Contents

Presentation

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 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 two 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

Data available

The data available depend on the type of Sepam.

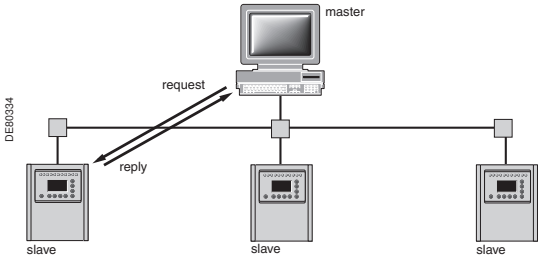
Measurement readout
■ phase and earth fault currents
■ peak demand phase currents
■ tripping currents
■ cumulative breaking current
■ phase-to-phase, phase-to-neutral and residual voltages
■ active, reactive and apparent power
■ active and reactive energy
■ frequency
■ temperatures
■ thermal capacity used
■ starts per hour and inhibit time
■ running hours counter
■ motor starting current and time
■ operating time before overload tripping
■ waiting time after tripping
■ operating time and number of operations
■ circuit breaker charging time.

Program logic data readout
■ a table of 144 pre-assigned remote indications (TS) (depends on the type of Sepam) enables the readout of program logic data status
■ readout of the status of 10 logic inputs.

Remote control orders
Writing of 16 impulse-type remote control orders (TC) in either direct mode or SBO (Select Before Operate) mode via 16 selection bits.

Other functions
■ reading of Sepam configuration and identification
■ time-tagging of events (synchronization via the network or externally via logic input I21), time-tagging within a millisecond
■ remote reading of Sepam settings
■ remote setting of protection units
■ remote control of the analog output (with MSA141 option)
■ transfer of disturbance recording data.

Modbus protocol
Presentation



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.

Modbus functions supported
The Modbus protocol used by Sepam is a compatible sub-group of the RTU Modbus protocol.
The functions listed below are handled by Sepam:
- 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 6: writing of 1 word
  - 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

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).

Modbus specification
The full description of the Modbus protocol can be found at www.modbus.org.

Modbus protocol
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.

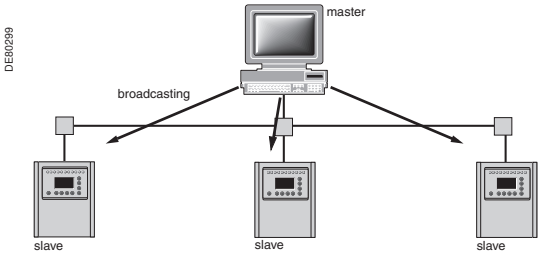
Slave address	Modbus PDU	Check (CRC16)

- 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 40).

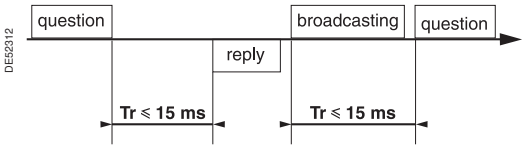
Synchronization of exchanges

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.



Response time

The communication coupler **response time (Tr)** is less than 15 ms, including a 3-character silence (approximately 3 ms at 9600 bauds).
This time is given with the following parameters:
- 9600 bauds
- format: 8 bits, odd parity, 1 stop bit.

Modbus protocol
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

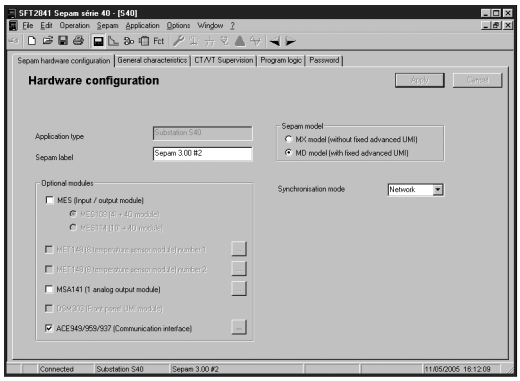
- MBAP (Modbus Application) Header (7 bytes): identifies the frame
- Modbus PDU: as previously described.

Modbus Application header

It contains the following fields:

Field	Length	Description	Request	Response
Transaction identifier	2 bytes	Identification of a Modbus request/ response transaction	Field initialized by the client	Field copied by the server from the received request
Protocol identifier	2 bytes	0 = Modbus protocol	Field initialized by the client	Field copied by the server from the received request
Length	2 bytes	Number of following bytes (including unit identifier)	Field initialized by the client	Field 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.	Field initialized by the client	Field copied by the server from the received request

Configuring the communication interfaces
Serial line communication



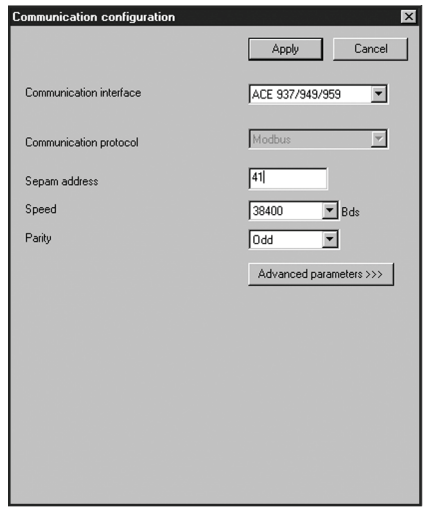
SFT2841: Sepam Configuration screen.

Access to configuration parameters

The Sepam communication interfaces are configured using SFT2841 software. The configuration parameters can be accessed from the Communication configuration window in SFT2841.
To access this window:
- open the **Sepam configuration** window in SFT2841
- check the box for ACExxx (communication interface)
- click [...]: 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			■
Modbus advanced parameters	■	■	■
E-LAN parameters		■	■



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 set at 1.
If a configuration with parity is selected, each character will contain 11 bits: 1 start bit + 8 data bits + 1 parity bit + 1 stop bit.
If a no parity configuration is 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:
- 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 bauds	19200 bauds
Parity	None, Even or Odd	Even

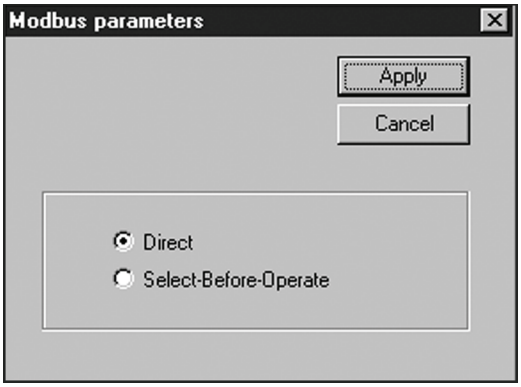
Configuring the ACE969FO-2 fiber-optic port

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

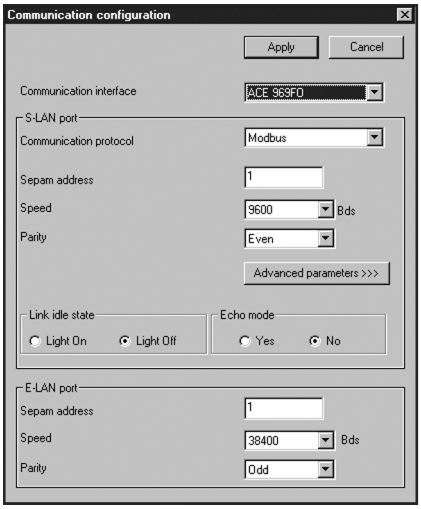


SFT2841: Modbus advanced parameters window.

Configuring Modbus advanced parameters

The Sepam remote control mode is selected from the Advanced parameters window.

Advanced parameters	Authorized values	Default value
Remote control mode	Direct or SBO (Select Before Operate) mode	Direct



SFT2841: 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 set at 1.

If a configuration with parity is selected, each character will contain 11 bits: 1 start bit + 8 data bits + 1 parity bit + 1 stop bit.

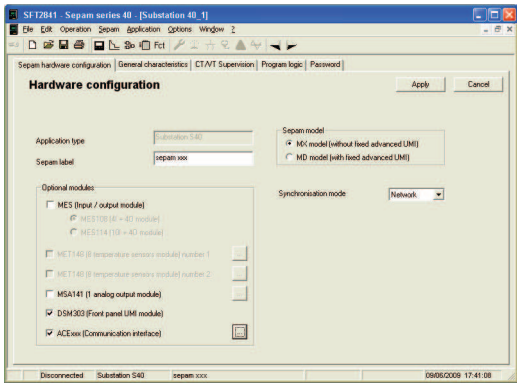
If a no parity configuration is selected, each character will contain 10 bits: 1 start bit + 8 data bits + 1 stop bit.

Parameters	Authorized values	Default value
Sepam address	1 to 247	1
Speed	4800, 9600, 19200 or 38400 bauds	38400 bauds
Parity	None, 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 making the connection 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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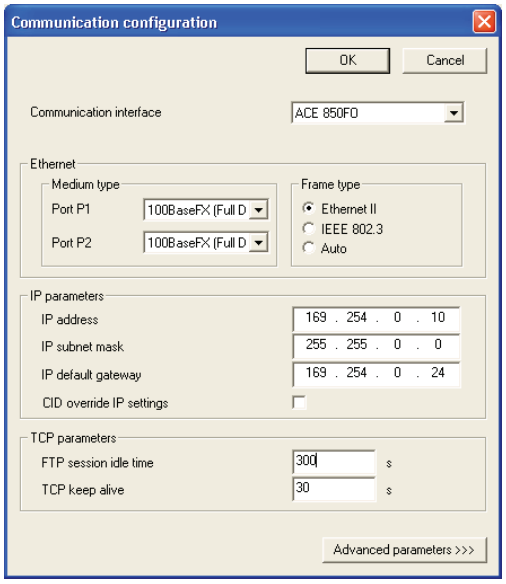
SFT2841: Sepam configuration screen.



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SFT2841: Ethernet and TCP/IP configuration.

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
- check the box for ACExxx (communication interface)
- 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.

Ethernet and TCP/IP configuration

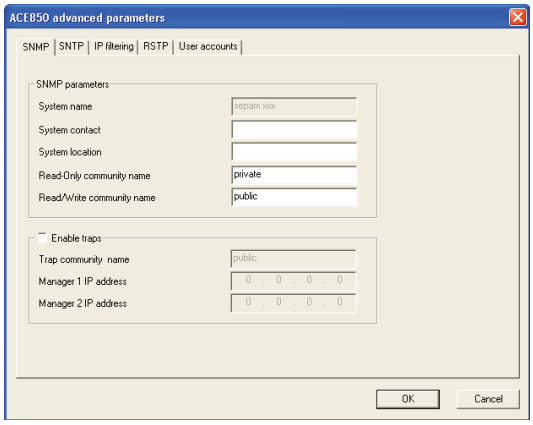
Before configuring the ACE850, obtain a unique static IP address, subnet mask, and default gateway address from the network administrator. See the section on IP address and parameter guidelines, page 151.

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 parameter is not used for Modbus only communication.	**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



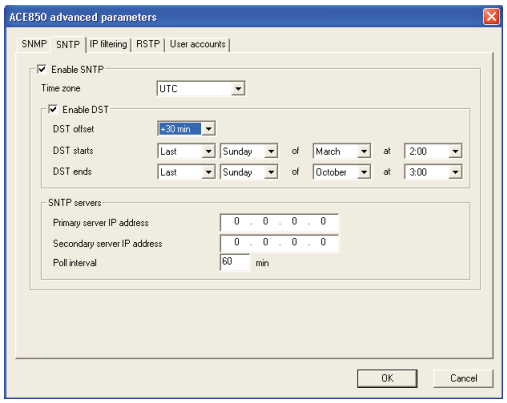
SFT2841: SNMP configuration.

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.

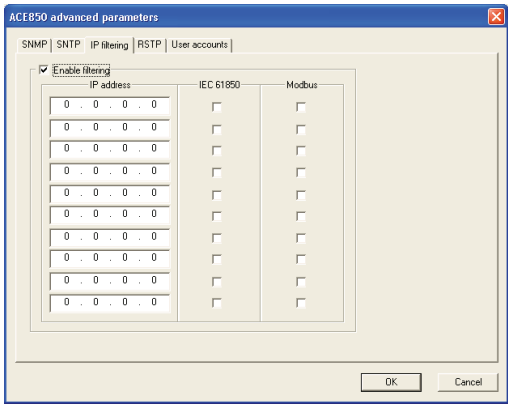
SNTP configuration

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



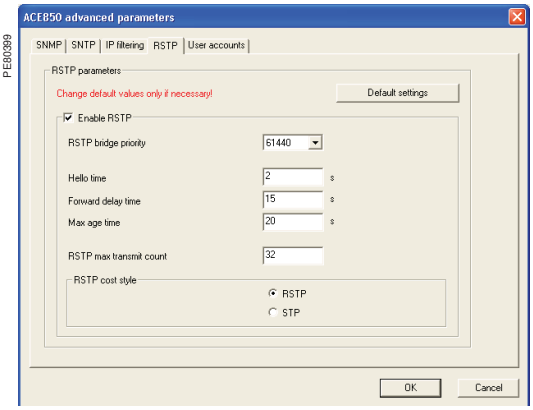
SFT2841: IP filtering configuration.

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



SFT2841: RSTP configuration.

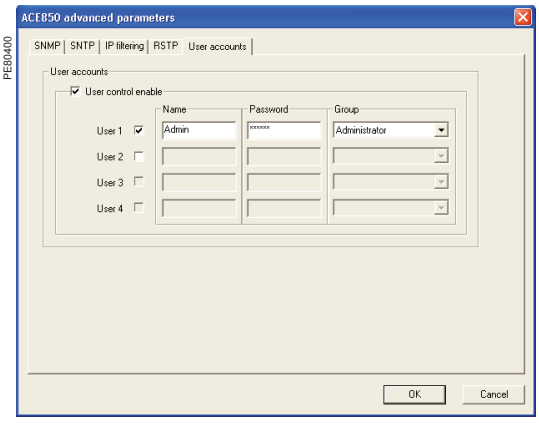
RSTP configuration

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).*

Configuring the communication interfaces
Ethernet communication



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

The communication network must first be the subject of a technical study to determine the following, according to the installation characteristics and constraints (geography, amount of information processed, etc.):

- 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 user manual

The communication interfaces must be installed and connected in accordance with the instructions in the Installation chapter of this manual.

Preliminary checks

The following preliminary checks must be made:

- 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.

Checking the operation of the ACE interface

You can use the following to check that an ACE interface is operating correctly:

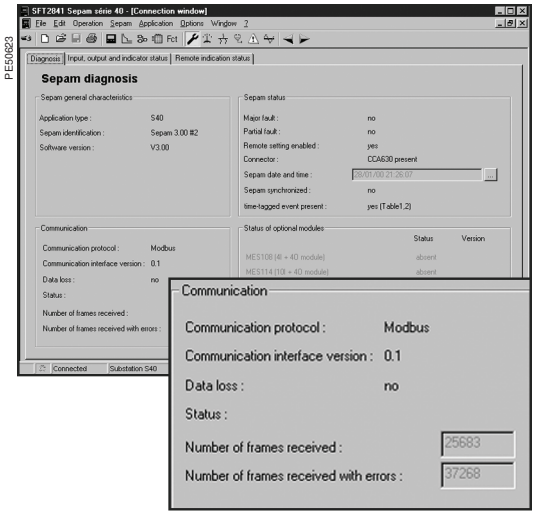
- the indicator LEDs on the front panel of the ACE
- the information provided by the SFT2841 software connected to Sepam:
  - on the Diagnosis screen
  - on the Communication configuration screens.

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
- link activity LED: S-LAN Tx flashing, Sepam transmission active
- link activity LED: S-LAN Rx flashing, Sepam reception active.



SFT2841: Sepam series 40 diagnosis screen.

Diagnosis using SFT2841 software

Sepam diagnosis screen

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

Sepam communication diagnosis

The operator is provided with the following information to assist with identifying and resolving communication problems:

- name of the protocol configured
- 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 set up.

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 875A
Reception	01 03 02 1234 B533
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)

In the 2-wire RS 485 mode, the counter must not be taken into account (meaningless).
- **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 communication problems. They can be accessed by the dedicated read functions (Modbus protocol functions 8 and 11).
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.

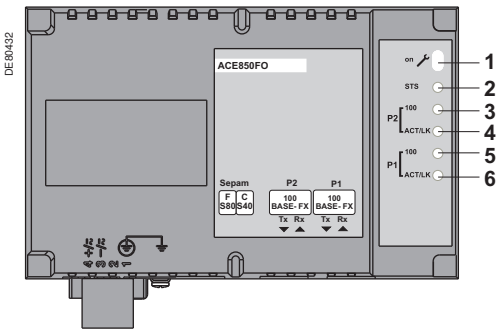
Operating anomalies

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 connected, powered and set up correctly
- for a fiber-optic ring, check that the Modbus master can handle the echo of its requests correctly.

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



ACE850 communication interface.

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 instructions given in this manual page 244. See also the ACE850 installation guide delivered with each ACE850, reference BBV35290.

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

Diagnosis using indicator LEDs on the ACE850

1 On/fault indicator. This indicator has the following states:

- Off: the module 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.

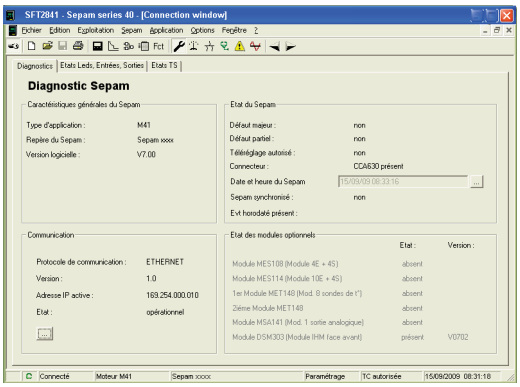
3 and **5** Speed indicators. These indicators have the following states:

- 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:

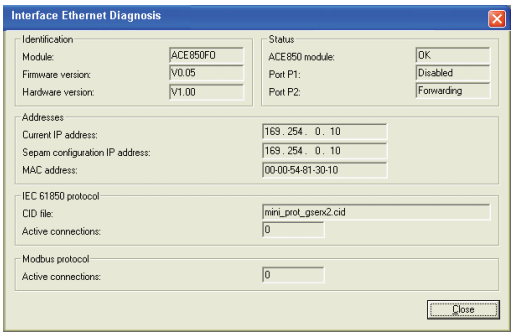
- Off: the corresponding physical link is not established
- On: the corresponding physical link is established
- blinking: the indicator blinks with the activity on the link.

PE80578



SFT2841: Sepam diagnosis screen.

PE80402



SFT2841: Ethernet diagnosis screen.

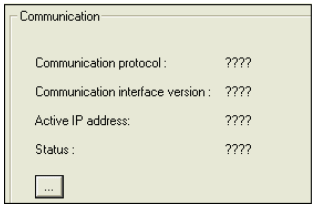
PE80403

ACE850 home page.

Diagnosis using SFT2841 software

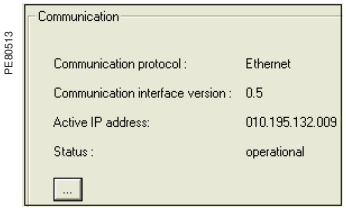
When connected to Sepam, the SFT2841 software informs the operator of the general Sepam status and of the Sepam communication status in particular.
Sepam status information appears on the Sepam diagnosis screen on which buttons can be used to obtain detailed status information on each communication channel.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

PE80512



Diagnosis screen detail:
ACE850 not or improperly connected.

PE80513



Diagnosis screen detail:
ACE850 connected properly.

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.

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.

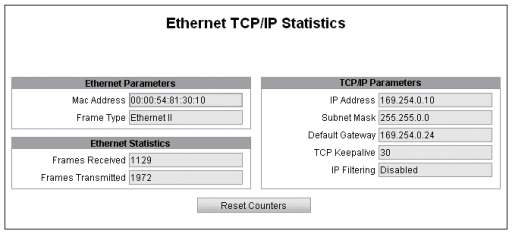
Diagnostics Web pages

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

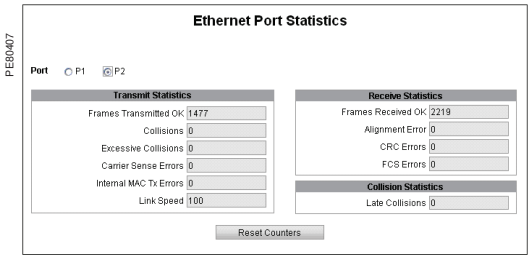
Diagnostic pages are automatically refreshed every 5 seconds (approximately).

PE80404



ACE850 Ethernet TCP/IP statistics.

PE80407



ACE850 Ethernet port statistics.

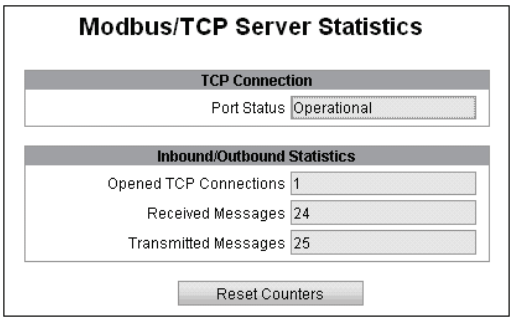
Ethernet TCP/IP statistics

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



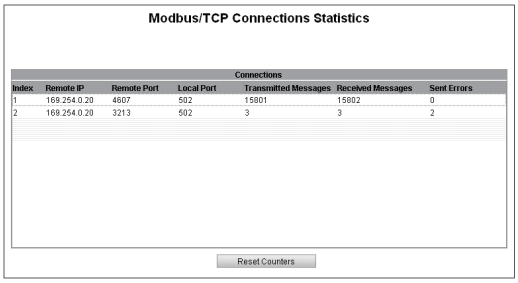
ACE850 Modbus/TCP server statistics.

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

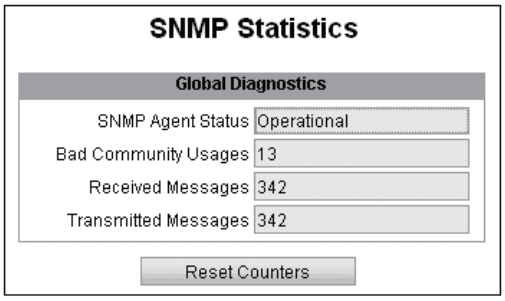


ACE850 Modbus/TCP connections statistics.

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

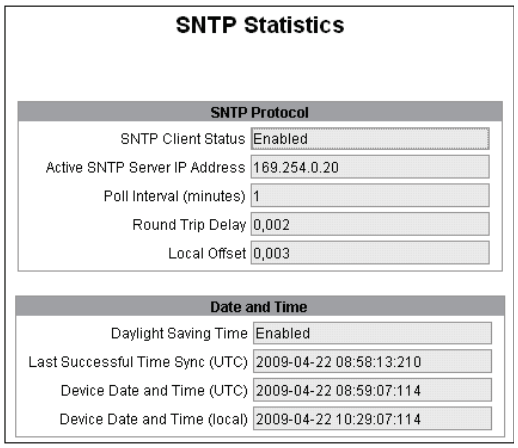


ACE850 SNMP statistics.

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

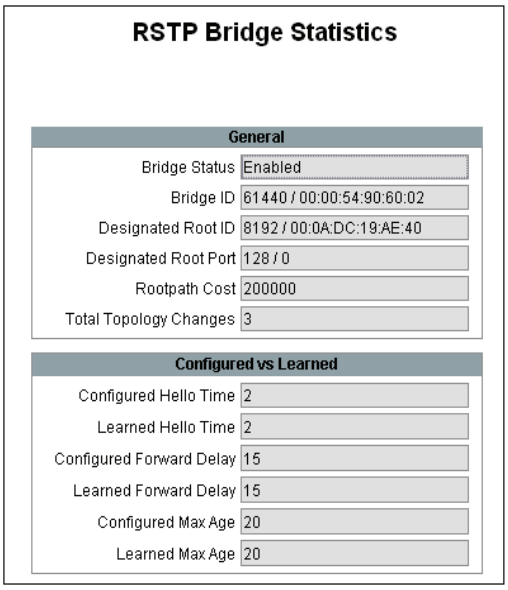


ACE850 SNTP statistics.

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

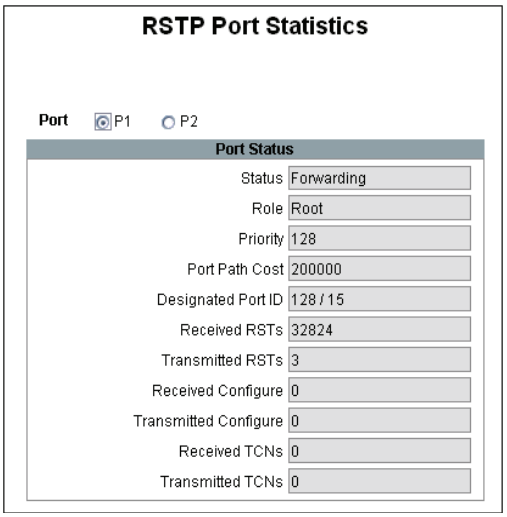


ACE850 RSTP bridge statistics.

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 encoding

NOTICE

RISK OF DATA CORRUPTION

When using an ACE850 communication interface with IEC 61850 communication enabled, do not use the following address zones:

- Event table 1 (0040-0060),
- Protections settings zone 1 (1E00-1F7C),
- Disturbance recording zone 1 (2200-237C).

Failure to follow these instructions can result in equipment damage.

Presentation

Data which are similar from the monitoring and control application viewpoint are grouped together in adjacent address zones:

	Hexadecimal starting address	Ending address	Modbus functions enabled
Synchronization zone	0002	0005	3, 16
Identification zone	0006	000F	3
Event table 1			
Exchange word	0040	0040	3, 6, 16
Events (1 to 4)	0041	0060	3
Event table 2			
Exchange word	0070	0070	3, 6, 16
Events (1 to 4)	0071	0090	3
Data			
Remote control orders	00F0	00F0	3, 4, 6, 16
	00F2	00F2	1, 2, 5, 15 (1)
Remote control selection	00F1	00F1	3, 4, 6, 16
	00F3	00F3	1, 2, 5, 15 (1)
Status	0100	0112	3, 4
			1, 2 (1)
Measurements	0113	0158	3, 4
Diagnosis	0159	0185	3, 4
Phase displacement	01A0	01A9	3, 4
Tripping context	0250	027F	3, 4
Switchgear diagnosis	0290	02A5	3, 4
Application	02CC	02FE	3
Test zone	0C00	0C0F	3, 4, 6, 16
			1, 2, 5, 15
Protection settings zone 1			
Read settings	1E00	1E7C	3
Read request	1E80	1E80	3, 6, 16
Remote settings	1F00	1F7C	3, 6
Protection settings zone 2			
Read settings	2000	207C	3
Read request	2080	2080	3, 6, 16
Remote settings	2100	217C	3, 16
Disturbance recording zone 1			
Record selection	2200	2203	3, 16
Identification zone	2204	2271	3
Disturb. rec. exchange word	2300	2300	3, 6, 16
Disturbance recording data	2301	237C	3
Disturbance recording zone 2			
Record selection	2400	2403	3, 16
Identification zone	2404	2471	3
Disturb. rec. exchange word	2500	2500	3, 6, 16
Disturbance recording data	2501	257C	3
S-LAN communication monitoring			
Time delay	5815	5815	3, 16 (2)

Note: *non-addressable zones may reply by an exception message or else supply non-significant data.*

(1) *Zones accessible in word mode or bit mode.*
The address of bit i (0 ⩽ i ⩽ F) of address word J is then (J x 16) + i.
Example: 0C00 bit 0 = C000 0C00 bit 7 = C007.

(2) *Range allowed: 10 to 65535 x 100 ms (Time delay can be set from 1 to 6553.5 s with increments of 0.1 s).*

Data addresses and encoding

Data encoding

For all formats

If a measurement overruns the maximum permissible value for the related format, the value read for the measurement will be the maximum permissible value for the format.

16NS format

The information is encoded in a 16-bit word, in binary format, absolute value (unsigned). The 0 bit (b0) is the least significant bit in the word.

16S format signed measurements (temperatures,...)

The information is encoded in a 16-bit word as a complement of 2.
Example:
- 0001 represents +1
- FFFF represents -1.

32NS or 2 x 16NS format

The information is encoded in two 16-bit words, in binary format, unsigned. The first word is the most significant word.

32S format

The information is encoded as a complement of 2 in 2 words. The first word is the most significant word:
- 0000, 0001 represents +1
- FFFF, FFFF represents -1.

B format

Rank i bit in the word, with i between 0 and F.

Examples		F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
TS1 to	Word address 0101																
TS16		16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	Bit address 101x																
TS49 to	Word address 0104																
TS64		64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
	Bit address 104x																
TC1 to	Word address 00F0																
TC16		16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	Bit address 0F0x																
STC1 to	Word address 00F1																
STC16		16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	Bit address 0F1x																

X format: Sepam check-word

This format applies only to the Sepam check-word that may be accessed at the word address 0100h. This word contains various items of information relating to:
- Sepam operating mode
- time-tagging of events.

Each data item contained in the Sepam check-word may be accessed bit by bit, from address **1000** for bit 0 to **100F** for bit 15.
- bit 15 : event present in event zone 1
- bit 14 : Sepam in “data loss” status in event zone 1
- bit 13 : Sepam not synchronous
- bit 12 : Sepam time not correct
- bit 11 : presence of events in event zone 2
- bit 10 : Sepam in "data loss" status in event zone 2
- bit 9 : major fault in Sepam
- bit 8 : partial fault in Sepam
- bit 7 : setting group A in service
- bit 6 : setting group B in service
- bit 1 : Sepam in local setting mode
- other bits reserved (undetermined values).

Status changes of bits 1, 6, 7, 8, 10, 12, 13 and 14 of this word trigger the sending of a time-tagged event.

Data addresses and encoding

Synchronization zone

The synchronization zone is a table which contains the absolute date and time for the time-tagging function. Time messages should be written in a single block containing 4 words, using function 16: write word.
Messages can be read word by word or by groups of words using function 3.

Synchronization zone	Word address	Access	Modbus function enabled
Binary time (year)	0002	Read/write	3, 16
Binary time (months + days)	0003	Read	3
Binary time (hours + minutes)	0004	Read	3
Binary time (milliseconds)	0005	Read	3

See "time-tagging of events" chapter for data format.

Identification zone

The identification zone contains system-type information pertaining to the identification of the Sepam equipment.
Some of the information in the identification zone is also found in the configuration zone at the address 02CCh.

Identification zone	Word address	Access	Modbus function enabled	Format	Value
Manufacturer identification	0006	R	3		0100
Equipment identification	0007	R	3		0
Marking + equipment type	0008	R	3		Idem 02E2
Modbus version	0009	R	3	Not managed	0
Application version	000A/B	R	3	(1)	
Sepam check-word	000C	R	3		Idem 0100
Extension word	000D	R	3	Not managed	0
Command	000E	R/W	3/16	Not managed	Init. to 0
Extension address	000F	R	3		02CC

(1) *MSB word 2: major index*
LSB word 2: minor index.

Events 1 zone

The event zone is a table which contains a maximum of 4 time-tagged events.
Events should be read in a single block containing 33 words using function 3.
The exchange word can be written using functions 6 or 16, and read individually using function 3.

Events 1 zone	Word address	Access	Modbus function enabled
Exchange word	0040	Read/write	3, 6, 16
Event n°1	0041-0048	Read	3
Event n°2	0049-0050	Read	3
Event n°3	0051-0058	Read	3
Event n°4	0059-0060	Read	3

See "time-tagging of events" chapter for data format.

Events 2 zone

The event zone is a table which contains a maximum of 4 time-tagged events.
Events should be read in a single block containing 33 words using function 3.
The exchange word can be written using functions 6 or 16 and read individually using function 3.

Events 2 zone	Word address	Access	Modbus function enabled
Exchange word	0070	Read/write	3, 6, 16
Event n°1	0071-0078	Read	3
Event n°2	0079-0080	Read	3
Event n°3	0081-0088	Read	3
Event n°4	0089-0090	Read	3

See "time-tagging of events" chapter for data format.

Remote control zone

The remote control zone is a table which contains the pre-assigned remote control bits (TC). The zone may be read or written using the word functions or bit functions. The use of remote control orders is discussed in detail on page 172.

Remote control orders	Word address	Bit address	Access	Function	Format
TC1-TC16	00F0	0F00	R/W	3/4/6/16 1/2/5/15	B
STC1-STC16	00F1	0F10	R/W	3/4/6/16 1/2/5/15	B
TC17-TC32	00F2	0F20	R/W	3/4/6/16 1/2/5/15	B
STC17-STC32	00F3	0F30	R/W	3/4/6/16 1/2/5/15	B

Status zone

The **status zone** is a table that contains the Sepam check-word, pre-assigned remote indication bits (TS), logic inputs, logic equation bits, logic outputs, LEDs and analog output control word.
The TS assignments are discussed in detail on page 169.

Status	Word address	Bit address	Access	Modbus function enabled	Format
Sepam check-word	0100	1000	R	3/4 or 1, 2, 7	X
TS1-TS16	0101	1010	R	3/4 or 1, 2	B
TS17-TS32	0102	1020	R	3/4 or 1, 2	B
TS33-TS48	0103	1030	R	3/4 or 1, 2	B
TS49-TS64 (reserved)	0104	1040	R	3/4 or 1, 2	B
TS65-TS80	0105	1050	R	3/4 or 1, 2	B
TS81-TS96	0106	1060	R	3/4 or 1, 2	B
TS97-TS112	0107	1070	R	3/4 or 1, 2	B
TS113-TS128	0108	1080	R	3/4 or 1, 2	B
TS129-TS144	0109	1090	R	3/4 or 1, 2	B
Reserved	010A	10A0	-	_	_
Logic inputs	010B	10B0	R	3/4 or 1, 2	B
Logic equation bits	010C	10C0	R	3/4 or 1, 2	B
Logic outputs	010D	10D0	R	3/4 or 1, 2	B
LEDs	010E	10E0	R	3/4 or 1, 2	B
Analog output	010F	10F0	R/W	3, 6, 16	16S

Address word 010B: logic input status (bit address 10B0 to 10BF)

Bit	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
Inputs	-	-	-	-	-	-	I26	I25	I24	I23	I22	I21	I14	I13	I12	I11

Address word 010C: logic equation bit status (bit address 10C0 to 10CF)

Bit	7	6	5	4	3	2	1	0
Equation	V8	V7	V6	V5	V4	V3	V2	V1

Bit	F	E	D	C	B	A	9	8
Equation	-	-	V_FLAGREC	V_INHIBCLOSE	V_CLOSECB	V_TRIPCB	V10	V9

Address word 010D: logic output status (bit address 10D0 to 10DF)

Bit	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
Output	-	-	-	-	-	-	-	-	O14	O13	O12	O11	O4	O3	O2	O1

Address word 010E: LED status (bit address 10E0 à 10EF)

Bit	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
LED	-	-	-	-	-	-	L9	L8	L7	L6	L5	L4	L3	L2	L1	LD

LD: red LED indicating Sepam unavailable.

Measurement zone x 1

Measurements x 1	Word address	Access	Modbus function enabled	Format	Unit
Phase current I1 (x 1)	0113	R	3, 4	16NS	0.1 A
Phase current I2 (x 1)	0114	R	3, 4	16NS	0.1 A
Phase current I3 (x 1)	0115	R	3, 4	16NS	0.1 A
Residual current I0 Sum (x 1)	0116	R	3, 4	16NS	0.1 A
Residual current measured (x 1)	0117	R	3, 4	16NS	0.1 A
Average phase current Im1 (x 1)	0118	R	3, 4	16NS	0.1 A
Average phase current Im2 (x 1)	0119	R	3, 4	16NS	0.1 A
Average phase current Im3 (x 1)	011A	R	3, 4	16NS	0.1 A
Peak demand phase current IM1 (x 1)	011B	R	3, 4	16NS	0.1 A
Peak demand phase current IM2 (x 1)	011C	R	3, 4	16NS	0.1 A
Peak demand phase current IM3 (x 1)	011D	R	3, 4	16NS	0.1 A
Phase-to-phase voltage U21 (x 1)	011E	R	3, 4	16NS	1 V
Phase-to-phase voltage U32 (x 1)	011F	R	3, 4	16NS	1 V
Phase-to-phase voltage U13 (x 1)	0120	R	3, 4	16NS	1 V
Phase-to-neutral voltage V1 (x 1)	0121	R	3, 4	16NS	1 V
Phase-to-neutral voltage V2 (x 1)	0122	R	3, 4	16NS	1 V
Phase-to-neutral voltage V3 (x 1)	0123	R	3, 4	16NS	1 V
Residual voltage V0 (x 1)	0124	R	3, 4	16NS	1 V
Positive sequence voltage Vd (x 1)	0125	R	3, 4	16NS	1 V
Negative sequence voltage Vi (x 1)	0126	R	3, 4	16NS	1 V
Frequency	0127	R	3, 4	16NS	0.01 Hz
Active power P (x 1)	0128	R	3, 4	16S	1 kW
Reactive power Q (x 1)	0129	R	3, 4	16S	1 kvar
Apparent power S (x 1)	012A	R	3, 4	16S	1 kVA
Peak demand active power Pm (x 1)	012B	R	3, 4	16S	1 kW
Peak demand reactive power Qm (x 1)	012C	R	3, 4	16S	1 kvar
Power factor cos φ (x 100)	012D	R	3, 4	16S	0.01
Positive active energy Ea+ (x 1)	012E/012F	R	3, 4	2 x 16NS	100 kW.h
Negative active energy Ea- (x 1)	0130/0131	R	3, 4	2 x 16NS	100 kW.h
Positive reactive energy Er+ (x 1)	0132/0133	R	3, 4	2 x 16NS	100 kvar.h
Negative reactive energy Er- (x 1)	0134/0135	R	3, 4	2 x 16NS	100 kvar.h

Measurement zone x 10

Measurements x 10	Word address	Access	Modbus function enabled	Format	Unit
Phase current I1 (x 10)	0136	R	3, 4	16NS	1 A
Phase current I2 (x 10)	0137	R	3, 4	16NS	1 A
Phase current I3 (x 10)	0138	R	3, 4	16NS	1 A
Residual current I0 Sum (x 10)	0139	R	3, 4	16NS	1 A
Residual current measured (x 10)	013A	R	3, 4	16NS	1 A
Average phase current Im1 (x 10)	013B	R	3, 4	16NS	1 A
Average phase current Im2 (x 10)	013C	R	3, 4	16NS	1 A
Average phase current Im3 (x 10)	013D	R	3, 4	16NS	1 A
Peak demand phase current IM1 (x 10)	013E	R	3, 4	16NS	1 A
Peak demand phase current IM2 (x 10)	013F	R	3, 4	16NS	1 A
Peak demand phase current IM3 (x 10)	0140	R	3, 4	16NS	1 A
Phase-to-phase voltage U21 (x 10)	0141	R	3, 4	16NS	10 V
Phase-to-phase voltage U32 (x 10)	0142	R	3, 4	16NS	10 V
Phase-to-phase voltage U13 (x 10)	0143	R	3, 4	16NS	10 V
Phase-to-neutral voltage V1 (x 10)	0144	R	3, 4	16NS	10 V
Phase-to-neutral voltage V2 (x 10)	0145	R	3, 4	16NS	10 V
Phase-to-neutral voltage V3 (x 10)	0146	R	3, 4	16NS	10 V
Residual voltage V0 (x 10)	0147	R	3, 4	16NS	10 V
Positive sequence voltage Vd (x 10)	0148	R	3, 4	16NS	10 V
Negative sequence voltage Vi (x 10)	0149	R	3, 4	16NS	10 V
Frequency	014A	R	3, 4	16NS	0.01 Hz
Active power P (x 100)	014B	R	3, 4	16S	100 kW
Reactive power Q (x 100)	014C	R	3, 4	16S	100 kvar
Apparent power S (x 100)	014D	R	3, 4	16S	100 kVA
Peak demand active power Pm (x 100)	014E	R	3, 4	16S	100 kW
Peak demand reactive power Qm (x 100)	014F	R	3, 4	16S	100 kvar
Power factor cos φ (x 100)	0150	R	3, 4	16S	0.01
Positive active energy Ea+ (x 1)	0151/0152	R	3, 4	2 x 16NS	100 kW.h
Energie active négative Ea- (x 1)	0153/0154	R	3, 4	2 x 16NS	100 kW.h
Positive reactive energy Er+ (x 1)	0155/0156	R	3, 4	2 x 16NS	100 kvar.h
Negative reactive energy Er- (x 1)	0157/0158	R	3, 4	2 x 16NS	100 kvar.h

Diagnosis

Diagnosis	Word address	Access	Modbus function enabled	Format	Unit
Peak demand Ii/Id	0159	L	3, 4	16NS	%
Last tripping current Itrip1	015A	R	3, 4	16NS	10 A
Last tripping current Itrip2	015B	R	3, 4	16NS	10 A
Last tripping current Itrip3	015C	R	3, 4	16NS	10 A
Reserved	015D	-	-	-	-
Cumulative breaking current	015E	R	3, 4	16NS	$1(kA)^2$
Number of operations	015F	R	3, 4	16NS	1
Operating time	0160	R	3, 4	16NS	1 ms
Charging time	0161	R	3, 4	16NS	0.1 s
Running hours counter / operation time	0162	R	3, 4	16NS	1 h
Reserved	0163	-	-	-	-
Thermal capacity used	0164	R	3, 4	16NS	%
Time before tripping	0165	R	3, 4	16NS	1 min
Time before closing	0166	R	3, 4	16NS	1 min
Negative sequence / unbalance	0167	R	3, 4	16NS	% Ib
Starting time / overload	0168	R	3, 4	16NS	0.1 s
Starting current / overload	0169	R	3, 4	16NS	1 A
Start inhibit time delay	016A	R	3, 4	16NS	1 min
Number of starts allowed	016B	R	3, 4	16NS	1
Temperatures 1 to 16	016C/017B	R	3, 4	16S	1 °C (1 °F)
External positive active energy Ea+ ext	017C/017D	R	3, 4	32NS	100 kW.h
External negative active energy Ea- ext	017E/017F	R	3, 4	32NS	100 kW.h
External positive reactive energy Er+ ext	0180/0181	R	3, 4	32NS	100 kvar.h
External negative reactive energy Er- ext	0182/0183	R	3, 4	32NS	100 kvar.h
Learnt cooling time constant T2 (49 RMS) thermal rate 1	0184	R	3, 4	16NS	mn
Learnt cooling time constant T2 (49 RMS) thermal rate 2	0185	R	3, 4	16NS	mn

Phase displacement zone

Phase displacement	Word address	Access	Modbus function enabled	Format	Unit
Phase displacement φ0Σ	01A0/01A1	L	3, 4	32NS	1°
Phase displacement φ0	01A2/01A3	L	3, 4	32NS	1°
Phase displacement φ1	01A4/01A5	L	3, 4	32NS	1°
Phase displacement φ2	01A6/01A7	L	3, 4	32NS	1°
Phase displacement φ3	01A8/01A9	L	3, 4	32NS	1°

Tripping context zone

Latest tripping context	Word address Modbus	Access	Modbus function enabled	Format	Unit
Time-tagging of the context (see "time-tagging of events" chapter, page 173)	0250/0253	R	3	IEC	-
Tripping current Itrip1	0254	R	3, 4	32NS	0.1 A
Tripping current Itrip2	0256	R	3, 4	32NS	0.1 A
Tripping current Itrip3	0258	R	3, 4	32NS	0.1 A
Residual current I0 Sum	025A	R	3, 4	32NS	0.1 A
Residual current I0 measured	025C	R	3, 4	32NS	0.1 A
Phase-to-phase voltage U21	025E	R	3, 4	32NS	1 V
Phase-to-phase voltage U32	0260	R	3, 4	32NS	1 V
Phase-to-phase voltage U13	0262	R	3, 4	32NS	1 V
Phase-to-neutral voltage V1	0264	R	3, 4	32NS	1 V
Phase-to-neutral voltage V2	0266	R	3, 4	32NS	1 V
Phase-to-neutral voltage V3	0268	R	3, 4	32NS	1 V
Residual voltage V0	026A	R	3, 4	32NS	1 V
Positive sequence voltage Vd	026C	R	3, 4	32NS	1 V
Negative sequence voltage Vi	026E	R	3, 4	32NS	1 V
Frequency	0270	R	3, 4	32NS	0.01 Hz
Active power P	0272	R	3, 4	32S	1 kW
Reactive power Q	0274	R	3, 4	32S	1 kvar
Negative-sequence current Ii	0276	R	3, 4	32NS	0.1 A
Positive-sequence current Id	0278	R	3, 4	32NS	0.1 A
Faulty phase (s)	027A	R	3, 4	32NS	(1)
Fault location	027C	R	3, 4	32NS	m
Fault resistance	027E	R	3, 4	32NS	mΩ

(1) *bit 0* = faulty phase *1*
bit 1 = faulty phase *2*
bit 2 = faulty phase *3*

Switchgear diagnosis zone

Switchgear diagnosis	Word address	Access	Modbus function enabled	Format	Unit
Initial value of cumulative breaking current	0290	R	3, 4	32NS	1 kA²
Cumulative breaking current (0 < I < 2 In)	0292	R	3, 4	32NS	1 kA²
Cumulative breaking current (2 In < I < 5 In)	0294	R	3, 4	32NS	1 kA²
Cumulative breaking current (5 In < I < 10 In)	0296	R	3, 4	32NS	1 kA²
Cumulative breaking current (10 In < I < 40 In)	0298	R	3, 4	32NS	1 kA²
Cumulative breaking current (I > 40 In)	029A	R	3, 4	32NS	1 kA²
Cumulative breaking current	029C	R	3, 4	32NS	1 kA²
Reserved	029E	-	-	-	-
Number of operations (If MES114)	02A0	R	3, 4	32NS	1
Operating time (With MES114)	02A2	R	3, 4	32NS	1 ms
Charging time (With MES114)	02A4	R	3, 4	32NS	1 ms

Configuration and application zone

Configuration and application	Word address	Access	Modbus function enabled	Format	Unit
Type of application (1)	02CC	R	3	-	-
Name of application (S40, S41, T42…)	02CD/02D2	R	3	ASCII 12c	-
Sepam marking	02D3/02DC	R	3	ASCII 20c	-
Sepam application version	02DD/02DF	R	3	ASCII 6c	-
Modbus address (slave number) for Level 2	02E0	R	3	-	-
Modbus address (slave number) for RHM	02E1	R	3	-	-
Marking + type of equipment (3)	02E2	R	3	-	-
Type of coupler (0 = Modbus)	02E3	R	3	-	-
Communication version	02E4	R	3	NG	-
MET148-2 n° 1 module version	02E5/02E7	R	3	ASCII 6c	-
MET148-2 n° 2 module version	02E8/02EA	R	3	ASCII 6c	-
MSA141 module version	02EB/02ED	R	3	ASCII 6c	-
DSM303 module version	02EE/02F0	R	3	ASCII 6c	-
Name of language	02F1/02FA	R	3	ASCII 20c	-
Customized languaged version number (2)	02FB	R	3	-	-
English language version number (2)	02FC	R	3	-	-
Boot version number (2)	02FD	R	3	-	-
Extension word (4)	02FE	R	3	-	-

(1) *40 : not configured 41 : S40 42 : S41 43 : S42 44 : T40*
45 : T42 46 : M41 47 : G40 60 : S43 61 : S50
62 : S51 63 : S52 64 : T50 65 : T52 66 : S44
67 : M40 68 : S54 80 : S53

(2) *MSB: major index, LSB: minor index.*

(3) *2E2 word: MSB: 11 h (Sepam series 40)*
LSB: hardware configuration.

Bit	7	6	5	4	3	2	1	0
Option	**MD/MX**	**Extension**	**MET148-2/2**	**DSM303**	**MSA141**	**MET148-2/1**	**MES114**	**MES108**
Mod.MX	0	z	x	x	x	x	y	y
Mod.MD	1	z	x	0	x	x	y	y

x = 1 if option included
y = 1 if option included, exclusive options
z = 1 if extension in 2FE word (4).

(4) *Bit 0: = 1 if MES114E or MES114F Vac set up.*

Accuracy
Measurement accuracy depends on the weight of the unit; it is equal to the value of the point divided by 2.

Examples:		
I1	Unit = 1 A	Accuracy = 1/2 = 0.5 A
U21	Unit = 10 V	Accuracy = 10/2 = 5 V

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.

Test zone	Word address	Bit address	Access	Modbus function enabled	Format	
Test	0C00	C000-C00F	Read/write	1, 2, 3, 4, 5, 6, 15, 16	None	Initialized to 0
	0C0F	C0F0-C0FF	Read/write	1, 2, 3, 4, 5, 6, 15, 16	None	Initialized to 0

Protection setting zone

The protection setting zone is an exchange table which is used to read and set the protection functions. 2 setting zones are available to be used by 2 masters.

Protection setting	Word address zone 1	Word address zone 2	Access	Modbus function enabled
Setting read buffer	1E00/1E7C	2000/207C	R	3
Setting read request	1E80	2080	R/W	3/6/16
Remote setting request buffer	1F00/1F7C	2100/217C	R/W	3/16

See "Protection settings" chapter.

Fault recorder zone

The fault recorder zone is an exchange table which is used to read disturbance recording records. 2 zones are available to be used by 2 masters.

Disturbance recording	Word address zone 1	Word address zone 2	Access	Modbus function enabled
Choice of transfer function	2200/2203	2400/2403	R/W	3/16
Identification zone	2204/2228	2404/2428	R	3
Disturb. rec. exchange zone	2300	2500	R/W	3/6/16
Disturbance recording data	2301/237C	2501/257C	R	3

See "Disturbance recording" chapter.

Use of remote indication bits

Sepam provides the communication link with 144 TS.
The remote indications (TS) are pre-assigned to protection and control functions which depend on the Sepam model.
The TSs may be read using the bit or word functions. Each TS transition is time-tagged and stored in the event stack (see “Time-tagging”, page 173).

Address word 0101: TS1 to TS16 (Bit address 1010 to 101F)

TS	Application	S40 S50	S41 S51	S42 S52	S43 S53	S44 S54	T40 T50	T42 T52	M40	M41	G40
1	Protection 50/51 unit 1	■	■	■	■	■	■	■	■	■	■
2	Protection 50/51 unit 2	■	■	■	■	■	■	■	■	■	■
3	Protection 50/51 unit 3	■	■	■	■	■	■	■	■	■	■
4	Protection 50/51 unit 4	■	■	■	■	■	■	■	■	■	■
5	Protection 50N/51N unit 1	■	■	■	■	■	■	■	■	■	■
6	Protection 50N/51N unit 2	■	■	■	■	■	■	■	■	■	■
7	Protection 50N/51N unit 3	■	■	■	■	■	■	■	■	■	■
8	Protection 50N/51N unit 4	■	■	■	■	■	■	■	■	■	■
9	Protection 49 RMS alarm set point						■	■	■	■	■
10	Protection 49 RMS tripping set point						■	■	■	■	■
11	Protection 37								■	■	
12	Protection 46 unit 1	■	■	■	■	■	■	■	■	■	■
13	Protection 46 unit 2	■	■	■	■	■	■	■	■	■	■
14	Protection 48/51LR/14 (locked rotor)								■	■	
15	Protection 48/51LR/14 (rotor locking on start)								■	■	
16	Protection 48/51LR/14 (excessive starting time)								■	■	

Address word 0102: TS17 to TS32 (Bit address 1020 to 102F)

TS	Application	S40 S50	S41 S51	S42 S52	S43 S53	S44 S54	T40 T50	T42 T52	M40	M41	G40
17	Protection 27D unit 1								■	■	
18	Protection 27D unit 2								■	■	
19	Protection 27/27S unit 1	■	■	■		■	■	■	■	■	■
20	Protection 27/27S unit 2	■	■	■		■	■	■		■	■
21	Protection 27R								■	■	
22	Protection 59 unit 1	■	■	■		■	■	■	■	■	■
23	Protection 59 unit 2	■	■	■		■	■	■	■	■	■
24	Protection 59N unit 1	■	■	■			■	■		■	■
25	Protection 59N unit 2	■	■	■			■	■		■	■
26	Protection 81H unit 1	■	■	■			■	■		■	■
27	Protection 81H unit 2	■	■	■			■	■		■	■
28	Protection 81L unit 1	■	■	■			■	■		■	■
29	Protection 81L unit 2	■	■	■			■	■		■	■
30	Protection 81L unit 3	■	■	■			■	■		■	■
31	Protection 81L unit 4	■	■	■			■	■		■	■
32	Protection 66								■	■	

Address word 0103: TS33 to TS48 (Bit address 1030 to 103F)

TS	Application	S40 S50	S41 S51	S42 S52	S43 S53	S44 S54	T40 T50	T42 T52	M40	M41	G40
33	Protection 67 unit 1			■				■			
34	Protection 67 unit 2			■				■			
35	Protection 67N unit 1		■	■	■			■		■	
36	Protection 67N unit 2		■	■	■			■		■	
37	Protection 47	■	■	■		■	■	■		■	■
38	Protection 32P		■	■	■					■	■
39	Protection 50BF	■	■	■	■	■	■	■	■	■	■
40	Protection 32Q									■	■
41	Protection 51V										■
42	TC fault	■	■	■	■	■	■	■	■	■	■
43	TP Phase fault	■	■	■	■	■	■	■	■	■	■
44	TP V0 fault	■	■	■	■	■	■	■	■	■	■
45	*Reserved*										
46	*Reserved*										
47	*Reserved*										
48	*Reserved*										

Data addresses and encoding

Address word 0104: TS49 to TS64 (Bit address 1040 to 104F)

TS	Application	S40 S50	S41 S51	S42 S52	S43 S53	S44 S54	T40 T50	T42 T52	M40	M41	G40
49	*Reserved*										
50	*Reserved*										
51	*Reserved*										
52	*Reserved*										
53	*Reserved*										
54	*Reserved*										
55	*Reserved*										
56	*Reserved*										
57	*Reserved*										
58	*Reserved*										
59	*Reserved*										
60	*Reserved*										
61	*Reserved*										
62	*Reserved*										
63	*Reserved*										
64	*Reserved*										

Address word 0105: TS65 to TS80 (Bit address 1050 to 105F)

TS	Application	S40 S50	S41 S51	S42 S52	S43 S53	S44 S54	T40 T50	T42 T52	M40	M41	G40
65	Protection 38/49T module 1 alarm set point sensor 1						■	■	■	■	■
66	Protection 38/49T module 1 tripping set point sensor 1						■	■	■	■	■
67	Protection 38/49T module 1 alarm set point sensor 2						■	■	■	■	■
68	Protection 38/49T module 1 tripping set point sensor 2						■	■	■	■	■
69	Protection 38/49T module 1 alarm set point sensor 3						■	■	■	■	■
70	Protection 38/49T module 1 tripping set point sensor 3						■	■	■	■	■
71	Protection 38/49T module 1 alarm set point sensor 4						■	■	■	■	■
72	Protection 38/49T module 1 tripping set point sensor 4						■	■	■	■	■
73	Protection 38/49T module 1 alarm set point sensor 5						■	■	■	■	■
74	Protection 38/49T module 1 tripping set point sensor 5						■	■	■	■	■
75	Protection 38/49T module 1 alarm set point sensor 6						■	■	■	■	■
76	Protection 38/49T module 1 tripping set point sensor 6						■	■	■	■	■
77	Protection 38/49T module 1 alarm set point sensor 7						■	■	■	■	■
78	Protection 38/49T module 1 tripping set point sensor 7						■	■	■	■	■
79	Protection 38/49T module 1 alarm set point sensor 8						■	■	■	■	■
80	Protection 38/49T module 1 tripping set point sensor 8						■	■	■	■	■

Address word 0106: TS81 to TS96 (Bit address 1060 to 106F)

TS	Application	S40 S50	S41 S51	S42 S52	S43 S53	S44 S54	T40 T50	T42 T52	M40	M41	G40
81	Protection 38/49T module 2 alarm set point sensor 1						■	■	■	■	■
82	Protection 38/49T module 2 tripping set point sensor 1						■	■	■	■	■
83	Protection 38/49T module 2 alarm set point sensor 2						■	■	■	■	■
84	Protection 38/49T module 2 tripping set point sensor 2						■	■	■	■	■
85	Protection 38/49T module 2 alarm set point sensor 3						■	■	■	■	■
86	Protection 38/49T module 2 tripping set point sensor 3						■	■	■	■	■
87	Protection 38/49T module 2 alarm set point sensor 4						■	■	■	■	■
88	Protection 38/49T module 2 tripping set point sensor 4						■	■	■	■	■
89	Protection 38/49T module 2 alarm set point sensor 5						■	■	■	■	■
90	Protection 38/49T module 2 tripping set point sensor 5						■	■	■	■	■
91	Protection 38/49T module 2 alarm set point sensor 6						■	■	■	■	■
92	Protection 38/49T module 2 tripping set point sensor 6						■	■	■	■	■
93	Protection 38/49T module 2 alarm set point sensor 7						■	■	■	■	■
94	Protection 38/49T module 2 tripping set point sensor 7						■	■	■	■	■
95	Protection 38/49T module 2 alarm set point sensor 8						■	■	■	■	■
96	Protection 38/49T module 2 tripping set point sensor 8						■	■	■	■	■

Data addresses and encoding

Address word 0107: TS97 to TS112 (Bit address 1070 to 107F)

TS	Application	S40 S50	S41 S51	S42 S52	S43 S53	S44 S54	T40 T50	T42 T52	M40	M41	G40
97	Recloser in service	■	■	■	■	■					
98	Recloser in progress	■	■	■	■	■					
99	Recloser final trip	■	■	■	■	■					
100	Recloser successful reclosing	■	■	■	■	■					
101	Send blocking input 1	■	■	■	■	■	■	■	■	■	■
102	Remote setting inhibited	■	■	■	■	■	■	■	■	■	■
103	Remote control inhibited	■	■	■	■	■	■	■	■	■	■
104	Sepam not reset after fault	■	■	■	■	■	■	■	■	■	■
105	TC/ position discrepancy	■	■	■	■	■	■	■	■	■	■
106	Matching fault or Trip Circuit Supervision	■	■	■	■	■	■	■	■	■	■
107	Disturbance recording stored	■	■	■	■	■	■	■	■	■	■
108	Control fault	■	■	■	■	■	■	■	■	■	■
109	Disturbance recording inhibited	■	■	■	■	■	■	■	■	■	■
110	Thermal protection inhibited						■	■	■	■	■
111	MET148-1 module sensor fault						■	■	■	■	■
112	MET148-2 module sensor fault						■	■	■	■	■

Address word 0108: TS113 to TS128 (Bit address 1080 to 108F)

TS	Application	S40 S50	S41 S51	S42 S52	S43 S53	S44 S54	T40 T50	T42 T52	M40	M41	G40
113	Thermistor tripping	■	■	■	■	■	■	■	■	■	■
114	Thermistor alarm	■	■	■	■	■	■	■	■	■	■
115	External tripping 1	■	■	■	■	■	■	■	■	■	■
116	External tripping 2	■	■	■	■	■	■	■	■	■	■
117	External tripping 3	■	■	■	■	■	■	■	■	■	■
118	Buchholz tripping						■	■			
119	Thermostat tripping						■	■			
120	Pressure tripping						■	■			
121	Buchholz alarm						■	■			
122	Thermostat alarm						■	■			
123	Pressure alarm						■	■			
124	SF6 alarm	■	■	■	■	■	■	■	■	■	■
125	Recloser ready	■	■	■	■	■					
126	Inductive (1)	■	■	■	■	■	■	■	■	■	■
127	Capacitive (1)	■	■	■	■	■	■	■	■	■	■
128	Phase inverse rotation	■	■	■	■	■	■	■	■	■	■

(1) *TC17 can be used to inhibit this TS.*

Address word 0109: TS129 to TS144 (Bit address 1090 to 109F)

TS	Application	S40 S50	S41 S51	S42 S52	S43 S53	S44 S54	T40 T50	T42 T52	M40	M41	G40
129	Send blocking input 2			■							
130	Tripping due to protection	■	■	■	■	■	■	■	■	■	■
131	S-LAN communication monitoring enabled	■	■	■	■	■	■	■	■	■	■
132	46BC protection (2)	■	■	■	■	■	■	■			
133	*Reserved*										
134	*Reserved*										
135	*Reserved*										
136	*Reserved*										
137	*Reserved*										
138	*Reserved*										
139	*Reserved*										
140	*Reserved*										
141	*Reserved*										
142	*Reserved*										
143	*Reserved*										
144	*Reserved*										

(2) *Only available on S5X and T5X applications.*

Use of remote control orders

Remote control orders are pre-assigned to protection, control and metering functions.
Remote control orders may be carried out in two modes:
- direct mode
- confirmed SBO (select before operate) mode.

It is possible to inhibit all the remote control orders via one logic input assigned to the function "inhibit remote control", with the exception of the remote control tripping order TC1 which can be activated at any time.
The parameter setting of the logic input may be done in two modes:
- inhibition if the input is at 1
- inhibition if the input is at 0 (negative input)

The device tripping and closing and recloser enabling and disabling remote control orders are acknowledged if the "CB control" function is confirmed and if the inputs required for that logic are present on the MES114 (or MES108) optional module.

Direct remote control order

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.

Confirmed SBO remote control order

(select before operate)
In this 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 word are set: the program logic resets the STC bit 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.

Address word 00F0: TC1 to TC16 (Bit address 0F00 to 0F0F)

TC	Application	S40 S50	S41 S51	S42 S52	S43 S53	S44 S54	T40 T50	T42 T52	M40	M41	G40
1	Tripping	■	■	■	■	■	■	■	■	■	■
2	Closing	■	■	■	■	■	■	■	■	■	■
3	Swtiching to setting group A	■	■	■	■	■	■	■	■	■	■
4	Switching to setting group B	■	■	■	■	■	■	■	■	■	■
5	Sepam reset	■	■	■	■	■	■	■	■	■	■
6	Peak demand current zero reset (2)	■	■	■	■	■	■	■	■	■	■
7	Inhibit thermal protection						■	■	■	■	■
8	Inhibit disturbance recording triggering (OPG (1))	■	■	■	■	■	■	■	■	■	■
9	Confirm disturbance recording triggering (OPG (1))	■	■	■	■	■	■	■	■	■	■
10	Manual disturbance recording triggering (OPG (1))	■	■	■	■	■	■	■	■	■	■
11	Enable recloser	■	■	■	■	■					
12	Disable recloser	■	■	■	■	■					
13	Confirm thermal protection						■	■	■	■	■
14	Reset undercurrent protection								■	■	
15	S-LAN communication monitoring activation (3)	■	■	■	■	■	■	■	■	■	■
16	S-LAN communication monitoring inhibition	■	■	■	■	■	■	■	■	■	■

(1) *OPG : French acronym for disturbance recording.*
(2) *Zero resetting of all the peak demands except the peak demand of the negative and positive sequence current ratio.*
(3) *TC15 Remote control order follows the same TC1 inhibition mode.*

Address word 00F2: TC17 to TC32 (Bit address 0F20 to 0F2F)

TC	Application	S40 S50	S41 S51	S42 S52	S43 S53	S44 S54	T40 T50	T42 T52	M40	M41	G40
17	Inhibit TS126 (Inductive) and TS127 (Capacitive)	■	■	■	■	■	■	■	■	■	■
18	Confirm TS126 (Inductive) and TS127 (Capacitive)	■	■	■	■	■	■	■	■	■	■
19-32	*Reserved*										

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 (word address 010F). The usable range of the numerical value transmitted is defined by the "min. value" and "max. value" settings of the analog output.
This function is not affected by remote control inhibition conditions.

Time-tagging of events

Presentation

The communication system time-tags the data processed by Sepam. The time-tagging function assigns a date and precise time to status changes so that they can be accurately classified over time.
Time-tagged data are events that can be processed in the control room by the remote monitoring and control system using the communication protocol for the data logging and chronological display functions.
Sepam time-tags the following data:
- logic inputs
- remote indications
- information pertaining to Sepam equipment (see Sepam check-word).

Time-tagging is carried out systematically.
The remote monitoring and control system provides a chronological display of the time-tagged data.

Time-tagging

Sepam time-tagging of events uses absolute time (see section on date and time). When an event is detected, it is tagged with the absolute time given by Sepam's internal clock.
All the Sepam internal clocks must be synchronized so as to avoid drifts and all be the same, thereby allowing inter-Sepam chronological sorting.
Sepam has two mechanisms for managing its internal clock:
- **time-setting**:

to initialize or modify the absolute time. A special Modbus message, called "time message", is used to time-set each Sepam
- **synchronization**:

to avoid Sepam internal clock drifts and ensure inter-Sepam synchronization.
Synchronization may be carried out according to two principles:
- **internal synchronization**:

via the communication network without any additional wiring
- **external synchronization**:

via a logic input with additional wiring.

At the time of commissioning, the user sets the synchronization mode parameter.

Initialization of the time-tagging function
Each time the communication system is initialized (energizing of Sepam), the events are generated in the following order:
- appearance of "data loss"
- appearance of "incorrect time"
- appearance of "not synchronous"
- disappearance of "data loss".

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.
It can only be interrupted by saturation of the internal event storage queue or by the presence of a major fault in Sepam.

Date and time

Presentation
An absolute date and time are generated internally by Sepam, comprising the following information: Year: Month: Day: Hour: minute: millisecond.
The date and time format is standardized (ref.: IEC 60870-5-4).

Power failure protection
The internal clock of Sepam is saved for 24 hours. After a power outage that lasts for more than 24 hours, the time must be reset.
The period over which Sepam data and time settings are maintained in the event of a power outage depends on the ambient temperature and the age of the Sepam unit.
Typical values:

■ at 25 °C	■ at 40 °C
□ 24 hours for 7 years	□ 24 hours for 3 years
□ 18 hours for 10 years	□ 16 hours for 10 years
□ 14 hours for 15 years	□ 10 hours for 15 years

Resetting the date and time
The internal clock of Sepam may be time-set in three different ways:
- by the remote monitoring and control system, via the Modbus link,
- via the SFT2841 software tool, "General characteristics" screen
- via the display of Sepam units equipped with the advanced UMI.

The time tagged on events is encoded in 8 bytes as follows:

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00	word
0	0	0	0	0	0	0	0	0	Y	Y	Y	Y	Y	Y	Y	word 1
0	0	0	0	M	M	M	M	0	0	0	D	D	D	D	D	word 2
0	0	0	H	H	H	H	H	0	0	mn	mn	mn	mn	mn	mn	word 3
ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	word 4

Y - 1 byte for years: varies from 0 to 99 years.
The remote monitoring and control system must ensure that the year 00 is greater than 99.
M - 1 byte for months: varies from 1 to 12.
D - 1 byte for days: varies from 1 to 31.
H - 1 byte for hours: varies from 0 to 23.
mn - 1 byte for minutes: varies from 0 to 59.
ms - 2 bytes for milliseconds: varies from 0 to 59999.
These data are encoded in binary format. Sepam is time-set via the "write word" function (function 16) at the address 0002 with a mandatory 4-word time message.
The bits set to "0" in the description above correspond to format fields which are not used in and not managed by Sepam.
Since these bits can be transmitted to Sepam with random values, Sepam performs the necessary disabling.
Sepam does not check the consistency or validity of the date and time received.

Synchronization clock

A synchronization clock is required to set the Sepam date and time;
Schneider Electric has tested the following equipment:
Gorgy Timing, ref. RT300, equipped with the M540 module.

Time-tagging of events

Reading of events

Sepam provides the master or masters with two event tables. The master reads the event table and acknowledges by writing the exchange word. Sepam updates its event table.

The events sent by Sepam are not sorted chronologically.

Structure of event table 1:
- exchange word 0040h
- event number 1

0041h ... 0048h
- event number 2

0049h ... 0050h
- event number 3

0051h ... 0058h
- event number 4

0059h ... 0060h

Structure of event table 2:
- exchange word 0070h
- event number 1

0071h ... 0078h
- event number 2

0079h ... 0080h
- event number 3

0081h ... 0088h
- event number 4

0089h ... 0090h

The master has to read a block of 33 words starting at the address 0040h/0070h, or 1 word at the address 0040h/0070h.

Exchange word

The exchange word is used to manage a special protocol to be sure not to lose events following a communication problem. The event table is numbered for that purpose.

The exchange word includes two fields:
- most significant byte (MSB) = exchange number (8 bits): 0..255

b15	b14	b13	b12	b11	b10	b09	b08

Exchange number: 0 .. 255

Description of the MSB of the exchange word.

The exchange number contains a numbering byte which identifies the exchanges. The exchange number is initialized to zero when Sepam is energized. When it reaches its maximum value (FFh), it automatically returns to 0.
Sepam numbers the exchanges and the master acknowledges the numbering.

- least significant byte (LSB) = number of events (8 bits): 0..4.

b07	b06	b05	b04	b03	b02	b01	b00

Number of events: 0 .. 4

Description of the LSB of the exchange word.

Sepam indicates the number of significant events in the event table in the least significant byte of the exchange word. Each non-significant event word is initialized to zero.

Event table acknowledgment

To inform Sepam that the block read by the master has been correctly received, the master writes the number of the last exchange made in the "Exchange number" field, and resets the "Number of events" field of the exchange word to zero. After acknowledgment, the 4 events in the event table are initialized to zero and the old, acknowledged events are erased in Sepam.
Until the exchange word written by the master becomes "X,0" (with X = number of the previous exchange that the master wishes to acknowledge), the exchange word in the table remains at "X, number of previous events".
Sepam only increments the exchange number when new events are present (X+1, number of new events).
If the event table is empty, Sepam performs no processing operations when the master reads the event table or the exchange word.
The data are encoded in binary format.

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).
This command leads the reset of the bits 10, 11, 14 and 15 of the control word without associated event generation.

Sepam in data loss (1) / no data loss (0) status

Sepam has two internal storage queues with a capacity of 64 events. If one of the queues becomes saturated, i.e. 63 events already present, the "**data loss**" event is generated by Sepam in the 64th position.
The detection of events stops and the most recent events are lost.

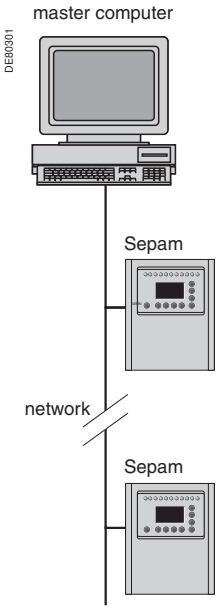
Time-tagging of events

Description of event encoding

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

Most significant byte	Least significant byte	
Word 1: type of event		
08	00	For remote indications, internal data logic inputs
Word 2: event address		
		See bit adresses 1000 to 10BF
Word 3: reserved		
00	00	
Word 4: falling edge: disappearance or rising edge: appearance		
00	00	Falling edge
00	01	Rising edge
Word 5: year		
00	0 to 99 (year)	
Word 6: month-day		
1 to 12 (month)	1 to 31 (day)	
Word 7: hours-minutes		
0 to 23 (hours)	0 to 59 (minutes)	
Word 8: milliseconds		
0 to 59999		

Time-tagging of events



Architecture for "internal synchronization" via the communication network.

Synchronization

Sepam accommodates two synchronization modes:

- "internal via the network" synchronization mode by the broadcasting of a "time message" frame via the communication network. Slave number 0 is used for broadcasting
- "external" synchronization mode via a logic input.

The synchronization mode is selected at the time of commissioning via SFT2841.

Internal synchronization via the network mode

The “time message" frame is used for both time-setting and synchronization of Sepam. In this case, it must be sent regularly at brief intervals (between 10 and 60 seconds) in order for synchronous time to be obtained.

Sepam’s internal clock is reset each time a new time frame is received, and synchronization is maintained if the difference in synchronism is less than 100 milliseconds.

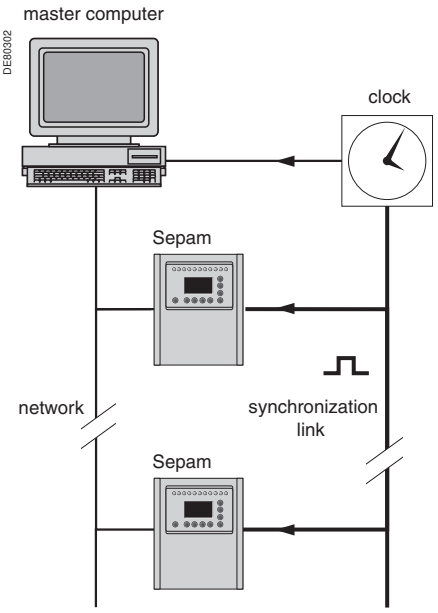
With internal synchronization via the network, accuracy is linked to the master and its mastery of time frame transmission in the communication network.

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 into a transitional non-synchronous status.

When Sepam is in synchronous status, if no "**time message**” is received for 200 seconds, the appearance of the "not synchronous" event is triggered.

Time-tagging of events



Architecture for "external synchronization" via a logic input.

Synchronization (cont'd)

External synchronization via a logic input mode

Sepam can be synchronized externally by means of a logic input (I21) (the MES114 module is required).

The synchronization pulse is determined by the rising edge of the logic input.

Sepam can adapt to all synchronization pulse periods from 10 to 60 s, by 10 s steps.

The shorter the synchronization period, the more accurate time-tagging of status changes is.

The first time frame is used to initialize Sepam with the absolute date and time (the following frames are used for the detection of any time changes).

The synchronization pulse is used to reset Sepam's internal clock. In the initialization phase, when Sepam is in "non-synchronous" mode, resetting is allowed, within an amplitude of ±4 seconds.

In the initialization phase, the resetting process (switching of Sepam into "synchronous" mode) is based on a measurement of the difference between Sepam's current time and the nearest ten second period. This measurement is taken at the time of the receipt of the synchronization pulse following the initialization time frame. Resetting is allowed if the difference is less than or equal to 4 seconds, in which case Sepam switches to "synchronous" mode.

As of that time (after the switching to "synchronous" mode), the resetting process is based on the measurement of a difference (between Sepam's current time and the nearest ten second period at the time of the receipt of a synchronization pulse), which is adapted to match the synchronization pulse period.

The synchronization pulse period is determined automatically by Sepam when it is energized, based on the first two pulses received: the synchronization pulse must therefore be operational before Sepam is energized.

The synchronization function only operates after Sepam has been time-set, i.e. after the disappearance of the "incorrect time" event.

Any time changes greater than ±4 seconds in amplitude are made by sending a new time frame. The switch from summer time to winter time (and vice versa) is made in this way as well.

There is a temporary loss of synchronism when the time is changed.

The external synchronization mode requires additional equipment, a "synchronization clock " to generate a precise periodic synchronization time pulse.

If Sepam is in "correct time and synchronous" status, and if the difference in synchronism between the nearest ten second period and the receipt of the synchronization pulse is greater than the synchronism error for 2 consecutive synchronization pulses, it switches into non-synchronous status and generates the appearance of a "not synchronous" event.

Likewise, if Sepam is in "correct time and synchronous" status, the failure to receive a synchronization pulse for 200 seconds generates the appearance of a "not synchronous" event.

Access to remote settings

Reading of remote settings (remote reading)

Settings accessible for remote reading
Reading of the settings of all the protection functions may be accessed remotely in 2 independent zones to enable operation with 2 masters.

Exchange principle
Remote reading of settings (remote reading) takes place in two steps:
■ first of all, the master indicates the code of the function for which it wishes to know the settings by means of a "request frame". The request is acknowledged, in the Modbus sense of the term, to free the network
■ the master then reads a reply zone to find the required information by means of a "reply frame". Each function has its own particular reply zone contents. The time needed between the request and the reply is linked to Sepam's low-priority cycle time and may vary from a few tens to several hundreds of milliseconds.
■ setting zone 1
□ read: 1E00h-1E7Ch
□ read request: 1E80h
□ remote setting: 1F00h-1F7Ch
■ setting zone 2
□ read: 2000h -207Ch
□ read request: 2080h
□ remote setting: 2100h -217Ch

Request frame
The request is made by the master using a "write word" operation (function 6 or 16) at the address 1E80h or 2080h of a 1-word frame consisting of the following:

1E80h/2080h

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
Function code								Unit number							

The content of the address 1E80h/2080h may be read using a Modbus "read word" operation (function 3).
The function code field may have the following values:
■ 01h to 99h (BCD encoding) for protection functions.
The unit number field is used as follows:
■ for protection functions, it indicates the unit involved, varying from 1 to N, N being the maximum number of relays available in the Sepam
■ when only one unit of a protection function is available, this number field is not controlled.

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

Reply frame
The reply, sent back by Sepam, fits into a zone with a maximum length of 25 words at the address 1E00h or 2000h, which comprises the following:

1E00h-1E7Ch/2000h-207Ch

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
Function code								Unit number							
Settings															
.....															
(special field for each function)															
.....															

This zone is read by a Modbus "read word" operation (function 3) at the address 2000h.
The length of the exchange may concern:
■ first word only (validity test)
■ maximum size of the zone (125 mots)
■ usable size of the zone (determined by the function being addressed).
However, reading must always begin at the first word in the zone (any other address triggers an exception reply "incorrect address").
The first word in the zone (function code and unit number) may have the following values:
■ **xxyy**: with
□ function code xx different from 00 and FFh
□ unit number yy different from FFh.
The settings are available and confirmed. They word is a copy of the "request frame". The zone contents remain valid until the next request is made.
■ **FFFFh**: the "request frame" has been processed, but the results in the "reply zone" are not yet available. It is necessary to repeat "reply frame" reading. The other words are not significant.
■ **xxFFh**: with the function code xx different from 00 and FFh. The read request for the settings of the designated function is not valid. The function is not included in the particular Sepam, or remote reading of it is not authorized: refer to the list of functions which accommodate remote reading of settings.

Access to remote settings

NOTICE

RISK OF UNINTENDED 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 following 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.

Remote setting

Data that can be remotely set

Writing of the settings of all the protection functions may be accessed remotely.

Exchange principle

Remote setting is allowed for Sepam units.

Remote setting is carried out for a given function unit by unit.

It takes place in two steps:

■ first of all, the master indicates the function code and unit number, followed by the values of all the settings in the "write request frame". The request is acknowledged to free the network

■ the master then reads a reply zone designed for checking that the settings have been processed. Each function has its own particular reply zone contents.

They are the same as those of the remote reading function reply frame.

To use remote setting, it is necessary to make all the settings for the function concerned, even if some of them have not changed.

Request frame

The request is made by the master using a "write n words" operation (function 16) at the address 1F00h or 2100h. The zone to be written contains a maximum of 123 words.

It contains the values of all the settings and consists of the following:

1F00h/2100h

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
Function code								Unit number							
Settings															
.....															
(special field for each function)															
.....															

The content of the address 2100h may be read using a "read n words" operation (function 3).

■ the function code field may have the following values:

01h to 99h (BCD encoding) for the list of protection functions F01 to F99

■ the unit number field is used as follows:

for protection functions, it indicates the unit involved, varying from 1 to N, N being the maximum number of units available in the Sepam. It may never be equal to 0.

Exception reply

In addition to the usual cases, le 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.

Reply frame

The reply sent back by Sepam is the same as the remote reading reply frame. It fits into a zone with a maximum length of 125 words at the address 1E00h or 2000h, and is composed of the effective settings of the function following a semantic check:

1E00h-1E7Ch/2000h-207Ch

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
Function code								Unit number							
Settings															
.....															
(special field for each function)															
.....															

This zone is read by a "read n words" operation (function 3) at the address 1E00h or 2000h.

The length of the exchange may concern:

- first word only (validity test)
- maximum size of the zone (125 words)
- usable size of the zone (determined by the function being addressed).

However, reading must always begin at the first word in the zone (any other address triggers an exception reply "incorrect address").

The first word in the zone (function code and unit number) has the same values as those described for the remote reading reply frame.

- **xxyy**: with:
  - function code xx different from 00 and FFh
  - unit number yy different from FFh.

The settings are available and confirmed. The word is a copy of the "request frame". The zone contents remain valid until the next request is made.

- **0000h**: no "request frame has yet been formulated.

This is espcially the case when Sepam is energized.

The other words are not significant.

- **FFFFh**: the "request frame" has been processed, but the results in the "reply zone" are not yet available. It is necessary to repeat "reply frame" reading. The other words are not significant.
- **xxFFh**: with the function code xx different from 00 and FFh. The read request for the settings of the designated function is not valid. The function is not included in the particular Sepam, or access to settings is impossible, in both read and write modes.

Description of settings

Data format
All the settings are transmitted in signed 32-bit integer format (encoding, as a complement of 2).
Particular setting value:
7FFF FFFFh means that the setting is out of the validity range.

① The Enabled or Disabled setting is encoded as follows:
0 = Disabled, 1 = Enabled

② The tripping curve setting is encoded as follows:
0 = definite
1 = inverse
2 = long time inverse
3 = very inverse
4 = extremely inverse
5 = ultra inverse
6 = RI
7 = IEC SIT/A
8 = IEC LTI/B
9 = IEC VIT/B
10 = IEC EIT/C
11 = IEEE Mod. inverse
12 = IEEE Very inverse
13 = IEEE Extr. inverse
14 = IAC inverse
15 = IAC very inverse
16 = IAC extr. inverse

③ The timer hold delay curve setting is encoded as follows:
0 = definite time
1 = IDMT

④ The H2 restraint variable is encoded as follows:
0 = H2 restraint
1 = no H2 restraint

⑤ The tripping curve setting is:
0 = definite time
1 = IDMT

⑥ Setting of latching and CB control
0 = No
1 = Yes

⑦ Tripping curve for negative sequence undercurrent:
0 = definite
7 = IEC SIT/A
8 = IEC LTI/B
9 = IEC VIT/B
10 = IEC EIT/C
11 = IEEE Mod. inverse
12 = IEEE Very inverse
13 = IEEE Extr. inverse
17 = Schneider specific

⑧ The activation of each of the cycles is encoded as follows:
Correspondence between bit position / protection according to the table below:

Bit	Activation by
0	Instantaneous phase overcurrent, unit 1
1	Time-delayed phase overcurrent, unit 1
2	Instantaneous phase overcurrent, unit 2
3	Time-delayed phase overcurrent, unit 2
4	Instantaneous phase overcurrent, unit 3
5	Time-delayed phase overcurrent, unit 3
6	Instantaneous phase overcurrent, unit 4
7	Time-delayed phase overcurrent, unit 4
8	Instantaneous earth fault, unit 1
9	Time-delayed earth fault, unit 1
10	Instantaneous earth fault, unit 2
11	Time-delayed earth fault, unit 2
12	Instantaneous earth fault, unit 3
13	Time-delayed earth fault, unit 3
14	Instantaneous earth fault, unit 4
15	Time-delayed earth fault, unit 4
16	Instantaneous directional earth fault, unit 1
17	Time-delayed directional earth fault, unit 1
18	Instantaneous directional earth fault, unit 2
19	Time-delayed directional earth fault, unit 2
20	Instantaneous directional phase overcurrent, unit 1
21	Time-delayed directional phase overcurrent, unit 1
22	Instantaneous directional phase overcurrent, unit 2
23	Time-delayed directional phase overcurrent, unit 2
24	V_TRIPCB (logic equation)

The bit status is encoded as follows:
0 = No activation by the protection function
1 = Activation by the protection function.

⑨ The time delay unit of the CLPU functions is coded the following way:
0 = millisecond
1 = second
2 = minute

General settings

Function number: 3002

Setting	Data	Format/Unit
1	Rated frequency	0 = 50 Hz, 1 = 60 Hz
2	Remote setting enabled	1 = disabled
3	Working language	0 = English, 1 = other
4	Active group of settings	0 = Group A 1 = Group B 3 = Choice by I13 4 = Choice by remote control
5	Setting mode	0 = TMS, 1 = I/Is
6	Phase CT rating	0 = 5 A, 1 = 1 A, 2 = LPCT
7	Number of phase CTs	0 = 3 CTs, 1 = 2 CTs
8	Rated current In	A
9	Basic current Ib	A
10	Residual current determination mode	0 = None 1 = 2 A CSH 2 = 20 A CSH 3 = 1 A CT 4 = 5 A CT 5 = ACE990 Range 1 6 = ACE990 Range 2 7 = 5 A CSH 8 = Sensitive 1 A CT 9 = Sensitive 5 A CT
11	Rated residual current (In0)	0.1 A
12	Integration period	0 = 5 mn, 1 = 10 mn 2 = 15 mn, 3 = 30 mn 4 = 60 mn
13	*Reserved*	
14	Rated primary voltage Unp	V
15	Rated secondary voltage Uns	0 = 100 V, 1 = 110 V 2 = 115 V, 3 = 120 V 4 = 200 V, 5 = 230 V 6 = Numerical value, see setting 21
16	VT wiring	0 = 3 V, 1 = 2 U, 2 = 1 U
17	Residual voltage mode	0 = None 1 = Σ 3 V 2 = external VT – Uns/$\sqrt{3}$ 3 = external VT – Uns/3
18	Type of cubicle	0 = incomer 1= feeder
19	Increment active power	0.1 kW.h
20	Increment reactive power	0.1 kvar.h
21	Rated secondary voltage Uns	V

Protection settings

They are organized according to increasing ANSI codes.

ANSI 27/27S - Undervoltage

Function number: 10xx
relay 1: xx = 01, relay 2: xx = 02

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Voltage mode	0 = phase-to-neutral, 1 = phase-to-phase
7	Us (or Vs) set point	% Unp (or Vnp)
8	Tripping time delay	10 ms
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-
12	*Reserved*	-

ANSI 27D - Positive sequence undervoltage

Function number: 08xx
relay 1: xx = 01, relay 2: xx = 02

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Vsd set point	% Unp
7	Tripping time delay	10 ms
8	*Reserved*	-
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-

ANSI 27R - Remanent undervoltage

Function number: 0901

Setting	Data	Format/Unit
1	Latching	⑥
2	*Reserved*	-
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Us set point	% Unp
7	Tripping time delay	10 ms
8	*Reserved*	-
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-

ANSI 32P - Active overpower

Function number: 2301

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	Type	0 = reverse power 1 = overpower
5	*Reserved*	-
6	*Reserved*	-
7	Ps set point	100 W
8	Tripping time delay	10 ms
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-
12	*Reserved*	-

ANSI 32Q - Reactive overpower
Function number: 2401

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	Type	0 = reverse power 1 = overpower
5	*Reserved*	-
6	*Reserved*	-
7	Qs set point	100 var
8	Tripping time delay	10 ms
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-
12	*Reserved*	-

ANSI 37 - Phase undercurrent
Function number: 0501

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Is set point	% Ib
7	Tripping time delay	10 ms
8	*Reserved*	-
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-

ANSI 38/49T - Temperature monitoring
Function number: 15xx
relay 1: xx = 01 to relay 16: xx = 10h

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Alarm set point	°C
7	Trip set point	°C
8	*Reserved*	-
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-

ANSI 46 - Negative sequence / unbalance
Function number: 03xx
relay 1: xx = 01, relay 2: xx = 02

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Tripping curve	⑦
7	Is set point	% Ib
8	Tripping time delay	10 ms
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-
12	*Reserved*	-

ANSI 46BC - Broken Conductor
Function number: 2801

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Set point	%
7	Tripping time delay	10 ms

ANSI 47 - Negative sequence overvoltage
Function number: 1901

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Vsi set point	% Unp
7	Tripping time delay	10 ms
8	*Reserved*	-
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-

ANSI 48/51LR/14 - Locked rotor, excessive starting time
Function number: 0601

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Is set point	% Ib
7	Excessive starting time delay	10 ms
8	Locked rotor time delay	10 ms
9	Locked rotor on start time delay	10 ms
10	*Reserved*	-
11	*Reserved*	-
12	*Reserved*	-
13	*Reserved*	-

ANSI 49RMS - Thermal overload

Function number: 0401

Setting	Data	Format/Unit
1	Latching	(6)
2	CB control	(6)
3	Activity	(1)
4	Negative sequence factor K	0: without 1: low (2.25) 2: average (4.5) 3: high (9)
5	Current threshold Is (switching from rate 1/rate 2)	% Ib
6	Accounting for ambient temperature	0: no 1: yes
7	Maximum equipment temperature	°C
8	Additional settings taken into account (rate 2)	0: no 1: yes
9	Learnt cooling time constant (T2 learnt) taken into account	0: no 1: yes
10	*Reserved*	
11	*Reserved*	
12	Rate 1 - heatrise alarm set point	%
13	Rate 1 - heatrise tripping set point	%
14	Rate 1 - heating time constant	mn
15	Rate 1 - cooling time constant	mn
16	Rate 1 - initial heatrise	%
17	*Reserved*	
18	*Reserved*	
19	*Reserved*	
20	*Reserved*	
21	*Reserved*	
22	Rate 2 - heatrise alarm set point	%
23	Rate 2 - heatrise tripping set point	%
24	Rate 2 - heating time constant	mn
25	Rate 2 - cooling time constant	mn
26	Rate 2 - initial heatrise	%
27	Rate 2 - base current for rate 2	0.1 A
28	*Reserved*	
29	*Reserved*	
30	*Reserved*	
31	*Reserved*	

ANSI 50/51 - Phase overcurrent
Function number: 01xx
relay 1: xx = 01 to relay 4: xx = 04

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	Confirmation	0 = none, 1 = neg. seq. overvoltage, 2 = undervoltage
5	H2 restraint set point (1)	%
6	*Reserved*	-
7	Group A – tripping curve	②
8	Group A – Is set point	0.1 A
9	Group A – tripping time delay	10 ms
10	Group A – timer hold curve	③
11	Group A – timer hold delay	10 ms
12	Group A – H2 restraint	①
13	Group A – Iscmin	0.1 A
14	*Reserved*	-
15	*Reserved*	-
16	Group B – tripping curve	②
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 delay	10 ms
21	Group B – H2 restraint	①
22	Group B – Iscmin	0.1 A
23	*Reserved*	
24	*Reserved*	

(1) *Set point utilized by all the groups.*

ANSI 50BF - Breaker failure
Function number: 2001

Setting	Data	Format/Unit
1	Latching	⑥
2	*Reserved*	-
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Use close position of circuit breaker	⑥
7	Is set point	0.1 A
8	Tripping time delay	10 ms
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-
12	*Reserved*	-

ANSI 50N/51N - Earth fault
Function number: 02xx
relay 1: xx = 01 to relay 4: xx = 04

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	Type of I0	0 calculated, 1 measured
5	*Reserved*	-
6	*Reserved*	-
7	Group A – tripping curve	②
8	Group A – Is0 set point	0.1 A
9	Group A – tripping time delay	10 ms
10	Group A – timer hold curve	③
11	Group A – timer hold delay	10 ms
12	Group A – H2 restraint	0 yes, 1 no
13	*Reserved*	-
14	*Reserved*	-
15	*Reserved*	-
16	*Reserved*	-
17	Group B – tripping curve	②
18	Group B – Is0 set point	0.1 A
19	Group B – tripping time delay	10 ms
20	Group B – timer hold curve	③
21	Group B – timer hold delay	10 ms
22	Group B – H2 restraint	0 yes, 1 no
23	*Reserved*	-
24	*Reserved*	-
25	*Reserved*	-
26	*Reserved*	-

ANSI 51V - Voltage-restrained phase overcurrent
Function number: 2501

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Tripping curve	②
7	Is set point	0.1 A
8	Tripping time delay	10 ms
9	Timer hold curve	③
10	Timer hold delay	10 ms
11	*Reserved*	-
12	*Reserved*	-
13	*Reserved*	-
14	*Reserved*	-

ANSI 59 - Overvoltage
Function number: 11xx
relay 1: xx = 01, relay 2: xx = 02

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Voltage mode	0 = phase-to-neutral 1 = phase-to-phase
7	Us (or Vs) set point	% Unp (or Vnp)
8	Tripping time delay	10 ms
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-
12	*Reserved*	-

ANSI 59N - Neutral voltage displacement
Function number: 12xx
relay 1: xx = 01, relay 2: xx = 02

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Vs0 set point	% Unp
7	Tripping time delay	10 ms
8	*Reserved*	-
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-

ANSI 66 - Starts per hour
Function number: 0701

Setting	Data	Format/Unit
1	Latching	⑥
2	*Reserved*	-
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Period of time	Hours
7	Total number of starts	1
8	Number of consecutive hot starts	1
9	Number of consecutive starts	1
10	Time delay between starts	Minutes
11	*Reserved*	-
12	*Reserved*	-
13	*Reserved*	-
14	*Reserved*	-

ANSI 67 - Directional phase overcurrent
Function number: 21xx
relay 1: xx = 01, relay 2: xx = 02

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Group A – direction	0 line, 1 busbar
7	Group A – characteristic angle	0 = 30° angle 1 = 45° angle 2 = 60° angle
8	Group A – tripping logic	0 = one out of three 1 = two out of three
9	Group A – tripping curve	②
10	Group A – Is set point	0.1 A
11	Group A – tripping time delay	10 ms
12	Group A – timer hold curve	③
13	Group A – timer hold delay	10 ms
14	*Reserved*	-
15	*Reserved*	-
16	*Reserved*	-
17	*Reserved*	-
18	Group B – direction	0 line, 1 busbar
19	Group B – characteristic angle	0 = 30° angle 1 = 45° angle 2 = 60° angle
20	Group B – tripping logic	0: 1 on 3, 1: 2 on 3
21	Group B – tripping curve	②
22	Group B – Is set point	0.1 A
23	Group B – tripping time delay	10 ms
24	Group B – timer hold curve	③
25	Group B – timer hold delay	10 ms
26	*Reserved*	-
27	*Reserved*	-
28	*Reserved*	-
29	*Reserved*	-

ANSI 67N/67NC - Directional earth fault
Function number: 22xx
relay 1: xx = 01, relay 2: xx = 02

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	Type	0 = projection 1 = directionalized
5	Type of I0 (Sum or Core balance CT)	0 calculated, 1 measured
6	*Reserved*	-
7	*Reserved*	-
8	Group A – direction	0 line, 1 busbar
9	Group A – types 1 and 2: characteristic angle	0 = -45° angle 1 = 0° angle 2 = 15° angle 3 = 30° angle 4 = 45° angle 5 = 60° angle 6 = 90° angle
	Group A – type 3: limit 1	0 to 359°
10	Group A – type 1: sector	2 = 76° sector 3 = 83° sector 4 = 86° sector
	Group A – type 3: limit 2	0 to 359°
11	Group A – tripping curve	②
12	Group A – types 1 and 2: Is0 set point	0.1 A
	Group A – type 3: Is0 set point	0.01 A
13	Group A – tripping time delay	10 ms
14	Group A – types 1 and 2: Vs0	% Unp
	Group A – type 3: Vs0	0.1 % Unp
15	Group A – timer hold curve	③
16	Group A – timer hold delay	10 ms
17	Group A – memory time	10 ms
18	Group A – memory voltage	% Unp
19	*Reserved*	-
20	*Reserved*	-
21	*Reserved*	-
22	*Reserved*	-
23	Group B – direction	0 line, 1 busbar
24	Group B – types 1 and 2: characteristic angle	0 = -45° angle 1 = 0° angle 2 = 15° angle 3 = 30° angle 4 = 45° angle 5 = 60° angle 6 = 90° angle
	Group B – type 3: limit 1	0 to 359°
25	Group B – type 1: sector	2 = 76° sector 3 = 83° sector 4 = 86° sector
	Group B – type 3: limit 2	0 to 359°
26	Group B – tripping curve	②
27	Group B – types 1 and 2: Is0 set point	0.1 A
	Group B – type 3: Is0 set point	0.01 A
28	Group B – tripping time delay	10 ms
29	Group B – types 1 and 2: Vs0	% Unp
	Group B – type 3: Vs0	0.1 % Unp
30	Group B – timer hold curve	③
31	Group B – timer hold delay	10 ms
32	Group B – memory time	10 ms
33	Group B – memory voltage	% Unp
34	*Reserved*	-
35	*Reserved*	-
36	*Reserved*	-
37	*Reserved*	-

Access to remote settings

ANSI 79 - Recloser
Function number: 1701

Setting	Data	Format/Unit
1	Activity	①
2	Number of cycles	1 to 4
3	Reclaim time	10 ms
4	Safety time until ready	10 ms
5	Dead time extension	⑥
6	Maximum waiting time	10 ms
7	*Reserved*	-
8	*Reserved*	-
9	Cycle 1 activation mode	⑧
10	Cycle 1 dead time	10 ms
11	*Reserved*	-
12	*Reserved*	-
13	Cycle 2, 3, 4 activation mode	⑧
14	Cycle 2 dead time	10 ms
15	Cycle 3 dead time	10 ms
16	Cycle 4 dead time	10 ms
17	*Reserved*	-
18	*Reserved*	-

ANSI 81H - Overfrequency
Function number: 13xx
relay 1: xx = 01, relay 2: xx = 02

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Fs set point	0.1 Hz
7	Tripping time delay	10 ms
8	*Reserved*	-
9	Vs set point	% Unp
10	*Reserved*	-
11	*Reserved*	-
12	*Reserved*	-
13	*Reserved*	-

ANSI 81L - Underfrequency
Function number: 14xx
relay 1: xx = 01 to relay 4: xx = 04

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Fs set point	0.1 Hz
7	Tripping time delay	10 ms
8	Restraint	0 none 1 on frequency variation
9	Vs set point	% Unp
10	Inhibited threshold	on frequency variation
11	*Reserved*	-
12	*Reserved*	-
13	*Reserved*	-
14	*Reserved*	-

CLPU 50/51 and CLPU 50N/51N protection settings

Function number: 2A01

Setting	Data	Format/Unit
1	*Reserved*	-
2	*Reserved*	-
3	*Reserved*	-
4	Time before activation Tcold	10 ms
5	Pick-up threshold CLPUs	% In
6	*Reserved*	
7	CLPU 50/51 global action setting	0 = blocking 1 = multiplication
8	Activation of ANSI 50/51 protection unit x: OFF or ON	(1) (2)
9	Unit 1 / Group A 50/51: unit of activation time delay T	(9)
10	Unit 1 / Group A 50/51: activation time delay T	(1)
11	Unit 1 / Group A 50/51: multiplying factor M	% Is
12	Unit 2 / Group A 50/51: unit of activation time delay T	(9)
13	Unit 2 / Group A 50/51: activation time delay T	(1)
14	Unit 2 / Group A 50/51: multiplying factor M	% Is
15	Unit 3 / Group A 50/51: unit of activation time delay T	(9)
16	Unit 3 / Group A 50/51: activation time delay T	(1)
17	Unit 3 / Group A 50/51: multiplying factor M	% Is
18	Unit 4 / Group A 50/51: unit of activation time delay T	(9)
19	Unit 4 / Group A 50/51: activation time delay T	(1)
20	Unit 4 / Group A 50/51: multiplying factor M	% Is
21	Unit 1 / Group B 50/51: unit of activation time delay T	(9)
22	Unit 1 / Group B 50/51: activation time delay T	(1)
23	Unit 1 / Group B 50/51: multiplying factor M	% Is
24	Unit 2 / Group B 50/51: unit of activation time delay T	(9)
25	Unit 2 / Group B 50/51: activation time delay T	(1)
26	Unit 2 / Group B 50/51: multiplying factor M	% Is
27	Unit 3 / Group B 50/51: unit of activation time delay T	(9)
28	Unit 3 / Group B 50/51: activation time delay T	(1)
29	Unit 3 / Group B 50/51: multiplying factor M	% Is
30	Unit 4 / Group B 50/51: unit of activation time delay T	(9)
31	Unit 4 / Group B 50/51: activation time delay T	(1)
32	Unit 4 / Group B 50/51: multiplying factor M	% Is
33	CLPU 50N/51N global action setting	0 = blocking 1 = multiplication
34	Activation of ANSI 50N/51N protection unit x: OFF or ON	(1) (2)
35	Unit 1 / Group A 50N/51N: unit of activation time delay T0	(9)
36	Unit 1 / Group A 50N/51N: activation time delay T0	(1)
37	Unit 1 / Group A 50N/51N: multiplying factor M0	% Is0
38	Unit 2 / Group A 50N/51N: unit of activation time delay T0	(9)
39	Unit 2 / Group A 50N/51N: activation time delay T0	(1)
40	Unit 2 / Group A 50N/51N: multiplying factor M0	% Is0
41	Unit 3 / Group A 50N/51N: unit of activation time delay T0	(9)
42	Unit 3 / Group A 50N/51N: activation time delay T0	(1)
43	Unit 3 / Group A 50N/51N: multiplying factor M0	% Is0
44	Unit 4 / Group A 50N/51N: unit of activation time delay T0	(9)
45	Unit 4 / Group A 50N/51N: activation time delay T0	(1)
46	Unit 4 / Group A 50N/51N: multiplying factor M0	% Is0
47	Unit 1 / Group B 50N/51N: unit of activation time delay T0	(9)
48	Unit 1 / Group B 50N/51N: activation time delay T0	(1)
49	Unit 1 / Group B 50N/51N: multiplying factor M0	% Is0
50	Unit 2 / Group B 50N/51N: unit of activation time delay T0	(9)
51	Unit 2 / Group B 50N/51N: activation time delay T0	(1)
52	Unit 2 / Group B 50N/51N: multiplying factor M0	% Is0
53	Unit 3 / Group B 50N/51N: unit of activation time delay T0	(9)
54	Unit 3 / Group B 50N/51N: activation time delay T0	(1)
55	Unit 3 / Group B 50N/51N: multiplying factor M0	% Is0
56	Unit 4 / Group B 50N/51N: unit of activation time delay T0	(9)
57	Unit 4 / Group B 50N/51N: activation time delay T0	(1)
58	Unit 4 / Group B 50N/51N: multiplying factor M0	% Is0

(1) *numerical value, see setting of time delay unit T.*

(2) *bit 0 : unit 1 group A activation*
bit 1 : unit 2 group A activation
bit 2 : unit 3 group A activation
bit 3 : unit 4 group A activation
bit 4 : unit 1 group B activation
bit 5 : unit 2 group B activation
bit 6 : unit 3 group B activation
bit 7 : unit 4 group B activation

Other protection settings

ANSI 21FL - Fault Locator

Function number : 2901

Setting	Data	Format/Unit
1	*Reserved*	-
2	*Reserved*	-
3	Activity	(1)
4	Time delay T	Numerical value, see unit at setting 5
5	Unit of time delay T	0 = s 1 = mn
6	Location unit (1)	0 = km 1 = miles
7	Positive sequence resistance of lines (Rdl)	mΩ/km
8	Positive sequence reactance of lines (Xdl)	mΩ/km
9	Zero sequence resistance of lines (R0l)	mΩ/km
10	Zero sequence reactance of lines (X0l)	mΩ/km
11	Positive sequence resistance of cables (Rdc)	mΩ/km
12	Positive sequence reactance of cables (Xdc)	mΩ/km
13	Zero sequence resistance of cables (R0c)	mΩ/km
14	Zero sequence reactance of cables (X0c)	mΩ/km
15	Percentage of cable	%

(1) This parameter is only valid to display the settings 7 to 14 on the advanced UMI and SFT2841 software.

ANSI 60 - CT supervision

Function number: 2601

Setting	Data	Format/Unit
1	*Reserved*	-
2	*Reserved*	-
3	Activity	(1)
4	*Reserved*	-
5	*Reserved*	-
6	Behavior on 46, 51N, 32P, 32Q functions	0 none, 1 inhibition
7	Tripping time delay	10 ms
8	*Reserved*	-
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-

ANSI 60FL - VT supervision

Function number: 2701

Setting	Data	Format/Unit
1	*Reserved*	-
2	*Reserved*	-
3	Activity	(1)
4	*Reserved*	-
5	*Reserved*	-
6	Check loss of 3 V/2 U	(6)
7	Test current	(6)
8	Use Vi, Ii criterion	(6)
9	Behavior on 27/27S, 27D, 32P, 32Q, 47, 51V, 59, 59N functions	0 none, 1 inhibition
10	Behavior on 67 function	0 non directional, 1 inhibition
11	Behavior on 67N function	0 non directional, 1 inhibition
12	Vi set point	% Vn
13	Ii set point	% In
14	Time delay loss 3 V/ 2 U	10 ms
15	Time delay Vi, Ii	10 ms
16	*Reserved*	-
17	*Reserved*	-
18	*Reserved*	-
19	*Reserved*	-

Disturbance recording

Presentation

The disturbance recording function is used to record analog and logical signals during a time interval.
Sepam can store up to 19 records.
Each record comprises two files:
- configuration file with suffix .CFG
- data file with suffix .DAT.

The data of each record may be transferred via the Modbus link.
It is possible to transfer 1 to 19 records to a remote monitoring and control system. A record may be transferred as many times as possible, 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 stopped.
If a command (e.g. remote read or remote setting request) is carried out during the transfer of a disturbance recording record, the record in not disturbed.

Time-setting

Each record can be dated.
Time-setting of Sepam is described in the "Time-tagging of events" section.

Transferring records

Transfer requests are made record by record. A configuration file and a data file are produced for each record.
The master sends the commands to:
- find out the characteristics of the records stored in an identification zone
- read the contents of the different files
- acknowledge each transfer
- reread the identification zone to ensure that the record still appears in the list of records available.

2 transfer zones are available:
- transfer zone 1
  - request frame: 2200h-2203h
  - identification zone: starting at 2204h
  - reply frame: starting at 2300h
- transfer zone 2
  - request frame: 2400h-2403h
  - identification zone: starting at 2404h
  - reply frame: starting at 2500h.

Reading the identification zone

Given the volume of data to be transmitted, the master must ensure that there are data to be recovered and prepare the exchanges when necessary.
The identification zone, described below, is read by the reading of N words starting at the address 2204h/2404h:
- 2 reserve words forced to 0
- size of record configuration files encoded in 1 word
- size of record data files encoded in 2 words
- number of records encoded in 1 word
- date of record 1 (least recent) encoded in 4 words (see format below)
- date of record 2 encoded in 4 words (see format below)
- ...
- date of record 19 (most recent) encoded in 4 words (see format below)
- 27 reserve words.

All of these data are consecutive.

Reading the contents of the different files

Request frame

The master makes the request by writing the date of the record to be transferred (function 16) in 4 words starting at the address 2200h.
It should be noted that requesting a new record amounts to stopping the transfers that are in progress. This is not the case for an identification zone transfer request.

2200h/2400h

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
O	O	O	O	O	O	O	O	Y	Y	Y	Y	Y	Y	Y	Y
O	O	O	O	M	M	M	M	O	O	O	D	D	D	D	D
O	O	O	H	H	H	H	H	O	O	mn	mn	mn	mn	mn	mn
ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms

Y - 1 byte for years: varies from 0 to 99 years.
The remote monitoring and control system must ensure that the year 00 is later than 99.
M - 1 byte for months: varies from 1 to 12.
D - 1 byte for days: varies from 1 to 31.
H - 1 byte for hours: varies from 0 to 23.
mn - 1 byte for minutes: varies from 0 to 59.
ms - 2 bytes for milliseconds: varies from 0 to 59999.

Reply frame

Reading of each portion of configuration and data file records by a 125-word read frame (function 3) starting at the address 2300h.

2300h/2500h

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
Exchange number								Number of usable bytes in the data zone							
.....															
Data zone															
.....															

Reading should always begin with the first word in the address zone (any other address triggers an exception reply "incorrect address").
The configuration and data files are read in their entirety in Sepam. They are transferred adjacently.

If the master requests more exchanges than necessary, the exchange number remains unchanged and the number of usable bytes is forced to 0. To guarantee data transfers, it is necessary to allow a response time of about 500 ms between each read operation at 2300h.
The first word transmitted is an exchange word. The exchange word comprises two fields:
■ the most significant byte contains the exchange number. It is initialized to zero after an energizing operation. It is incremented by 1 by Sepam each time a transfer takes place successfully. When it reaches the value FF, it automatically goes back to zero
■ the least significant byte contains the number of usable bytes in the data zone. It is initialized to zero after an energizing operation and must be different from FFh.
The exchange word may also have the following values:
■ **xxyy**: the number of usable bytes in the data zone yy must be different from FFh
■ **0000h**: no "read requeste frame" has yet been formulated.
This is especially the case when Sepam is energized.
The other words are not significant.
■ **FFFFh**: the "request frameé has been processed, but the results in the reply zone are not yet available.
It is necessary to repeat "reply frame" reading.
The other words are not significant.
The words that follow the exchange word make up the data zone.
SInce the configuration and data files are adjacent, a frame may contain the edn of the configuration and the beginning of the data file of a record.
It is up to the remote monitoring and control system software to reconstruct the files in accordance with the transmitted number of usable bytes and the size of the files indicated in the identification zone.

Acknowledging a transfer
To inform Sepam that a record block that it has just read has been received correctly, the master must write the number of the last exchange that it has carried out in the "exchange number" field and set the "number of usable bytes in the data zone" of the exchange word to zero.
Sepam only increments the exchange number if new acquisition bursts are present.

Rereading the identification zone
To ensure that the record has not been modified, during its transfer by a new record, the master rereads the contents of the identification zone and ensures that the date of the recovered record is still present.

Reading Sepam identification

Presentation

The "Read Device Identification" function is used to access in a standardized manner the information required to clearly identify a device.
The description is made up of a set of objects (ASCII character strings).
Sepam series 40 accepts the "read identification" function (conformity level 02).
For a complete description of the function, go to **www.modbus.org**. The description below covers a subset of the function, adapted to Sepam series 40.

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 or 03	1	*Type of error*
CRC16	2	

Sepam series 40 identification

The objects making up the Sepam series 40 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 40"
5	ModelName	Application name (e.g. "M41 Motor")
6	UserAppName	Sepam marking

Contents

Safety instructions
Before starting

This page contains important safety instructions that must be followed precisely before attempting to install, repair, service or maintain electrical equipment. Carefully read and follow the safety instructions described below.

⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC, BURNS OR EXPLOSION

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Before performing visual inspections, tests, or maintenance on this equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Beware of potential hazards, wear personal protective equipment, carefully inspect the work area for tools and objects that may have been left inside the equipment.
- The successful operation of this equipment depends upon proper handling, installation, and operation. Neglecting fundamental installation requirements can lead to personal injury as well as damage to electrical equipment or other property.
- Handling this product requires relevant expertise in the field of protection of electrical networks. Only competent people who have this expertise are allowed to configure and set up this product.
- Before performing Dielectric (Hi-Pot) or Megger testing on any equipment in which the relay is installed, disconnect all input and output wires to the relay. High voltage testing can damage electronic components contained in the Sepam unit.

Failure to follow these instructions will result in death or serious injury.

Precautions

We recommend that you follow the instructions given in this document for quick, correct installation of your Sepam unit:

- *Equipment identification*
- *Assembly*
- *Connection of inputs, current, voltage and sensors*
- *Connection of power supply*
- *Checking prior to commissioning*

Transport, handing and storage

Sepam in its original packaging

Transport:
Sepam can be shipped to any destination by all usual means of transport without taking any additional precautions.

Handling:
Sepam can be handled without any particular care and can even withstand being dropped by a person standing at floor-level.

Storage:
Sepam can be stored in its original packaging, in an appropriate location for several years:

- Temperature between -25°C and +70°C (between -13°F and +158°F)
- Humidity ⩽ 90%.

Periodic, yearly checking of the environment and the packaging condition is recommended.
Energize the Sepam for 1 hour:

- every 5 years for a storage temperature < 30 ° C (86 ° F)
- every 3 years for a storage temperature ⩾ 30 ° C (86 ° F)
- every 2 years for a storage temperature ⩾ 50 ° C (122 ° F)

Once Sepam has been unpacked, it should be energized as soon as possible.

Sepam installed in a cubicle

Transport:
Sepam can be transported by all usual means of transport in the customary conditions used for cubicles. Storage conditions should be taken into consideration for a long period of transport.

Handling:
Should the Sepam fall out of a cubicle, check its condition by visual inspection and energizing.

Storage:
Keep the cubicle protection packing for as long as possible. Sepam, like all electronic units, should not be stored in a damp environment for more than a month. Sepam should be energized as quickly as possible. If this is not possible, the cubicle reheating system should be activated.

Environment of the installed Sepam

Operation in a damp environment
The temperature/relative humidity factors must be compatible with the unit's environmental withstand characteristics.
If the use conditions are outside the normal zone, special arrangements should be made before commissioning, such as air conditioning of the premises.

Operation in a polluted atmosphere
A contaminated industrial atmosphere (such as the presence of chlorine, hydrofluoric acid, sulfur, solvents, etc.) can cause corrosion of the electronic components, in which case environmental control arrangements should be made (such as pressurized premises with filtered air, etc.) before commissioning.
The effect of corrosion on Sepam has been tested according to the IEC 60068-2-60 and EIA 364-65A (See "Environmental Characteristic", page 18).

Equipment identification
Identification of the base unit

Identification of the base unit

Each Sepam comes in a single package which contains the base unit and 2 connectors:

- 1 x 20-pin connector (CCA620 or CCA622)
- 1 x 6-pin connector (CCA626 or CCA627)

The other optional accessories such as modules, current input connectors or voltage and cords are supplied in separate packages.

To identify a Sepam, check the 2 labels on the right side panel of the base unit describing the product's functional and hardware features.

- Hardware reference and designation label

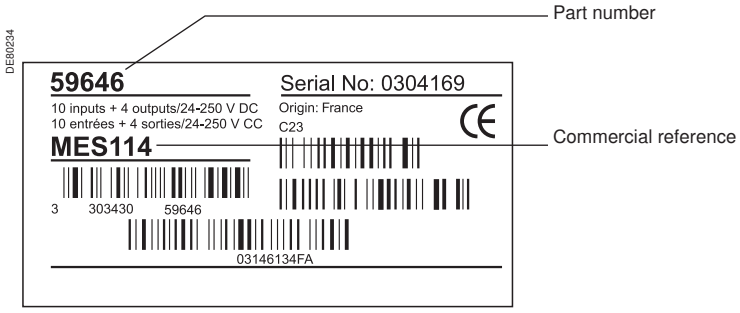
- Software reference and designation label

Equipment identification
Identification of accessories

Identification of accessories

The accessories such as optional modules, current or voltage connectors and connection cords come in separate packages, which are identified by labels.

■ Example of MES114 module identification label:



Equipment identification
Sepam series 40

List of Sepam series 40 references

Reference	Description
59600	Base unit with basic UMI, 24-250 V DC and 100-240 V AC power supply
59604	Base unit with advanced UMI, 24-250 V DC and 100-240 V AC power supply
59608	DSM303, remote advanced UMI module
59615	Working language English/French
59616	Working language English/Spanish
59629	CCA634 connector for 1 A/5 A CT + I0 current sensors
59630	CCA630 connector for 1 A/5 A CT current sensors
59631	CCA670 connector for LPCT current sensors
59634	CSH30 interposing ring CT for I0 input
59635	CSH120 residual current sensor, diameter 120 mm (4.75 in)
59636	CSH200 residual current sensor, diameter 200 mm (7.87 in)
59638	ECI850 IEC 61850 Sepam server with PRI voltage surge arrester
59639	AMT852 lead sealing accessory
59641	MET148-2 8-temperature sensor module
59642	ACE949-2 2-wire RS 485 network interface
59643	ACE959 4-wire RS 485 network interface
59644	ACE937 optical fiber interface
59646	MES114 10 input + 4 output module/24-250 V DC (1)
59647	MSA141 1 analog output module
59648	ACE909-2 RS 485/RS 232 converter
59649	ACE919CA RS 485/RS 485 interface (AC power supply)
59650	ACE919CC RS 485/RS 485 interface (DC power supply)
59651	MES114E 10 input + 4 output module/110-125 V DC and V AC
59652	MES114F 10 input + 4 output module/220-250 V DC and V AC
TCSEAK0100	Ethernet configuration kit for ECI850

(1) *Reference 59645 "MES108 module 4I/4O" cancelled and replaced by 59646.*

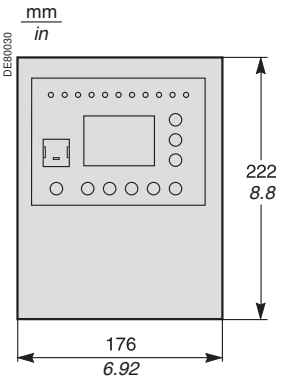
Equipment identification
Sepam series 40

List of Sepam series 40 references

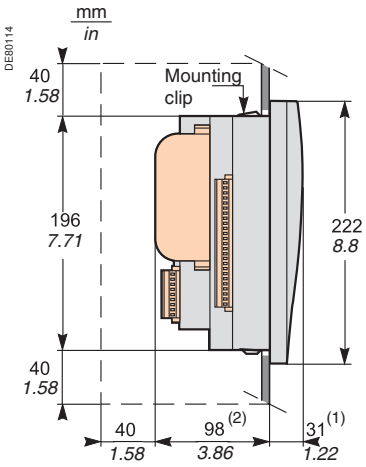
59656	CCA626 6-pin screw type connector
59657	CCA627 6-pin ring lug connector
59658	ACE850TP RJ45 Ethernet multi-protocol interface (IEC 61850, Modbus TCP/IP)
59659	ACE850FO fiber-optic Ethernet multi-protocol interface (IEC 61850, Modbus TCP/IP)
59660	CCA770 remote module connection cord, L = 0.6 m (2 ft)
59661	CCA772 remote module connection cord, L = 2 m (6.6 ft)
59662	CCA774 remote module connection cord, L = 4 m (13.1 ft)
59663	CCA612 communication interface communication cord (except ACE850), L = 3 m (9.8 ft)
59664	CCA783 PC RS 232 port connection cord
59666	CCA613 LPCT test plug
59667	ACE917 LPCT injection adapter
59668	CCA620 20-pin screw type connector
59669	CCA622 20-pin ring lug connector
59670	AMT840 mounting plate
59671	CCA784 PC USB port connection cord
59672	ACE990 core balance CT interface for I0 input
59676	Kit 2640 2 sets of spare connectors for MES114
59679	SFT2841 CD-ROM with SFT2841 and SFT2826 software, without CCA783 cord
59680	Substation application type S40
59681	Substation application type S41
59682	Substation application type S42
59683	Transformer application type T40
59684	Transformer application type T42
59685	Motor application type M41
59686	Generator application type G40
59687	Substation application type S43
59688	Substation application type S44
59689	Motor application type M40
59723	ACE969TP-2 2-wire RS 485 multi-protocol interface (Modbus, DNP3 or IEC 60870-5-103) (1)
59724	ACE969FO-2 fiber-optic multi-protocol interface (Modbus, DNP3 or IEC 60870-5-103) (1)
59726	CD SFT850 CD-ROM with IEC 61850 configuration software
59751	CCA614 ACE850 communication interface connection cord, L = 3 m (9.8 ft)
59754	TCP/IP firmware option (mandatory for using ACE850 multi-protocol communication interfaces with Sepam series 40, Sepam series 60 and Sepam series 80).
59780	Substation application type S50
59781	Substation application type S51
59782	Substation application type S52
59783	Substation application type S53
59784	Transformer application type T50
59785	Transformer application type T52
59786	Substation application type S54

(1) *Reference 59720 "ACE969TP" cancelled and replaced by 59723, reference 59721 "ACE969FO" cancelled and replaced by 59724.*

Dimensions

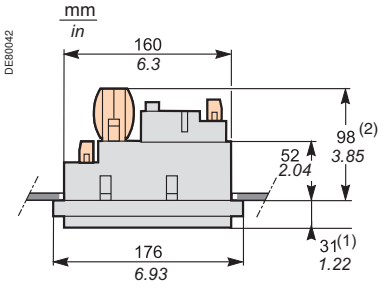


Front view of Sepam.



Sepam with advanced UMI and MES114, flush-mounted in front panel.

Clearance for Sepam assembly and wiring.



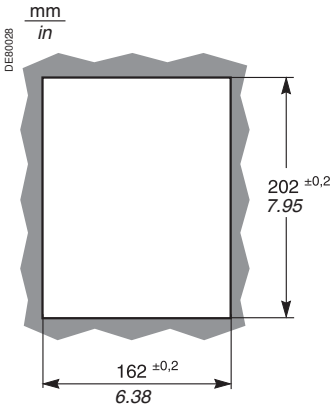
Sepam with advanced UMI and MES114, flush-mounted in front panel.

***(1)** With basic UMI: 23 mm (0.91 in).*
***(2)** With CCA634: 105 mm (4.13 in).*

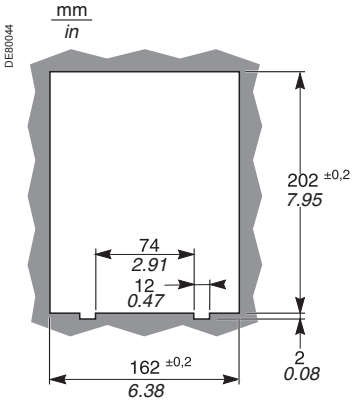
Cut-out

Cut-out accuracy must be complied with to ensure good withstand.

For mounting plate between 1.5 mm (0.059 in) and 3 mm (0.12 in) thick



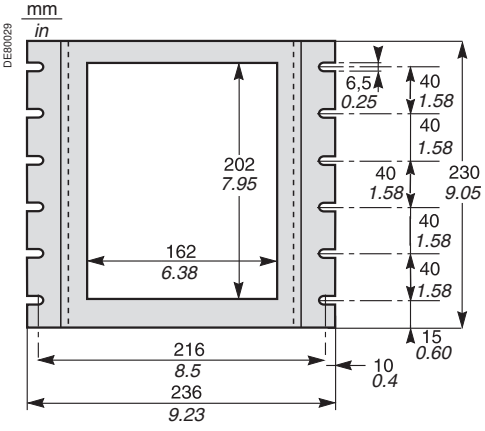
For mounting plate 3.17 mm (0.125 inch) thick



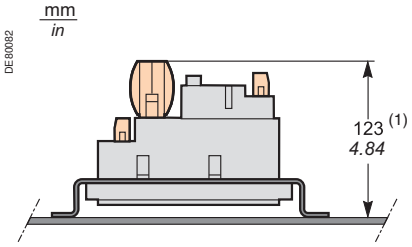
> **⚠ CAUTION**
>
> **HAZARD OF CUTS**
> Trim the edges of the cut-out plates to remove any jagged edges.
>
> **Failure to follow these instructions can result in serious injury.**

Assembly with AMT840 mounting plate

Used to mount Sepam with basic UMI at the back of the compartment with access to the connectors on the rear panel.
Mounting associated with the use of the remote advanced UMI (DSM303).



AMT840 mounting plate.



Sepam with basic UMI and MES114, mounted with AMT840 plate.
Mounting plate thickness: 2 mm (0.079 in).

(1) With CCA634: 130 mm (5.12 In).

Base unit
Assembly

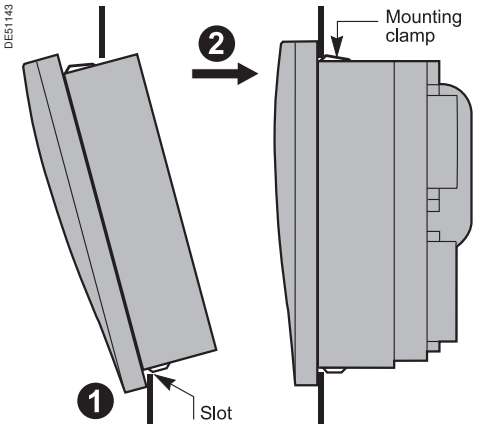
⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.

Failure to follow these instructions will result in death or serious injury.

The Sepam is simply flush-mounted and secured by its clips. No additional screw type fastening is required.



① Present the product as indicated, making sure the metal plate is correctly entered in the groove at the bottom.

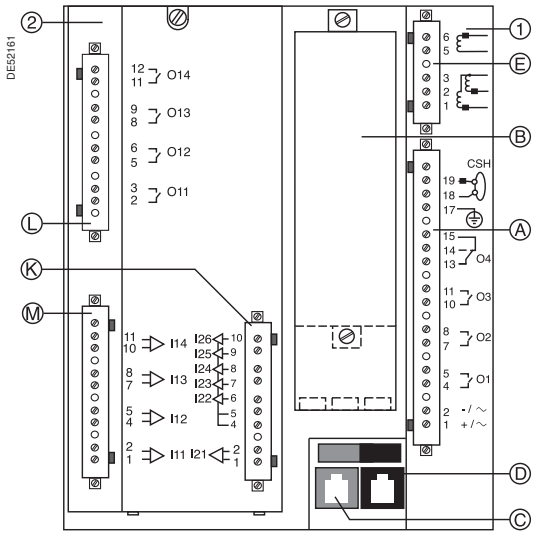
② Tilt the product and press on the top part to clamp it with the clips.

Base unit
Connection

Sepam components

■ base unit ①
□ Ⓐ base unit connector:
- power supply
- output relay
- CSH30, 120, 200 or ACE990 input.

Screw-type connector shown (CCA620), or ring lug connector (CCA622)
□ Ⓑ 1/5 CT A current input connector (CCA630 or CCA634) or LPCT current input connector (CCA670)
□ Ⓒ communication module link connection (white)
□ Ⓓ remote inter-module link connection (black)
□ Ⓔ voltage input connection, screw-type connector shown (CCA626) or ring lug connector (CCA627)
■ optional input/output module ② (MES114)
□ Ⓛ Ⓜ MES114 module connectors
□ Ⓚ MES114 module connector.



Base unit
Connection

Connection of the base unit

The Sepam connections are made to the removable connectors located on the rear panel. All the connectors are screw-lockable.

NOTICE

LOSS OF PROTECTION OR RISK OF NUISANCE TRIPPING

If the Sepam is no longer supplied with power or is in fail-safe position, the protection functions are no longer active and all the Sepam output relays are dropped out. Check that this operating mode and the watchdog relay wiring are compatible with your installation.

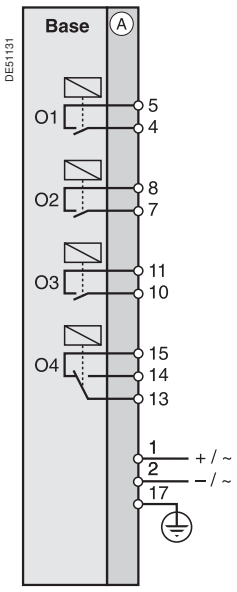
Failure to follow these instructions can result in equipment damage and unwanted shutdown of the electrical installation.

⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Start by connecting the device to the protective ground and to the functional ground.
- Screw tight all terminals, even those not in use.

Failure to follow these instructions will result in death or serious injury.



Wiring of connectors CCA620 and CCA626:

- Without fitting:
  - 1 wire with maximum cross-section of 0.2 to 2.5 mm^2 (≥ AWG 24-12) or 2 wires with maximum cross-section of 0.2 to 1 mm^2 (≥ AWG 24-16)
  - Stripped length: 8 to 10 mm (0.31 to 0.39 in)
- With fitting:
  - Recommended wiring with Telemecanique fitting:
    - DZ5CE015D for 1 wire 1.5 mm^2 (AWG 16)
    - DZ5CE025D for 1 wire 2.5 mm^2 (AWG 12)
    - AZ5DE010D for 2 wires 1 mm^2 (AWG 18)
  - Tube length: 8.2 mm (0.32 in)
  - Stripped length: 8 mm (0.31 in)

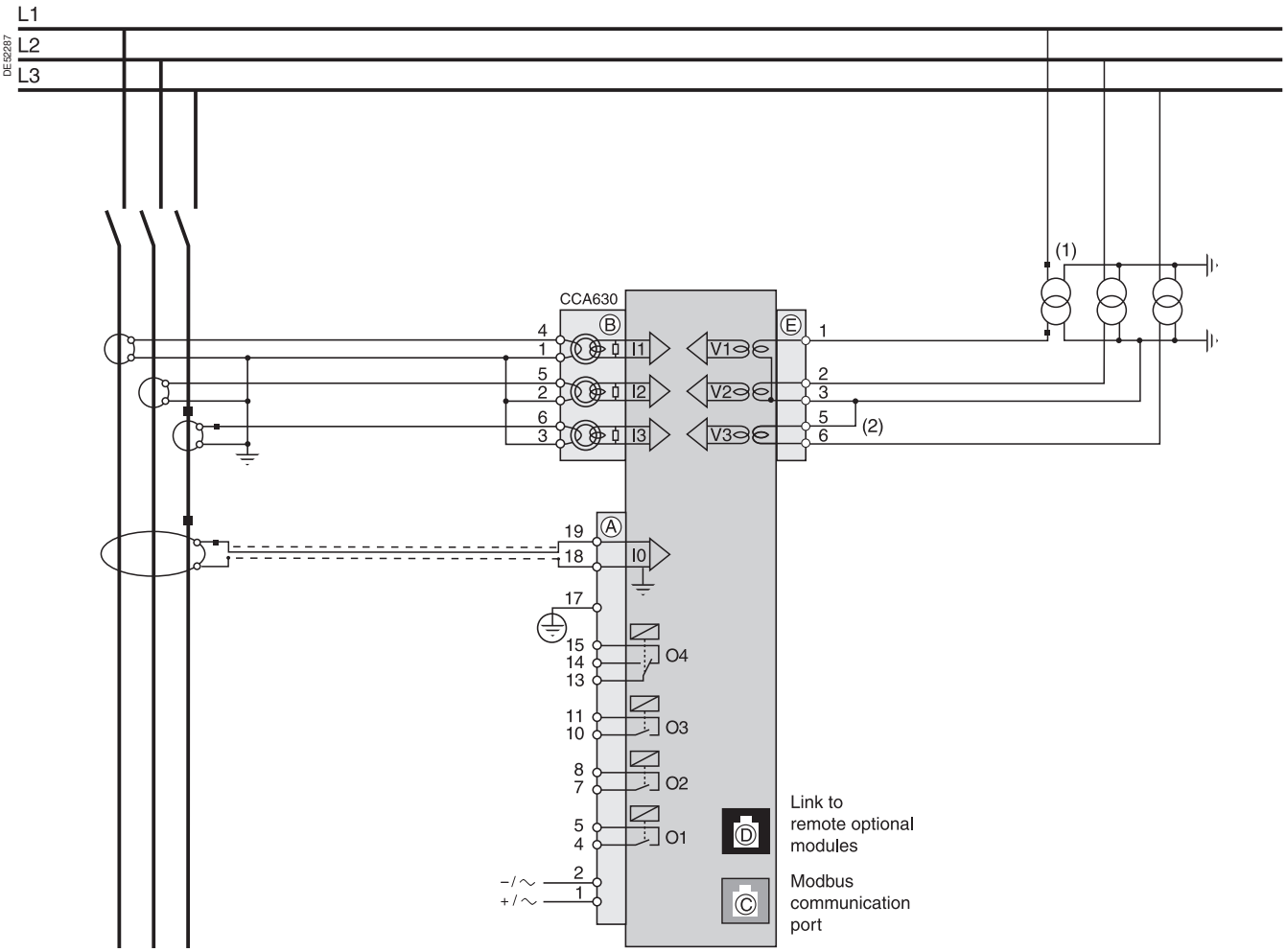
Wiring of connectors CCA622 and CCA627:

- Ring or spade lug: 6.35 mm (1/4")
- Wire with maximum cross-section 0.2 to 2.5 mm^2 (AWG 24-12)
- Stripped length: 6 mm (0.236 in)
- Use an appropriate tool to crimp the lugs onto the wires
- 2 ring or spade lugs maximum per terminal
- Tightening torque: 0.7 to 1 N•m (6 to 9 lb-in).

Characteristics of the 4 base unit relay outputs O1, O2, O3, O4

- O1 and O2 are 2 control outputs, used by the breaking device control function for:
  - O1: breaking device tripping
  - O2: breaking device closing inhibition
- O3 is a non assigned control output.
- O4 is a non assigned indication output. It can be assigned to the watchdog function.

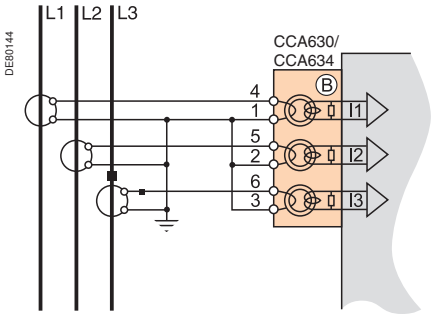
Base unit
Connection of current input



(1) *This type of connection allows the calculation of residual voltage.*
(2) *Accessory for bridging terminals 3 and 5 supplied with CCA626 connector.*

Base unit
Other phase current input connection schemes

Variant 1: phase current measurements by 3 x 1 A or 5 A CTs (standard connection)



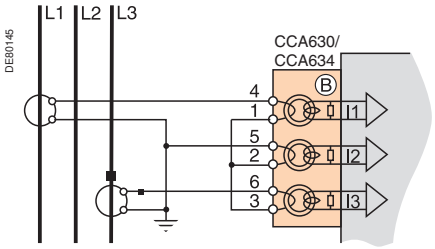
Description
Connection of 3 x 1 A or 5 A sensors to the CCA630 or CCA634 connector.

The measurement of the 3 phase currents allows the calculation of residual current.

Parameters

Sensor type	5 A CT or 1 A CT
Number of CTs	I1, I2, I3
Rated current (In)	1 A to 6250 A

Variant 2: phase current measurement by 2 x 1 A or 5 A CTs



Description
Connection of 2 x 1 A or 5 A sensors to the CCA630 or CCA634 connector.

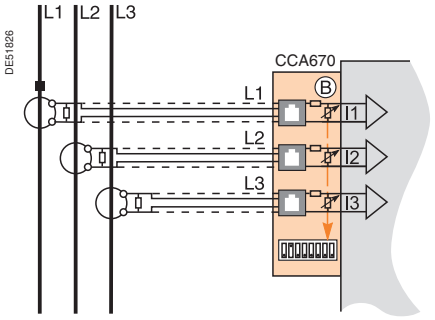
The measurement of phase currents 1 and 3 is sufficient to ensure all the phase current-based protection functions.
The phase current I2 is only assessed for metering functions, assuming that I0 = 0.

This arrangement does not allow the calculation of residual current.

Parameters

Sensor type	5 A CT or 1 A CT
Number of CTs	I1, I3
Rated current (In)	1 A to 6250 A

Variant 3: phase current measurement by 3 LPCT type sensors



Description
Connection of 3 Low Power Current Transducer (LPCT) type sensors to the CCA670 connector. The connection of only one or two LPCT sensors is not allowed and causes Sepam to go into fail-safe position.

The measurement of the 3 phase currents allows the calculation of residual current.

Parameters

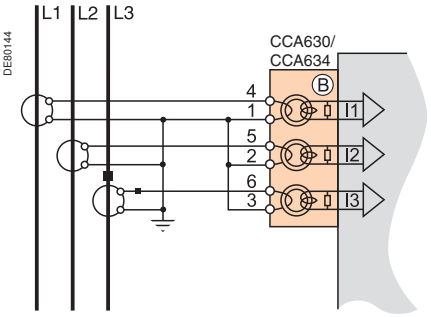
Sensor type	LPCT
Number of CTs	I1, I2, I3
Rated current (In)	25, 50, 100, 125, 133, 200, 250, 320, 400, 500, 630, 666, 1000, 1600, 2000 or 3150 A

Note: *Parameter In must be set 2 twice:*

- *Software parameter setting using the advanced UMI or the SFT2841 software tool*
- *Hardware parameter setting using microswitches on the CCA670 connector*

Base unit
Other residual current input connection schemes

Variant 1: residual current calculation by sum of 3 phase currents

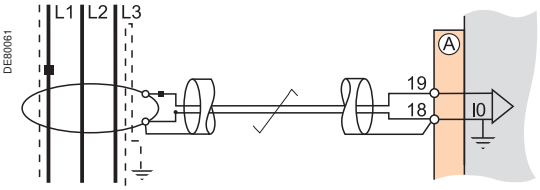


Description
Residual current is calculated by the vector sum of the 3 phase currents I1, I2 and I3, measured by 3 x 1 A or 5 A CTs or by 3 LPCT type sensors.
See current input connection diagrams, page 211.

Parameters

Residual current	Rated residual current	Measuring range
None	In0 = In, CT primary current	0.1 to 40 In0

Variant 2: residual current measurement by CSH120 or CSH200 core balance CT (standard connection)

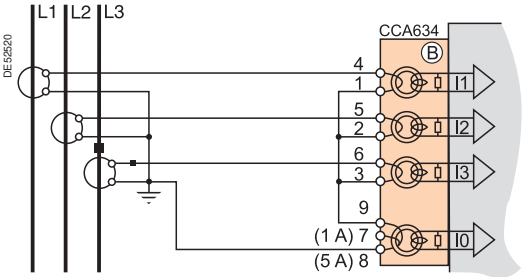


Description
Arrangement recommended for the protection of isolated or compensated neutral systems, in which very low fault currents need to be detected.

Parameters

Residual current	Rated residual current	Measuring range
2 A rating CSH	In0 = 2 A	0.2 to 40 A
5 A rating CSH	In0 = 5 A	0.5 to 100 A
20 A rating CSH	In0 = 20 A	2 to 400 A

Variant 3: residual current measurement by 1 A or 5 A CTs and CCA634

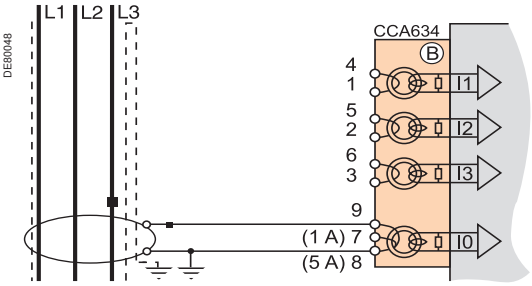


Description
Residual current measurement by 1 A or 5 A CTs.
- Terminal 7: 1 A CT
- Terminal 8: 5 A CT

The sensitivity can be multiplied by 10 using the "sensitive" parameter setting with In0 = In/10.

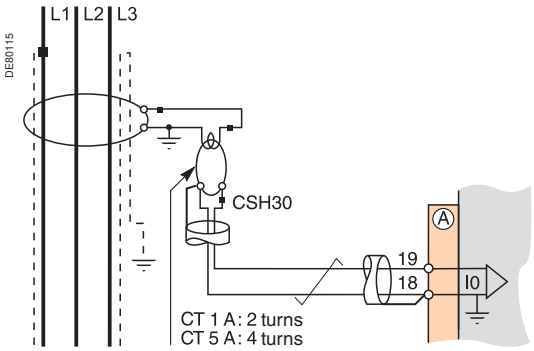
Parameters

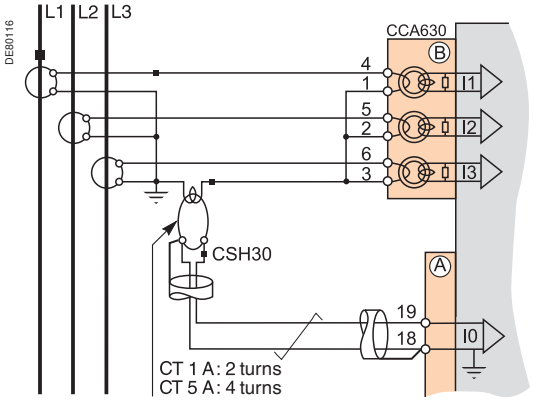
Residual current	Rated residual current	Measuring range
1 A CT	In0 = In, CT primary current	0.1 to 20 In0
Sensitive 1 A CT	In0 = In/10	0.1 to 20 In0
5 A CT	In0 = In, CT primary current	0.1 to 20 In0
Sensitive 5 A CT	In0 = In/10	0.1 to 20 In0



Base unit
Other residual current input connection schemes

Variant 4: residual current measurement by 1 A or 5 A CTs and CSH30 interposing ring CT





Description

The CSH30 interposing ring CT is used to connect 1 A or 5 A CTs to Sepam to measure residual current:

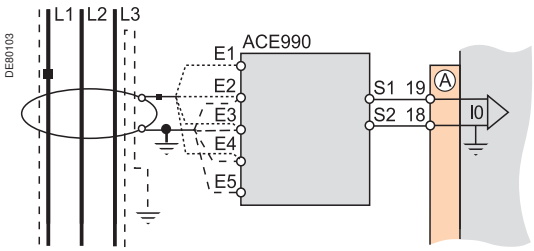
- Connection of CSH30 interposing ring CT to 1 A CT: make 2 turns through CSH primary
- Connection of CSH30 interposing ring CT to 5 A CT: make 4 turns through CSH primary.

The sensitivity can be multiplied by 10 using the "sensitive" parameter setting with In0 = In/10.

Parameters

Residual current	Rated residual current	Measuring range
1 A CT	In0 = In, CT primary current	0.1 to 20 In0
Sensitive 1 A CT	In0 = In/10	0.1 to 20 In0
5 A CT	In0 = In, CT primary current	0.1 to 20 In0
Sensitive 5 A CT	In0 = In/10	0.1 to 20 In0

Variant 5: residual current measurement by core balance CT with ratio of 1/n (n between 50 and 1500)



Description

The ACE990 is used as an interface between an MV core balance CT with a ratio of 1/n
(50 < n < 1500) and the Sepam residual current input.
This arrangement allows the continued use of existing core balance CTs on the installation.

Parameters

Residual current	Rated residual current	Measuring range
ACE990 - range 1 (0.00578 ⩽ k ⩽ 0.04)	In0 = Ik.n(1)	0.1 to 20 In0
ACE990 - range 2 (0.0578 ⩽ k ⩽ 0.26316)	In0 = Ik.n(1)	0.1 to 20 In0

(1) *n = number of core balance CT turns*
k = factor to be determined according to ACE990 wiring and setting range used by Sepam

Base unit
Connection of low voltage residual current inputs

Variant 1: residual current measurement by CTs on the neutral earthing link (with or without CSH30 interposing ring CT)

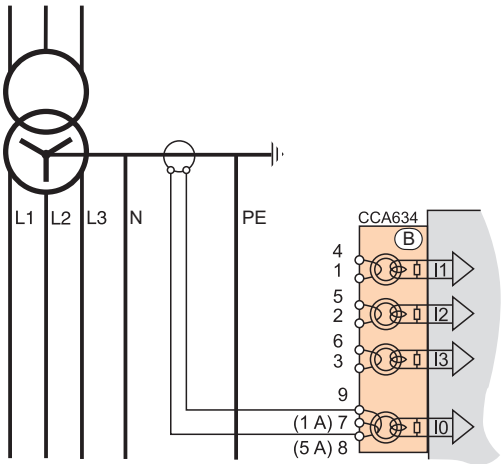
DE80103

Description
Residual current is measured with a 1 A or 5 A CT on the neutral point.

Parameters

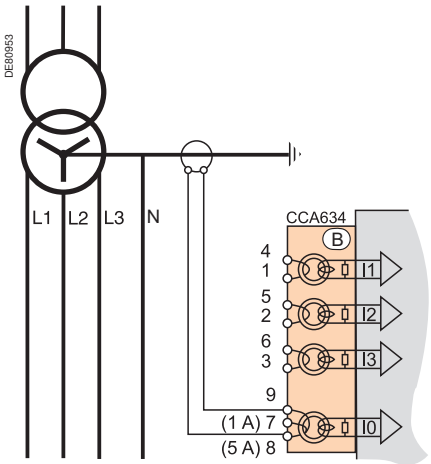
Residual current	Rated residual current	Measuring range
1 A CT	In0 = neutral point CT In	0.1 to 20 In0
5 A CT	In0 = neutral point CT In	0.1 to 20 In0

DE80952



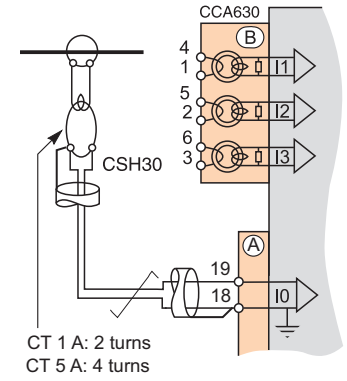
Connection on TN-S network.

DE80953



Connection on TT network.

DE81047



Connection with CSH30.

Variant 2: residual current measurement by CSH120 or CSH200 core balance CT on the neutral earthing link

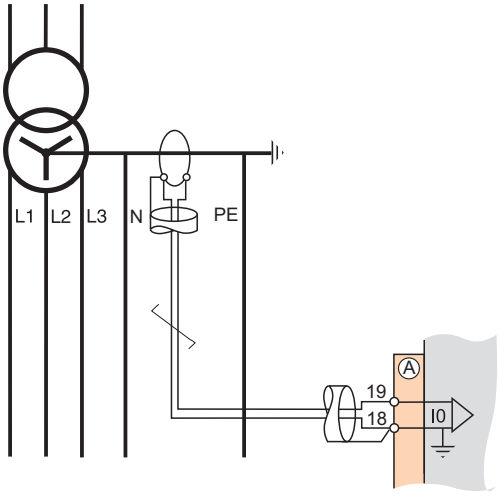
DE80103

Description
Residual current is measured with a core balance CT on the neutral point. Core balance CTs are recommended for measuring very low fault currents provided that the earth fault current remains below 2 kA. Above this value it is advisable to use the standard variant 1.

Parameters

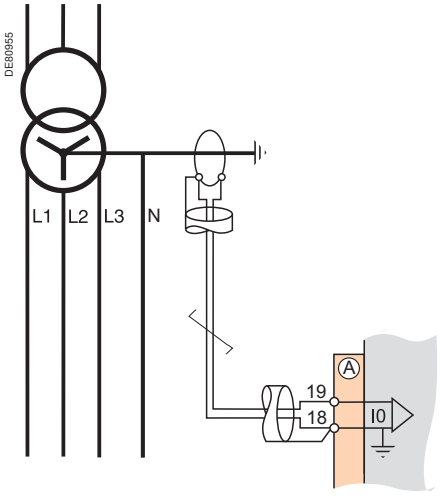
Residual current	Rated residual current	Measuring range
2 A rating CSH	In0 = 2 A	0.1 to 20 In0
5 A rating CSH	In0 = 5 A	0.1 to 20 In0
20 A rating CSH	In0 = 20 A	0.1 to 20 In0

DE80954



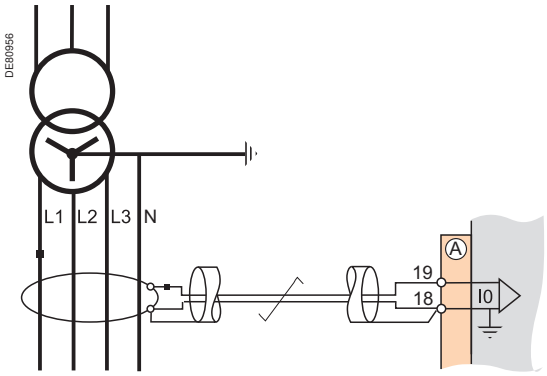
Connection on TN-S network.

DE80955



Connection on TT network.

Variant 3: residual current measurement by sum of 3 phase currents and neutral current measurement by CSH120 or CSH200 core balance CT



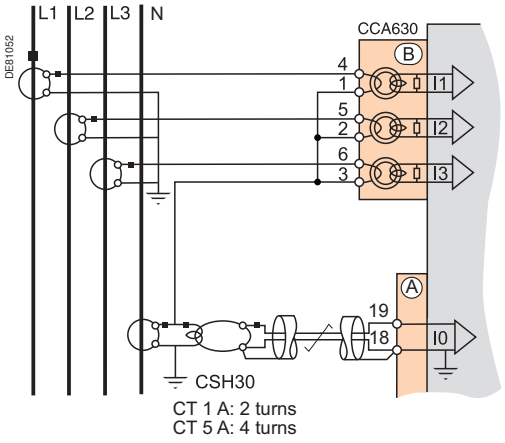
Connection on TN-S and TT networks.

Description
Measurement by core balance CT is recommended for measuring very low fault currents.

Parameters

Residual current	Rated residual current	Measuring range
2 A rating CSH	In0 = 2 A	0.1 to 20 In0
5 A rating CSH	In0 = 5 A	0.1 to 20 In0
20 A rating CSH	In0 = 20 A	0.1 to 20 In0

Variant 4: residual current measurement by sum of 3 phase currents and neutral current measurement by 1 A or 5 A CTs and CSH30 interposing ring CT



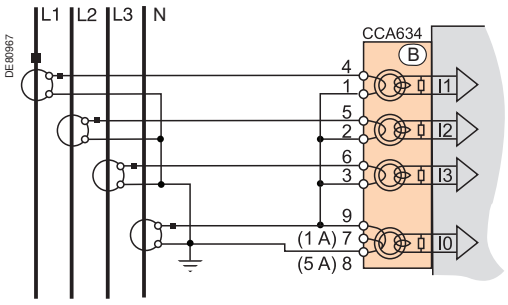
Connection on TN-S and TT networks.

Description
The phase and neutral CTs should have the same primary and secondary currents.
The CSH30 interposing ring CT is used to connect 1 A or 5 A CTs to Sepam to measure residual current:
- Connection of CSH30 interposing ring CT to 1 A CT: make 2 turns through CSH primary
- Connection of CSH30 interposing ring CT to 5 A CT: make 4 turns through CSH primary.

Parameters

Residual current	Rated residual current	Measuring range
1 A CT	In0 = phase CT primary current In	0.1 to 20 In0
5 A CT	In0 = phase CT primary current In	0.1 to 20 In0

Variant 5: residual current measurement by sum of 3 phase currents and neutral current measurement by 1 A or 5 A CTs and CCA634 connector



Connection on TN-S and TT networks.

Description
The phase and neutral CTs should have the same primary and secondary currents.
Residual current measurement by 1 A or 5 A CTs.
- Terminal 7: 1 A CT
- Terminal 8: 5 A CT

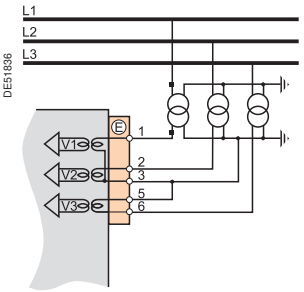
Parameters

Residual current	Rated residual current	Measuring range
1 A CT	In0 = phase CT primary current In	0.1 to 20 In0
5 A CT	In0 = phase CT primary current In	0.1 to 20 In0

Base unit
Connections of input voltage

The phase and residual voltage transformer secondary circuits are connected directly to the connector, item Ⓔ.
The 3 impedance matching and isolation transformers are integrated in the base unit of Sepam series 40.

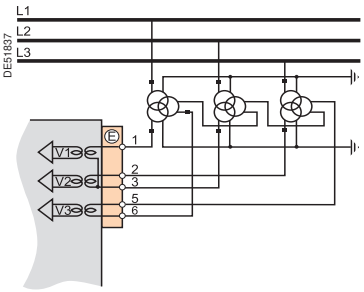
Variant 1: measurement of 3 phase-to-neutral voltages (standard connection)



Parameters	
Voltages measured by VTs	V1, V2, V3
Residual voltage	None

Functions available	
Voltages measured	V1, V2, V3
Values calculated	U21, U32, U13, V0, Vd, Vi, f
Measurements available	All
Protection functions available (according to type of Sepam)	All

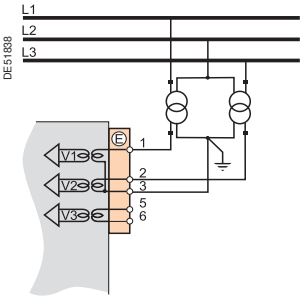
Variant 2: measurement of 2 phase-to-phase voltages and residual voltage



Parameters	
Voltages measured by VTs	U21, U32
Residual voltage	External VT

Functions available	
Voltages measured	U21, U32, V0
Values calculated	U13, V1, V2, V3, Vd, Vi, f
Measurements available	All
Protection functions available (according to type of Sepam)	All

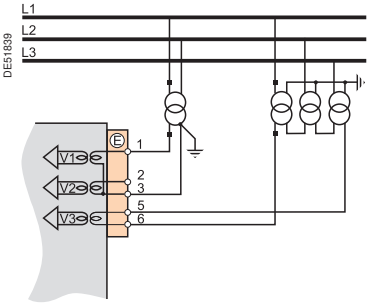
Variant 3: measurement of 2 phase-to-phase voltages



Parameters	
Voltages measured by VTs	U21, U32
Residual voltage	None

Functions available	
Voltages measured	U21, U32
Values calculated	U13, Vd, Vi, f
Measurements available	U21, U32, U13, Vd, Vi, f
Protection functions available (according to type of Sepam)	All except 67N/67NC, 59N

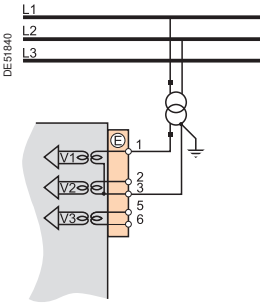
Variant 4: measurement of 1 phase-to-phase voltage and residual voltage



Parameters	
Voltages measured by VTs	U21 or V1
Residual voltage	External VT

Functions available	
Voltages measured	U21, V0
Values calculated	f
Measurements available	U21, V0, f
Protection functions available (according to type of Sepam)	All except 67, 47, 27D,32P, 32Q/40, 27S

Variant 5: measurement of 1 phase-to-phase voltage

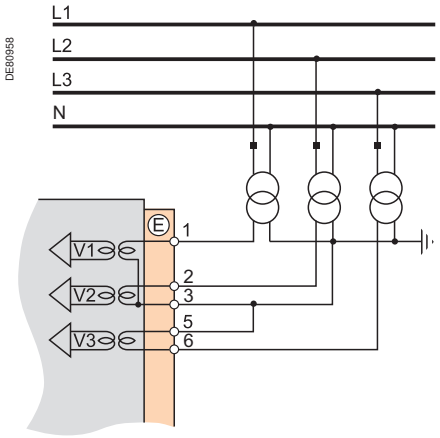


Parameters	
Voltages measured by VTs	U21 or V1
Residual voltage	None

Functions available	
Voltages measured	U21 or V1
Values calculated	f
Measurements available	U21 or V1, f
Protection functions available (according to type of Sepam)	All except 67, 47, 27D,32P, 32Q/40, 67N/67NC, 59N, 27S

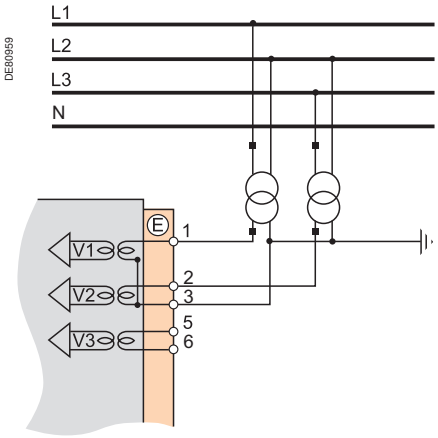
Base unit
Connection of low voltage phase voltage inputs

Variant 1: TN-S and TN-C networks



When a ground fault occurs on a TN-S or TN-C network, the neutral potential is not affected: the neutral can act as a reference for the VTs.

Variant 2: TT and IT networks



When a ground fault occurs on a TT or IT network, the neutral potential is affected: the neutral cannot act as a reference for the VTs, phase-to-phase voltages must be used on both phases.

1 A/5 A current transformers

ARJA1.

ARJP3.

Function

Sepam may be connected to any standard 1 A and 5 A current transformer. Schneider Electric offers a range of current transformers to measure primary currents from 50 A to 2500 A.
Please consult us for further information.

Sizing of current transformers

Current transformers should be dimensioned so as not to become saturated by the current values they are required to measure accurately (minimum 5 In).

For overcurrent protection

■ Definite time:
The saturation current must be more than 1.5 times the setting value.
■ IDMT:
The saturation current must be more than 1.5 times the highest working value on the curve.

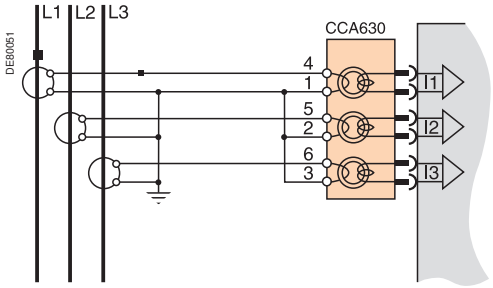
Practical solution when there is no information on the settings

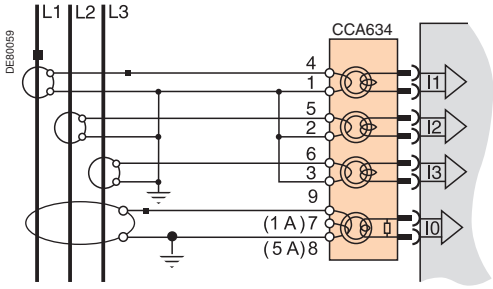
Rated secondary current in	Rated burden	Accuracy class	CT secondary resistance R_{CT}	Wiring resistance Rf
1 A	2.5 VA	5P 20	< 3 Ω	< 0.075 Ω
5 A	7.5 VA	5P 20	< 0.2 Ω	< 0.075 Ω

CCA630/CCA634 connector

Function

The current transformers (1 A or 5 A) are connected to the CCA630 or CCA634 connector on the rear panel of Sepam:
■ The CCA630 connector is used to connect 3 phase current transformers to Sepam
■ The CCA634 connector is used to connect 3 phase current transformers and a residual current transformer to Sepam.
The CCA630 and CCA634 connectors contain interposing ring CTs with through primaries, which ensure impedance matching and isolation between the 1 A or 5 A circuits and Sepam when measuring phase and residual currents.
The connectors can be disconnected with the power on since disconnection does not open the CT secondary circuit.





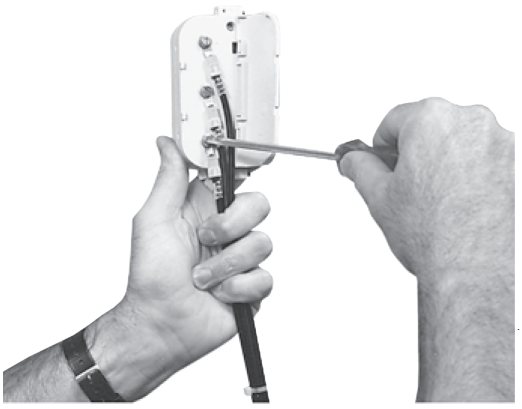
⚠ DANGER

HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS

■ Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
■ NEVER work alone.
■ Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
■ Always use a properly rated voltage sensing device to confirm that all power is off.
■ To remove current inputs to the Sepam unit, unplug the CCA630 or CCA634 connector without disconnecting the wires from it. The CCA630 and CCA634 connectors ensure continuity of the current transformer secondary circuits.
■ Before disconnecting the wires connected to the CCA630 or CCA634 connector, short-circuit the current transformer secondary circuits.

Failure to follow these instructions will result in death or serious injury.

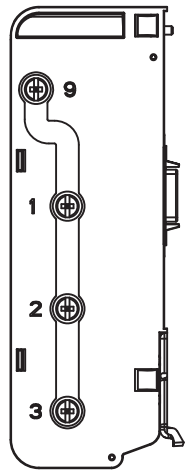
MT10490



Connecting and assembling the CCA630 connector

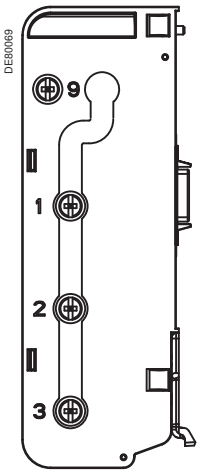
1. Open the 2 side shields for access to the connection terminals. The shields can be removed, if necessary, to make wiring easier. If removed, they must be replaced after wiring.
2. If necessary, remove the bridging strap linking terminals 1, 2 and 3. This strap is supplied with the CCA630.
3. Connect the wires using 4 mm (0.16 in) ring lugs and check the tightness of the 6 screws that guarantee the continuity of the CT secondary circuits.
The connector accommodates wires with cross-sections of 1.5 to 6 mm² (AWG 16-10).
4. Close the side shields.
5. Plug the connector into the 9-pin inlet on the rear panel (item Ⓑ).
6. Tighten the 2 CCA630 connector fastening screws on the rear panel of Sepam.

DE80068



Bridging of terminals 1, 2, 3 and 9

DE80069



Bridging of terminals 1, 2 and 3

Connecting and assembling the CCA634 connector

1. Open the 2 side shields for access to the connection terminals. The shields can be removed, if necessary, to make wiring easier. If removed, they must be replaced after wiring.
2. According to the wiring required, remove or reverse the bridging strap. This is used to link either terminals 1, 2 and 3, or terminals 1, 2, 3 and 9 (see picture opposite).
3. Use terminal 7 (1 A) or 8 (5 A) to measure the residual current according to the CT secondary.
4. Connect the wires using 4 mm (0.16 in) ring lugs and check the tightness of the 6 screws that guarantee the continuity of the CT secondary circuits.
The connector accommodates wires with cross-sections of 1.5 to 6 mm² (AWG 16-10).
The wires only exit from the base.
5. Close the side shields.
6. Insert the connector pins into the slots on the base unit.
7. Flatten the connector against the unit to plug it into the 9-pin SUB-D connector (principle similar to that of the MES module).
8. Tighten the mounting screw.

NOTICE

HAZARD OF IMPROPER OPERATION

Do not use a CCA634 on connector B1 and residual current input I0 on connector A (terminals 18 and 19) simultaneously.
Even if it is not connected to a sensor, a CCA634 will disturb input I0 on connector A.

Failure to follow these instructions can result in equipment damage.

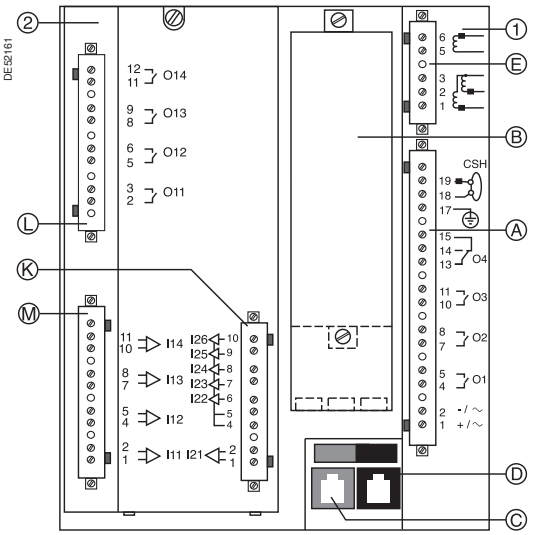
⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Turn off all power supplying this equipment before working on or inside it. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Start by connecting the device to the protective ground and to the functional ground.
- Screw tight all terminals, even those not in use.

Failure to follow these instructions will result in death or serious injury.

The phase and residual voltage transformer secondary circuits are connected to the connector, item Ⓔ.



Connections

Connections are made using the screw connectors (CCA626) or ring lug connectors (CCA627) that can be accessed on the rear panel.

Wiring of the CCA626 connector:

- Without fitting:
  - 1 wire with maximum cross-section of 0.2 to 2.5 mm² (≥ AWG 24-12) or 2 wires with maximum cross-section of 0.2 to 1 mm² (≥ AWG 24-16)
  - Stripped length: 8 to 10 mm (0.31 to 0.39 in)
- With fitting:
  - Recommended wiring with Telemecanique fitting:
    - DZ5CE015D for 1 wire 1.5 mm² (AWG 16)
    - DZ5CE025D for 1 wire 2.5 mm² (AWG 12)
    - AZ5DE010D for 2 wires 1 mm² (AWG 18)
  - Tube length: 8.2 mm (0.32 in)
  - Stripped length: 8 mm (0.31 in)

Wiring of the CCA627 connector:

- Ring or spade lug: 6.35 mm (1/4")
- Wire with maximum cross-section 0.2 to 2.5 mm² (AWG 24-12)
- Stripped length: 6 mm (0.236 in)
- Use an appropriate tool to crimp the lugs onto the wires
- 2 ring or spade lugs maximum per terminal
- Tightening torque: 0.7 to 1 N•m (6 to 9 lb-in).