C	yes
T3: temperature 3 MET n° 1	FA12	3, 4	-	16O	1°C	yes
T4: temperature 4 MET n° 1	FA13	3, 4	-	16O	1°C	yes
T5: temperature 5 MET n° 1	FA14	3, 4	-	16O	1°C	yes
T6: temperature 6 MET n° 1	FA15	3, 4	-	16O	1°C	yes
T7: temperature 7 MET n° 1	FA16	3, 4	-	16O	1°C	yes
T8: temperature 8 MET n° 1	FA17	3, 4	-	16O	1°C	yes
T9: temperature 1 MET n° 2	FA18	3, 4	-	16O	1°C	yes
T10: temperature 2 MET n° 2	FA19	3, 4	-	16O	1°C	yes
T11: temperature 3 MET n° 2	FA1A	3, 4	-	16O	1°C	yes
T12: temperature 4 MET n° 2	FA1B	3, 4	-	16O	1°C	yes
Thermal capacity used	FA1C	3, 4	-	16NS	0.1%	yes
Number of starts	FA1D	3, 4	-	16NS	1	yes
Phase current I'1	FA1E	3, 4	-	16NS	0.1 A	yes
Phase current I'2	FA1F	3, 4	-	16NS	0.1 A	yes
Phase current I'3	FA20	3, 4	-	16NS	0.1 A	yes
Residual current I'0Σ	FA21	3, 4	-	16NS	0.1 A	yes
Phase-to-neutral voltage V1	FA22	3, 4	-	16NS	1 V	yes
Phase-to-neutral voltage V2	FA23	3, 4	-	16NS	1 V	yes
Phase-to-neutral voltage V3	FA24	3, 4	-	16NS	1 V	yes
Residual voltage V0	FA25	3, 4	-	16NS	1 V	yes
Residual current I0	FA26	3, 4	-	16NS	0.1 A	yes
Phase-to-phase voltage U'21	FA27	3, 4	-	16NS	1 V	yes
Phase-to-phase voltage U'32	FA28	3, 4	-	16NS	1 V	yes
Phase-to-phase voltage U'13	FA29	3, 4	-	16NS	1 V	yes
Phase-to-neutral voltage V'1	FA2A	3, 4	-	16NS	1 V	yes
Phase-to-neutral voltage V'2	FA2B	3, 4	-	16NS	1 V	yes
Phase-to-neutral voltage V'3	FA2C	3, 4	-	16NS	1 V	yes
Residual voltage V'0	FA2D	3, 4	-	16NS	1 V	yes
Residual current I'0	FA2E	3, 4	-	16NS	0.1 A	yes
Inhibit time	FA2F	3, 4	-	16NS	1 min.	yes

Addresses in direct-access mode

Residual current

On Sepam 2000, measured and calculated residual currents are exclusive, i.e. they have the same Modbus address. On Sepam series 80, the two values may both exist: the compatible address is used for the calculated value and the new address is used for the measured value.

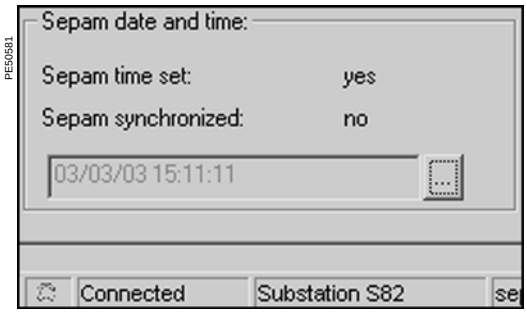
Metering zone x 10

Metering zone x 10	Address	Read	Write	Format	Unit	Config.
Phase current I1	FB00	3, 4	-	16NS	1 A	yes
Phase current I2	FB01	3, 4	-	16NS	1 A	yes
Phase current I3	FB02	3, 4	-	16NS	1 A	yes
Peak demand current IM1	FB03	3, 4	-	16NS	1 A	yes
Peak demand current IM2	FB04	3, 4	-	16NS	1 A	yes
Peak demand current IM3	FB05	3, 4	-	16NS	1 A	yes
Phase-to-phase voltage U21	FB06	3, 4	-	16NS	10 V	yes
Phase-to-phase voltage U32	FB07	3, 4	-	16NS	10 V	yes
Phase-to-phase voltage U13	FB08	3, 4	-	16NS	10 V	yes
Frequency f	FB09	3, 4	-	16NS	0.1 Hz	yes
Active power P	FB0A	3, 4	-	16O	10 kW	yes
Reactive power Q	FB0B	3, 4	-	16O	10 kvar	yes
Power factor cos φ	FB0C	3, 4	-	16O	0.01	yes
Peak demand active power PM	FB0D	3, 4	-	16NS	10 kW	yes
Peak demand reactive power QM	FB0E	3, 4	-	16NS	10 kvar	yes
Residual current I0Σ	FB0F	3, 4	-	16NS	1 A	yes
Last tripping current Itrip1	FB10	3, 4	-	16NS	10 A	yes
Last tripping current Itrip2	FB11	3, 4	-	16NS	10 A	yes
Last tripping current Itrip3	FB12	3, 4	-	16NS	10 A	yes
Last tripping current Itrip0	FB13	3, 4	-	16NS	1 A	yes
Phase current I'1	FB14	3, 4	-	16NS	1 A	yes
Phase current I'2	FB15	3, 4	-	16NS	1 A	yes
Phase current I'3	FB16	3, 4	-	16NS	1 A	yes
Phase-to-neutral voltage V1	FB17	3, 4	-	16NS	10 V	yes
Phase-to-neutral voltage V2	FB18	3, 4	-	16NS	10 V	yes
Phase-to-neutral voltage V3	FB19	3, 4	-	16NS	10 V	yes
Reserved	FB1A	3, 4	-	-	-	yes
Reserved	FB1B	3, 4	-	-	-	yes
Reserved	FB1C	3, 4	-	-	-	yes
Residual voltage V0	FB1D	3, 4	-	16NS	10 V	yes
Residual current I'0Σ	FB1E	3, 4	-	16NS	1 A	yes
Reserved	FB1F	3, 4	-	-	-	yes
Reserved	FB20	3, 4	-	-	-	yes
Reserved	FB21	3, 4	-	-	-	yes
Reserved	FB22	3, 4	-	-	-	yes
Residual current I0	FB23	3, 4	-	16NS	1 A	yes
Residual current I'0	FB24	3, 4	-	16NS	1 A	yes

Compact zone

Compact zone	Address	Read	Write	Format	Unit	Config.
Phase current I1 (x 1)	FB80	3, 4	-	16NS	0.1 A	-
Phase-to-phase voltage U21 (x 1)	FB81	3, 4	-	16NS	1 V	-
Active power P (x 1)	FB82	3, 4	-	16O	1 kW	-
Reactive power Q (x 1)	FB83	3, 4	-	16O	1 kvar	-
Sepam check-word (copy)	FB84	3, 4	-	B	-	-
TS1-TS16	FB85	3, 4	-	B	-	-
TS17-TS32	FB86	3, 4	-	B	-	-
TS33-TS48	FB87	3, 4	-	B	-	-
TS49-TS64	FB88	3, 4	-	B	-	-
Logic inputs I101 to I114	FB89	3, 4	-	B	-	-
Logic inputs I201 to I214	FB8A	3, 4	-	B	-	-
Logic inputs I301 to I314	FB8B	3, 4	-	B	-	-
Reserved	FB8C	3, 4	-	-	-	-
Logipam event counter C1	FB8D	3, 4	-	16NS	-	-
Logipam event counter C2	FB8E	3, 4	-	16NS	-	-
Reserved	FB8F	3, 4	-	-	-	-

Time-setting and synchronization



SFT2841: date and time on the "Sepam diagnosis" screen.

Presentation

Sepam series 80 manages the date and time internally. If auxiliary power is lost, the date and time function continues to operate, on the condition that a charged battery was installed.
The Sepam internal time function is used in particular to date alarms and other records.
Sepam time can be viewed:
- with SFT2841 ("Sepam diagnosis" screen)
- on the Sepam display
- by a Modbus read of the synchronization zone.

Sepam also supplies in the check-word the indication "Sepam time not correct" if it is necessary to reset the time (often the case when the battery is low or absent). This information can also be viewed with SFT2841, on the "Sepam diagnosis" screen.

Time setting

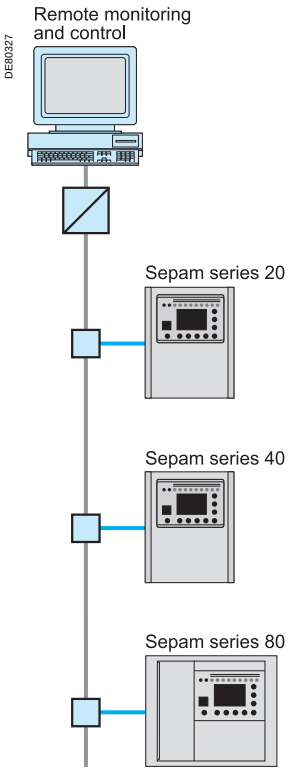
When Sepam is energized, the time is automatically set using the clock powered by the backup battery, if the battery is charged.
When necessary, it is possible to set the time on the Sepam series 80 using:
- SFT2841 ("Sepam diagnosis" screen)
- Sepam User Machine Interface
- Serial Modbus communication (COM1 or COM2)
- Modbus/TCP or SNTP (Ethernet)

Modbus time is set by writing, in a single block, the new value for the date and time in the synchronization zone (time frame).

Synchronization

To ensure long-term time stability or to coordinate a number of devices, it is possible to synchronize Sepam relays.
A number of synchronization sources are accepted:
- none (synchronization inhibited)
- a pulse to logic input I103
- Modbus communication on COM1
- Modbus communication on COM2
- Ethernet (Modbus or SNTP)

The source is selected using the SFT2841 software, on the "General characteristics" screen.
Non-synchronous status is indicated in the check-word. This information can also be viewed with SFT2841, on the "Sepam diagnosis" screen.
When Sepam is synchronized, time setting is authorized only by sources that are compatible with the synchronization.

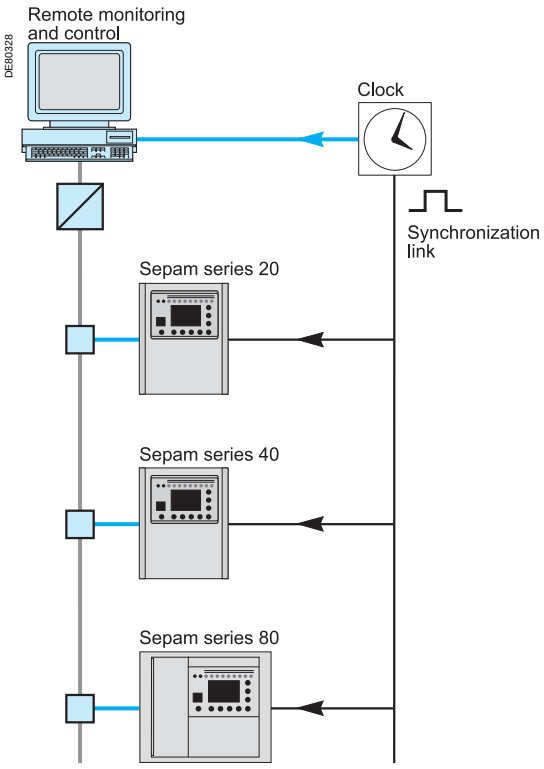


Synchronization of the Sepam clock by the communication network.

Time setting	Synchronization source			
	None	COM1	COM2/Ethernet	I103
Local	■			
Via COM1	■	■		■
Via COM2/Ethernet	■		■	■

Synchronization by the Modbus communication link

The time frame is used for both time setting and synchronization of Sepam. In this case, it must be regularly sent at brief intervals (between 10 and 60 seconds) to maintain synchronous time.
It is generally broadcast (slave number = 0).
The Sepam internal clock is reset each time a new time frame is received.
Synchronization is maintained if the reset amplitude is less than 100 milliseconds.
With synchronization via the Modbus network, accuracy depends on the master and its control over frame transmission time on the communication network. Sepam is synchronized without delay at the end of the receipt of the frame.
Time changes are made by sending a frame to Sepam with the new date and time. Sepam then switches to a transitional non-synchronous status.
In synchronous status, non-reception of a time frame for over 200 seconds results in the loss of synchronization.



External synchronization of the Sepam clock by sending a synchronization pulse to a logic input.

Pulse synchronization

Sepam can be synchronized externally by sending a periodic pulse (synchronization pulse) to logic input I103 (the MES120 module is required).
The pulse is used to reset the Sepam internal clock. Synchronization is carried out on the rising edge of the logic input.
Sepam adapts to synchronization periods from 10 to 60 seconds, in 10-second steps. The shorter the period, the more accurate the time setting.
When energized (or following a loss of synchronization), Sepam is in "non-synchronous" mode. The resetting process (switching of Sepam to "synchronous" mode) is based on a measurement of the difference between Sepam current time and the nearest ten-second period. This measurement is taken when the pulse is received following time setting. Resetting is authorized if the difference is less than or equal to 4 seconds. In this case, Sepam shifts to "synchronous" mode.
Subsequently (after switching to "synchronous" mode), the resetting process is based on the measurement of a difference (between Sepam current time and the nearest ten second period when the pulse is received), which is adapted to match the pulse period.

The pulse period is determined automatically by Sepam when it is energized, based on the first two pulses received. The pulse must be operational before Sepam is energized.
Synchronization operates only after Sepam has been time-set, i.e. after the "incorrect time" end event.

Any time changes greater than ± 4 seconds are made by sending a new time frame. The switch from summer time to winter time (and back) is made in this way as well. There is a temporary loss of synchronization when the time is changed.
Synchronization is lost if:
- the difference in synchronization between the closest 10-second period and pulse reception is greater than the synchronization error for two consecutive pulses
- the pulse is not received for a period longer than 200 seconds.

Synchronization-pulse characteristics

Electrical characteristics
They are identical to those for MES120 module inputs.

Time characteristics
Period: 10 to 60 seconds, in 10-second steps
State 1 minimum duration: 100 ms
State 0 minimum duration: 100 ms

Synchronization clock

The external synchronization mode requires additional equipment, a "synchronization clock " to generate a precise periodic synchronization time pulse.
Schneider Electric has tested the following products:
Gorgy Timing, part no. RT3000, equipped with the M540 module

Time-tagged events

Presentation

The time-tagging function assigns a date and precise time to status changes (events) so that they can be accurately organized over time.
Time-tagging is systematic and concerns:
- logic inputs
- remote indications
- certain information pertaining to Sepam equipment (see Sepam check-word).

Events may be used by a remote monitoring and control system for data logging and histories, for example.
The remote monitoring and control system provides a chronological display of the time-tagged data.

Description

Time-tagging

Event time-tagging uses the Sepam internal clock. When an event is detected, it is tagged with the current Sepam time.
Time-tagging accuracy depends essentially on how well the Sepam internal clock is synchronized (see the section on time setting and synchronization).

Inhibition in Test mode

Test mode may be used to temporarily stop the transmission of all time-tagged events when remote operation of the installation is not to be disturbed by maintenance operations carried out on the electrical equipment. This mode may be accessed via mimic-based UMIs by turning the key-switch.

When Sepam enters Test mode, it:
- transmits remote-indication TS208 "Test mode" with a value of 1
- interrupts the transmission of all time-tagged events.

When Sepam leaves Test mode, it transmits remote-indication TS208 "Test mode" with a value of 0.
Time-tagged events can be transmitted again. Status changes that take place in Test mode are permanently lost.

Event queues

Sepam has four internal storage queues (two per communication port) with a capacity of 64 events. Each queue is independent.
If one queue is full (63 events already recorded), a "**data loss**" event is generated in the 64th position and the queue no longer receives event data. The other queues are not affected and continue to receive any new detected events.
When a queue in "data loss" status is completely emptied, a "data loss" end event is generated and the queue then receives any detected events.

For each event queue of a Modbus port, the check-work contains certain information:
- presence of an event: indicates that there is at least one event that has not been read in the corresponding queue
- data loss: indicates that the queue is in "data loss" status (full).

Initialization

Each time Sepam is initialized (energized), events are generated in the following order:
- "data loss"
- "not synchronous"
- end of "data loss".

The "time not correct" event may also appear if there is no battery.
The function is initialized with the current values of the remote indication and logic input status without creating any events related to those data. After the initialization phase, event detection is activated.

Time-tagged events

Reading must address only the exchange word, or the entire table.

Reading of events

Two Modbus tables are used to read the corresponding queues of events, in groups of four maximum, using a specific protocol to make sure no events are lost, even if communication problems occur.

Event tables	Addr. table 1	Addr. table 2	Read	Write	Config.
Exchange word	0040	0070	3	6, 16	-
Event 1	0041/0048	0071/0078	3	-	-
Event 2	0049/0050	0079/0080	3	-	-
Event 3	0051/0058	0081/0088	3	-	-
Event 4	0059/0060	0089/0090	3	-	-

Exchange word

It is used to check event reading. It consists of the elements below.

Bit	*15*	*14*	*13*	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
	Exchange number 0…255								Event number 0…4							

The exchange number is initialized to zero when Sepam is energized and is incremented for each transfer of a new set of events. When it reaches its maximum value (FFh), it automatically goes back to zero.
Sepam numbers the exchanges and the master acknowledges the numbering.
The event number indicates the number of significant events are truly present in the table. The remainder of the table is less significant.

Event table acknowledgment

Following correct reception of the set of events, the master must acknowledge the exchange by writing an exchange word with:
- "Exchange number" field: number of the last exchange carried out
- "Event number" field: set to zero.

The acknowledged events are then cleared from the Sepam queue. If there are other events, they are made available in the table and the exchange number is incremented.
As long as an exchange is not acknowledged, the table remains as is and it is possible to read it again.
If acknowledgment is incorrect (incorrect value for the exchange word), it is not taken into account and the table remains as is.

Clearing an event queue

Writing a value "xxFFh" in the exchange word (any exchange number, event number = FFh) reinitializes the corresponding event queue (all stored events not yet transmitted are deleted).

Description of event coding

An event is coded in 8 words with the following structure:

Word	Information	Coding
1	Type of event	0800 h
2	Event address	Bit address (see inputs, TS, check-word)
3	Reserved	0
4	Event direction	0: falling edge 1: rising edge
5 to 8	Event time	IEC

Transferring records

Presentation

Sepam series 80 records different types of data:
- disturbance recording
- tripping contexts
- out-of-sync context.

The list of available records may be read in the corresponding directory zones.
Two Modbus transfer zones per port recover records using a specific protocol ensuring correct transfer, even if communication problems occur.

Transfer

Transfer is carried out in the same manner for all types of records. Given the volume of data, it is transferred in blocks that are compatible in size with Modbus frames.
To make a transfer, the master:
- determines the list of available records by reading the directory zone
- selects the desired record
- waits until it is available and recovers the first block of data, using the exchange word to ensure correct synchronization
- acknowledges block transfer
- repeats reading and acknowledgment until all the blocks have been received
- reads the directory zone again to check that the record was not overwritten during transfer.

A record may be transferred as many times as desired, until it is overwritten by a new record. If a record is made by Sepam while the oldest record is being transferred, the oldest record is overwritten.
Selection of a new record while a transfer is in progress interrupts the transfer.

Transfer zones

Each transfer zone comprises a zone for record selection and a zone reading record data.

Selection zone

Record transfer is initiated by writing the record identifier to this zone.

Selection	Addr. zone 1	Addr. zone 2	Read	Write	Config.
Word 1	2200	D200	3	16	-
Word 2	2201	D201	3	16	-
Word 3	2202	D202	3	16	-
Word 4	2203	D203	3	16	-

The zone should be written in a single block containing 4 words, using function 16 (write word).
Sepam series 80 capacity for simultaneous transfers is limited. If Sepam cannot handle the request, a type 07 exception reply is sent. In this case, a new request must be made later.

Record identifier

The records to be transferred are identified by their date as indicated in the directory zone, with an indicator in the most-significant byte of word 1:
0: disturbance recording
1: tripping contexts
2: out-of-sync context.

Bit	*15*	*14*	*13*	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Word 1	**Type of record**															
Word 2	Date of record (IEC)															
Word 3																
Word 4																

The record transfer is reset if more than 2 seconds elapse between consecutive data read operations.

Data read zone

Record data are made available in this zone.

Data reading	Addr. zone 1	Addr. zone 2	Read	Write	Config.
Exchange word	2300	D300	3	6, 16	-
Data word 1	2301	D301	3	-	-
Data word 2	2302	D302	3	-	-
...	...	...	3	-	-
Data word 124	237C	D37C	3	-	-

Reading must always begin at the beginning of the zone (exchange word). The data bytes not included in the significant information (see the section on the exchange word) do not contain significant values.

Exchange word

It is used to check data reading. It consists of the elements below.

Bit	*15*	*14*	*13*	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
	Exchange number 0…255								Number of usable bytes 0…248							

The exchange number is initialized to zero when Sepam is energized and is incremented for each transfer of a new block of data. When it reaches its maximum value (FFh), it automatically goes back to zero.
Sepam numbers the exchanges and the master acknowledges the numbering.
The number of bytes indicates the usable size of the data zone. It is initialized to zero after an energizing operation and varies between 0 and 248 (F8h).
The exchange word may also have the following values:

- **0000h:** no "read request" has yet been made. This is especially the case when Sepam is energized. The other data words are not significant.
- **FFFFh:** the "read request" has been processed, but the results are not yet available in the read zone. It is necessary to read again later.
- **xxFEh:** the transfer has been cancelled.

Reading acknowledgment

Following correct reception of the block of data, the master must acknowledge reading by writing an exchange word with:

- "Exchange number" field: number of the last exchange carried out
- "Number of bytes" field: set to zero.

If transfer of the record is not finished, the exchange word is reset to FFFFh while the next block of data is prepared, otherwise the exchange word is not modified.
As long as a read has not been acknowledged, the zone remains as is and it is possible to read it again.
If acknowledgment is incorrect (incorrect value for the exchange word), it is not taken into account and the zone remains as is.

Note: *it is not necessary to acknowledge tripping contexts which are contained in a single block.*

Data coding

Disturbance recording

Each record comprises two files as defined by the COMTRADE standard:

- configuration file (.CFG)
- data file (.DAT) in binary mode.

Because the configuration and data files are transferred together, a block may contain the end of the configuration file and the beginning of the data file of a record. It is up to the remote monitoring and control system to reconstruct the files in accordance with the transmitted number of usable bytes and the size of the files indicated in the directory zone.

Tripping contexts

Word	Information	Format	Unit
00	(exchange word)		
01 to 04	Context date	IEC	-
05/06	Tripping current phase 1 Itrip1	32NS	0.1 A
07/08	Tripping current phase 2 Itrip2	32NS	0.1 A
09/0A	Tripping current phase 3 Itrip3	32NS	0.1 A
0B/0C	Residual current I0Σ	32NS	0.1 A
0D/0E	Residual current I0	32NS	0.1 A
0F/10	Negative-sequence current Ii	32NS	0.1 A
11/12	Phase-to-phase voltage U21	32NS	1 V
13/14	Phase-to-phase voltage U32	32NS	1 V
15/16	Phase-to-phase voltage U13	32NS	1 V
17/18	Phase-to-neutral voltage V1	32NS	1 V
19/1A	Phase-to-neutral voltage V2	32NS	1 V
1B/1C	Phase-to-neutral voltage V3	32NS	1 V
1D/1E	Residual voltage V0	32NS	1 V
1F/20	Positive sequence voltage Vd	32NS	1 V
21/22	Negative-sequence voltage Vi	32NS	1 V
23/24	Frequency f	32NS	0.01 Hz
25/26	Active power P	32S	1 kW
27/28	Reactive power Q	32S	1 kvar
29/2A	Apparent power S	32S	1 kVA
2B/2C	Additional tripping current I'trip1	32NS	0.1 A
2D/2E	Additional tripping current I'trip2	32NS	0.1 A
2F/30	Additional tripping current I'trip3	32NS	0.1 A
31/32	Additional residual current I'0Σ	32NS	0.1 A
33/34	Additional residual current I'0	32NS	0.1 A
35/36	Additional negative-sequence current I'i	32NS	0.1 A
37/38	Phase-to-phase voltage U'21	32NS	1 V
39/3A	Phase-to-phase voltage U'32	32NS	1 V
3B/3C	Phase-to-phase voltage U'13	32NS	1 V
3D/3E	Phase-to-neutral voltage V'1	32NS	1 V
3F/40	Phase-to-neutral voltage V'2	32NS	1 V
41/42	Phase-to-neutral voltage V'3	32NS	1 V
43/44	Residual voltage V'0	32NS	1 V
45/46	Positive sequence voltage V'd	32NS	1 V
47/48	Negative sequence voltage V'i	32NS	1 V
49/4A	Frequency f'	32NS	0.01 Hz
4B/4C	Neutral-point voltage Vnt	32NS	1 V
4D/4E	H3 neutral-point voltage V3nt	32NS	0.1 %
4F/50	H3 residual voltage V3r	32NS	0.1 %
51/52	Differential current Id1	32NS	0.1 A
53/54	Differential current Id2	32NS	0.1 A
55/56	Differential current Id3	32NS	0.1 A
57/58	Through current It1	32NS	0.1 A
59/5A	Through current It2	32NS	0.1 A
5B/5C	Through current It3	32NS	0.1 A

Out-of-sync context

Word	Information	Format	Unit
00	(exchange word)		
01 to 04	Context date	IEC	-
05/06	Voltage difference dU	32NS	1 V
07	Frequency difference df	16NS	0.01 Hz
08	Phase difference dφ	16NS	0.1°

Access to remote settings

Presentation

Access to Sepam settings via Modbus communication allows the user to remotely:
- read settings remotely (remote reading)
- modify settings remotely (remote setting), if it has been authorized.

Two Modbus zones per port offer access to the settings, using a specific protocol.

Accessible functions

Remote reading of settings concerns:
- all protection and similar functions
- the main Sepam general parameters.

Remote setting concerns exclusively the protection and similar functions.

Inhibiting remote setting

It is possible to inhibit the remote-setting function using a configuration parameter accessible via SFT2841. In the default set-up (factory settings), the remote-setting function is inhibited.

Inhibition of remote setting also concerns the SFT2841 connected to Modbus communication ports. When remote setting is inhibited, only the SFT2841 locally connected to Sepam can modify settings and parameters.

Security

It is possible to protect the remote-setting zone against writing, see the section on security.

Operating principle

Remote setting reading

For remote setting reading, the master:
- selects the function whose settings are requested (write in the request zone)
- waits until it is available and recovers the setting values, using the exchange word to ensure correct synchronization (read the setting read zone).

Remote setting

For remote setting, the master:
- selects the function whose settings are to be modified remotely and provides the list of new settings (write in the remote-setting zone)
- waits until processing is finished and recovers the accepted setting values, using the exchange word to ensure correct synchronization (read the setting read zone)
- checks that the settings have been accepted and processes any refusals.

It is necessary to make all the settings for the function concerned, even if some of them have not changed.

CAUTION

HAZARD OF IMPROPER OPERATION
- The device must only be configured and set by qualified personnel, using the results of the installation protection system study.
- During commissioning of the installation and after any modification, check that the Sepam configuration and protection function settings are consistent with the results of this study.

Failure to follow these instructions can result in equipment damage

Setting access zones

Each setting-access zone includes a zone to select the function whose settings are requested, a zone to read the settings of the selected function and a zone to write the settings.

Selection zone for setting requests

A setting read is initiated by writing the function identifier to this zone.

Setting request	Addr. zone 1	Addr. zone 2	Read	Write	Config.
Function identifier	2080	D080	3	6, 16	-

Function identification

Each function is identified by a function code, with a unit number (protection) or a subcode (other functions). A list of the function codes is provided in the appendices, no other values are valid.

Bit	*15*	*14*	*13*	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
	Function code								Unit number or subcode							

Exception replies

In addition to the usual cases, Sepam can send Modbus type 07 exception replies (not acknowledged) if another remote reading (or remote setting) request is being processed.

Setting read zone

Setting values are made available in this zone.

Read settings
Exchange word
Setting 1
Setting 2
...
Setting 62

Reading must always begin at the beginning of the zone (exchange word). The length of the exchange may concern:
- the exchange word only (validity test)
- the maximum size of the zone (125 words)
- the usable size of the zone (determined by the function being addressed).

Exchange word

It is used to check the reading of the settings and can have the following values:
- **xxyy:** where
  - function code **xx** is not 00 or FFh
  - unit number or subcode **yy** is not FFh.

The requested settings are available in the words below. The word is a copy of the request. The zone contents remain valid until the next request is made.
- **FFFFh:** the request has been processed, but the results are not yet available. It is necessary to read again later. The other words are not significant.
- **xxFFh:** where the function code **xx** is not 00 or FFh. The read request for the settings of the designated function is not valid. The function (or the unit) does not exist for this Sepam.
- **0000h**: no "request frame" has yet been formulated. This is especially the case when Sepam is energized. The other words are not significant.

Settings

All settings are 32 bits in length (two Modbus words). They are specific to each function and are described in the appendices.

Remote-setting zone

The new setting values are written in this zone.

Read settings	Addr. zone 1	Addr. zone 2	Read	Write	Config.
Function identifier	2100	D100	3	16	-
Setting 1	2101/2102	D101/D102	3	16	-
Setting 2	2103/2004	D102/D003	3	16	-
...	...	...	3	16	-
Setting 61	2179/217A	D179/D17A	3	16	-

Writing must always begin at the beginning of the zone.

Function identifier

It is identical to that used to read the settings.

Settings

All settings are 32 bits in length (two Modbus words). They are specific to each function and are described in the appendices.

Exception reply

In addition to the usual cases, Sepam can send type 07 exception replies (not acknowledged) if:
- another remote reading or setting request is being processed
- the remote setting function is inhibited
- Sepam is being set locally (SFT2841 or UMI).

Check on setting acceptance

After processing the remote-setting zone, Sepam updates the read zone with the current function settings. In this case, the exchange word may also have another value:
- **FFFEh** meaning that the settings have been refused. Certain values are incorrect and are replaced by 7FFFFFFFh in the read zone.

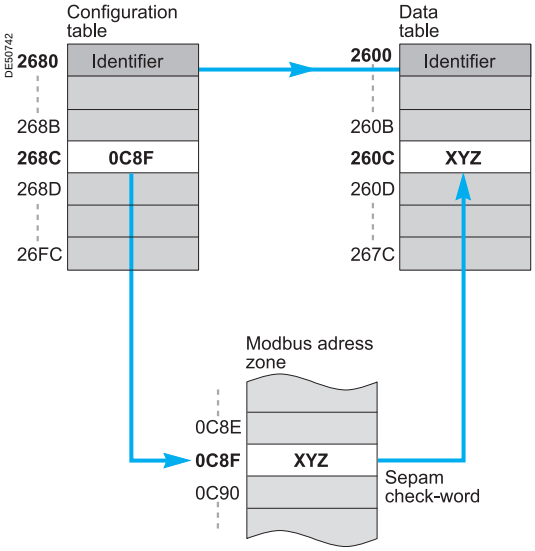
Presentation

To reduce the number of Modbus exchanges required by the master to collect the most frequently used information (and the bandwidth used on the network), a customized table can be set up on each communication port of Sepam series 80. This table is defined via Modbus, using a configuration table.

Use

Configuration table

Configuration table	Address	Read	Write	Config.
Identifier	2680	3	16	-
Address datum 1	2681	3	16	-
Address datum 2	2682	3	16	-
...	...	3	16	-
Address datum 124	26FC	3	16	-



Example: *by writing 0C8F to 268C, the result at 260C is a copy of the contents at address 0C8F (check-word).*

Writing the configuration table

This function is used to configure the data table. The first word in the configuration table is used as the configuration identifier. It is copied as is in the first word of the data table. The identifier can have any value, except 0. If the identifier is set to 0, table configuration is cancelled.

The identifier enables masters to generate a number of typical configurations and to check which is active. It is also the means to check that no other master has modified the active configuration. This requires concerted management between the masters.

Each other word in the table contains the Modbus address of the datum that should be set up in the corresponding spot in the data table (0 if the position is not used).

Only certain Modbus addresses can be set up in these tables. The valid addresses are indicated in this document by "yes" in the "Config." column in the descriptions.

It is possible to write the table in part or in whole from any address. When 125 words are used (the maximum size of the data table), at least two writings are required to fill the configuration table because the maximum size of a Modbus write is 123 words.

Reading the configuration table

This function is used to read and check the configuration of the data table. Each address word can have one of the following values:

- 0000: position not used
- FFFFh: invalid address
- Address: address correctly configured.

It is possible to read the zone in part or in whole from any address.

Customized table

***Caution**: configuration takes place one Modbus word after the other. For a 32-bit value, it is necessary to provide the two successive addresses of the value. (This characteristic may be used to switch the order of words if there is a compatibility problem with the 32-bit format. It is also possible to use only the least-significant part of the 32-bit values if the range is sufficient for the given application.)*

Data table

Data table	Address	Read	Write	Config.
Identifier	2600	3	-	-
Datum 1	2601	3	-	-
Datum 2	2602	3	-	-
...	...	3	-	-
Datum 124	267C	3	-	-

Reading the data table

This function is used to read the data set up at the corresponding position.
The validity of the datum is indicated in the configuration table.
It is possible to read the table in part or in whole from any address.

Exception replies

Sepam sends a Modbus type 07 exception reply (not acknowledged) if the data table has not been set up. This may occur in the following cases:

- the table was never set up
- the table was set up, but one or more addresses are incorrect

The configuration table can be read again to identify the addresses in question;

- the configuration was cancelled (the identifier was set to 0)
- the configuration was lost (Sepam de-energized). In this case, it must be reloaded.

Presentation

With Sepam series 80, it is possible to protect remote controls and remote settings using a password.
If enabled in the SFT2841 software, the Sepam series 80 remote control and settings can be password-protected.
Two different passwords are required:
- one password for the remote controls
- one password for the remote settings

thus offering differentiated access.
The ON/OFF status of the security function is given by bit 01 of the Sepam check-word.

Implementation

The security function uses an extension of the Modbus protocol that encapsulates the standard remote-control and remote-setting frames in a special frame.

Request frames

The request frame is made of the following components.

Field	*Size (bytes)*	
Slave number	1	
102 (66h)	1	*Security function code*
00	1	*Security version*
0000	2	*Reserved*
xxxx	2	*Password (BCD coding)*
Standard function code	1	
Standard frame data ...	n	***Encapsulated standard frame***
CRC16	2	

The standard function codes that can be used in the request are the codes accepted for writing to the corresponding addresses, i.e. 6 and 16 for words and 5 and 15 for bits.
The security function does not affect reading.
The indicated password is the one created with SFT2841, for the given zone. It is a 16-bit BCD code (e.g. the entered password is 1234, the value in the Modbus field is 1234h).

Reply frames

The standard reply frame is also encapsulated, with a reduced header.

Field	*Size (bytes)*	
Slave number	1	
102 (66h)	1	*Security function code*
00	1	*Security version*
Standard function code	1	
Standard reply ...	n	***Encapsulated standard reply***
CRC16	2	

Exception replies

Security-function (access control) exceptions
When the security function is enabled on Sepam, request 102 must be used to access Sepam's protected data.
If a non-secure request is used, a standard exception reply 02 (incorrect data addresses) is sent to indicate that the requested data cannot be accessed.
When request 102 is used, a security-function exception reply 80 can be sent to indicate access refused in the following two cases:
- Incorrect security level (the level asked for in the request is not 00)
- Incorrect password

Standard-function (encapsulated) exceptions
When access control has been negotiated successfully, the reply to request 102 can encapsulate a standard exception reply, as described for replies associated with Modbus standard function codes.

Examples

Secure writing using function 16 (write word) of value 9999h to Modbus address ABCDh on slave 3.

Request frames

03	*Slave*
66	*Security function code*
00	*Version*
0000	*Reserved*
1234	*Password*
10	*Write-word function code*
ABCD	*Address*
0001	*Number of words to be written*
02	*Number of bytes*
9999	*Value to be written*
xxxx	*CRC16*

Normal reply frames

03	*Slave*
66	*Security function code*
00	*Version*
10	*Write-word function code*
0001	*Number of words written*
xxxx	*CRC16*

Exception frames

Write-word function exception: it is not possible to write to the given address.

03	*Slave*
66	*Security function code*
00	*Version*
90	*Write-word exception (10 + 80)*
02	*Incorrect address*
xxxx	*CRC16*

Security exception: incorrect password

03	*Slave*
E6	*Security exception (66 + 80)*
80	*Access refused*
xxxx	*CRC16*

Reading Sepam identification

Presentation

The "Read Device Identification" function provides standardized access to the information required to clearly identify a device.
The description is made up of a set of objects (ASCII character strings).
Sepam series 80 accepts the "read identification" function (conformity level 02).
For a complete description of the function, refer to **www.modbus.org**. The description below covers a subset of the function, adapted to Sepam series 80.

Implementation

Request frame

The request frame is made of the following components.

Field	*Size (bytes)*	
Slave number	1	
43 (2Bh)	1	*Generic access function code*
14 (0Eh)	1	*Read device identification*
01 or 02	1	*Type of read*
00	1	*Object number*
CRC16	2	

The type of read is used to select a simplified (01) or a standard (02) description.

Reply frame

The reply frame is made of the following components:

Field	*Size (bytes)*	
Slave number	1	
43 (2Bh)	1	*Generic access function code*
14 (0Eh)	1	*Read device identification*
01 or 02	1	*Type of read*
02	1	*Conformity level*
00	1	*Continuation-frame flag (none for Sepam)*
00	1	*Reserved*
n	1	*Number of objects (according to read type)*
0bj1	1	*Number of first object*
lg1	1	*Length first object*
txt1	lg1	*ASCII string of first object*
.....	...	
objn	1	*Number n^{th} object*
lgn	1	*Length n^{th} object*
txtn	lgn	*ASCII string of n^{th} object*
CRC16	2	

Exception frame

If an error occurs during request processing, a special exception frame is sent.

Field	*Size (bytes)*	
Slave number	1	
171 (ABh)	1	*Generic access exception (2Bh + 80h)*
14 (0Eh)	1	*Read device identification*
01	1	*Type of error*
CRC16	2	

Sepam series 80 identification

The objects making up the Sepam series 80 identification are listed below.

Number	Type	Value
0:	VendorName	"Merlin Gerin" or "Schneider Electric"
1:	ProductCode	Application EAN13 code
2:	MajorMinorRevision	Application version number (Vx.yy)
3:	VendorURL	"www.schneider-electric.com"
4:	ProductName	"Sepam series 80"
5:	ModelName	Application name (e.g. "M87 Motor")
6:	UserAppName	Sepam marking

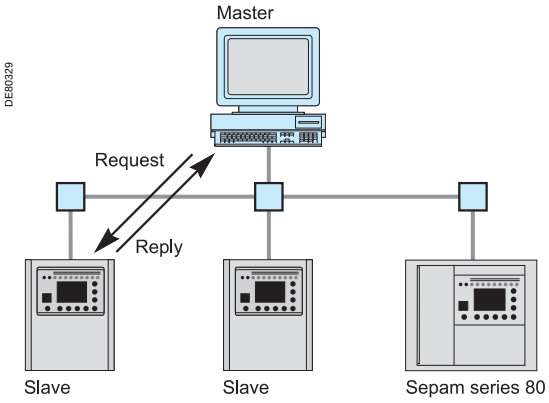
The simplified description includes only objects 0 to 2.

Appendix 1. Modbus protocol

Introduction

This appendix describes the Modbus protocol and the functions required for Modbus communication with Sepam series 80. It is not intended to present the entire protocol.

Presentation



Modbus is a master-slave network.

Exchanges

The Modbus protocol exchanges information using a request-reply mechanism between a master and a slave.
An exchange is always initiated (request sent) by the master. The only action on the part of a slave is to reply to requests received.
Where the communication network permits, several slaves units can be connected to a single master. A request contains the slave address (a unique number) to identify the recipient. Non-addressed slaves disregard the requests received.

Modbus Protocol Data Unit

Every Modbus request or response frame includes a Modbus PDU (protocol data unit) made up of 2 fields.

Function code	Data

- function code (1 byte): indicates the type of request (1 to 127)
- data (0 to n bytes): depends on the function code, see below.

If there is no error, the function codes in the reply and in the request are identical.

Modbus data types

Modbus uses 2 types of data: bits and 16-bit words (also called registers).
Each element of data is identified by a 16-bit address.
The most-significant byte in 16-bit words is always sent first, for both data and addresses.

Serial line Modbus

This description is limited to the Modbus protocol using a serial link in binary mode (RTU mode).

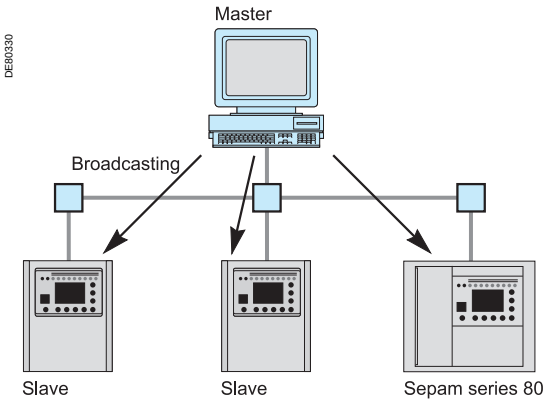
Frames

All the frames exchanged have the same structure, made up of 3 parts.

Slave address	Modbus PDU	Check (CRC16)

- Slave address (1 byte): from 1 to 247 (0 for broadcasting)
- Modbus PDU: as previously described
- Check (2 bytes): CRC16 used to check frame integrity.

The slave addresses in the reply and in the request are identical.
The maximum size of a frame is 256 bytes (255 for Sepam series 80).



The broadcasting technique.

Synchronization of exchanges

Any character that is received after a silence of more than 3.5 characters is considered as the beginning of a new frame. A minimum silence of 3.5 characters must always be observed between two frames.
A slave disregards all frames:

- received with a physical error for 1 or more characters (format error, parity error, etc.)
- with an incorrect CRC16 result
- for which it is not the recipient.

Broadcasting

The master can also address all slaves using the conventional address 0. This type of exchange is called broadcasting.
Slaves do not respond to broadcast messages. As a result, only messages that do not require the transmission of data by the slaves can be broadcast.

Modbus over TCP/IP

Requests and replies are exchanged as TCP/IP messages over a TCP connection. The slave address is therefore its IP address.

Frames

The application layer part of a Modbus/TCP frame is made up of 2 fields:

MBAP Header	Modbus PDU

- MBAP (Modbus Application) Header (7 bytes): identifies the frame
- Modbus PDU: as previously described.

Modbus Application header

It contains the following fields:

Field	Length	Description	Request	Response
Transaction identifier	2 bytes	Identification of a Modbus request/ response transaction	Initialized by the client	Copied by the server from the received request
Protocol identifier	2 bytes	0 = Modbus protocol	Initialized by the client	Copied by the server from the received request
Length	2 bytes	Number of following bytes (including unit identifier)	Initialized by the client	Initialized by the server
Unit identifier	1 byte	In case of gateways, identifies a remote slave device connected on a serial line. Should be 255 in other cases.	Initialized by the client	Copied by the server from the received request

Modbus protocol data units

Types of functions

The Modbus protocol provides read and write functions as well as network-management and diagnostics functions.

Read N bits functions (1 and 2)

Request

1 or 2	Address of first bit to be read	Number of bits N to be read
1 byte	*2 bytes*	*2 bytes*

Reply

1 or 2	Number of bytes read	Data
1 byte	*1 byte*	*(N + 7)/8 bytes*

Function code

- 1 for internal or output bits
- 2 for input bits.

Data

The first bit sent is the LSB in the first byte and the subsequent bits follow in that order. Any excess bits in the last byte are set to 0.

	byte 1								*byte 2*							
7	*6*	*5*	*4*	*3*	*2*	*1*	*0*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1
1	1	0	0	0	0	0	0				2	1	1	1	1
B	A	9	8	7	6	5	4				0	F	E	D	C

Example: coding of the data field for reading 13 bits, starting at address 104h, with two reply bytes (the vertical numbers indicate the Modbus address of the bit in the corresponding position in the reply).

Read N words functions (3 and 4)

Request

3 or 4	Address of first word to be read	Number of words N to be read
1 byte	*2 bytes*	*2 bytes*

Reply

3 or 4	Number of bytes read	Data
1 byte	*1 byte*	*2N bytes*

Function code

- 3 for internal or output words
- 4 for input words.

Data

Words are sent in the order of increasing addresses.

Write bit function (5)

Request

5	Bit address	Bit value	0: bit set to 0 FFh: bit set to 1	0
1 byte	*2 bytes*	*1 byte*		*1 byte*

Reply

It is identical to the request.

Write word function (6)

Request

6	Word address	Word value
1 byte	*2 bytes*	*2 bytes*

Reply

It is identical to the request.

Write N consecutive bits function (15)

Request

0Fh	Address of 1st bit	Number of bits	Number of bytes	Data
1 byte	*2 bytes*	*2 bytes*	*1 byte*	*(N + 7)/8 bytes*

Data

Bits are coded similar to the Read bits function.

Reply

0Fh	Address of 1st bit written	Number of bits written
1 byte	*2 bytes*	*2 bytes*

Write N consecutive words function (16)

Request

10h	Address of 1st word	Number of words	Number of bytes	Data
1 byte	*2 bytes*	*2 bytes*	*1 byte*	*2N bytes*

Data
Words are sent in the order of increasing addresses.

Reply

10h	Address of 1st word written	Number of words written
1 byte	*2 bytes*	*2 bytes*

High-speed reading of 8 bits function (7)

Request

7
1 byte

Reply

7	Status byte
1 byte	*1 byte*

For Sepam series 80, the status byte is the most-significant byte in the Sepam check-word (address 0C8Fh), i.e. the bits C8F8h to C8FFh.

Diagnosis function (8)

Request

8	Subcode	Data
1 byte	*2 bytes*	*2 bytes*

Reply

8	Subcode	Data
1 byte	*2 bytes*	*2 bytes*

Subcodes for function 8

Sub-code	Use	Request Datum	Reply Datum
0000h	Echo mode	Any	Datum received
000Ah	Reset counters CPT1 to CPT9	0000	0000
000Bh	Read CPT1 (frames without errors)	0000	CPT1
000Ch	Read CPT2 (frames with errors)	0000	CPT2
000Dh	Read CPT3 (exception replies)	0000	CPT3
000Eh	Read CPT4 (frames sent to station)	0000	CPT4
000Fh	Read CPT5 (frames broadcast)	0000	CPT5
0010h	Read CPT6 (not managed by Sepam)	0000	CPT6
0011h	Read CPT7 (not managed by Sepam)	0000	CPT7
0012h	Read CPT8 (frames with physical errors)	0000	CPT8

Read event counter function (11)

For Sepam series 80, the event counter is CPT9 (number of correct requests received and correctly executed).

Request

0Bh
1 byte

Reply

0Bh	0000	Counter CPT9
1 byte	*2 bytes*	*2 bytes*

Exception replies

Each time a slave station receives a frame without errors that it cannot process, it sends an exception reply with the elements below.

Request function code + 80h	Type of exception
1 byte	*1 byte*

Type of exception	Meaning
01	Unknown function code
02	Incorrect address
03	Incorrect datum
04	Device not ready
07	Negative acknowledgment

Calculation of the CRC16

The CRC16 is calculated by the station sending the frame. On reception, the CRC16 is recalculated and compared to the received value. If the two values are not the same, the frame is rejected.
The CRC16 uses two bytes. Contrary to the general Modbus rule, the least-significant byte is sent first. It is the product of the polynomial division of the frame by the generating polynomial $X^{16} + X^{15} + X^2 + 1$.
A number of methods may be used to calculate it. The table method is often used because it is very effective. The program below, written in the C language, is an example of this method.

Example of calculation in the C language

The function uses two parameters:
- `unsigned char *puchMsg`: points to the frame for CRC calculation
- `unsigned short usDataLen`: number of bytes in the frame.

The function returns the CRC as an `unsigned short` type. All possible CRC values are listed in two tables indexed according to the value of the successive bytes in the frame. One table contains the 256 possible values for the most-significant byte in the CRC and the other table contains the 256 possible values for the least-significant byte in the CRC.

Note: *the result is ready to be inserted in the frame, the order of the bytes has already been reversed.*

```
unsigned short CRC16(puchMsg, usDataLen)
unsigned char *puchMsg ;                          /* message to calculate CRC upon */
unsigned short usDataLen ;                        /* quantity of bytes in message */
{
   unsigned char uchCRCHi = 0xFF ;                /* high byte of CRC initialized */
   unsigned char uchCRCLo = 0xFF ;                /* low byte of CRC initialized */
   unsigned uIndex ;                              /* will index into CRC lookup table */
   while (usDataLen--) {                          /* pass through message buffer */
        uIndex = uchCRCHi ^ *puchMsgg++ ;         /* calculate the CRC */
        uchCRCHi = uchCRCLo ^ auchCRCHi[uIndex} ;
        uchCRCLo = auchCRCLo[uIndex] ;
   }
   return (uchCRCHi << 8 | uchCRCLo) ;
}

/* Table of CRC values for high–order byte */
static unsigned char auchCRCHi[] = {
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40 } ;

/* Table of CRC values for low–order byte */
static char auchCRCLo[] = {
0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06, 0x07, 0xC7, 0x05, 0xC5, 0xC4, 0x04,
0xCC, 0x0C, 0x0D, 0xCD, 0x0F, 0xCF, 0xCE, 0x0E, 0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09, 0x08, 0xC8,
0xD8, 0x18, 0x19, 0xD9, 0x1B, 0xDB, 0xDA, 0x1A, 0x1E, 0xDE, 0xDF, 0x1F, 0xDD, 0x1D, 0x1C, 0xDC,
0x14, 0xD4, 0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2, 0x12, 0x13, 0xD3, 0x11, 0xD1, 0xD0, 0x10,
0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3, 0xF2, 0x32, 0x36, 0xF6, 0xF7, 0x37, 0xF5, 0x35, 0x34, 0xF4,
0x3C, 0xFC, 0xFD, 0x3D, 0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A, 0x3B, 0xFB, 0x39, 0xF9, 0xF8, 0x38,
0x28, 0xE8, 0xE9, 0x29, 0xEB, 0x2B, 0x2A, 0xEA, 0xEE, 0x2E, 0x2F, 0xEF, 0x2D, 0xED, 0xEC, 0x2C,
0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7, 0xE6, 0x26, 0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0,
0xA0, 0x60, 0x61, 0xA1, 0x63, 0xA3, 0xA2, 0x62, 0x66, 0xA6, 0xA7, 0x67, 0xA5, 0x65, 0x64, 0xA4,
0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F, 0x6E, 0xAE, 0xAA, 0x6A, 0x6B, 0xAB, 0x69, 0xA9, 0xA8, 0x68,
0x78, 0xB8, 0xB9, 0x79, 0xBB, 0x7B, 0x7A, 0xBA, 0xBE, 0x7E, 0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C,
0xB4, 0x74, 0x75, 0xB5, 0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71, 0x70, 0xB0,
0x50, 0x90, 0x91, 0x51, 0x93, 0x53, 0x52, 0x92, 0x96, 0x56, 0x57, 0x97, 0x55, 0x95, 0x94, 0x54,
0x9C, 0x5C, 0x5D, 0x9D, 0x5F, 0x9F, 0x9E, 0x5E, 0x5A, 0x9A, 0x9B, 0x5B, 0x99, 0x59, 0x58, 0x98,
0x88, 0x48, 0x49, 0x89, 0x4B, 0x8B, 0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D, 0x4C, 0x8C,
0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42, 0x43, 0x83, 0x41, 0x81, 0x80, 0x40 } ;
```

Setting coding

Data format

All the settings are transmitted in 32-bit signed 2's complement integer format.

Coding of tripping and timer hold curves

The numbers correspond to the setting columns in the lists of settings.

(1) Tripping curves

0 = definite time
1 = inverse
2 = long time inverse
3 = very inverse
4 = extremely inverse
5 = ultra inverse
6 = RI
7 = IEC inverse / A
8 = IEC long time inverse / B
9 = IEC very inverse / B
10 = IEC extremely inverse / C
11 = IEEE moderately inverse
12 = IEEE very inverse
13 = IEEE extremely inverse
14 = IAC inverse
15 = IAC very inverse
16 = IAC extr. inverse
24 = Customized curve
25 = EPATR-B
26 = EPATR-C

(2) Tripping curves

0 = definite time
7 = IEC inverse / A
8 = IEC long time inverse / B
9 = IEC very inverse / B
10 = IEC extremely inverse / C
11 = IEEE moderately inverse
12 = IEEE very inverse
13 = IEEE extremely inverse
17 = Specific Schneider curve
20 = RI^2

(3) Timer hold curves

0 = definite time
1 = IDMT

Common protection settings

All protection functions have the following settings at the head of the table.

Setting	Data	Format/Unit
1	Latching	0: no 1: yes
2	Program logic	see below
3	Activity	0: Off 1: On
4	Measurement origin	0: main 1: additional or special case, see below

Details on program-logic field

Bit	*31*	*30*	*....*	*4*	*3*	*2*	*1*	*0*
						DES	AGR	CDC

CDC = 1: the protection function takes part in circuit-breaker/contactor control
= 0: the protection function does not take part

AGR = 1: the protection function takes part in genset shutdown (generator application)
= 0: the protection function does not take part

DES = 1: the protection function takes part in de-excitation (generator application)
= 0: the protection function does not take part

When a common protection setting is not applicable to a particular protection function, it is signaled "reserved" in the table for the function.

Measurement origin

A few special cases of coding for the measurement-origin field, for the ANSI 50N/51 N, ANSI 67N/67NC and ANSI 59N protection functions, are indicated in the table below:

Value	50N/51N	67N/67NC	59N
0	I0Σ	I0Σ	V0
1	I0	I0	Vnt
2	I'0	I'0	
3	I'0Σ		

Protection settings

They are organized according to **increasing ANSI codes**.

ANSI 12 - Overspeed

Function number: 72xx
Unit 1: xx = 01, unit 2: xx = 02

Setting	Data	Format/Unit
1 to 3	Common settings	
4	Reserved	
5	Set point	%
6	Tripping time delay	10 ms

ANSI 14 - Underspeed

Function number: 77xx
Unit 1: xx = 01, unit 2: xx = 02

Setting	Data	Format/Unit
1 to 3	Common settings	
4	Reserved	
5	Set point	%
6	Tripping time delay	10 ms

ANSI 21B - Underimpedance

Function number: 7401

Setting	Data	Format/Unit
1 to 3	Common settings	
4	Reserved	
5	Zs set point	mΩ
6	Tripping time delay	10 ms

ANSI 24 - Overfluxing (V/Hz)

Function number: 75xx
Unit 1: xx = 01, unit 2: xx = 02

Setting	Data	Format/Unit
1 to 3	Common settings	
4	Reserved	
5	Machine coupling	0: delta 1: star
6	Tripping curve	0 = definite 21 = Type A 22 = Type B 23 = Type C
7	Gs set point	0.01 pu
8	Tripping time delay	10 ms

ANSI 25 – Synchro-check

Function number: 1801

Setting	Data	Format/Unit
1	Reserved	
2	Reserved	
3	Activity	0: off 1: on
4	dUs set point	% Vnp sync1 or % Unp sync1
5	dFs set point	0.01 Hz
6	dPhis set point	°
7	Us high set point	% Vnp sync1 or % Unp sync1
8	Us low set point	% Vnp sync1 or % Unp sync1
9	Operating modes (no-voltage conditions for which coupling is allowed)	1: Dead1 AND Live2 2: Live1 AND Dead2 3: Dead1 XOR Dead2 4: Dead1 OR Dead2 5: Dead1 AND Dead2
10	Lead time	10 ms
11	Use of voltage check for coupling authorization	0: no 1: yes

ANSI 27 - Undervoltage

Function number: 32xx
Unit 1: xx = 01 to unit 4: xx = 04

Setting	Data	Format/Unit
1 to 4	Common settings	
5	Tripping curve	0: definite 19: IDMT
6	Voltage mode	0: phase-to-neutral 1: phase-to-phase
7	Us set point	% Unp
8	Tripping time delay	10 ms

ANSI 27D - Positive sequence undervoltage

Function number: 38xx
Unit 1: xx = 01, unit 2: xx = 02

Setting	Data	Format/Unit
1 to 4	Common settings	
5	Vds set point	% Unp
6	Tripping time delay	10 ms

ANSI 27R - Remanent undervoltage

Function number: 35xx
Unit 1: xx = 01, unit 2: xx = 02

Setting	Data	Format/Unit
1 to 4	Common settings	
5	Us set point	% Unp
6	Tripping time delay	10 ms

ANSI 27TN/64G2 - Third harmonic undervoltage

Function number: 71xx
Unit 1: xx = 01, unit 2: xx = 02

Setting	Data	Format/Unit
1 to 3	Common settings	
4	Reserved	
5	Access	0: adaptive 1: fixed
6	Vs set point	0.1 % Untp
7	Min. Ss set point	% Sb
8	Min. Vs set point	% Unp
9	K set point	0.01
10	Tripping time delay	10 ms

ANSI 32P - Directional active overpower

Function number: 53xx
Unit 1: xx = 01, unit 2: xx = 02

Setting	Data	Format/Unit
1 to 3	Common settings	
4	Reserved	
5	Access	0: reverse power 1: overpower
6	Ps set point	100 W
7	Tripping time delay	10 ms

ANSI 32Q - Directional reactive overpower

Function number: 5401

Setting	Data	Format/Unit
1 to 3	Common settings	
4	Reserved	
5	Access	0: reverse power 1: overpower
6	Qs set point	100 var
7	Tripping time delay	10 ms

ANSI 37 - Phase undercurrent

Function number: 2201

Setting	Data	Format/Unit
1 to 3	Common settings	
4	Reserved	
5	Is set point	% Ib
6	Tripping time delay	10 ms

ANSI 37P - Directional active underpower

Function number: 55xx

Unit 1: xx = 01, unit 2: xx = 02

Setting	Data	Format/Unit
1 to 3	Common settings	
4	Reserved	
5	Access	0: drawn 1: supplied
6	Ps set point	100 W
7	Tripping time delay	10 ms

ANSI 38/49T - Temperature monitoring

Function number: 46xx

Unit 1: xx = 01 to unit 16: xx = 10h

Setting	Data	Format/Unit
1 to 3	Common settings	
4	Reserved	
5	Ts1 alarm set point	°C
6	Ts2 alarm set point	°C

ANSI 40 - Field loss (underimpedance)

Function number: 7001

Setting	Data	Format/Unit
1 to 3	Common settings	
4	Reserved	
5	Xa resistance	1 mΩ
6	Xb resistance	1 mΩ
7	Xc resistance	1 mΩ
8	Tripping time delay circle 1	10 ms
9	Tripping time delay circle Xd	10 ms

ANSI 46 - Negative sequence / unbalance

Function number: 45xx

Unit 1: xx = 01, unit 2: xx = 02

Setting	Data	Format/Unit
1 to 4	Common settings	
5	Tripping curve	②
6	Is set point	% Ib or % I'b
7	Tripping time delay	10 ms
8	K setting	1 to 100

ANSI 47 - Negative sequence overvoltage

Function number: 40xx

Unit 1: xx = 01, unit 2: xx = 02

Setting	Data	Format/Unit
1 to 4	Common settings	
5	Vis set point	% Unp
6	Tripping time delay	10 ms

ANSI 48/51LR - Locked rotor / excessive starting time

Function number: 4401

Setting	Data	Format/Unit
1 to 3	Common settings	
4	Reserved	
5	Is set point	% Ib
6	ST excessive starting time	10 ms
7	LT locked rotor time	10 ms
8	LTS locked on start time	10 ms

ANSI 49RMS - Thermal overload

Function number: 4301

Setting	Data	Format/Unit
1 to 4	Common settings	
5	Negative sequence factor (K)	0: none (0) 1: low (2.25) 2: medium (4.5) 3: high (9)
6	Is set point (shift group 1/group 2)	% Ib
7	Ambient temperature taken into account	0: no 1: yes
8	Maximum equipment temperature	°C
9	Additional settings taken into account (group 2)	0: no 1: yes
10	Learnt cooling time constant (T2 learnt) taken into account	0: no 1: yes
11	Group 1 - thermal alarm set point	%
12	Group 1 - thermal tripping set point	%
13	Group 1 - heating time constant	min.
14	Group 1 - cooling time constant	min.
15	Group 1 - initial heat rise	%
16	Group 2 - thermal alarm set point	%
17	Group 2 - thermal tripping set point	%
18	Group 2 - heating time constant	min.
9	Group 2 - cooling time constant	min.
20	Group 2 - initial heat rise	%
21	Group 2 - base current for group 2	0.1 A
22	49RMS cable - admissible current	0.1 A
	49RMS capacitor - tripping current	0.1 A
23	Associated time constant	min.
24	Current setting	0.1 A
25	Alarm current	0.1 A

Note: ■ *thermal overload for machines: parameters 1 to 21*
■ *thermal overload for cables: parameters 1 to 4 and 22 to 23*
■ *thermal overload for capacitors: parameters 1 to 4 and 22 to 25*

ANSI 50BF - Breaker failure

Function number: 9801

Setting	Data	Format/Unit
1	Common settings	
2	Reserved	
3	Common settings	
4	Reserved	
5	Use of breaker closed input	0: no 1: yes
6	Is set point	0.1 A
7	Time	10 ms

ANSI 50/27 - Inadvertent energization

Function number: 7301

Setting	Data	Format/Unit
1 to 3	Common settings	
4	Reserved	
5	Is set point	0.1 A
6	Vs set point	% Unp
7	T1 time	10 ms
8	T2 time	10 ms
9	Use of breaker-position inputs	0: no 1: yes

ANSI 50/51 - Phase overcurrent

Function number: 01xx
Unit 1: xx = 01 to unit 8: xx = 08

Setting	Data	Format/Unit
1 to 4	Common settings	
5	Confirmation	0 = none 1 = neg. seq. overvoltage 2 = undervoltage
6	Group A - tripping curve	①
7	Group A - Is set point	0.1 A
8	Group A - tripping time delay	10 ms
9	Group A - timer hold curve	③
10	Group A - timer hold	10 ms
11	Group B - tripping curve	①
12	Group B - Is set point	0.1 A
13	Group B - tripping time delay	10 ms
14	Group B - timer hold curve	③
15	Group B - timer hold	10 ms

ANSI 50N/51N - Earth fault

Function number: 06xx
Unit 1: xx = 01 to unit 8: xx = 08

Setting	Data	Format/Unit
1 to 4	Common settings	
5	Group A - tripping curve	①
6	Group A - Is0 set point	0.1 A
7	Group A - tripping time delay	10 ms
8	Group A - timer hold curve	③
9	Group A - timer hold	10 ms
10	Group A - H2 restraint	0: yes 1: no
11	Group B - tripping curve	①
12	Group B - Is0 set point	0.1 A
13	Group B - tripping time delay	10 ms
14	Group B - timer hold curve	③
15	Group B - timer hold	10 ms
16	Group B - H2 restraint	0: yes 1: no

ANSI 50V/51V - Voltage-restrained phase overcurrent

Function number: 19xx
Unit 1: xx = 01, unit 2: xx = 02

Setting	Data	Format/Unit
1 to 4	Common settings	
5	Tripping curve	①
6	Is set point	0.1 A
7	Tripping time delay	10 ms
8	Timer hold curve	③
9	Timer hold	10 ms

ANSI 51C – Capacitor bank unbalance

Function number: 03xx
Unit 1: xx = 01 to unit 8: xx = 08

Setting	Data	Format/Unit
1	Latching	0: no 1: yes
2	Switchgear control	0: no 1: yes
3	Activity	0: off 1: on
4	Reserved	
5	Is set point	0.01 A
6	Tripping time delay	10 ms

ANSI 59 - Overvoltage

Function number: 28xx
Unit 1: xx = 01 to unit 4: xx = 04

Setting	Data	Format/Unit
1 to 4	Common settings	
5	Voltage mode	0: phase-to-neutral 1: phase-to-phase
6	Us set point	% Unp
7	Tripping time delay	10 ms

ANSI 59N - Neutral voltage displacement

Function number: 39xx
Unit 1: xx = 01, unit 2: xx = 02

Setting	Data	Format/Unit
1 to 4	Common settings	
5	Tripping curve	0: definite 18: IDMT
6	Vs0 set point	% Unp
7	Tripping time delay	10 ms

ANSI 64 REF - Restricted earth fault differential

Function number: 64xx
Unit 1: xx = 01, unit 2: xx = 02

Setting	Data	Format/Unit
1 to 4	Common settings	
5	Is0 set point	0.1 A

ANSI 66 - Starts per hour

Function number: 4201

Setting	Data	Format/Unit
1	Common settings	
2	Reserved	
3	Common settings	
4	Reserved	
5	Period of time	Hours
6	Total number of starts	1
7	Number of consecutive hot starts	1
8	Number of consecutive cold starts	1
9	Time delay between stop and start	min.

ANSI 67 - Directional phase overcurrent

Function number: 52xx
Unit 1: xx = 01, unit 2: xx = 02

Setting	Data	Format/Unit		
1 to 3	Common settings			
4	Reserved			
5	Group A - direction	0: line	1: busbar	
6	Group A - characteristic angle	3: 30°	4: 45°	5: 60°
7	Group A - tripping logic	0: 1/3	1: 2/3	
8	Group A - tripping curve	①		
9	Group A - Is set point	0.1 A		
10	Group A - tripping time delay	10 ms		
11	Group A - timer hold curve	③		
12	Group A - timer hold	10 ms		
13	Group B - direction	0: line	1: busbar	
14	Group B - characteristic angle	3: 30°	4: 45°	5: 60°
15	Group B - tripping logic	0: 1/3	1: 2/3	
16	Group B - tripping curve	①		
17	Group B - Is set point	0.1 A		
18	Group B - tripping time delay	10 ms		
19	Group B - timer hold curve	③		
20	Group B - timer hold	10 ms		

ANSI 67N/67NC - Directional earth fault

Function number: 50xx

Unit 1: xx = 01, unit 2: xx = 02

Setting	Data	Format/Unit
1 to 4	Common settings	
5	Access	0: projection (type 1) 1: directional (type 2) 2: directional with adjustable sector (type 3)
6	Group A - direction	0: line 1: busbar
7	Group A - types 1 and 2: characteristic angle	0: -45° 1: 0° 2: 15° 3: 30° 4: 45° 5: 60° 6: 90°
	Group A - type 3: limiting angle 1	0° to 359°
8	Group A - type 1: sector	2: sector 76° 3: sector 83° 4: sector 86°
	Group A - type 3: limiting angle 2	0° to 359°
9	Group A - tripping curve	①
10	Group A – Is0 set point	0.1 A
11	Group A - tripping time delay	10 ms
12	Group A - types 1 and 2: Vs0 set point	% Unp
	Group A - type 3: Vs0 set point	0.1% Unp
13	Group A - timer hold curve	③
14	Group A - timer hold	10 ms
15	Group A - memory time	10 ms
16	Group A - memory voltage	% Unp
17	Group B - direction	0: line 1: busbar
18	Group B - types 1 and 2: characteristic angle	Same as group A
	Group B - type 3: limiting angle 1	0° to 359°
19	Group B - type 1: sector	Same as group A
	Group B - type 3: limiting angle 2	0° to 359°
20	Group B - tripping curve	①
21	Group B - Is0 set point	0.1 A
22	Group B - tripping time delay	10 ms
23	Group B - types 1 and 2: Vs0 set point	% Unp
	Group B - type 3: Vs0 set point	0.1% Unp
24	Group B - timer hold curve	③
25	Group B - timer hold	10 ms
26	Group B - memory time	10 ms
27	Group B - memory voltage	% Unp

ANSI 78PS - Pole slip

Function number: 7601

Setting	Data	Format/Unit
1 to 3	Common settings	
4	Reserved	
5	Access	0: equal-area criterion 1: power-swing criterion 2: both criteria
6	T area	10 ms
7	Max. number of power swings	1 to 30
8	Max. time between power swings	10 ms

ANSI 81H - Overfrequency

Function number: 57xx

Unit 1: xx = 01, unit 2: xx = 02

Setting	Data	Format/Unit
1 to 4	Common settings	
5	Fs set point	0.1 Hz
6	Tripping time delay	10 ms
7	Reserved	
8	Vs set point	% Unp

ANSI 81L - Underfrequency

Function number: 56xx

Unit 1: xx = 01 to unit 4: xx = 04

Setting	Data	Format/Unit
1 to 4	Common settings	
5	Fs set point	0.1 Hz
6	Tripping time delay	10 ms
7	Restraint	0: no 1: yes
8	Vs set point	% Unp
9	Inhibition set point for frequency variation	Hz/s

ANSI 81R – Rate of change of frequency

Function number: 58xx
Unit: 1 xx = 01, unit 2: xx = 02

Setting	Data	Format/Unit
1	Latching	0: no 1: yes
2	Switchgear control	0: no 1: yes
3	Activity	0: off 1: on
4	Reserved	
5	dfs/dt set point	0.01 Hz/s
6	Tripping time delay	10 ms

ANSI 87M - Machine differential

Function number: 6201

Setting	Data	Format/Unit
1 to 3	Common settings	
4	Reserved	
5	Ids set point	1 A
6	Restraint on sensor loss	0: no 1: yes

ANSI 87T - Transformer differential

Function number: 6001

Setting	Data	Format/Unit
1 to 3	Common settings	
4	Reserved	
5	Ids low set point	% In1
6	Id/It slope	%
7	Restraint on CT loss	0: off 1: on
8	Test mode	0: off 1: on
9	Id/It2 slope	%
10	Id/It2 characteristic	0: off 1: on
11	Slope change point	0.1 A
12	Idmax high set point	0.1 A
13	Idmax high set point activity	0: off 1: on
14	Selection of restraint	0: conventional 1: self-adaptive
15	Second-harmonic set point	%
16	Second-harmonic restraint	0: off 1: on
17	Second-harmonic restraint type	0: phase-specific 1: global
18	Fifth-harmonic set point	%
19	Fifth-harmonic restraint	0: off 1: on
20	Fifth-harmonic restraint type	0: phase-specific 1: global
21	Isinr set point	%
22	Restraint on closing	0: off 1: on
23	Restraint on closing time delay	10 ms

Other function settings

ANSI 60 - CT supervision

Function number: 2601: CT supervision
2602: additional CT supervision

Setting	Data	Format/Unit
1	Reserved	
2	Reserved	
3	Common settings	
4	Reserved	
5	Action on 21G, 46, 40, 51N, 32P, 37P, 32Q, 78PS and 64REF functions	0: none 1: inhibition
6	Tripping time delay	10 ms

ANSI 60FL - VT supervision

Function number: 2701: VT supervision
2702: additional VT supervision

Setting	Data	Format/Unit
1	Reserved	
2	Reserved	
3	Common settings	
4	Reserved	
5	Use breaker-position or voltage-presence criterion	0: circuit breaker 1: voltage
6	Check loss of 3 V/2 U	0: no 1: yes
7	Test current	0: no 1: yes
8	Use Vi, Ii criterion	0: no 1: yes
9	Action on 21G, 27/27S, 27D, 27TN, 32P, 32Q, 37P, 40, 47, 50/27, 51V, 59, 59N and 78PS functions	0: none 1: inhibition
10	Action on 67 function	0: non directional 1: inhibition
11	Action on 67N function	0: non directional 1: inhibition
12	Vi tripping set point	%
13	Ii tripping set point	%
14	3 V/ 2 U loss time	10 ms
15	Vi, Ii criterion time	10 ms

ANSI 79 - Recloser

Function number: 1701

Setting	Data	Format/Unit
1	Reserved	
2	Reserved	
3	Common settings	
4	Reserved	
5	Number of cycles	1 to 4
6	Reclaim time	10 ms
7	Safety time until ready	10 ms
8	Maximum additional dead time	0: no 1: yes
9	Maximum wait time	10 ms
10	Cycle 1 activation mode	see below
11	Cycle 2, 3, 4 activation mode	see below
12	Cycle 1 dead time	10 ms
13	Cycle 2 dead time	10 ms
14	Cycle 3 dead time	10 ms
15	Cycle 4 dead time	10 ms

Cycle activation mode

The activation mode of each cycle is coded as follows:

Bit	Activation by (if bit set to 1) / Non activation by (if bit set to 0)
0	Instantaneous protection 50/51 unit 1
1	Delayed protection 50/51 unit 1
2	Instantaneous protection 50/51 unit 2
3	Delayed protection 50/51 unit 2
4	Instantaneous protection 50/51 unit 3
5	Delayed protection 50/51 unit 3
6	Instantaneous protection 50/51 unit 4
7	Delayed protection 50/51 unit 4
8	Instantaneous protection 50N/51N unit 1
9	Delayed protection 50N/51N unit 1
10	Instantaneous protection 50N/51N unit 2
11	Delayed protection 50N/51N unit 2
12	Instantaneous protection 50N/51N unit 3
13	Delayed protection 50N/51N unit 3
14	Instantaneous protection 50N/51N unit 4
15	Delayed protection 50N/51N unit 4
16	Instantaneous protection 67N unit 1
17	Delayed protection 67N unit 1
18	Instantaneous protection 67N unit 2
19	Delayed protection 67N unit 2
20	Instantaneous protection 67 unit 1
21	Delayed protection 67 unit 1
22	Instantaneous protection 67 unit 2
23	Delayed protection 67 unit 2
24	Instantaneous V_DECL logic equation

General parameters

These settings are read accessible only.
Function number: D002

Setting	Data	Format/Unit
1	Working language	1: English 2: other
2	Rated frequency	50, 60 (Hz)
3	Active group of settings	1: group A 2: group B 3: selection by logic input 4: selection by remote control
4	Demand-value integration period	5, 10, 15, 30, 60 minutes
5	Type of cubicle	1: incomer 2: feeder
6	Active-energy increment	100 to 5000000 (W)
7	Reactive-energy increment	100 to 5000000 (var)
8	Phase-rotation direction	1: direction 123 2: direction 132
9	Temperature unit	1: °C 2: °F
10	Remote-setting authorization	1: no 2: yes
11	Time synchronization mode	1: COM1 port 2: COM2 port 3: input I103 5: none 6: Ethernet port
12	Remote-control mode	1: SBO mode 2: direct mode
13	Reserved	
14	Monitoring of auxiliary power	1: inactive 2: active
15	Rated auxiliary voltage	24 to 250 (V DC)
16	Aux. voltage alarm low set point	% rated Vaux, min. 20 V
17	Aux. voltage alarm high set point	% rated Vaux, max. 275 V
18	Logic inputs ignored on loss of Vaux	1: inactive 2: active
19	Base current Ib	0.2 to 1.3 In (A)
20	Rated current In	1 to 6250 A
21	Number of phase CTs	1: 2 CTs 2: 3 CTs
22	Phase CT rating	1: 1 A 2: 5 A 3: LPCT
23	Rated residual current In0	10 to 62500 (0.1 A)
24	Residual current measurement mode	1: CSH 2 A 3: CSH 20 A 4: 1 A CT 6: 5 A CT 8: ACE990 range 1 9: ACE990 range 2 11: not measured
25	Reserved	
26	Rated primary voltage Unp	220 to 250000 (V)
27	Rated secondary voltage Uns	90 to 230 (V)
28	VT wiring	1: 3 V, 2: 2 U, 3: 1 U, 4: 1 V
29	Residual voltage mode	1: none 2: Σ3V 3: VT Uns/$\sqrt{3}$ 4: VT Uns/3
30	Neutral-point residual voltage measurement	1: none 2: present
31	Neutral-point rated voltage Unp	220 to 250000 (V)
32	Neutral-point rated voltage Uns	57 V to 133 V
33	Reserved	
34	Reserved	
35	Additional rated current I'n	1 to 6250 A
36	Number of additional phase CTs	1: 2 CTs 2: 3 CTs 3: none
37	Additional phase CT rating	1: 1 A 2: 5 A 3: LPCT
38	Additional rated residual current I'n0	10 to 62500 (0.1 A)
39	Additional residual current measurement mode	Idem 24
40	Reserved	
41	Rated primary voltage U'np	220 to 250000 (V)
42	Rated secondary voltage U'ns	90 to 230 (V)
43	VT wiring, additional channels	1: 3 V, 2: 2 U, 3: 1 U, 4: 1 V
44	Residual voltage mode, additional channels	1: none 2: Σ3V 3: VT Uns/$\sqrt{3}$ 4: VT Uns/3
45	Reserved	
46	Reserved	
47	Reserved	
48	Reserved	

Application-specific parameters

These settings are read accessible only.
Function number: D003

Setting	Data	Format/Unit
1	Transformer presence	1: no 2: yes
2	Voltage winding 1 Un1	220 to 250000 V
3	Voltage winding 2 Un2	220 to 440000 V
4	Power S	100 to 999000 kVA
5	Vector shift	0 to 11
6	Rated motor speed	100 to 3600 rpm
7	Number of pulses per rotation	1 to 1800
8	Zero speed threshold	5 to 20%
9	Number of capacitor steps	1 to 4
10	Type of capacitor step connection	0: delta 1: star
11	Weight of capacitor step 1	1
12	Weight of capacitor step 2	1, 2
13	Weight of capacitor step 3	1, 2, 3, 4
14	Weight of capacitor step 4	1, 2, 3, 4, 6, 8

Notes

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