Electrical network protection

Sepam series 10

Reference manual

Schneider Electric

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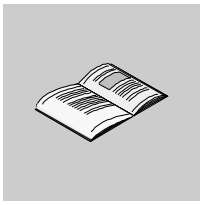
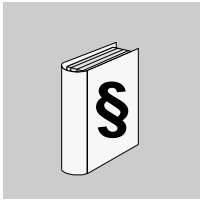


Safety Information



Important Information

NOTICE

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

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

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

⚠ DANGER

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

⚠ WARNING

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

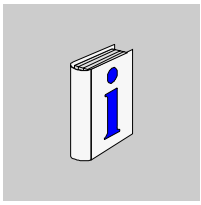
⚠ CAUTION

CAUTION indicates a potentially hazardous situation, which, if not avoided, **can result** in injury or equipment damage.

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

About the Book



At a Glance

Document Scope

This manual is intended for personnel responsible for installing, commissioning and using Sepam series 10 protection relays. It gives more details than the instruction sheet supplied with the equipment.

Validity Note

The data and illustrations in this documentation by no means imply any kind of contractual obligation. We reserve the right to modify our products in line with our policy of continuous development. The information given in this document may be modified without notice and must not be interpreted as binding on the part of Schneider Electric.

Please contact us if you have any suggestions for improvements or modifications, or if you find any errors in this publication.

Product Related Warnings

All relevant local safety regulations must be followed when installing and using this product. For safety reasons, and to ensure conformity with the documented system data, only the manufacturer is authorized to repair the components.

Failure to comply with this warning can result in injury or equipment damage.

User Comments

We welcome your comments about this document. You can reach us by e-mail at techpub@schneider-electric.com

Presentation

1

What's in this Chapter?

This chapter contains the following topics:

Introduction

The Sepam Series 10 Family

The Sepam series 10 family of protection relays is designed for the protection and operation of MV/LV utility substations and electrical distribution networks in industrial installations.

It comprises three models suitable for normal protection applications involving current measurement:
- Sepam series 10 N, for earth fault protection
- Sepam series 10 B, for phase, earth fault and thermal overload protection
- Sepam series 10 A, for phase, earth fault and thermal overload protection, which may require logic inputs and a communication port

Example: Sepam series 10 A

Main Advantages of Sepam

Sepam is easily installed in a switchboard:
- It is compact.
- It is held in place in the switchboard by catches which are locked and unlocked from the front.
- The connection terminals are clearly identified.

Sepam is quick to commission:
- It comes with default parameters.
- Its settings are entered on the front panel by means of its display and well-designed keypad.
- It can be commissioned without using a PC.

Sepam makes it easy to operate substations:
- It has numerous customization options so that it can be adapted to specific operating constraints.
- Its display unit can display screens in several languages.
- It indicates tripping explicitly and spontaneously.

Sepam is a robust product that is easy to maintain:
- The case is made of insulated plastic.
- The unit can withstand harsh environments:
  - Front panel degree of protection: IP54
  - Range of operating temperatures: –40 to +70 °C (–40 to +158 °F)
- The current input connector can be disconnected while on load.

Sepam Series 10 N Applications

Sepam series 10 N units are suitable for the following applications:
- Protection against earth faults for feeders protected against phase-to-phase short-circuits by fuses
- Protection of the transformer neutral point

Sepam Series 10 B Applications

Sepam series 10 B units are suitable for the following applications:
- Protection of substation incomers and feeders
- Protection of MV/LV transformers

They offer the following protection functions:
- Phase overcurrent protection
- Earth fault protection
- Thermal overload protection

Sepam Series 10 A Applications

Sepam series 10 A units are suitable for the following applications:
- Protection of substation incomers and feeders
- Protection of MV/LV transformers

They offer the following main functions:
- Phase overcurrent protection
- Earth fault protection
- Thermal overload protection
- Trip circuit supervision (TCS)
- Logic discrimination
- External trip
- Communication for remote operation

Selection Table

The selection table lists the functions performed by the various Sepam series 10 models in standard operation.

The customization options for these functions are described in the *Custom Operation* chapter.

Function		**ANSI Code**	**Sepam Series 10**		
			N	**B**	**A**
Earth fault protection	Standard	50N-51N 50G-51G	••	••	••
	Sensitive			••	••
	Very sensitive		••	••	••
Phase overcurrent protection		50-51		•	•
Thermal overload protection		49 RMS		•	•
Phase overcurrent cold load pick-up				•	•
Earth fault cold load pick-up				•	•
Circuit breaker trip lockout		86	•	•	•
Tripping annunciation			•	•	•
Trip circuit supervision					•
Logic discrimination - Send blocking input		68	•••	•••	•
Logic discrimination - Receive blocking input		68			•••
External trip					•
Communication via Modbus protocol or IEC 60870-5-103					•
Circuit breaker remote control					•
Customized operation of output relays and fault LEDs			•••	•••	•••
Customized assignment of the logic inputs					•••
Earth fault current measurement			•	•	•
Phase current measurement				•	•
Phase peak demand current values				•	•
Record of the last fault			•	•	
Time-tagged record of the last 5 events					•
Watchdog			•••	•••	•

- • Function available in standard mode
- •• Function available in standard mode depending on the Sepam type
- ••• Function available in custom mode

Earth Fault Protection

To protect networks against phase-to-earth faults, choose the earth fault protection sensitivity level from one of three values. The sensors to be used and the set point setting range depend on the chosen sensitivity:

Sensitivity	Sensor	Setting range
Standard	3 phase CTs or 1 earth CT, at primary rated current Ino	0.1...24 Ino
Sensitive	3 phase CTs or 1 earth CT, at primary rated current Ino	0.01...2.4 Ino
Very sensitive	CSH120, CSH200 or GO110 specific core balance CT, with ratio 470/1	0.2...240 A primary, i.e. 0.0004...0.5 Ino

Resources

The table below lists the Sepam resources:

Inputs/Outputs	Sepam Series 10 N	Sepam Series 10 B	Sepam Series 10 A
Earth fault current inputs	1	1	1
Phase current inputs	0	2 or 3	3
Output relays	3	3	7
Logic inputs	0	0	4
Communication port	0	0	1

Power Supply Voltage

The Sepam power supply voltage can be DC or AC. Three power supply voltage ranges are available, as indicated in the table below:

Power supply	Sepam Series 10 N	Sepam Series 10 B	Sepam Series 10 A
24...125 V DC or 100...120 V AC	•	•	•
110...250 V DC or 100...240 V AC	•	•	•
220...250 V DC	–	–	•

Sepam series 10 A relays powered by 220...250 V DC have high-set logic inputs.

Operating Modes

There are two possible operating modes for the output relays, the fault LEDs on the front panel and, in the case of Sepam series 10 A, the logic inputs:

- *Standard* operating mode is operation resulting from the pre-assignment of the output relays, the fault LEDs on the front panel and the logic inputs. Sepam series 10 relays are delivered from the factory in this mode.
- *Custom* operating mode is used, if necessary, to modify operation of the output relays, the fault LEDs on the front panel and the logic inputs.

Circuit Breaker Control

Sepam relays are compatible with the following types of circuit breaker trip:

- Shunt trip coils
- Undervoltage trip coils

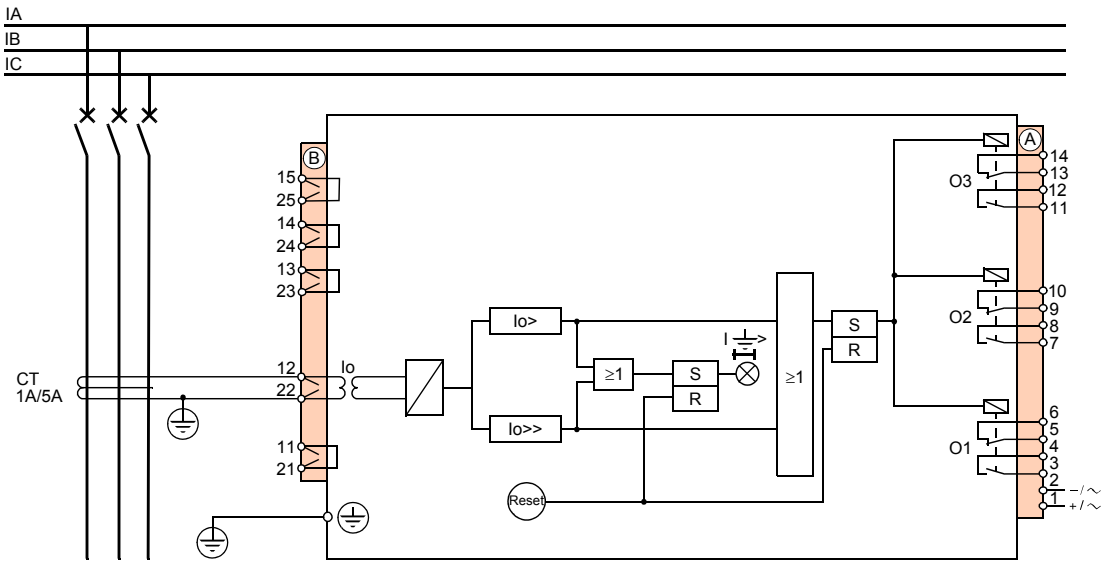
Standard Operation

Introduction

The mimic diagrams below show the functional chains for each Sepam model in standard operating mode with:

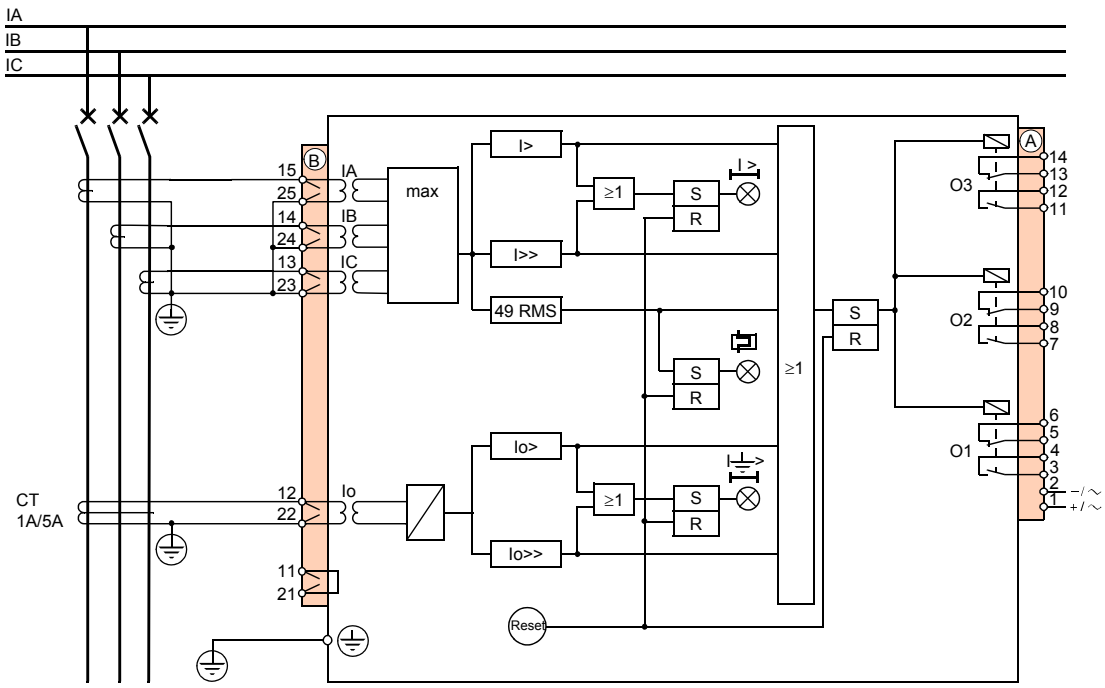
- Connection of the earth fault current input to an earth CT, for example
- Connection of the phase current inputs, if necessary
- Connection of the protective earth

Mimic Diagram of Sepam Series 10 N Operation



Output Relays	Assignment
O1	Circuit breaker tripping
O2	Circuit breaker trip lockout
O3	Tripping annunciation

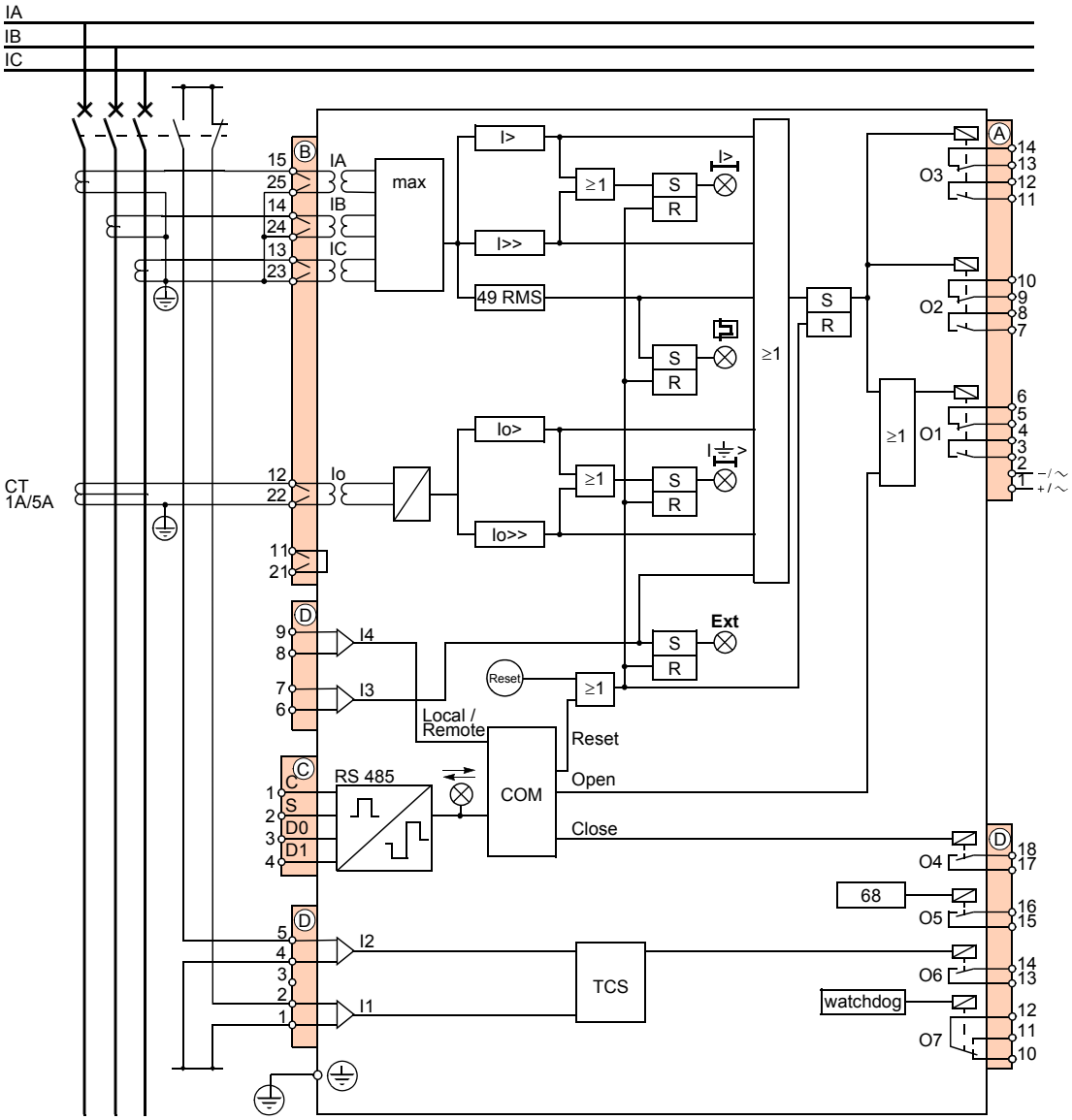
Mimic Diagram of Sepam Series 10 B Operation



Output Relays	Assignment
O1	Circuit breaker tripping
O2	Circuit breaker trip lockout
O3	Tripping annunciation

Mimic Diagram of Sepam Series 10 A Operation

The mimic diagram for the Sepam series 10 A also represents the connection of logic inputs I1 and I2:



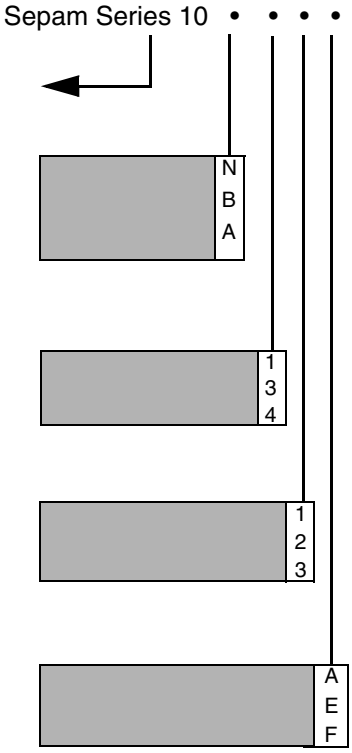
Output Relays	Assignment
O1	Circuit breaker tripping
O2	Circuit breaker trip lockout
O3	Tripping annunciation
O4	Circuit breaker closing via the communication
O5	Send blocking input
O6	TCS annunciation
O7	Watchdog

Logic Inputs	Assignment
I1	Open circuit breaker
I2	Closed circuit breaker
I3	External trip
I4	Local/Remote

Identification

Identification Code

The identification code for a Sepam series 10 is an alphanumeric code that defines the Sepam's main functions. It consists of several fields:



Family Sepam series 10

Model
- N: Earth fault protection
- B: Phase and earth fault overcurrent protection
- A: Phase and earth fault overcurrent protection, logic inputs and communication port

Number of current inputs
- 1: 1 earth current input
- 3: 2 phase current inputs + 1 earth current input
- 4: 3 phase current inputs + 1 earth current input

Sensitivity of earth fault protection
- 1: Standard (0.1...24 Ino)
- 2: Sensitive (0.01...2.4 Ino)
- 3: Very sensitive (0.2...24 A and 2...240 A)

Power supply
- A: 24...125 V DC and 100...120 V AC
- E: 110...250 V DC and 100...240 V AC
- F: 220...250 V DC and high-set logic inputs

Sepam Series 10 References

Model	Number of Current Inputs	Sensitivity of Earth Fault Protection	Power Supply		
			A	E	F
			24...125 V DC 100...120 V AC	110...250 V DC 100...240 V AC	220...250 V DC
Series 10 N	1	1: Standard	REL59817	REL59819	–
		3: Very sensitive	REL59818	REL59820	–
Series 10 B	3	1: Standard	REL59800	REL59801	–
	4	1: Standard	REL59802	REL59805	–
		2: Sensitive	REL59803	REL59806 REL59827 (2)	–
		3: Very sensitive	REL59804 REL59823 (1)	REL59807 REL59824 (1)	–
Series 10 A	4	1: Standard	REL59808	REL59811	REL59814
		2: Sensitive	REL59809	REL59812 REL59828 (2)	REL59815 REL59829 (2)
		3: Very sensitive	REL59810 REL59825 (1)	REL59813 REL59826 (1)	REL59816

(1) Sepam certified DK5600 (Italy)

(2) Sepam certified GOST (Russia)

Spare Part References

Reference	Description
REL59798	CCA680 - Pack of spare connectors (one of each connector A, B, C and D)

Accessory References

Reference	Description
59635	CSH120 - Closed core balance CT, diameter 120 mm (4.7 in)
59636	CSH200 - Closed core balance CT, diameter 196 mm (7.7 in)
50134	GO110 - Opening core balance CT, diameter 110 mm (4.3 in)
VW3A8306DR	Line termination resistor (150 Ω)

Installation

2

What's in this Chapter?

This chapter contains the following topics:

Safety Precautions

Before Starting

You are responsible for compliance with all the existing international and national electrical codes concerning protective earthing of any device.

You should also carefully read the safety precautions described below. These instructions must be followed strictly when installing, servicing or repairing electrical equipment.

⚠ 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, and carefully inspect the work area for tools and objects that may have been left inside the equipment.
- The successful operation of Sepam depends upon proper installation, setting, and operation.
- Setting the Sepam relay requires relevant expertise in the field of electrical network protection. Only competent people who have this expertise are allowed to set this product.

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

⚠ CAUTION

HAZARD OF DAMAGE TO SEPAM

- 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 may damage electronic components contained in the relay.
- Do not open the Sepam case. The Sepam relay contains components that are susceptible to electrostatic discharge. It is assembled in specially equipped premises. The only permitted operation is the removal of the depleted battery from its compartment on a Sepam series 10 A relay.

Failure to follow these instructions can result in injury or equipment damage.

Precautions

Introduction

Sepam relays are supplied in one of the following ways:
- Individually packaged
- Installed in a cubicle

The transport, handling and storage precautions for Sepam relays vary depending on which of these two methods is used.

Sepam in its Original Packaging

- **Transport**
  Sepam relays can be shipped to any destination by all suitable means of transport, without taking any additional precautions.
- **Handling**
  Sepam relays can be handled without any particular care and can withstand being dropped from a height of 1 m (3.28 ft).
- **Storage**
  A Sepam relay can be stored in its original packaging in a location with the following environmental characteristics:
  - Temperature: –40...+70 °C (or –40...+158 °F)
  - Humidity ≤ 90%
  - Storage is limited to a maximum of one month if the relative humidity is higher than 93% and the temperature higher than +40 °C (or +104 °F).

  For more information, refer to *Climatic Withstand, p. 254*.

  If the relays are to be stored for an extended period, we recommend the following:
  - Do not unpack the Sepam prior to its intended period of use.
  - Check the environment and the condition of the packaging annually.

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

Sepam Installed in a Cubicle

- **Transport**
  Sepam relays can be transported by all suitable means of transport in the usual conditions for cubicles. Storage conditions should be taken into consideration for a long period of transport.
- **Handling**
  If the cubicle is dropped, check the Sepam's condition by visual inspection and energizing.
- **Storage**
  We recommend keeping the cubicle protective packaging for as long as possible.
  Sepam relays, like all electronic units, should not be stored in a damp environment for more than a month. They should be energized as quickly as possible. If this is not possible, the cubicle reheating system should be activated.

Sepam Used in a Damp Environment

The temperature/relative humidity factors must be compatible with the Sepam relay's environmental withstand characteristics: Refer to *Climatic Withstand, p. 254*.

If the conditions of use are outside the normal zone, special arrangements should be made before commissioning, such as air conditioning of the premises.

Sepam Used in a Polluted Environment

An industrial atmosphere contaminated by the presence of chlorine, hydrofluoric acid, sulfur, solvents, etc. can cause corrosion of the electronic components. In this case, environmental control arrangements should be made (such as closed, pressurized premises with filtered air, etc.) before commissioning.

The effect of corrosion on Sepam relays has been tested according to the IEC 60068-2-60 standard under the following "2-gas" test conditions:

- 21 days' duration
- 25°C (or 77°F), 75% relative humidity
- 0.5 ppm H_2S, 1 ppm SO_2

Equipment Receipt and Identification

Equipment Receipt

The Sepam unit is shipped in a cardboard box which protects it against any knocks received in transport.

On receipt, check that the packaging has not been damaged. If it has, note any anomaly on the delivery slip and inform your supplier.

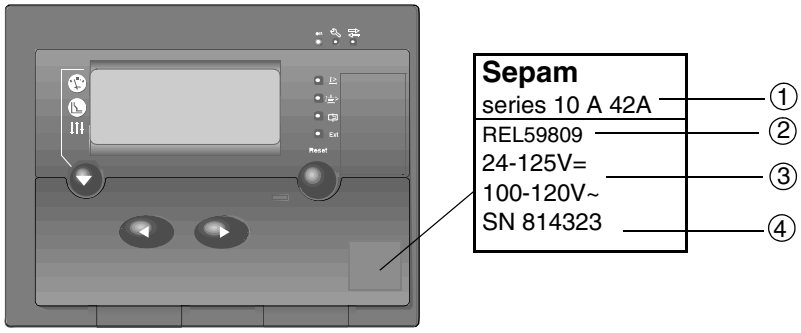
Package Contents

The box contains the following items:

- A Sepam relay without connectors
- A settings sheet to be completed and kept near the Sepam relay
- An instruction sheet providing the main information about installation and use
- A certificate of conformity
- 2 bags containing the connectors

Identification Label

The identification label on the front panel is used to identify the Sepam:



1 Identification code
2 Reference
3 Power supply voltage
4 Serial number

For the meaning of the identification codes, refer to *Identification, p. 18*.

Check After Unpacking

Make sure that the Sepam relay supplied corresponds to the product ordered. In particular, check that the power supply voltage is the correct one for your installation.

Mounting/Assembly

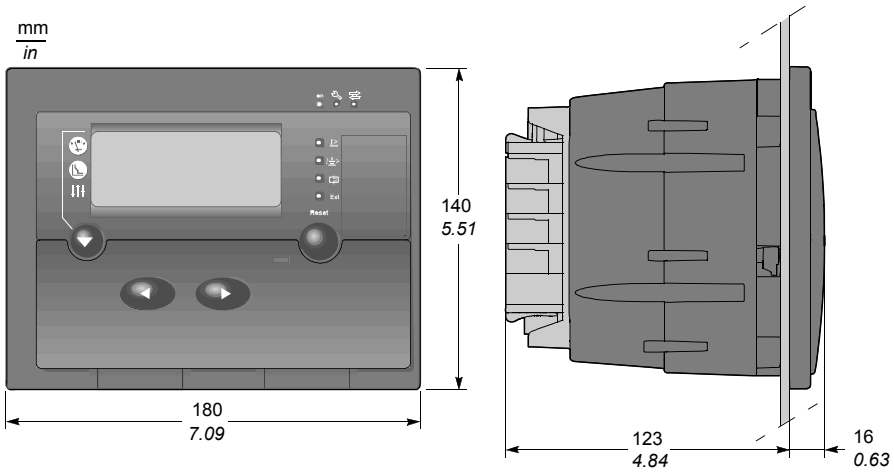
Introduction

Sepam relays weigh 1.3 kg (2.87 lb) maximum and are flush-mounted in a mounting plate 1.5 to 4 mm (0.06 to 0.16 in) thick.

They are designed to be mounted indoors.

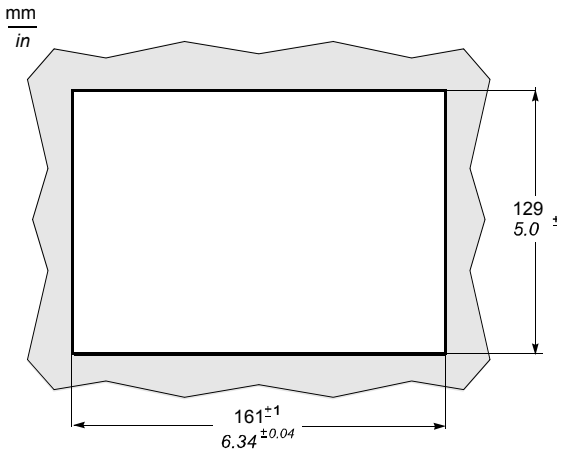
To ensure a waterproof seal, the surface of the panel must be smooth and solid.

Dimensions



Cut-out

Cut out the mounting plate as indicated:



⚠ CAUTION

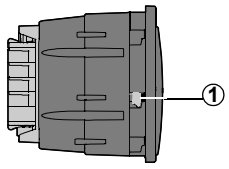
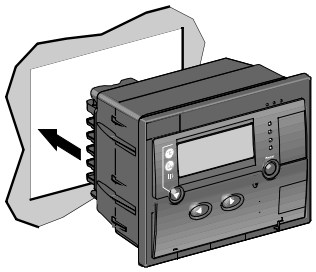
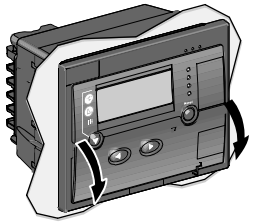
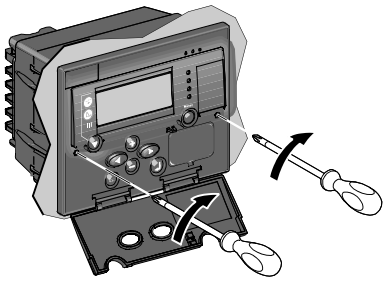
HAZARD OF CUTS

Trim the edges of the cut-out plates to remove any jagged edges.

Failure to follow these instructions can result in injury or equipment damage.

Installing the Sepam

The Sepam relay is held in place by 2 catches on the sides, behind the front panel:

Step	Action	Illustration
1	Mark the catches (1).	
2	Insert the Sepam unit through the cut-out.	
3	Open the settings protective flap.	
4	Tighten the screws as indicated using a no. 2 Pozidriv® screwdriver (maximum tightening torque: 2 N•m/17.7 lb-in).	
5	Check the position of the catches at the rear.	–
6	Close the settings protective flap.	–

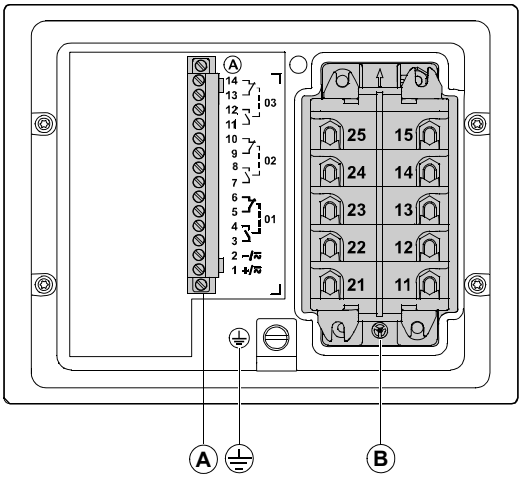
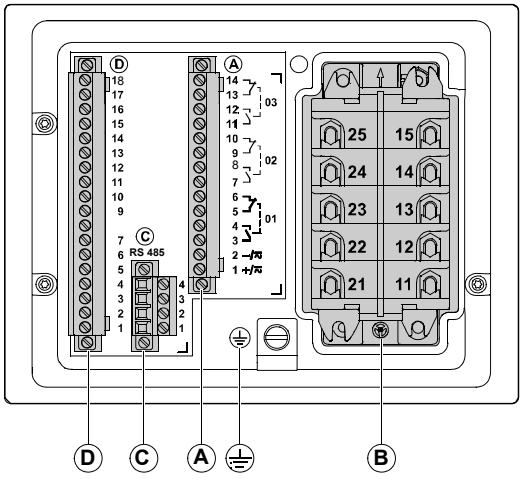
Connectors

Introduction

All the Sepam connectors can be accessed on the rear panel. They are removable and are attached to the Sepam casing with two screws.

The connectors are supplied separately: fix them in place using a flat blade screwdriver.

Identification of the Connectors on the Rear Panel

Sepam Series 10 N and Series 10 B	Sepam Series 10 A
	

A Connector for the auxiliary power supply and output relays O1 to O3
B Connector for the phase and earth fault current inputs
C 2-wire RS 485 communication port (Sepam series 10 A only)
D Connector for output relays O4 to O7 and logic inputs I1 to I4 (Sepam series 10 A only)
⏚ Protective earth

Connector Wiring

Ref.	Wiring	Type of Terminal	Screwdriver	Tightening Torque
B	● Wire 1.5...6 mm^2 (AWG 16...10) ● 2 lugs with internal diameter 4 mm (0.16 in) maximum	M4 screw	Pozidriv no. 2	1.2...1.5 N•m (10.6...13 lb-in)
A, C and D	● Wiring without fittings: • 1 wire: 0.2..2.5 mm^2 (AWG 24...12) • 2 wires: 0.2...1 mm^2 (AWG 24...18) • Stripped length: 8...10 mm (0.31...0.39 in) ● Wiring with Telemecanique fittings: • 1 wire 1.5 mm^2 (AWG 16) with DZ5CE015D fitting • 1 wire 2.5 mm^2 (AWG 12) with DZ5CE025D fitting • 2 wires 1 mm^2 (AWG 18) with DZ5CE010D fitting • Stripped length: 8 mm (0.31 in)	M2.5 screw	2.5 mm flat blade (0.09 in)	0.4...0.5 N•m (3.5...4.4 lb-in)
⏚	● Green-yellow wire 6 mm^2 (AWG 10) ● Lug with internal diameter 4 mm (0.16 in) maximum ● Length < 0.50 m (20 in)	M4 screw	Pozidriv no. 2	1.2...1.5 N•m (10.6...13 lb-in)

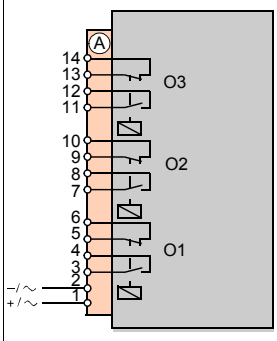
Remark: Connectors A and D supplied with the Sepam can be replaced by the ring lug connectors indicated in the table below. These connectors are not supplied and should be ordered separately.

Ref.	Wiring	Type of Terminal	Connector Reference
A	0.5..2.5 mm^2 wire (AWG 22...12)	M3.5 screw	Pitch Beau® EuroMate™ Molex no. 0399400414
D	0.5..2.5 mm^2 wire (AWG 22...12)	M3.5 screw	Pitch Beau® EuroMate™ Molex no. 0399400418

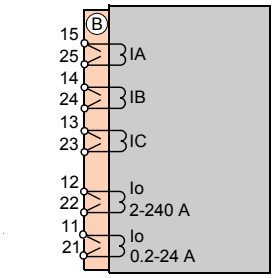
Shorting Connector

Connector B for connecting the current sensors (current transformers and core balance CT) is a shorting connector. It can be disconnected while on load: disconnecting it does not open the secondary circuit on the current sensors.

Connector A Connections

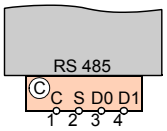
Diagram	Terminal	Data Item Connected
	1-2	Auxiliary power supply ● AC power supply voltage on terminals 1 and 2 ● DC power supply voltage • Terminal 1: positive polarity • Terminal 2: negative polarity
	3-4 and 5-6	Output relay O1 ● Terminals 3-4: Normally open contact (NO) ● Terminals 5-6: Normally closed contact (NC)
	7-8 and 9-10	Output relay O2 ● Terminals 7-8: Normally open contact (NO) ● Terminals 9-10: Normally closed contact (NC)
	11-12 and 13-14	Output relay O3 ● Terminals 11-12: Normally open contact (NO) ● Terminals 13-14: Normally closed contact (NC)

Connector B Connections

Diagram	Terminal	Data Item Connected
	15-25	Phase A current input
	14-24	Phase B current input
	13-23	Phase C current input
	12-22	Earth fault current input Io ● For the standard and sensitive earth fault protection functions ● For the very sensitive earth fault protection function (2 - 240 A rating)
	11-21	Earth fault current input Io for the very sensitive earth fault protection function only (0.2 - 24 A rating)

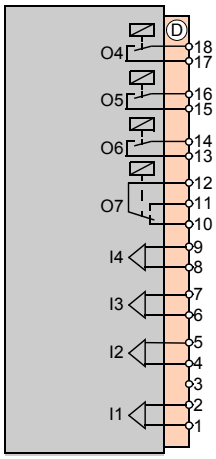
Connector C Connections

Connector C is the 2-wire RS 485 communication port on Sepam series 10 A relays:

Diagram	Terminal	Data Item Connected
	1	C: Common (communication interface 0V)
	2	S: Shielding (terminal connected to the Sepam earthing terminal)
	3	D0: Terminal to be connected to terminal A (or L–) of the supervisor port
	4	D1: Terminal to be connected to terminal B (or L+) of the supervisor port

Connector D Connections

The additional logic inputs and output relays for Sepam series 10 A relays are connected to connector D:

Diagram	Terminal	Data Item Connected
	1-2	Logic input I1
	3	Terminal not used
	4-5	Logic input I2
	6-7	Logic input I3
	8-9	Logic input I4
	10-11-12	Output relay O7: Watchdog ● Terminal 12: Common ● Terminal 11: Normally open contact (NO) ● Terminal 10: Normally closed contact (NC)
	13-14	Output relay O6, normally open contact (NO)
	15-16	Output relay O5, normally open contact (NO)
	17-18	Output relay O4, normally open contact (NO)

Connection Diagrams

General Safety Precautions

⚠ 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.
- Wear insulating gloves to avoid any contact with a conductor that has accidentally been energized.
- Screw tight all terminals, even those not in use.

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

Earthing

The Sepam earth terminal is a protective earth. It should be connected to the cubicle grounding with an earthing wire.

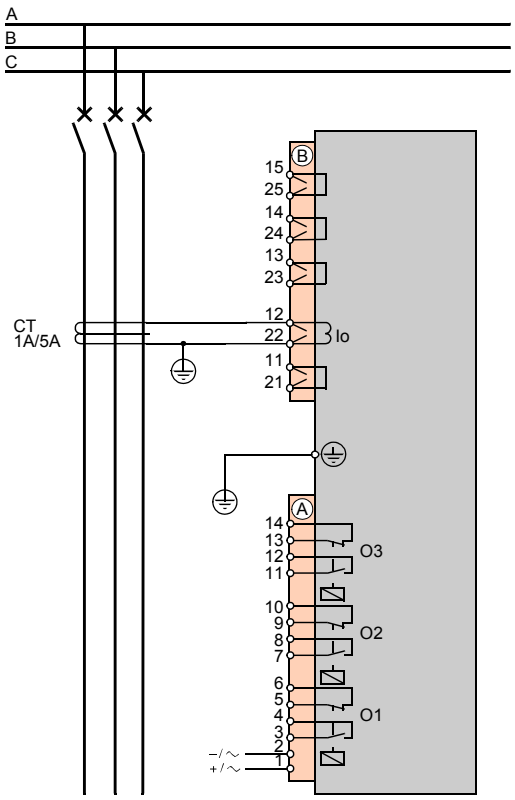
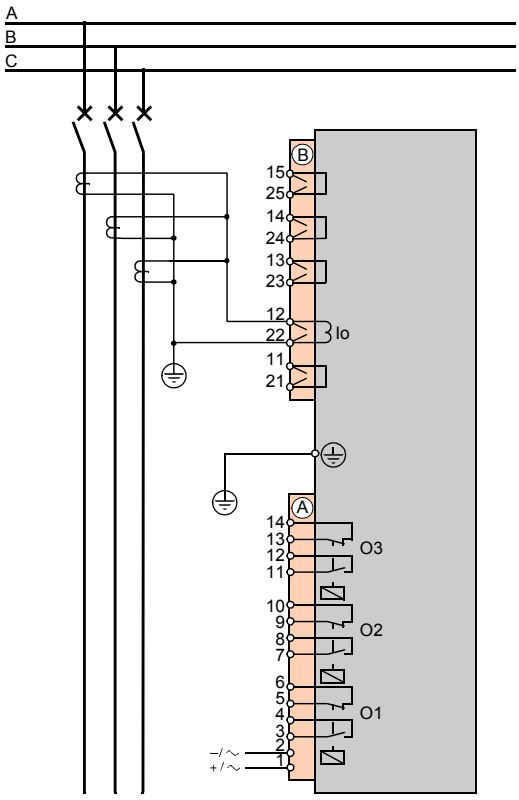
The characteristics of the earthing wire are as follows:

- Wire: green-yellow 6 mm^2 (AWG 10)
- Maximum length: 0.5 m (20 in)

Sepam Series 10 N 11•

Sepam series 10 N 11• relays measure the earth fault current, either:

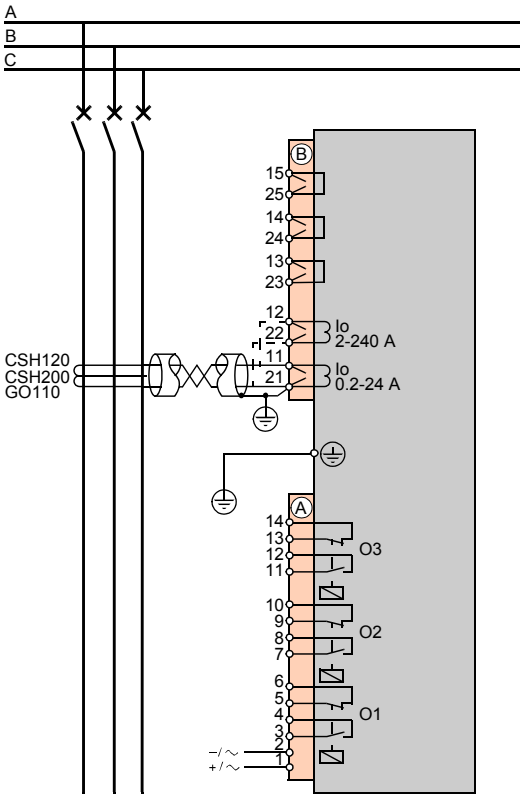
- By 1 earth CT
- On the common point of the 3 phase CTs

Variant no. 1	**Variant no. 2**
Earth fault current measured by 1 earth CT	Earth fault current measured on the common point of the 3 phase CTs
	

Sepam Series 10 N 13•

Sepam series 10 N 13• relays measure the earth fault current using 1 CSH120, CSH200 or GO110 core balance CT, connected to either of the following:

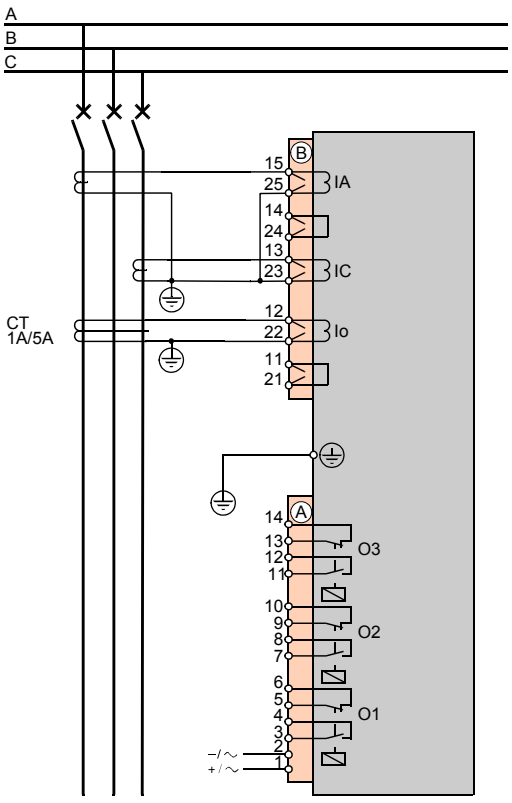
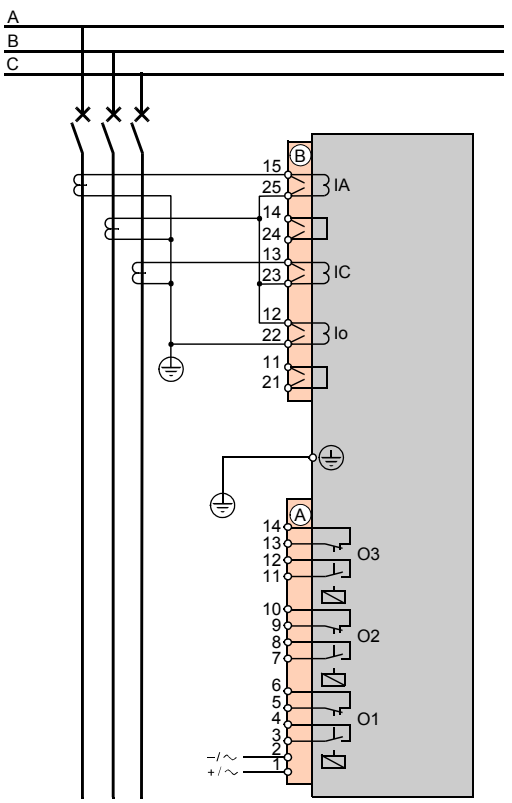
- The 2 - 240 A input
- The 0.2 - 24 A input



Sepam Series 10 B 31•

Sepam series 10 B 31• relays measure 3 currents:

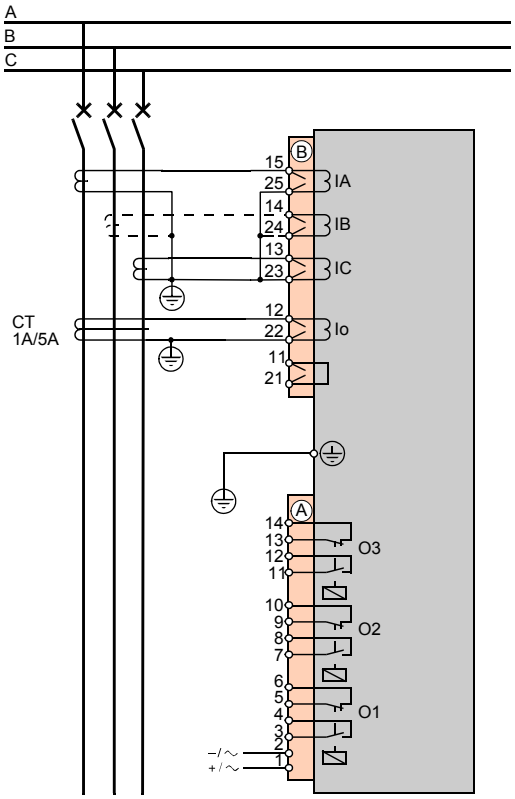
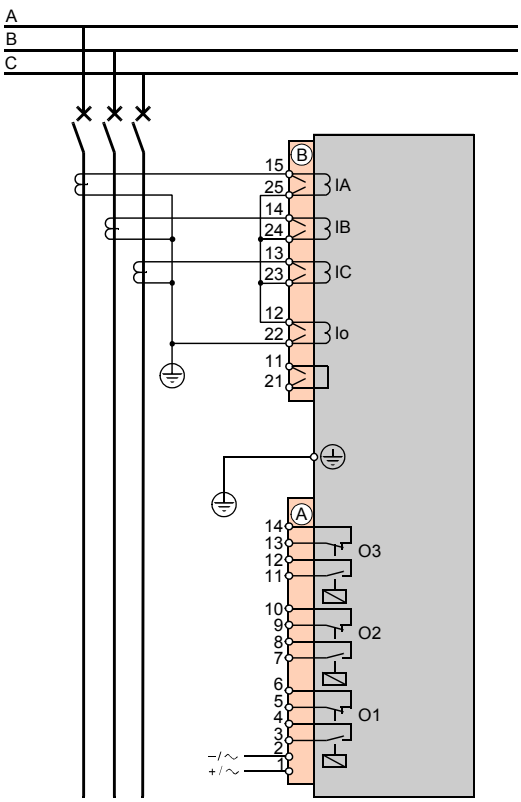
- 2 phase currents measured by 2 phase CTs
- 1 earth fault current measured either:
  - By 1 earth CT
  - On the common point of the 3 phase CTs

Variant no. 1	**Variant no. 2**
Earth fault current measured by 1 earth CT	Earth fault current measured on the common point of the 3 phase CTs
	

Sepam Series 10 B 41• and Series 10 B 42•

Sepam series 10 B 41• and series 10 B 42• relays measure the following currents:

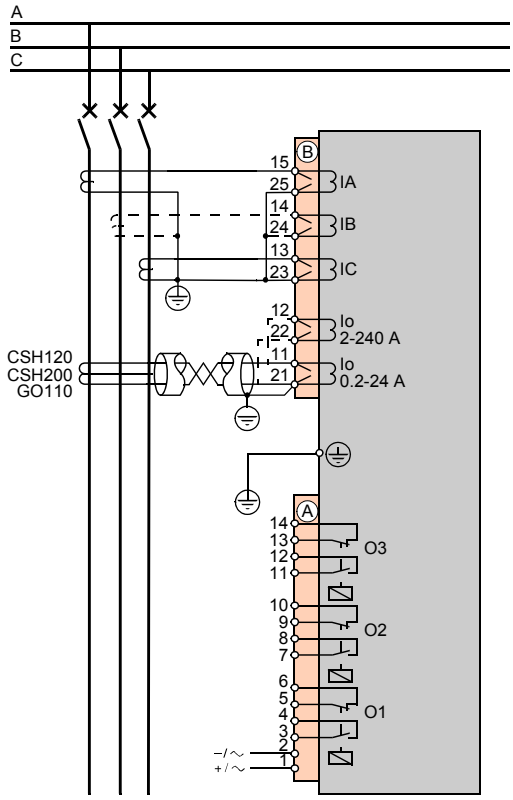
- Phase currents measured by 2 or 3 phase CTs
- 1 earth fault current measured either:
  - By 1 earth CT
  - On the common point of the 3 phase CTs

Variant no. 1	**Variant no. 2**
Earth fault current measured by 1 earth CT	Earth fault current measured on the common point of the 3 phase CTs
	

Sepam Series 10 B 43•

Sepam series 10 B 43• relays measure the following currents:

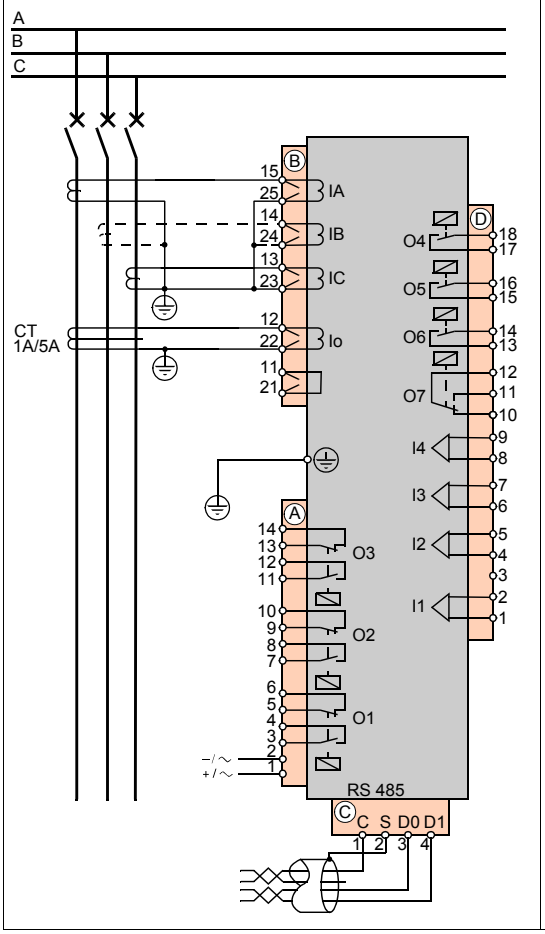
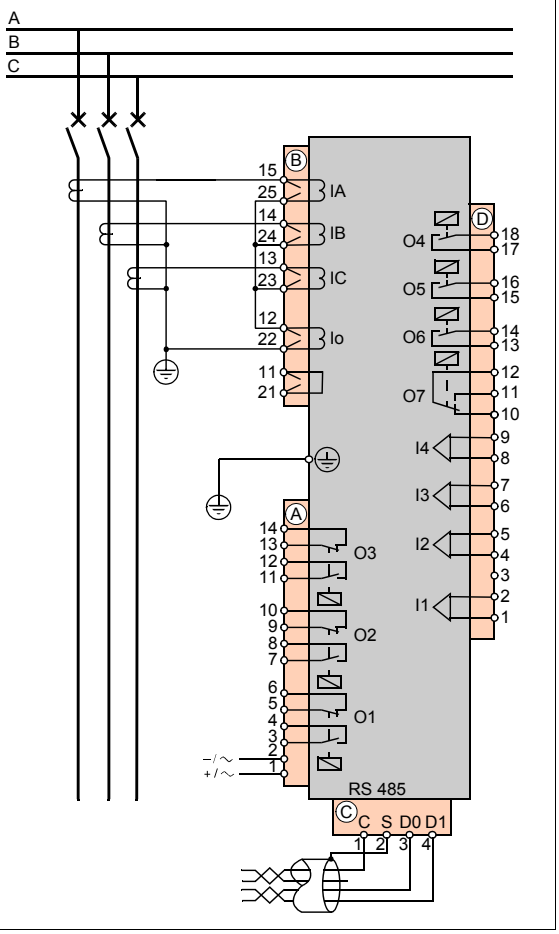
- Phase currents measured by 2 or 3 phase CTs
- Earth fault current measured by 1 CSH120, CSH200 or GO110 core balance CT, connected to either of the following:
  - The 2 - 240 A input
  - The 0.2 - 24 A input



Sepam Series 10 A 41• and Series 10 A 42•

Sepam series 10 A 41• and series 10 A 42• relays measure the following currents:

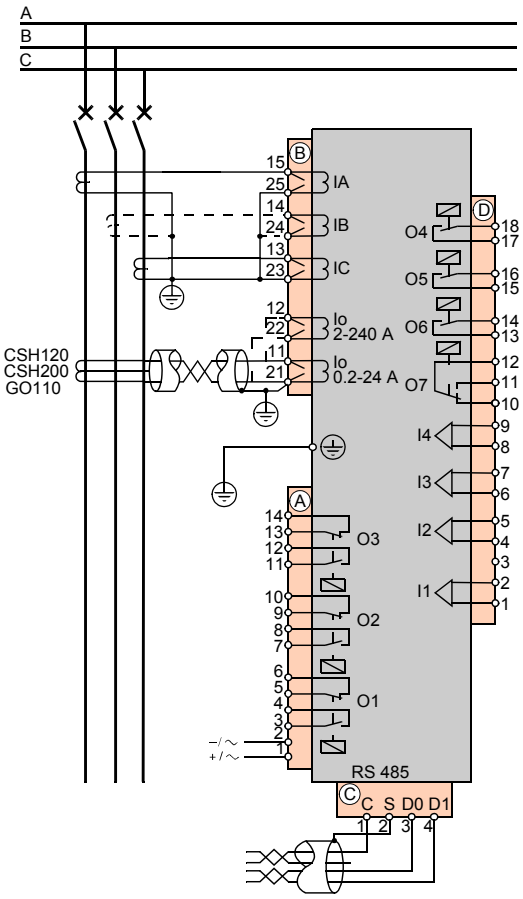
- Phase currents measured by 2 or 3 phase CTs
- 1 earth fault current measured either:
  - By 1 earth CT
  - On the common point of the 3 phase CTs

Variant no. 1	**Variant no. 2**
Earth fault current measured by 1 earth CT	Earth fault current measured on the common point of the 3 phase CTs
	

Sepam Series 10 A 43•

Sepam series 10 A 43• relays measure the following currents:

- Phase currents measured by 2 or 3 phase CTs
- Earth fault current measured by 1 CSH120, CSH200 or GO110 core balance CT, connected to either of the following:
  - The 2 - 240 A input
  - The 0.2 - 24 A input



Connecting Current Transformers (CTs)

Connecting CTs

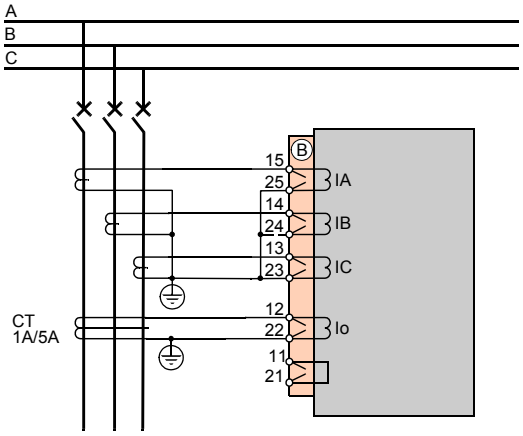
Standard 1 A or 5 A current transformers (CTs) can be connected to Sepam, to measure phase currents and the earth fault current.

To determine the CT size, refer to *Dimensioning the CTs, p. 44*.

Connection Example

The diagram below shows the connection of:

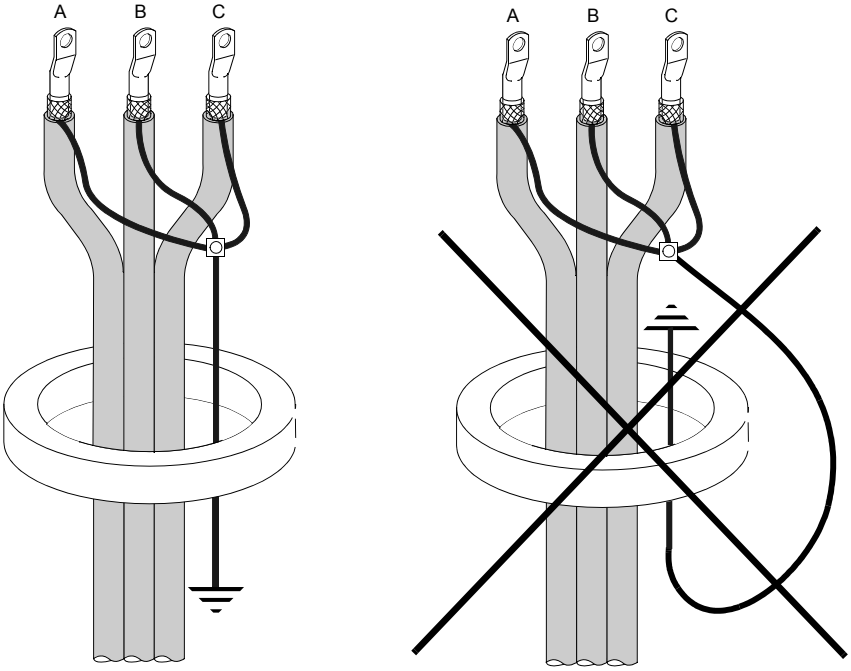
- 3 phase CTs to measure phase currents
- 1 earth fault CT to measure the earth fault current



Earth CT

The earth fault CT must only measure the sum of the 3 phase currents. The current circulating in the medium voltage cable shielding must therefore be excluded. To avoid the current circulating in the cable shielding being detected by the CT, its component must be canceled by making this current circulate a second time through the CT in the opposite direction.

This is achieved by connecting the shields coming out of the cable ends to earth via a wire that crosses the CT. This wire must not come into contact with any part connected to earth before it passes through the CT, otherwise use an insulated wire.



Connection Precautions

- In the cubicle CT compartment, check that the common points of the CT secondaries are connected, using wires of equal length and as short as possible, to a copper bar with a rectangular cross-section connected to the cubicle protective earth.
- Connect the CTs to shorting connector B.
- Flatten the cable against the metal frames of the cubicle.
- Connect terminals 23, 24 and 25 of the shorting connector together, without connecting them to earth.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS

- Never leave the current transformer secondary in open circuit. The high voltage that would result from opening the circuit is dangerous for the operator and for the equipment.
- Never undo the ring lugs on the cables of the CT secondaries when there is current on the primary.

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

If you need to disconnect the Sepam current inputs:

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS

- Wear insulating gloves to avoid any contact with a conductor that has accidentally been energized.
- Unplug shorting connector B without disconnecting the wires from it. This connector ensures continuity of the current transformer secondary circuits.

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

Recommended Cable

The cross-section of the cable for connecting the CTs must be selected according to the characteristics of the CT secondary and the length of the link so as to limit the wiring energy consumption.

For more information, refer to *Dimensioning the CTs, p. 44*.

Connecting a Core Balance CT

Connecting a Core Balance CT

The specifically designed CSH120, CSH200 and GO110 core balance CTs are for direct earth fault current measurement. They should be used with Sepam relays with very sensitive earth fault protection.

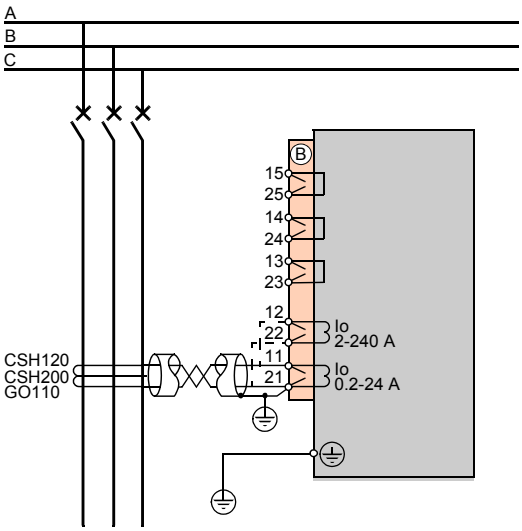
They can be connected to 2 earth fault current inputs with different sensitivities:

- 2-240 A input
- 0.2-24 A input

For detailed characteristics of core balance CTs, refer to *CSH120, CSH200 and GO110 Core Balance CTs, p. 46*.

Connection Diagram

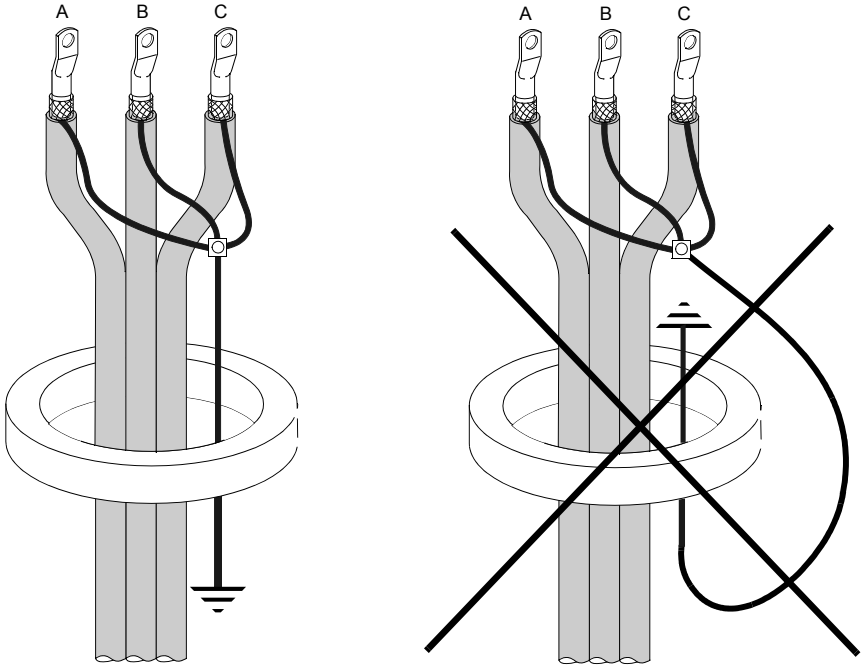
The diagram below shows the connection of a core balance CT to measure the earth fault current:



Core Balance CT

The core balance CT must only measure the sum of the 3 phase currents. The current circulating in the medium voltage cable shielding must therefore be excluded. To avoid the current circulating in the cable shielding being detected by the core balance CT, its component must be canceled by making this current circulate a second time through the core balance CT in the opposite direction.

This is achieved by connecting the shields coming out of the cable ends to earth via a wire that passes through the core balance CT. This wire must not come into contact with any part connected to earth before it passes through the core balance CT, otherwise use an insulated wire.



Connection Precautions

- Connect the core balance CT secondary to the cubicle protective earth, for example by connecting terminal 21 (or 22) on the Sepam relay to the protective earth.
- Flatten the cable against the metal frames of the cubicle.
- Connect the cable shielding in the shortest manner possible to the protective earth, for example, by means of terminal 21 (or 22) on the Sepam relay.
- Do not ground the cable by any other means.

Note: The maximum resistance of the Sepam connection wiring must not exceed 4 Ω (i.e. 20 m maximum for 100 mΩ/m or 66 ft for 30.5 mΩ/ft).

Recommended Cable

Use a sheathed cable with twisted pair shielded by tinned copper braid with the following characteristics:

Characteristics	Values
Conductor cross-section	> 1 mm^2 (AWG 18)
Resistance per unit length	< 100 mΩ/m (30.5 mΩ/ft)
Minimum dielectric withstand	1000 V (700 V RMS)

Connecting the Logic Inputs and Output Relays

Safety Precautions

⚠ DANGER

HAZARDOUS VOLTAGE

Do not allow hazardous live voltages to coexist with voltages that could be connected to accessible parts (SELV, PELV or PEB) on power supply and I/O connectors A and D. The logic inputs and output relays are isolated from one another with simple isolation.

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

Connecting the Output Relays

The Sepam output relays have volt-free contacts.

⚠ CAUTION

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 de-energized. Check that this operating mode and the watchdog relay wiring are compatible with your installation.

Failure to follow these instructions can result in injury or equipment damage.

Connecting the Logic Inputs

The 4 Sepam series 10 A logic inputs are independent and volt-free.

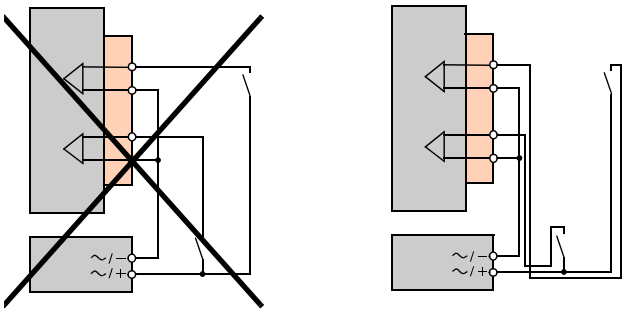
The Sepam series 10 A power supply voltage determines:
- The logic input supply voltage range
- The logic input switching threshold

These values are given in *Logic Inputs, p. 252*.

For Sepam series 10 A ••A and series 10 A ••E, the logic input operation should be adapted to the voltage type used to activate them: AC or DC. To do this, the voltage type should be configured in the ***LOGIC INPUTS*** screen in the parameters menu. The default value is DC (V DC).

Advice on Connecting Logic Inputs

To reduce the consequences of EMC disturbance, there should not be a loop between the live conductors contained in a single connection. A connection made with a twisted pair ensures that the outward and return conductors remain in close proximity along the whole length of the connection.



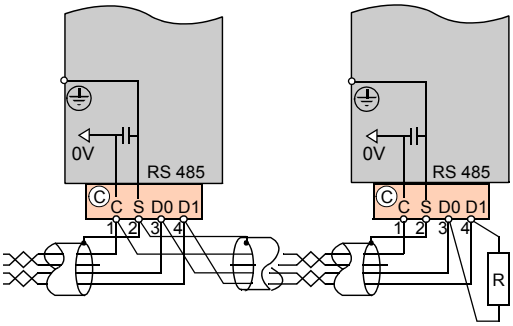
Connecting the Communication Port

Introduction

Sepam series 10 A can communicate using a 2-wire RS 485 EIA communication port. Connection to the bus is direct, and needs no accessories.

Connection Diagram

Connection is in a daisy-chain and requires a line termination resistor:



Terminal	Data item connected	Description
1	C: Common	Terminal connected to the communication interface 0V
2	S: Shielding	Terminal connected to the Sepam earthing terminal
3	D0	Terminal to be connected to terminal A (or L–) of the supervisor port
4	D1	Terminal to be connected to terminal B (or L+) of the supervisor port

Connection Precautions

The number of connected Sepam relays must not exceed 31 and the total cable length must not exceed 1300 m (4265 ft).

The cable shielding connection must also be as short as possible.

If the Sepam is at the end of the line, install a 150 Ω impedance matching resistor (reference: VW3A8306DR) between terminals 3 and 4 of connector C.

Recommended Cable

Use a sheathed cable with twisted pair, shielded by tinned copper braid with a minimum overlap of 85%, and with the following characteristics:

Characteristics	Values
Conductor cross-section	> 0.22 mm^2 (AWG 24)
Resistance per unit length	< 100 mΩ/m (30.5 mΩ/ft)
Capacitance between conductors	< 60 pF/m (18.3 pF/ft)
Capacitance between conductor and shielding	< 100 pF/m (30.5 pF/ft)

Dimensioning the CTs

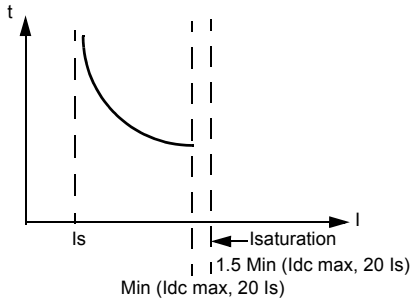
Introduction

The Sepam phase current inputs can be connected to standard 1 A or 5 A CTs.

CT Selection Principle

The CTs must be dimensioned so that they do not become saturated at currents where accuracy is required (with a minimum of 5 In).

The condition to be fulfilled by the CT saturation current depends on the type of overcurrent protection time delay:

Time Delay	Condition to be Fulfilled	Illustration
Definite time (DT)	Isaturation > 1.5 x set point (Is)	
IDMT	Isaturation > 1.5 x the curve value, which is the smallest of the following 2 values: ● Isc max, maximum installation short-circuit current ● 20 x Is (IDMT curve dynamic range)	

The method for calculating the saturation current depends on the CT accuracy class as indicated below.

Practical Information

In the absence of any information about the settings, the characteristics below are suitable for most situations:

Rated Secondary Current	Rated Burden	Accuracy Class and Accuracy-Limit Factor	CT Secondary Resistance	Wiring Resistance
Ins	**VAct**		**Rct**	**Rw**
1 A	2.5 VA	5P20	< 3 Ω	< 0.075 Ω
5 A	7.5 VA	5P20	< 0.2 Ω	< 0.075 Ω

Principle for Calculating the Saturation Current in Class P

A class P CT is characterized by:

- Inp: Rated primary current (in A)
- Ins: Rated secondary current (in A)
- Accuracy class, expressed by a percentage, 5P or 10P, followed by the accuracy-limit factor (FLP), whose usual values are 5, 10, 15, 20, 30
- VAct: Rated burden, whose usual values are 2.5/5/7.5/10/15/30 VA
- Rct: Maximum resistance of the secondary winding (in Ω)

The installation is characterized by the load resistance Rw at the CT secondary (wiring + protection relay).

If the CT load complies with the rated burden, i.e. Rw x $Ins^2 \leq$ VAct, the saturation current is higher than FLP x Inp.

If the resistance Rct is known, it is possible to calculate the actual CT FLP, which takes account of the actual CT load. The saturation current equals actualFLP x Inp, where:

$$\text{actualFLP} = \text{FLP} \times \frac{\text{Rct} \times \text{Ins}^2 + \text{VAct}}{(\text{Rct} + \text{Rw}) \times \text{Ins}^2}$$

Examples of Calculating the Saturation Current in Class P

Say for a CT with the following characteristics:
- Transformation ratio: 100 A/5 A
- Rated burden: 2.5 VA
- Accuracy class and accuracy-limit factor: 5P20
- Resistance of the secondary winding: 0.1 Ω

To have an FLP of at least 20, i.e. a saturation current of 20 x Inp = 2 kA, the load resistance Rw of the CT must be less than:

$$Rw,max = \frac{VAct}{Ins^2} = \frac{2.5}{5^2} = 0.1\ \Omega$$

This represents 12 m (39 ft) of wire with cross-section 2.5 mm^2 (AWG 12) for a resistance per unit length of 8 Ω/km (2.4 mΩ/ft) approximately.

For an installation with 50 m (164 ft) of wiring with section 2.5 mm^2 (AWG 12), Rw = 0.4 Ω.

As a result:

$$actualFLP = FLP \times \frac{Rct \times Ins^2 + VAct}{(Rct + Rw) \times Ins^2} = 20 \times \frac{0.1 \times 25 + 2.5}{(0.1 + 0.4) \times 25} = 8$$

Therefore, Isaturation = 8 x Inp = 800 A

Remark: The impedance of a Sepam relay's current inputs (< 0.004 Ω) is often negligible compared to the wiring resistance.

Principle for Calculating the Saturation Current in Class PX

A class PX CT is characterized by:
- Inp: Rated primary current (in A)
- Ins: Rated secondary current (in A)
- Vk: Rated knee-point voltage (in V)
- Rct: Maximum resistance of the secondary winding (in Ω)

The saturation current is calculated by the load resistance Rw at the CT secondary (wiring + protection relay).

$$Isaturation = \frac{Vk}{Rct + Rw} \times \frac{Inp}{Ins}$$

Examples of Calculating the Saturation Current in Class PX

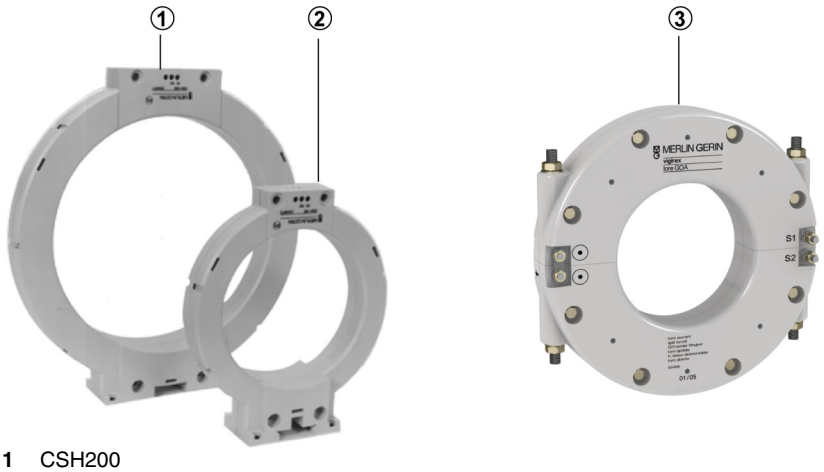
CT Transformation Ratio	Vk	Rct	Rw	Isaturation
100 A/5 A	17.4 V	0.13 Ω	0.4 Ω	$= \frac{17.4}{0.13 + 0.4} \times \frac{Inp}{5} = 6.56 \times Inp = 656\ A$
100 A/1 A	87.7 V	3.5 Ω	0.4 Ω	$= \frac{87.7}{3.5 + 0.4} \times \frac{Inp}{1} = 2.248 \times Inp = 2248\ A$

CSH120, CSH200 and GO110 Core Balance CTs

Function

The specifically designed CSH120, CSH200 and GO110 core balance CTs are for direct earth fault current measurement. Due to their low voltage insulation, they can only be used on cables.

- CSH120 and CSH200 are closed CTs, with different inner diameters:
  - The CSH120 inner diameter is 120 mm (4.75 in).
  - The CSH200 inner diameter is 196 mm (7.72 in).
- The GO110 is a split CT, with an inner diameter of 110 mm (4.33 in).

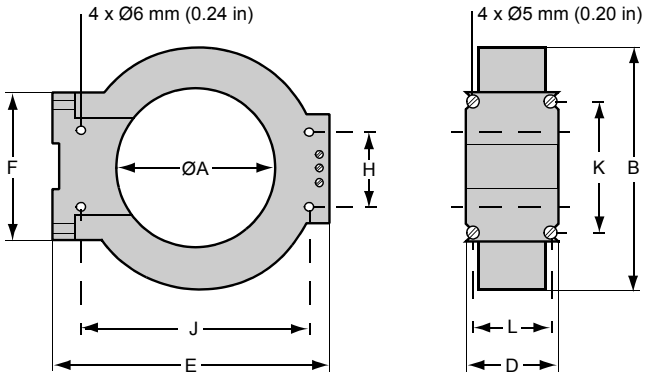


1 CSH200
2 CSH120
3 GO110

Characteristics

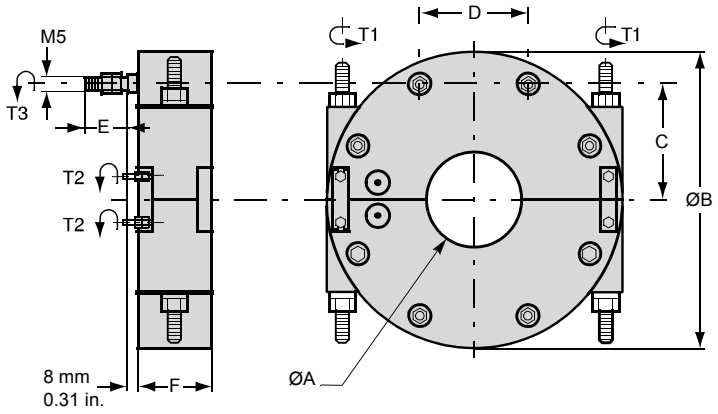
		CSH120	CSH200	GO110
Inner diameter		120 mm (4.7 in)	196 mm (7.7 in)	110 mm (4.3 in)
Weight		0.6 kg (1.32 lb)	1.4 kg (3.09 lb)	3.2 kg (7.04 lb)
Accuracy	at 20°C (68°F)	5%	5%	< 0.5% (10...250 A)
	at –25...+70°C (–13...+158°F)	< 6%	< 6%	< 1.5% (10...250 A)
Transformation ratio		470/1		
Maximum permissible current		20 kA - 1 s		
Operating temperature		–25...+70°C (–13...+158°F)		
Storage temperature		–40...+85°C (–40...+185°F)		

CSH120 and CSH200 Dimensions



Dimension		A	B	D	E	F	H	J	K	L
CSH120	mm	120	164	44	190	80	40	166	65	35
	in	4.75	6.46	1.73	7.48	3.15	1.57	6.54	2.56	1.38
CSH200	mm	196	256	46	274	120	60	254	104	37
	in	7.72	10.1	1.81	10.8	4.72	2.36	10.0	4.09	1.46

GO110 Dimensions



Dimension		A	B	C	D	E	F
GO110	mm	110	224	92	76	16	44
	in	4.33	8.82	3.62	2.99	0.63	1.73

Opening the GO110

To open the GO110 CT, proceed as follows:

Step	Action
1	Undo both T1 nuts and remove the 2 pins.
2	Undo both T2 nuts and remove the 2 bars.

Closing the GO110

To close the GO110 CT, proceed as follows:

Step	Action
1	Replace the 2 bars and tighten both T2 nuts. T2 tightening torque = 30 N•m or 0.34 lb-in.
2	Replace the 2 pins and tighten both T1 nuts. T1 tightening torque = 70 N•m or 0.79 lb-in.

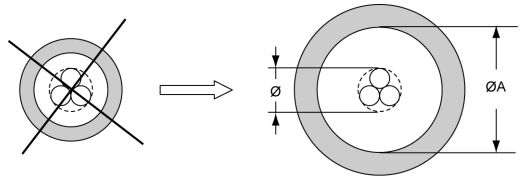
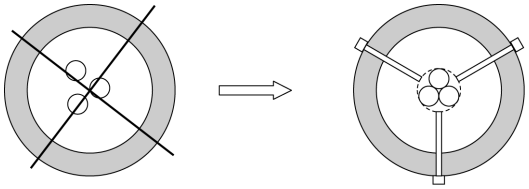
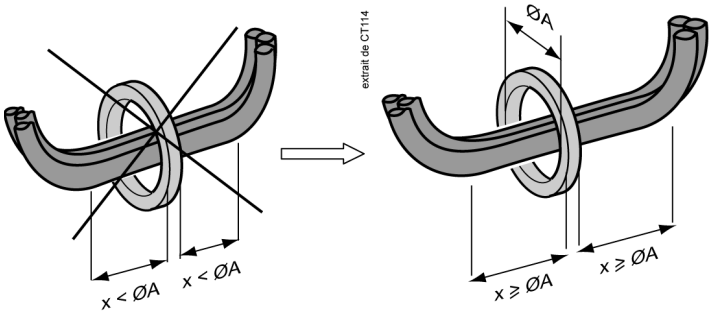
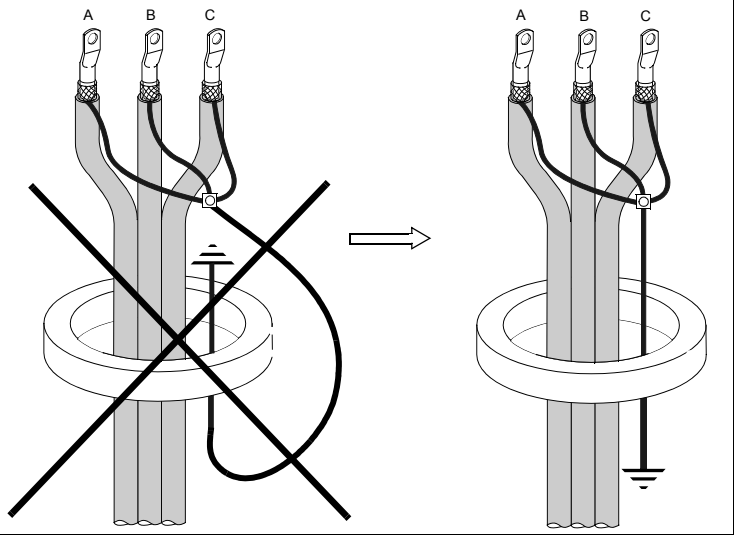
Mounting Precautions

⚠ 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.
- Screw tight all terminals, even those not in use.
- Only CSH120, CSH200 and GO110 core balance CTs can be used for very sensitive earth fault current measurement.
- Install the core balance CTs on insulated cables (the CTs do not have MV insulation).
- Cables with a rated voltage of more than 1000 V must also have shielding connected to the protective earth.

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

Mounting Instruction	Illustration
Select a CT with a diameter at least twice the size of the cable harness going through it.	
Group the cable(s) in the middle of the CT and use non-conducting binding to hold the CT in place around the cable harness.	
Do not bend the cable(s) close to the CT: Install the CT on a straight section of the cable(s) that is at least twice as long as the CT diameter.	
Remember to pass the shield earthing braid on the 3 cables back through the CT. Check that the braid goes the right way through the CT.	

Connection Characteristics

CT	Wiring	Type of Terminal	Tools	Tightening Torque
CSH120, CSH200	● 1..2.5 mm^2 wire (AWG 18...12) ● Stripped length: 8 mm (0.31 in)	M3.5 screw	Flat blade screwdriver 3.5 mm (0.14 in)	0.8...1 N•m (7.1...8.8 lb-in)
GO110	● Wire 1.5...6 mm^2 (AWG 16...10) ● Lug with inner diameter 5 mm (0.2 in)	M5 screw	Flat spanner for M5 nut	30 N•m (0.34 lb-in)

Use

3

What's in this Chapter?

This chapter contains the following topics:

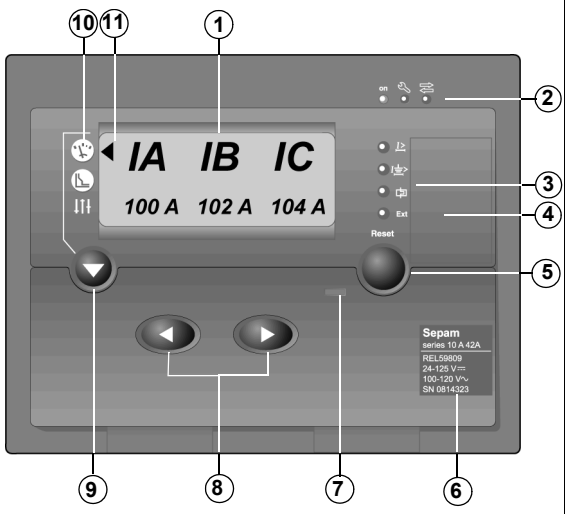
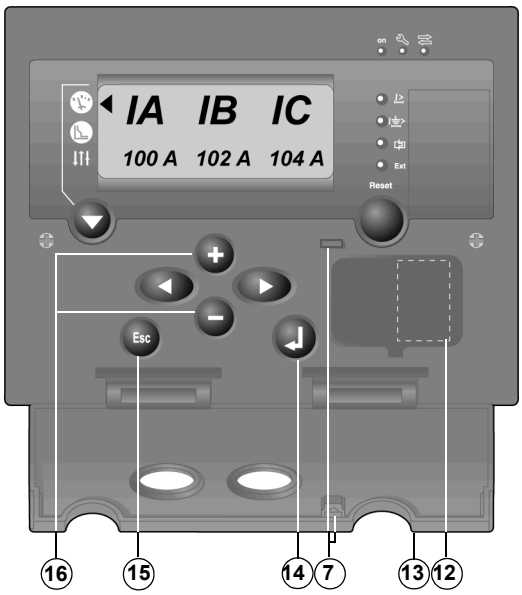
User-Machine Interface

Front Panel

The User-Machine Interface (UMI) on the front panel of Sepam relays consists of a display, LEDs and keys.

A sealable pivoting flap can prevent access to the setting keys by unauthorized persons.

The illustrations below show the two flap positions:

Flap Closed	Flap Open
	

1 Display
2 Status LEDs
3 Fault LEDs
4 Zone for a user-customizable label with pictograms of the fault LEDs
5 Sepam reset and peak demand value reset key
6 Identification label
7 Sealing ring
8 Selection keys
9 Key for selecting menus and testing LEDs
10 Menu pictograms
11 Menu selection pointer
12 Battery slot (Sepam series 10 A)
13 Settings protective flap
14 Confirm entry key
15 Abort entry key
16 Setting keys

Status LEDs

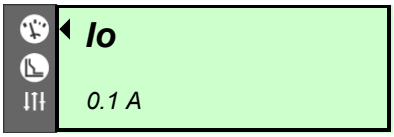
The status LEDs provide information about the Sepam's general status:

Pictogram	Function	Sepam Series 10		
ON	Green LED: Sepam on	N	B	A
	Red LED: Sepam unavailable (Sepam in the fail-safe position)	N	B	A
	Yellow LED: Communication activity	–	–	A

Display

The display is a backlit LCD unit.

Each Sepam function is presented in a screen consisting of the following items:
- First line: Symbols for electrical values or function name
- Second line: Displays the values of measurements or parameters associated with the function
- A menu pointer, on the left, it is pointing to the pictogram for the selected menu



Menu Organization

All the data available in the Sepam relay is divided between three menus:
- The metering menu contains the current measurements and records of the most recent events.
- The protection menu contains the essential settings for setting up the protection functions.
- The parameters menu contains the parameters that can be used to adapt the Sepam operation to particular applications. All these parameters have a default value. The protection functions are operational even with the parameters menu default values.

The menu content depends on the Sepam model. The list of screens by menu, for each model, is given at the end of this chapter:
- *List of Sepam Series 10 N Screens, p. 60*
- *List of Sepam Series 10 B Screens, p. 63*
- *List of Sepam Series 10 A Screens, p. 67*

Selecting a Screen in a Menu

Step	Action
1	Press the key to select one of the three menus. The menu pointer ◀ indicates the selected menu: : Metering menu : Protection menu : Parameters menu
2	Press the or keys to scroll through the screens in the selected menu, until the desired screen is displayed.

Default Screen

A default screen is displayed automatically 10 minutes after the last keystroke. This default screen is:
- The screen displaying the earth fault current for Sepam series 10 N relays
- The screen displaying the phase current for Sepam series 10 B and series 10 A relays

Operation

Access to Data

During operation, when the settings protective flap is closed, the user can access the following data:
- Readout of measurements, parameter and protection settings
- Local annunciation of the last fault:
  - by a flashing fault LED
  - by a fault screen on the display unit
- Acknowledgement of the last fault
- Readout of the last saved faults
- Reset of peak demand values
- LED and display unit test

Readout of Measurements, Settings and Parameters

When the settings protective flap is closed, the user can read all the data contained in the Sepam relay.

It is not possible to modify any protection or parameter settings.

Annunciation of the Last Fault

When a fault is detected by Sepam, it is indicated locally by:
- A fault LED, which flashes for as longs as the fault is present and has not been acknowledged
- A fault screen, which is displayed spontaneously on the display unit and remains displayed until the operator presses a key

The operator can acknowledge faults locally by pressing the Reset key.

Sepam series 10 A relays connected to a communication network:
- Indicate faults remotely by means of a remote-indication bit
- Can receive an order to acknowledge faults from the communication

Fault LEDs

The fault LEDs flash to indicate a fault, as shown in the table below.

Pictogram	Fault	Applicable to Sepam Series 10		
I>	Detection of a fault by the phase overcurrent protection	–	B	A
Io	Detection of a fault by the earth fault protection	N	B	A
θ	Detection of a fault by the thermal overload protection	–	B	A
Ext	External trip	–	–	A

Annunciation by a fault LED is latched in standard operating mode.

If latching of a fault LED has been disabled in custom operating mode at the time of commissioning, the fault LED goes out once the fault disappears.

For the first 3 LEDs, faster flashing may occur before the protection trips, to indicate the following information:

Pictogram	Overshoot	Applicable to Sepam Series 10		
I>	Overshoot of the instantaneous set point for phase overcurrent protection (pick-up outputs I> or I>>)	–	B	A
Io	Overshoot of the instantaneous set point for earth fault protection (pick-up outputs Io> or Io>>)	N	B	A
θ	Overshoot of the alarm set point for thermal overload protection	–	B	A

Refer to *Fault LEDs, p. 144*.

Remarks:

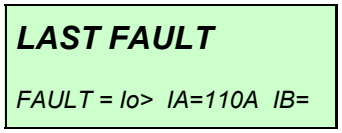
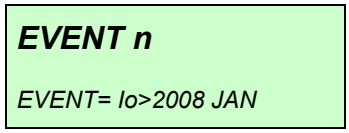
In custom mode, the protection set points cannot be associated with the output relay that causes the circuit breaker to trip but, for example, with an output relay that indicates a simple alarm. In this case, the protection LED may be active, without being associated with the circuit breaker trip.

The fault LED pictograms can be customized by sticking a label to the right of the LEDs.

Fault Screens

Fault screens inform the operator about the characteristics of the last fault detected by the Sepam relay.

The fault screens vary according to the Sepam model.

Sepam Series 10 N and Series 10 B	Sepam Series 10 A
	
First line: Name of the fault screen	First line: Name of the fault screen with its queue number *n*. Events are numbered continuously from 0 to 99999, then back to 0.
Second line: Scrolling display of the fault characteristics: ● Origin of the fault ● Values of the currents measured at the time of the fault	Second line: Scrolling display of the event characteristics: ● Origin of the event ● Date and time of the event ● Values of the currents measured at the time of the event

The operator can consult the other screens using the , or keys. In this case, the fault screen disappears, but the operator can still consult the last recorded fault in the metering menu.

Fault Acknowledgement

Pressing the Reset key acknowledges faults locally and causes:
- The latched output relays to be reset
- The fault LED to go out
- The fault screen to be cleared

After acknowledgement, the Sepam relay displays the screen that was present before the fault appeared.

Readout of the Last Recorded Faults

- Sepam series 10 N and series 10 B relays record the characteristics of the last fault.
- Sepam series 10 A relays record the characteristics of the last 5 faults.

These records can be accessed in the metering menu and are presented in the same way as the fault screens.

Reset of Peak Demand Values

The method for resetting the phase current peak demand values is indicated below:

Step	Action
1	Display the phase current peak demand values screen.
2	Press the Reset key for 2 seconds: the peak demand values are reset to zero.

LED and Display Unit Test

The LED and display unit test is used to check that each LED on the front panel and in each segment of the display is working correctly.

To perform the test, press and hold down the key.

After 2 seconds, all LEDs on the front panel and all segments of the display light up.

Battery Test

The battery in Sepam series 10 A relays is only used to power the internal clock in Sepam series 10 A relays in the event of failure of the Sepam auxiliary power supply. It is not involved in operation of the protection functions.

To check that the battery is in good working order, press the Reset key for 2 to 3 seconds. The 4 red fault LEDs should remain on clearly without fading for the whole time the key is pressed. If not, replace the battery: refer to *Replacing the Battery in the Sepam Series 10 A, p. 240*.

Setting

Access to Parameters and Settings

The Sepam protection and parameter settings can be modified using the keys that are revealed when the settings protective flap is opened.

These parameters and settings are divided into the following two menus:
- The protection menu, which contains the essential settings for setting up the protection functions
- The parameters menu, which contains the parameters that can be used to adapt Sepam operation to particular applications

Protecting the Settings with a Password

By default, modification of the Sepam protection and parameter settings is not protected by a password.

Protecting the settings by a password can be activated if necessary in the parameters menu.

If password protection has been activated at the time of commissioning, Sepam will ask for it automatically the first time the key is pressed during a setting operation. The password is a 4-digit number. Refer to *Entering a Password to Authorize a Setting, p. 57*.

Once the correct code has been entered, modification of the settings is allowed for 10 minutes after the last keystroke.

Setting a Parameter

The procedure for setting a protection function or a parameter is as follows:

Step	Action
1	Select the screen for the function to be set using the , or keys.
2	Press the key: ● If password protection is not active, the first function parameter flashes: the parameter is selected and can be set. ● Otherwise, the password entry screen is displayed: refer to the sections below.
3	Use the / keys to select the parameter to be set. The selected parameter flashes.
4	Use the / keys to scroll through the parameter values until the desired value is displayed. **Remarks**: ● Holding the / keys down makes the values scroll faster. ● Pressing the / keys aborts the parameter entry and selects the previous or next parameter.
5	● To confirm the new parameter value, press the key: the set parameter value is displayed (not flashing) to indicate that it has been taken into account by Sepam. ● To abort the current parameter entry, press the key: all parameters are deselected and are displayed (not flashing).
6	● If the set parameter is the last parameter in the function, the function is completely set and you can select a new screen using the / keys. ● Otherwise, the next parameter flashes and can be set as described in step 4.

Entering a Password to Authorize a Setting

The 4 password digits must be entered separately. The procedure for entering the password is as follows:

Step	Action
1	The password entry screen is displayed and the first digit (0) flashes: ***PASSWORD ?*** *0XXX*
2	Press the ⊕ / ⊖ keys to scroll through the digits from 0 to 9 and select the password digit.
3	Press the ↵ key to confirm the selected digit: ● A star is displayed rather than the selected digit. ● The next digit is a flashing 0.
4	Repeat steps 2 and 3 until you have entered all 4 password digits.
5	Once the password has been entered: ● If the code is correct: The current setting screen is displayed again. It is then possible to modify the protection and parameter settings. ● If the code is incorrect: The message ***PASSWORD NO OK*** is displayed temporarily, then the current setting screen is displayed again.

Activating the Password at the Time of Commissioning

The procedure for activating password protection of the settings is as follows:

Step	Action
1	Select the password setting screen in the parameters menu using the ▼, ◀ or ▶ keys: ***SET PASSWORD*** *NO PASSWORD*
2	Press the ↵ key: ***NO PASSWORD*** flashes.
3	Press the ⊕ / ⊖ keys, then the ↵ key: Sepam asks you to define the password you want. The password is defined in the next section.

Password Definition

The password is a 4-digit number, and each digit must be entered separately. The password must be re-entered to confirm it. The procedure for defining the password is as follows:

Step	Action
1	The password setting screen is displayed. Press the key until the first password digit (0) flashes: ***SET PASSWORD*** *PASSWORD = 0XXX*
2	Press the / keys to scroll through the digits from 0 to 9 and select the password digit.
3	Press the key to confirm the selected digit: ● A star is displayed rather than the selected digit. ● The next digit is a flashing 0.
4	Repeat steps 2 and 3 until you have defined all 4 password digits.
5	Once the password has been defined, it must be re-entered a second time following the same procedure as confirmation: ***SET PASSWORD*** *CONFIRM = XXXX*
6	Once the password has been entered and confirmed: ● If the two codes entered are identical: the ***PASSWORD SET*** message is displayed temporarily and the new password is active. ● If the two codes entered are not identical: the ***CONFIRMATION ERROR*** message is displayed temporarily.

Disabling the Password

The procedure for disabling password protection of the settings is as follows:

Step	Action
1	Select the password setting screen in the parameter menu using the , or keys: ***SET PASSWORD*** *PASSWORD = 0XXX*
2	Press the key: Sepam asks you to enter the active password to authorize changing the parameter. Refer to the *Entering the Password* section.
3	Once the password has been entered: ● If the code is correct and Sepam returns to the ***SET PASSWORD*** screen: use the / keys to select ***NO PASSWORD***, then press the key . Password protection is disabled. ● If the code is incorrect: The ***PASSWORD NO OK*** message is displayed temporarily. Sepam displays the screen for step 1 again.

Lost Password

If you lose the password, read the serial number on the Sepam front panel and contact your local Schneider Electric after-sales service.

Thermal Capacity Used Reset

The calculated thermal capacity used for the thermal overload protection can be reset by the user to:
- Authorize circuit breaker reclosing after a thermal overload protection trip, without waiting for the normal cooling time
- Delay tripping due to thermal overload protection after the thermal alarm set point is reached

The thermal capacity used reset is protected by the same password as the protection function settings.

Method for Resetting the Thermal Capacity Used

The procedure for resetting the thermal capacity used is as follows:

Step	Action
1	Display the ***THERMAL 49 2*** thermal alarm screen in the protection menu, where the value of the thermal capacity used calculated by Sepam appears.
2	Press the key: ● If password protection is not active, the thermal alarm set point flashes. ● Otherwise, the password entry screen is displayed. Refer to the *Entering the Password* section.
3	Select the thermal capacity used using the key: the thermal capacity used flashes.
4	Press the key to reset the thermal capacity used value.
5	Press the key to reset the thermal capacity used value.

List of Sepam Series 10 N Screens

Metering Menu

No.	Screen	Description
1	***Io*** *0.1 A*	Display of the earth fault current This is the default screen for Sepam series 10 N relays.
2	***LAST FAULT*** *FAULT = Io> Io = 60A*	Display of the characteristics of the last fault. This screen is only present when the Sepam relay has already recorded a fault.

Protection Menu

No.	Screen	Description
1a	***E/F CT*** *100A/1A*	Sepam series 10 N 11•: Display and setting of the characteristics of the earth CT or the phase CTs (Io sum): ● Primary rated current Ino or In ● Secondary rated current: 1 A or 5 A
1b	***E/F OP RANGE*** *0.2 - 24A*	Sepam series 10 N 13•: Display and selection of the measurement range by the earth fault core balance CT: 0.2-24 A/2-240 A
2	***FREQUENCY*** *50 HZ*	Network frequency selection
3	***Io>*** ***51N*** *EI 10A TD=0.8*	Display and setting of the low set point parameters for the earth fault protection: ● Activation and tripping curve ● Tripping set point ● Tripping time delay
4	***Io>>*** ***50N-51N*** *DT 10A T=0.10s*	Display and setting of the high set point parameters for the earth fault protection: ● Activation and tripping curve ● Tripping set point ● Tripping time delay

Standard Parameters Menu

No.	Screen	Description
1	***LANGUAGE*** *FRANCAIS*	Display and selection of the operating language
2	***RESET TIME*** *ON*	Activation of the reset time for the earth fault protection functions
3	***SET PASSWORD*** *PASSWORD = xxxx*	Password activation and definition
4	***OUT STATUS*** *O1 ... O3 = 000*	Display of the status of output relays O1 to O3, from left to right: State 0 (off)/State 1 (on)
5	***SEPAM*** *V1.3*	Display of the Sepam software version number
6	***I/O ASSIGN*** *STANDARD*	Display and selection of the Sepam operating mode: Standard/Custom

Custom Parameters Menu

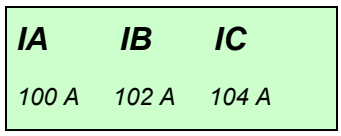
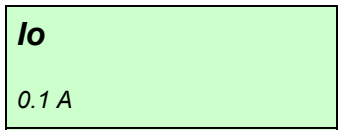
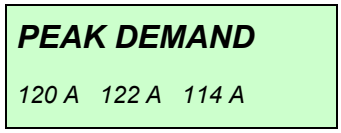
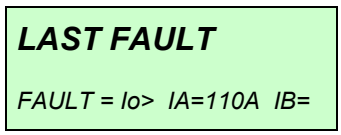
If custom operating mode has been selected, additional screens can be used to customize:

- Assignment of the output relays and fault LED
- Whether or not the output relays and fault LED are latched
- Inversion of the output relay control

No.	Screen	Description
7	***O1 ASSIGN*** *PROTECTION XX*	Display and selection of the O1 output relay assignment
8	***O2 ASSIGN*** *PROTECTION XX*	Display and selection of the O2 output relay assignment
9	***O3 ASSIGN*** *PROTECTION XX*	Display and selection of the O3 output relay assignment
10	***RELAYS LATCH*** *O1=YES O2=YES O3=YES*	Display and selection of O1, O2 and O3 output relay latching
11	***RELAYS INVER*** *O1=NO O2=NO*	Display and selection of O1 and O2 output relay control inversion
12	***LEDS LATCH*** *EARTH=YES*	Display and selection of earth fault LED latching

List of Sepam Series 10 B Screens

Metering Menu

No.	Screen	Description
1		Display of 2/3 phase currents, depending on the IA IC/IA IB IC setting in the ***I DISPLAY*** function. This is the default screen for Sepam series 10 B relays.
2		Display of the earth fault current
3		Display of the peak demand values for 2 or 3 phase currents, depending on the IA IC/IA IB IC setting
4		Display of the characteristics of the last fault. This screen is only present when the Sepam relay has already recorded a fault.

Protection Menu

No.	Screen	Description
1	***PHASE CT*** *600A/5A*	Display and setting of the characteristics of the phase CTs: ● Primary rated current In ● Secondary rated current: 1 A or 5 A
2a	***E/F CT*** *100A/1A*	Sepam series 10 B 31•, B 41• and B 42•: Display and setting of the characteristics of the earth CT or the phase CTs (Io sum): ● Primary rated current Ino or In ● Secondary rated current: 1 A or 5 A
2b	***E/F OP RANGE*** *0.2 - 24A*	Sepam series 10 B 43•: Display and selection of the measurement range by the earth fault core balance CT: 0.2-24 A/2-240 A
2c	***TC E/F RATIO*** *15*	Sepam series 10 B 42E certified GOST: Display and selection of the earth CT ratio: 15...200
3	***FREQUENCY*** *50 HZ*	Network frequency selection
4	***I>*** ***51*** *EI* *70A* *TD=0.8*	Display and setting of the low set point parameters for the phase overcurrent protection: ● Activation and tripping curve ● Tripping set point ● Tripping time delay
5	***I>>*** ***50-51*** *DT* *70A* *T=0.10s*	Display and setting of the high set point parameters for the phase overcurrent protection: ● Activation and tripping curve ● Tripping set point ● Tripping time delay
6	***Io>*** ***51N*** *EI* *10A* *TD=0.8*	Display and setting of the low set point parameters for the earth fault protection: ● Activation and tripping curve ● Tripping set point ● Tripping time delay
7	***Io>>*** ***50N-51N*** *DT* *10A* *T=0.10s*	Display and setting of the high set point parameters for the earth fault protection: ● Activation and tripping curve ● Tripping set point ● Tripping time delay
8	***THERMAL*** ***49 1*** *ON* *124A* *2MN*	Display and setting of the trip parameters for the thermal overload protection: ● Activation ● Maximum permissible continuous current ● Time constant of the protected equipment
9	***THERMAL*** ***49 2*** *ALARM=100* *HEAT.=0%*	Display and setting of the alarm parameters for the thermal overload protection if this has been activated: ● Alarm set point as a percentage of the calculated thermal capacity used ● Calculated thermal capacity used (display 0...999% and reset)

Standard Parameters Menu

No.	Screen	Description
1	***LANGUAGE*** *FRANCAIS*	Display and selection of the operating language
2	***I DISPLAY*** *IA IB IC*	Sepam series 10 B 4••: Display and selection of the number of phase currents to be displayed: IA IC/IA IB IC
3	***PEAK DEMAND*** *2MN*	Display and selection of the calculation period for the peak demand values
4	***COLD LOAD I*** *I> I>> 150% 1s*	Display and setting of the parameters of the phase overcurrent cold load pick-up function: ● Activation and operation ● Cold load pick-up percentage or set point blocking ● Pick-up duration
5	***COLD LOAD Io*** *Io> Io>> 150% 1s*	Display and setting of the parameters of the earth fault cold load pick-up function: ● Activation and operation ● Cold load pick-up percentage or set point blocking (or H2 restraint for Sepam series 10 B 41• and B 42•) ● Pick-up duration
6	***RESET TIME*** *ON*	Activation of the reset time for the phase and earth fault overcurrent protections
7	***SET PASSWORD*** *PASSWORD = xxxx*	Password activation and definition
8	***OUT STATUS*** *O1 ... O3 = 111*	Display of the status of output relays O1 to O3, from left to right: State 0 (off)/State 1 (on)
9	***SEPAM*** *V 1.3*	Display of the Sepam software version number
10	***I/O ASSIGN*** *STANDARD*	Display and selection of the Sepam operating mode: Standard/Custom

Custom Parameters Menu

After selecting custom operating mode, additional screens can be used to customize:

- Assignment of the output relays and fault LEDs
- Whether or not the output relays and fault LEDs are latched
- Inversion of the output relay control

No.	Screen	Description
11	***O1 ASSIGN*** *PROTECTION XXXXX*	Display and selection of the O1 output relay assignment
12	***O2 ASSIGN*** *PROTECTION XXXXX*	Display and selection of the O2 output relay assignment
13	***O3 ASSIGN*** *PROTECTION XXXXX*	Display and selection of the O3 output relay assignment
14	***RELAYS LATCH*** *O1=YES O2=YES O3=YES*	Display and selection of O1, O2 and O3 output relay latching
15	***RELAYS INVER*** *O1=NO O2=NO*	Display and selection of O1 and O2 output relay control inversion
16	***LEDS LATCH 1*** *PHASE=YES EARTH=YES*	Display and selection of latching of 2 fault LEDs: ● Phase fault ● Earth fault
17	***LEDS LATCH 2*** *THERM=YES*	Display and selection of latching of the thermal fault LED

List of Sepam Series 10 A Screens

Metering Menu

No.	Screen	Description
1	***IA IB IC*** *100 A 102 A 104 A*	Display of 2/3 phase currents, depending on the IA IC/IA IB IC setting in the ***I DISPLAY*** function. This is the default screen for Sepam series 10 A relays.
2	***Io*** *0.1 A*	Display of the earth fault current
3	***PEAK DEMAND*** *120 A 122 A 114 A*	Display of the peak demand values for 2 or 3 phase currents, depending on the IA IC/IA IB IC setting
4	***EVENT n*** *EVENT=Io> 2008 JAN*	Display of the characteristics of the last event (number n). This screen is only present when the Sepam relay has already recorded a fault.
5	***EVENT n-1*** *EVENT=Io> 2008 JAN*	Display of the characteristics of event number n-1. This screen is only present when the Sepam relay has already recorded 2 faults.
6	***EVENT n-2*** *EVENT=Io> 2008 JAN*	Display of the characteristics of event number n-2. This screen is only present when the Sepam relay has already recorded 3 faults.
7	***EVENT n-3*** *EVENT=Io> 2008 JAN*	Display of the characteristics of event number n-3. This screen is only present when the Sepam relay has already recorded 4 faults.
8	***EVENT n-4*** *EVENT=Io> 2008 JAN*	Display of the characteristics of event number n-4. This screen is only present when the Sepam relay has already recorded 5 faults.

Protection Menu

No.	Screen	Description
1	***PHASE CT*** *600A/5A*	Display and setting of the characteristics of the phase CTs: ● Primary rated current In ● Secondary rated current: 1 A or 5 A
2a	***E/F CT*** *100A/1A*	Sepam series 10 A 41• and A 42•: Display and setting of the characteristics of the earth CT or the phase CTs (Io sum): ● Primary rated current Ino or In ● Secondary rated current: 1 A or 5 A
2b	***E/F OP RANGE*** *0.2 - 24A*	Sepam series 10 A 43•: Display and selection of the measurement range by the earth fault core balance CT: 0.2-24 A/2-240 A
2c	***TC E/F RATIO*** *15*	Sepam series 10 A 42E and A 42F certified GOST: Display and selection of the earth CT ratio: 15...200
3	***FREQUENCY*** *50 HZ*	Network frequency selection
4	***I>*** ***51*** *EI 70A TD=0.8*	Display and setting of the low set point parameters for the phase overcurrent protection: ● Activation and tripping curve ● Tripping set point ● Tripping time delay
5	***I>>*** ***50-51*** *DT 70A T=0.10s*	Display and setting of the high set point parameters for the phase overcurrent protection: ● Activation and tripping curve ● Tripping set point ● Tripping time delay
6	***Io>*** ***51N*** *EI 10A TD=0.8*	Display and setting of the low set point parameters for the earth fault protection: ● Activation and tripping curve ● Tripping set point ● Tripping time delay
7	***Io>>*** ***50N-51N*** *DT 10A T=0.10s*	Display and setting of the high set point parameters for the earth fault protection: ● Activation and tripping curve ● Tripping set point ● Tripping time delay
8	***THERMAL*** ***49 1*** *ON 124A 2MN*	Display and setting of the trip parameters for the thermal overload protection: ● Activation ● Maximum permissible continuous current ● Time constant of the protected equipment
9	***THERMAL*** ***49 2*** *ALARM=100% HEAT.=0%*	Display and setting of the alarm parameters for the thermal overload protection if this has been activated: ● Alarm set point as a percentage of the calculated thermal capacity used ● Calculated thermal capacity used (display 0...999% and reset)

Standard Parameters Menu

No.	Screen	Description
1	***LANGUAGE*** *FRANCAIS*	Display and selection of the operating language
2	***I DISPLAY*** *IA IB IC*	Sepam series 10 A 4••: Display and selection of the number of phase currents to be displayed: IA IC/IA IB IC
3	***PEAK DEMAND*** *2MN*	Display and selection of the calculation period for the peak demand values
4	***COM PROTOCOL*** *MODBUS*	Display and selection of the communication protocol used: Modbus/IEC 60870-5-103
5a	***MODBUS*** *1 19200 EVEN SBO*	Display and setting of the Modbus communication protocol parameters (following selection in screen 4): ● Address ● Transmission speed ● Parity ● Remote control mode: Direct/confirmed (SBO)
5b	***IEC 870-5-103*** *1 19200 EVEN*	Display and setting of the IEC 60870-5-103 communication protocol parameters (following selection in screen 4): ● Address ● Transmission speed ● Parity
6	***COLD LOAD I*** *I> I>> 150% 1s*	Display and setting of the parameters of the phase overcurrent cold load pick-up function: ● Activation and operation ● Cold load pick-up percentage or set point blocking ● Pick-up duration
7	***COLD LOAD Io*** *Io> Io>> 150% 1s*	Display and setting of the parameters of the earth fault cold load pick-up function: ● Activation and operation ● Cold load pick-up percentage or set point blocking (or H2 restraint for Sepam series 10 A 41• and A 42•) ● Pick-up duration
8	***RESET TIME*** *ON*	Activation of the reset time for the phase and earth fault overcurrent protections
9	***TCS*** *ON TCS FAULT*	Trip circuit supervision: ● Activation of the trip circuit supervision function ● Annunciation of the TCS fault or circuit breaker position
10	***DATE*** *2008 JAN 1*	Display and setting of the Sepam date: ● Year ● Month ● Day

No.	Screen	Description
11	***TIME*** *0H 0MN 0s*	Display and setting of the Sepam time: ● Hours ● Minutes ● Seconds
12	***LOGIC INPUTS*** *VOLTAGE TYPE = DC*	Sepam series 10 A ••A and A ••E: Display and selection of the power supply voltage: AC/DC
13	***LOCAL MODE*** *OPEN ACCEPTED*	Activation of the remote opening function when Sepam is in local mode: remote opening accepted/not accepted
14	***SET PASSWORD*** *PASSWORD = xxxx*	Password activation and setting
15	***INPUT STATUS*** *I1 ... I4 = 1001*	Display of the status of logic inputs I1 to I4, from left to right: State 0 (off)/State 1 (on)
16	***OUT STATUS*** *O1 ... O6 = 000100*	Display of the status of output relays O1 to O6, from left to right: State 0 (off)/State 1 (on)
17	***SEPAM*** *V 1.3*	Display of the Sepam software version number
18	***I/O ASSIGN*** *STANDARD*	Display and selection of the Sepam operating mode: Standard/Custom

Custom Parameters Menu

If custom operating mode has been selected, additional screens can be used:

- To customize:
  - Assignment of the logic inputs, output relays and fault LEDs
  - Whether or not the output relays and fault LEDs are latched
  - Inversion of the output relay control
- To set the backup protection functions for the phase and earth fault overcurrent protections (settings associated with the use of logic discrimination)

No.	Screen	Description
19	***O1 ASSIGN*** *PROTECTION XXXXXX*	Display and selection of the O1 output relay assignment
20	***O2 ASSIGN*** *PROTECTION XXXXXX*	Display and selection of the O2 output relay assignment
21	***O3 ASSIGN*** *PROTECTION XXXXXX*	Display and selection of the O3 output relay assignment
22	***O5 ASSIGN*** *TCS*	Display and selection of the O5 output relay assignment
23	***O6 ASSIGN*** *ALARM 49*	Display and selection of the O6 output relay assignment
24	***RELAYS LATCH*** *O1=YES O2=YES O3=YES*	Display and selection of O1, O2 and O3 output relay latching
25	***RELAYS INVER*** *O1=NO O2=NO*	Display and selection of O1 and O2 output relay control inversion
26	***I3 ASSIGN*** *EXT TRIPPING*	Display and selection of the I3 logic input assignment
27	***I4 ASSIGN*** *EXT RESET*	Display and selection of the I4 logic input assignment
28	***LEDS LATCH 1*** *PHASE=YES EARTH=YES*	Display and selection of latching of 2 fault LEDs: ● Phase fault ● Earth fault
29	***LEDS LATCH 2*** *THERM=YES EXTERN=YES*	Display and selection of latching of 2 fault LEDs: ● Thermal fault ● External fault

No.	Screen	Description
30	***68 BKUP I>*** *OFF*	Display and setting of the backup tripping time delay of the low set point for phase overcurrent protection (settings associated with the use of logic discrimination): ● Activation and tripping curve (display only) ● Tripping set point (display only) ● Tripping time delay
31	***68 BKUP I>>*** *OFF*	Display and setting of the backup tripping time delay of the high set point for phase overcurrent protection (settings associated with the use of logic discrimination): ● Activation and tripping curve (display only) ● Tripping set point (display only) ● Tripping time delay
32	***68 BKUP Io>*** *OFF*	Display and setting of the backup tripping time delay of the low set point for earth fault protection (settings associated with the use of logic discrimination): ● Activation and tripping curve (display only) ● Tripping set point (display only) ● Tripping time delay
33	***68 BKUP Io>>*** *OFF*	Display and setting of the backup tripping time delay of the high set point for earth fault protection (settings associated with the use of logic discrimination): ● Activation and tripping curve (display only) ● Tripping set point (display only) ● Tripping time delay

Functions and parameters

4

What's in this Chapter?

This chapter contains the following topics:

General Principle

Introduction

The Functions and Parameters chapter describes the protection functions, the additional functions associated with them and also the parameters required for commissioning.

All this data is organized into the three menus described below.

Metering Menu

The metering menu is used to read values relating to the currents in the network and the characteristics of the recorded faults. The data in this menu can only be viewed. It cannot be modified.

Protection Menu

The protection menu contains the settings that are essential for operation of the metering and protection functions. These settings correspond to the electrical engineering characteristics for the installation to be protected, and must always be implemented at the time of commissioning.

Parameters Menu

The parameters menu contains the parameters and additional functions that can be used to adapt the Sepam operation to particular applications. On leaving the factory, all these parameters are preset to a default value. The protection functions are operational even if these parameters have not been set at the time of commissioning.

Standard Mode or Custom Mode

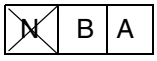
In the parameters menu, the ***I/O ASSIGN*** screen offers the choice of standard or custom operating mode. This affects operation of the output relays, logic inputs and fault LEDs. By default, these elements operate in standard mode and the customization screens do not appear in the parameters menu. To see the mimic diagrams of Sepam operation in standard mode, refer to *Standard Operation, p. 15*.

Custom mode is used to modify operation of the output relays, logic inputs and fault LEDs. In this case, the screens required to customize operation of these elements appear in the parameters menu. Refer to *Custom operating mode, p. 147*.

Which Topics Affect You?

Not all the topics discussed in this chapter apply to all Sepam models (series 10 N, series 10 B or series 10 A). Each topic begins with indicating which Sepam models it applies to: it does not apply to models whose identifier (N, B or A) is crossed out.

Example



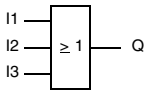
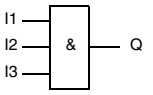
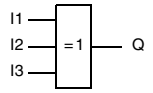
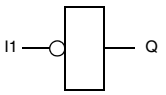
means that the topic only applies to Sepam series 10 B and Sepam series 10 A.

Definition of Symbols

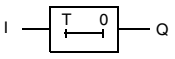
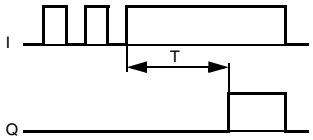
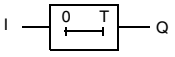
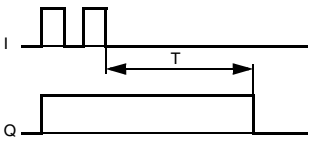
Introduction

The symbols used in the various block diagrams in this chapter are defined below. They are used to represent functions or settings.

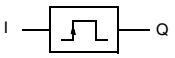
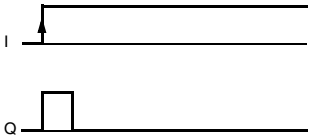
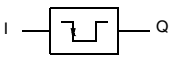
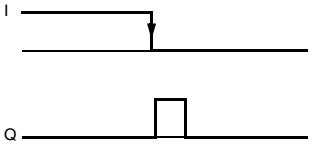
Logic Functions

Function	Equation	Description	Symbol
"OR"	Q = I1 + I2 + I3	Q = 1 if at least one input is at 1.	
"AND"	Q = I1 x I2 x I3	Q = 1 if all inputs are at 1.	
Exclusive "OR"	$Q = I1 x \overline{I2} x \overline{I3} + \overline{I1} x I2 x \overline{I3} + \overline{I1} x \overline{I2} x I3$	Q = 1 if only one input is at 1.	
Complement	$Q = \overline{I1}$	Q = 1 if I1 = 0.	

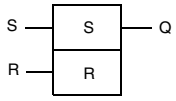
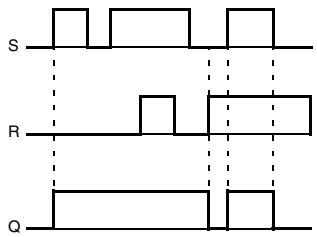
Time Delays

Type	Description	Symbol	Timing Diagram
Pick-up	Used to delay appearance of a data item for a time T.		
Drop-out	Used to delay disappearance of a data item for a time T.		

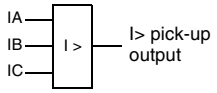
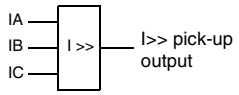
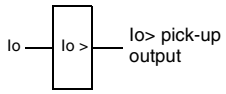
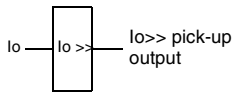
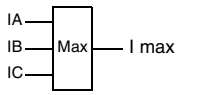
Monostable Function

Type	Description	Symbol	Timing Diagram
Pick-up	Used to create a short pulse (1 cycle) each time a logic signal appears.		
Drop-out	Used to create a short pulse (1 cycle) each time a logic signal disappears. **Remark:** Disappearance of a data item can be caused by the loss of the auxiliary power supply.		

Bistable Toggle Function

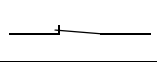
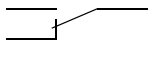
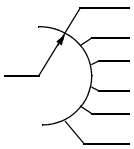
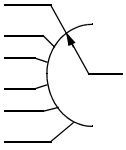
Function	Description	Symbol	Timing Diagram
Bistable toggle	Used to store information. Equation: $Q = S + \overline{R} \times Q$		

Current Input Functions

Function	Description	Symbol
I >	Indicates overshoot of the instantaneous low set point for phase overcurrent protection.	
I >>	Indicates overshoot of the instantaneous high set point for phase overcurrent protection.	
Io >	Indicates overshoot of the instantaneous low set point for earth fault protection.	
Io >>	Indicates overshoot of the instantaneous high set point for earth fault protection.	
Max	Selects the maximum rms values for all 3 phase currents.	

Settings

Using settings, the user can modify the Sepam logic. Ladder symbols are used to represent these settings, especially customizations.

Function	Description	Symbol
Switch	Assigns a signal to a logic function input.	
Selector switch with 2 inputs	Selects one of 2 inputs.	
Selector switch with 1 input - n outputs	Selects one of *n* outputs.	
Selector switch with n inputs - 1 output	Selects one of *n* inputs.	

Phase CT Ratio

Applicable to Sepam Series 10

~~M~~ B A

Description

The phase CT ratio can be accessed in the protection menu and must always be set at the time of commissioning. It is used by all Sepam functions which deal with the current.

Note: Set this ratio before implementing the protection settings. If the protection settings are entered before the ratio is modified, one or more of the protection set points may be outside the permitted current range. In this case, the Sepam itself resets the set points at the upper or lower limit of the permitted range and the operator has to re-check the earth fault current settings.

The parameter to be set is:

- Phase CT ratio setting (***PHASE CT*** screen)

Earth CT Ratio or Core balance CT Rating

Applicable to Sepam Series 10

N	B	A

Description

The earth CT ratio (or core balance CT rating) can be accessed in the protection menu and must always be set at the time of commissioning. It is used by all Sepam functions which deal with the earth fault current.

Note: Set this ratio before implementing the protection settings. If the settings are entered before the ratio (or rating) is modified, one or more of the protection set points may be outside the permitted current range. In this case, the Sepam itself resets the set point at the upper or lower limit of the permitted range and the operator has to re-check the earth fault current settings.

Example of Sepam Relays for Standard or Sensitive Earth Fault Protection

The Sepam relays concerned are:
- Sepam series 10 • •1• (standard earth fault protection)
- Sepam series 10 • •2• (sensitive earth fault protection)

These Sepam relays can be connected to a dedicated earth CT or to the common point of the 3 phase CTs.

The parameter to be set is:
- Earth CT ratio (***E/F CT or E/F RATIO CT*** screen)

If connected to the common point of the 3 phase CTs, this parameter must be set to the same value as the phase CT ratio.

Example of Sepam Relays for Very Sensitive Earth Fault Protection

The Sepam relays concerned are Sepam series 10 • •3• (very sensitive earth fault protection). This type of Sepam is designed to be connected to a CSH120, CSH200 or GO110 core balance CT.

The parameter to be set is:
- Choice of earth fault current measurement range (***E/F OP RANGE*** screen)

The possible choice is: 0.2-24 A or 2-240 A.

This choice must correspond to the current input to which the core balance CT is connected. Refer to *Connector B Connections, p. 29*. If not, the current measurement will be incorrect and the earth fault protection will not work properly.

Network Frequency

Applicable to Sepam Series 10

N	B	A

Description

The network frequency can be accessed in the protection menu and must always be indicated (50 or 60 Hz) at the time of commissioning. It is used by all Sepam functions which deal with the phase current and the earth fault current.

Sepam uses this parameter to adapt operation of the measurement and protection algorithms to the network frequency. If the setting is implemented incorrectly, the accuracy of the metering and protection functions will be seriously affected.

The parameter to be set is:

- Network frequency (***FREQUENCY*** screen)

Phase Overcurrent Protection (ANSI 50-51)

Applicable to Sepam Series 10

~~N~~	B	A

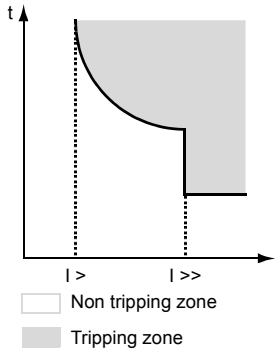
Description

Phase overcurrent protection is used to detect overcurrents due to phase-to-phase faults. It uses the measurement of the fundamental component of the currents produced by 2 or 3 phase CTs, with 1 A or 5 A secondary rating.

2 independent set points (I> and I>>) can be set to offer optimum discrimination:

- The low set point (I>) has either a definite time (DT) or inverse definite minimum time (IDMT) setting with different types of standardized curve (IEC, IEEE, RI).
- The high set point (I>>) only has a definite time (DT) setting. The minimum setting can be used to obtain instantaneous operation (ANSI 50 function).

Example: Curve for IDMT type I> set point and DT type I>> set point

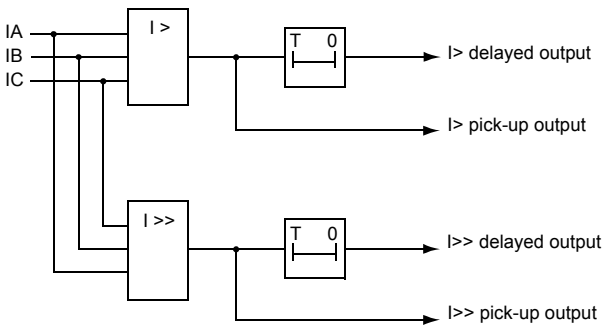


Additional Functions

Sepam integrates functions that complement phase overcurrent protection:

- *Reset time*:
  With an IDMT setting, the set point parameters are set in order to activate an IDMT reset time. This enables coordination with electromechanical relays. By default, the reset time is not active. Refer to *Reset Time, p. 93*.
- *Cold Load Pick-Up I* (or CLPU I):
  Operation of both the I> and I>> set points can be associated with the CLPU I function, which is used to avoid nuisance tripping of the protection when the installation is energized. By default, the CLPU I function is not active. Refer to *Phase Overcurrent Cold Load Pick-Up (Cold Load Pick-Up I), p. 102*
- *Logic discrimination:*
  Sepam can be integrated in the logic discrimination system. This system can be used when the installation requires the fault to be cleared within a short time. It is used to bypass the time interval between the protection stages, imposed by time discrimination. By default, on the Sepam series 10 A, the O5 output relay is assigned to the logic discrimination blocking output. Refer to *Logic Discrimination (ANSI 68), p. 121*.

Block Diagram



Standard Operation

If the 3 phase overcurrents exceed the I> or I>> set point:

- The fault LED flashes quickly.
- The corresponding pick-up output changes state.
  - The 2 pick-up outputs are used by the logic discrimination function to send a logic discrimination blocking order: refer to *Logic Discrimination (ANSI 68), p. 121*.
  - The state of both these outputs is available via the communication: refer to *Communication, p. 169*.

After the time delay associated with the I> or I>> set point has elapsed:

- The LED flashes slowly.
- Output relays O1, O2, O3 change status.
- The fault screen is displayed with the tripping current values.

If all 3 phase currents drop back below set points I> or I>>, then output relays O1, O2, O3 and the display remain in the same state (latching function).

Pressing the Reset key disables the latching function (refer to *Fault Acknowledgement, p. 146*):

- The LED goes out.
- The output relays return to their initial status.
- The fault screen is replaced by the screen displayed prior to appearance of the fault.

Remark: If the I>> time delay is set to ***INST*** (instantaneous), the I>> delayed output is the same as the I>> pick-up output.

Customization Option

Sepam's custom mode can be used to modify standard operation:

- Latching of the LED can be disabled.
- Assignment of the I> and I>> set points to output relays O1, O2, O3 can be modified.
- Latching of output relays O1, O2, O3 can be disabled.
- The activation logic of output relays O1 and O2 is configurable (contact closed or open on fault detection).

Refer to *Custom operating mode, p. 147*.

Settings

I> Set Point Settings		Authorized Values
Tripping curve For more information on tripping curves and the reset time, refer to *Overcurrent Protection Tripping Curves, p. 90*.		● OFF: Set point off ● DT: Definite time ● SIT/A: IEC standard inverse time ● VIT/B: IEC very inverse time ● LTI/B: IEC long time inverse ● EIT/C: IEC extremely inverse time ● MI: IEEE moderately inverse ● VI: IEEE very inverse ● EI: IEEE extremely inverse ● RI
I> set point	DT curve	0.1...24 In (minimum: 1 A)
	IDMT curves	0.1...2.4 In (minimum: 1 A)
Time delay	DT curve	0.05...300 s in steps of: ● 0.01 s, from 0.05 to 9.99 s ● 0.1 s, from 10.0 to 99.9 s ● 1 s, from 100 to 300 s
	IEC, RI curves	TMS: 0.02...2 (step: 0.01)
	IEEE curves	TD: 0.5...15 (step: 0.1)
	Reset time	Setting common to I> and Io> set points: ● OFF: Reset time off ● ON: Reset time on

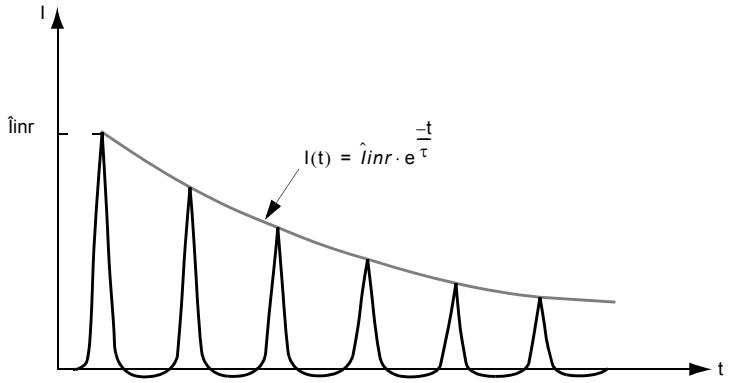
I>> Set Point Settings		Authorized Values
Tripping curve		● OFF: Set point off ● DT: Definite time
I>> set point	DT curve	0.1 In...24 In (minimum: 1 A)
Time delay	DT curve	Instantaneous (pick-up) or 0.05...300 s in steps of: ● 0.01 s, from 0.05 to 9.99 s ● 0.1 s, from 10.0 to 99.9 s ● 1 s, from 100 to 300 s

Remark: In is the phase CT primary rated current.

Sensitivity to Transformer Inrush Currents

When a transformer closes, the magnetizing currents can reach amplitudes, in peak values, of around 5 to 12 times the rated transformer current. These transient currents can be the source of nuisance tripping of the ANSI 51 protection functions.

These inrush currents have a strong aperiodic component:



Measurement of the Sepam currents is not affected by the presence of an aperiodic component (50 Hz or 60 Hz), which permits a significant reduction in the ANSI 51 protection function setting.

In instantaneous protection (ANSI 50), the high set point should be set to at least 37% of the peak value of the inrush current stated by the transformer manufacturer.

With delayed protection (ANSI 51), the same rule applies, taking account of the current attenuation according to the time constant stated by the transformer manufacturer.

Settings for Using the Function

Compulsory settings in the protection menu:

- Phase CT transformation ratio setting (***PHASE CT*** screen)
- Network frequency selection (***FREQUENCY*** screen)
- Low set point (I>) setting (***I> 51*** screen)
- High set point (I>>) setting (***I>> 50-51*** screen)

Additional settings in the parameters menu:

- Activation of the reset time (***RESET TIME*** screen) This setting is common to the I> and Io> set points.
- Cold Load Pick-Up I setting (***COLD LOAD I*** screen)

Earth Fault Protection (ANSI 50N-51N)

Applicable to Sepam Series 10

N	B	A

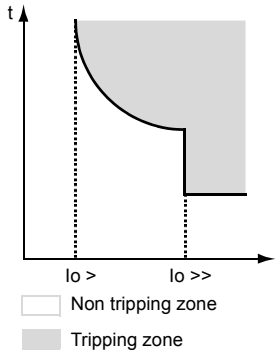
Description

Earth fault protection is used to detect overcurrents due to phase-to-earth faults. It uses the measurement of the earth fault current fundamental component according to several connection diagrams (see below).

This protection can be used in various application scenarios:
- Incomer/feeder protection
- Neutral point protection
- Tank earth leakage protection

2 independent set points (Io> and Io>>) can be set to offer optimum discrimination:
- The low set point (Io>) has either a definite time (DT) or inverse definite minimum time (IDMT) setting with different types of standardized curve (IEC, IEEE, RI).
- The high set point (Io>>) only has a definite time (DT) setting. The minimum setting can be used to obtain instantaneous operation (ANSI 50N function).

Example: Curve for IDMT type Io> set point and DT type Io>> set point

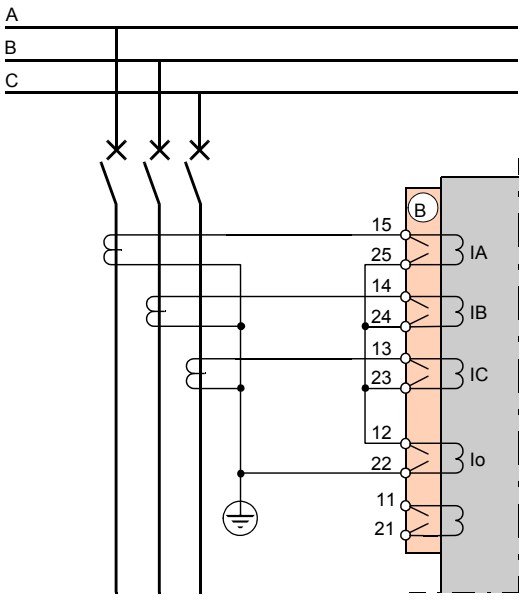
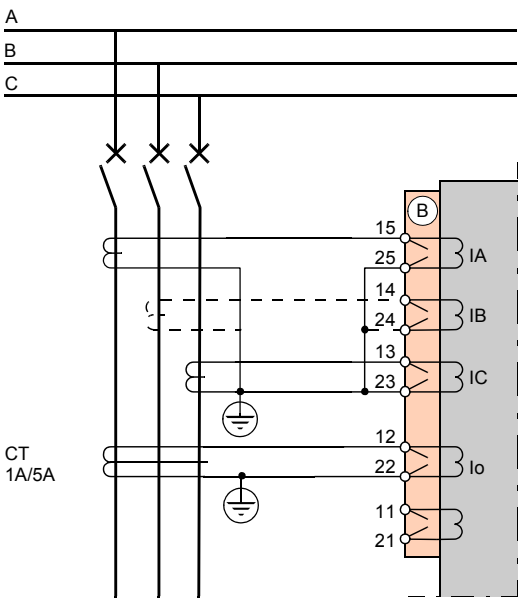


Sensitivity and Principle of Connection Diagrams

Depending on the sensitivity level required, three types of Sepam relay are available. Each type authorizes one or more connection diagrams to measure the earth fault current.

Standard earth fault protection - Sepam series 10 • •1•:

There are two possible connection diagrams:

Diagram 1	Diagram 2
Earth fault current measurement using the common point of the 3 phase CTs, with 1 A or 5 A secondary rating.	Current measurement from an earth CT with 1 A or 5 A secondary rating.
The connection is as follows: 	The connection is as follows: 

This version allows a minimum protection setting of 10% of the phase CT rating (diagram 1) or the earth CT rating (diagram 2).

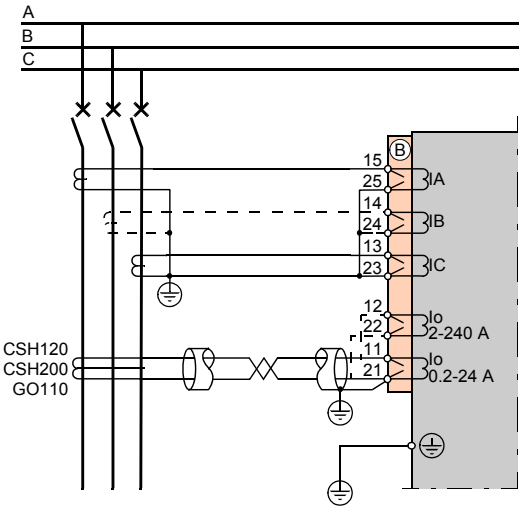
Sensitive earth fault protection - Sepam series 10 • •2•

The authorized connection diagrams are the same as the standard version. However, the minimum protection setting is divided by 10 compared with the standard version. It is 1% of the phase CT rating (diagram 1) or the earth CT rating (diagram 2).

However, if the protection set point needs to be set with low-level current values, use of an earth CT is strongly recommended (diagram 2). In the case of diagram 1, precision errors in the 3 phase CTs can result in *incorrect* earth fault current measurement. For set points below 10% CT In, this inaccuracy could lead to nuisance tripping of the protection.

Very sensitive earth fault protection - Sepam series 10 • •3•

This version operates with specifically designed core balance CTs. The connection diagram is as follows:



Three types of core balance CT are available:

Core Balance CT	Ratio	Type of CT	Inner Diameter
CSH120	470/1	Closed	120 mm (4.7 in)
CSH200	470/1	Closed	196 mm (7.7 in)
GO110	470/1	Opening	110 mm (4.3 in)

This version of Sepam is particularly suited to application scenarios requiring low-level earth fault current detection, wired as an alarm or as a trip.

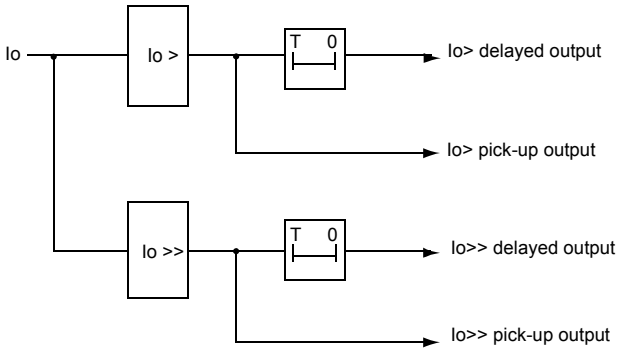
Sepam has 2 sensitivity ranges, depending on the connection of the core balance CT to the Sepam relay:
- 0.2-24 A range (primary current)
- 2.0-240 A range (primary current)

For more information on connecting the core balance CT to Sepam, refer to *Connecting a Core Balance CT, p. 40*.

Additional Functions

Sepam integrates functions that complement earth fault protection:
- *Reset time*:
  With an IDMT setting, the set point parameters are set in order to activate an IDMT reset time. This enables coordination with electromechanical relays. By default, the reset time is not active. Refer to *Reset Time, p. 93*.
- *Earth fault cold load pick-up* (Cold Load Pick-Up Io or CLPU Io):
  Operation of both the Io> and Io>> set points can be associated with the CLPU Io function, which is used to avoid nuisance tripping of the protection when the installation is energized. By default, the CLPU Io function is not active. Refer to *Earth Fault Cold Load Pick-Up (Cold Load Pick-Up Io), p. 105*.
- *Logic discrimination:*
  Sepam can be integrated in the logic discrimination system. This system can be used when the installation requires the fault to be cleared within a short time. It is used to bypass the time interval between the protection stages, imposed by time discrimination. By default, on the Sepam series 10 A, output relay O5 is assigned to the logic discrimination blocking output. Refer to *Logic Discrimination (ANSI 68), p. 121*.

Block Diagram



Standard Operation

If the earth fault current exceeds the Io> or Io>> set point:

- The I_{Δ}> fault LED flashes quickly.
- The corresponding pick-up output changes state.
  - The 2 pick-up outputs are used by the logic discrimination function to send a logic discrimination blocking order: refer to *Logic Discrimination (ANSI 68), p. 121*.
  - The state of both these outputs is available via the communication: Refer to the *Communication, p. 169* section.

After expiry of the time delay associated with the Io> or Io>> set point:

- The I_{Δ}> fault LED flashes slowly.
- Output relays O1, O2, O3 change state.
- The fault screen is displayed, with the tripping current values.

If the earth fault current drops back below the Io> or Io>> set point, then output relays O1, O2, O3 and the display remain in the same state (latching function). Pressing the Reset key disables the latching function (refer to *Fault Acknowledgement, p. 146*):

- The I_{Δ}> LED goes out.
- The output relays return to their initial state.
- The fault screen is replaced by the screen displayed prior to appearance of the fault.

Remark: If the Io>> time delay is set to ***INST*** (instantaneous), the Io>> delayed output is equivalent to the Io>> pick-up output.

Customization Option

Sepam's custom mode can be used to modify standard operation:

- Latching of the I_{Δ}> LED can be disabled.
- Assignment of the Io> and Io>> set points to the O1, O2, O3 output relays can be modified.
- Latching of output relays O1, O2, O3 can be disabled.
- The activation logic of output relays O1 and O2 is configurable (contact closed or open on fault detection).

Refer to *Custom operating mode, p. 147*.

Settings

Io> Set Point Settings				**Authorized Values**
Tripping curve For more information on tripping curves and the reset time, refer to *Overcurrent Protection Tripping Curves, p. 90*.				● OFF: Set point off ● DT: Definite time (DT) ● SIT/A: IEC standard inverse time ● VIT/B: IEC very inverse time ● LTI/B: IEC long time inverse ● EIT/C: IEC extremely inverse time ● MI: IEEE moderately inverse ● VI: IEEE very inverse ● EI: IEEE extremely inverse ● RI
Io> set point	DT curve	Standard version		0.1...24 Ino (minimum: 1 A)
		Sensitive version		0.01...2.4 Ino (minimum: 0.1 A)
		Very sensitive version	0.2-24 A rating	0.0004...0.05 Ino (0.2...24 A)
			2-240 A rating	0.004...0.5 Ino (2.0...240 A)
	IDMT curves	Standard version		0.1...2.4 Ino (minimum: 1 A)
		Sensitive version		0.01...0.24 Ino (minimum: 0.1 A)
		Very sensitive version	0.2-24 A rating	0.0004...0.005 Ino (0.2...2.4 A)
			2-240 A rating	0.004...0.05 Ino (2.0...24 A)
	Accuracy	Standard version		+/- 5% or +/- 0.03 Ino
		Sensitive version		+/- 5% or +/- 0.003 Ino
		Very sensitive version	0.2-24 A rating	+/- 5% or +/- 0.00015 Ino (+/- 0.07 A)
			2-240 A rating	+/- 5% or +/- 0.0015 Ino (+/- 0.7 A)
Time delay	DT curve			0.05...300 s in steps of: ● 0.01 s, from 0.05 to 9.99 s ● 0.1 s, from 10.0 to 99.9 s ● 1 s, from 100 to 300 s
	IEC, RI curves			TMS: 0.02...2 (step: 0.01)
	IEEE curves			TD: 0.5...15 (step: 0.1)
	Reset time			Setting common to I> and Io> set points: ● OFF: Reset time off ● ON: Reset time on

Io>> Set Point Settings				**Authorized Values**
Tripping curve				● OFF: Set point off ● DT: Definite time (DT)
Io>> set point	DT curve	Standard version		0.1...24 Ino (minimum: 1 A)
		Sensitive version		0.01...2.4 Ino (minimum: 0.1 A)
		Very sensitive version	0.2-24 A rating	0.0004...0.05 Ino (0.2...24 A)
			2-240 A rating	0.004...0.5 Ino (2.0...240 A)
	Accuracy	Standard version		+/- 5% or +/- 0.03 Ino
		Sensitive version		+/- 5% or +/- 0.003 Ino
		Very sensitive version	0.2-24 A rating	+/- 5% or +/- 0.00015 Ino (+/- 0.07 A)
			2-240 A rating	+/- 5% or +/- 0.0015 Ino (+/- 0.7 A)
Time delay	DT curve			Instantaneous (pick-up) or 0.05...300 s in steps of: ● 0.01 s, from 0.05 to 9.99 s ● 0.1 s, from 10.0 to 99.9 s ● 1 s, from 100 to 300 s

Remarks

- For standard and sensitive versions, Ino is the earth CT primary rated current.
- For the very sensitive version, Ino is the primary rated current Ino for CSH200, CSH120 and GO110 core balance CTs, i.e. 470 A.

Settings for Using the Function

Compulsory settings in the protection menu:

- Earth CT ratio setting (***E/F CT*** or ***E/F RATIO CT*** screen)
  If the measurement is taken on the common point of the 3 phase CTs, this setting is the same as the phase CT ratio.
- Low set point Io> setting (***Io> 51 N*** screen)
- High set point Io>> setting (***Io>> 50 N-51N*** screen)
- Network frequency selection (***FREQUENCY*** screen)

Additional settings in the parameters menu:

- Activation of the reset time (***RESET TIME*** screen). This setting is common to the I> and Io> set points.
- Cold Load Pick-Up Io setting (***COLD LOAD Io*** screen)

Overcurrent Protection Tripping Curves

Applicable to Sepam Series 10

N	B	A

Introduction

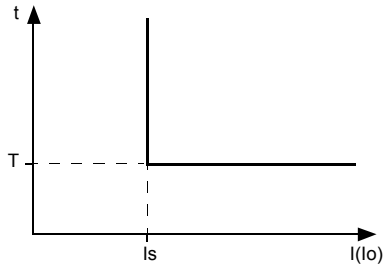
Phase or earth fault overcurrent protection can be delayed using the following types of tripping curve:
- Definite time (DT): low set points I>, Io> and high set points I>>, Io>>
- IDMT: low set points I>, Io> only

In the case of standardized IDMT curves (IEC and IEEE type only), a reset time can be activated. This reset time enables Sepam's coordination with electromechanical relays, placed upstream.

Definite Time (DT) Curve

In definite time (DT) protection functions, the tripping time is constant. The time delay is initialized as soon as the operating set point Is is passed.

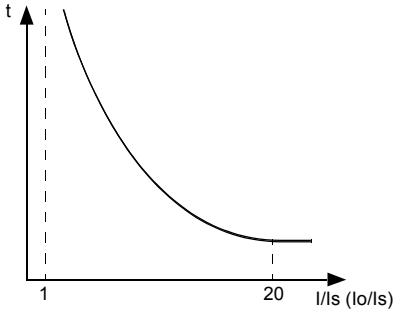
Definite time protection principle



IDMT Curve

In IDMT protection functions, the tripping time depends on the measured value (phase or earth fault current), in accordance with standards IEC 60255-3 and IEEE C-37112.

Operation is represented by characteristic curves t = f(I/Is) or t = f(Io/Is) (where Is is the operating set point), which look like this:



The curve is defined by:
- Its type (IEC, IEEE, inverse, very inverse, extremely inverse, etc.)
- Its current setting Is, which corresponds to the vertical asymptote of the curve
- Its time delay setting, which corresponds to a multiplying factor:
  - TMS (Time Multiplying Setting) for IEC and RI curves
  - TD (Time Dial) for IEEE curves

When a high current is being measured, the following rules apply:
- When the value being monitored is more than 20 times the set point, the maximum tripping time corresponds to a value of 20 times the set point.
- If the value being monitored exceeds Sepam's dynamic measurement range, the maximum tripping time corresponds to the maximum dynamic range given in the table below.

Inputs			**Dynamic Range**
Phase current inputs			40 In
Earth fault current input	Standard version		40 Ino
	Sensitive version		4 Ino
	Very sensitive version	0.2...24 A rating	40 A
		2...240 A rating	400 A

In and Ino: phase CT primary rated current or earth CT primary rated current respectively

Equation for IEC Curves

IEC curves are defined by the following equation:

$$td(I) = \frac{A}{\left(\frac{I}{Is}\right)^{p} - 1} \times TMS$$

Tripping curve parameters depending on the type of curve:

Characteristic Curve	**A**	**p**
IEC standard inverse time SIT/A	0.14	0.02
IEC very inverse time VIT/B	13.5	1
IEC long time inverse LTI/B	120	1
IEC extremely inverse time EIT/C	80	2

Equation for IEEE Curves

IEEE curves are defined by the following equation:

$$td(I) = \left(\frac{A}{\left(\frac{I}{Is}\right)^{p} - 1} + B \right) \times TD$$

Tripping curve parameters depending on the type of curve:

Characteristic Curve	A	B	p
IEEE moderately inverse (MI)	0.0103	0.0228	0.02
IEEE very inverse (VI)	3.922	0.0982	2
IEEE extremely inverse (EI)	5.64	0.02434	2

Equation for the RI Curve

The RI curve is defined by the following equation:

$$td(I) = \frac{1}{0,339 - 0,236\left(\frac{I}{Is}\right)^{-1}} \times TMS$$

Reset Time

When the low set points I> and Io> use standardized IDMT curves (IEC or IEEE type), it is possible to activate an IDMT reset time. This characteristic ensures coordination of a Sepam with an electromechanical overcurrent relay, placed upstream.

Without a reset time, the tripping time delay counter is reset once the current drops back below the set point (I < 95% Is).

With a reset time, when the current drops back below the set point, the time delay counter is decremented in line with a curve that depends on the measured current value. The aim is to reproduce the operation of the electromechanical relay disk. The reset time corresponds to the time it would take the disk to return from its maximum position (fault current) to its off-position. This time depends on the current measured by the Sepam relay.

The reset time curve is defined in standard IEEE C-37112.

It is defined by the following equation:

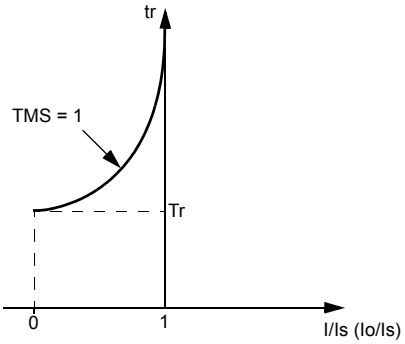
$$tr(I) = \frac{Tr}{1-\left(\frac{I}{Is}\right)^2} \times TMS$$

where:
- Is: Tripping set point value
- I (Io): Current measured by the protection function
- TMS (or TD): Tripping curve setting

Tr, the value of the reset time for a zero current and TMS = 1, is defined in the table below:

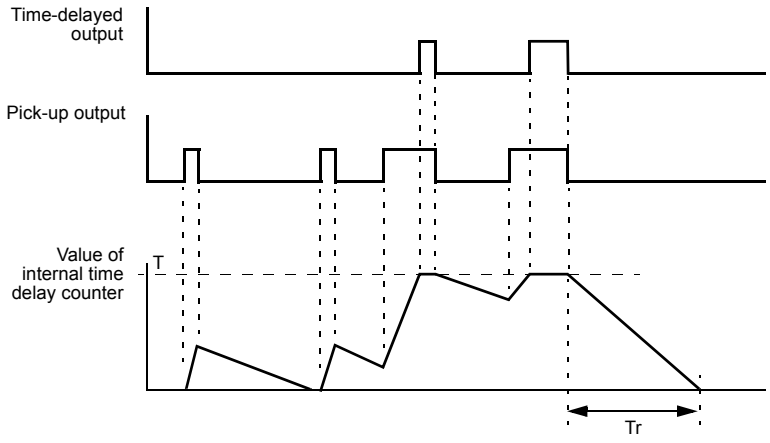
Characteristic Curve	**Tr**
IEC standard inverse time SIT/A	12.1
IEC very inverse time VIT/B	43.2
IEC long time inverse LTI/B	120
IEC extremely inverse time EIT/C	80
IEEE moderately inverse (MI)	0.97
IEEE very inverse (VI)	4.32
IEEE extremely inverse (EI)	5.82

The corresponding curve looks like this:

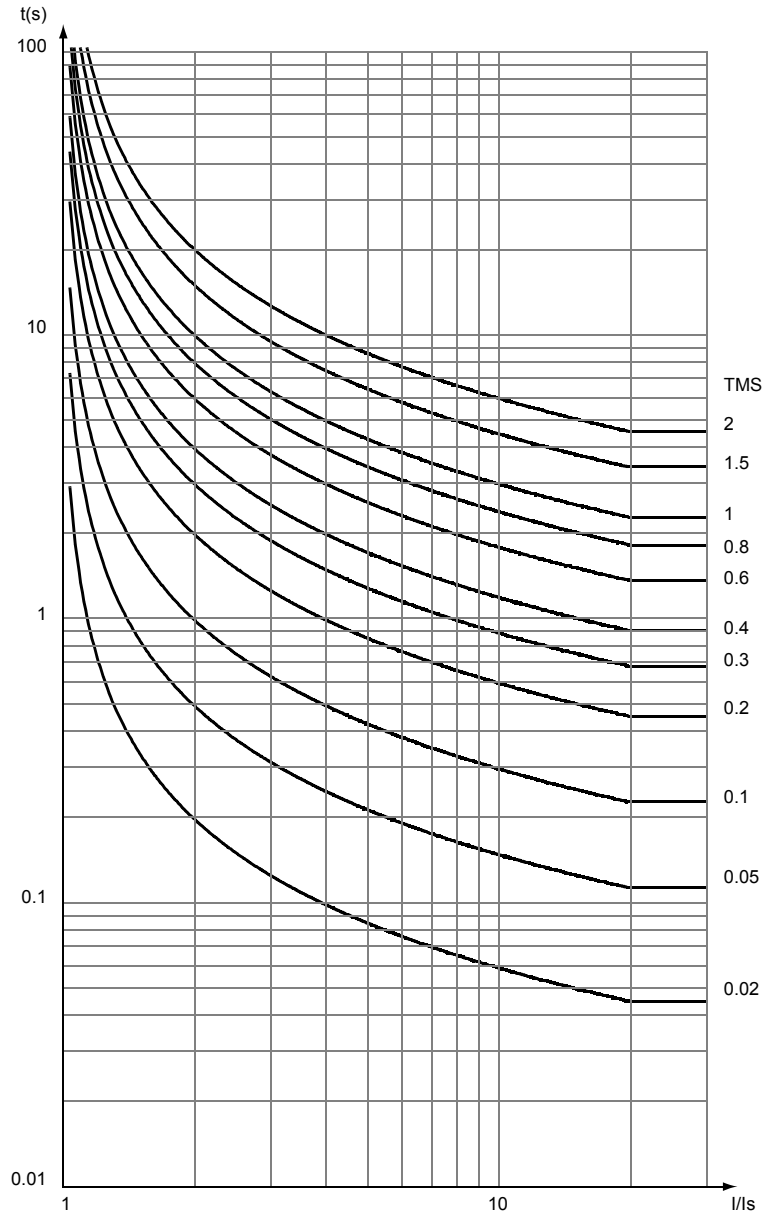


Example of Reset Time

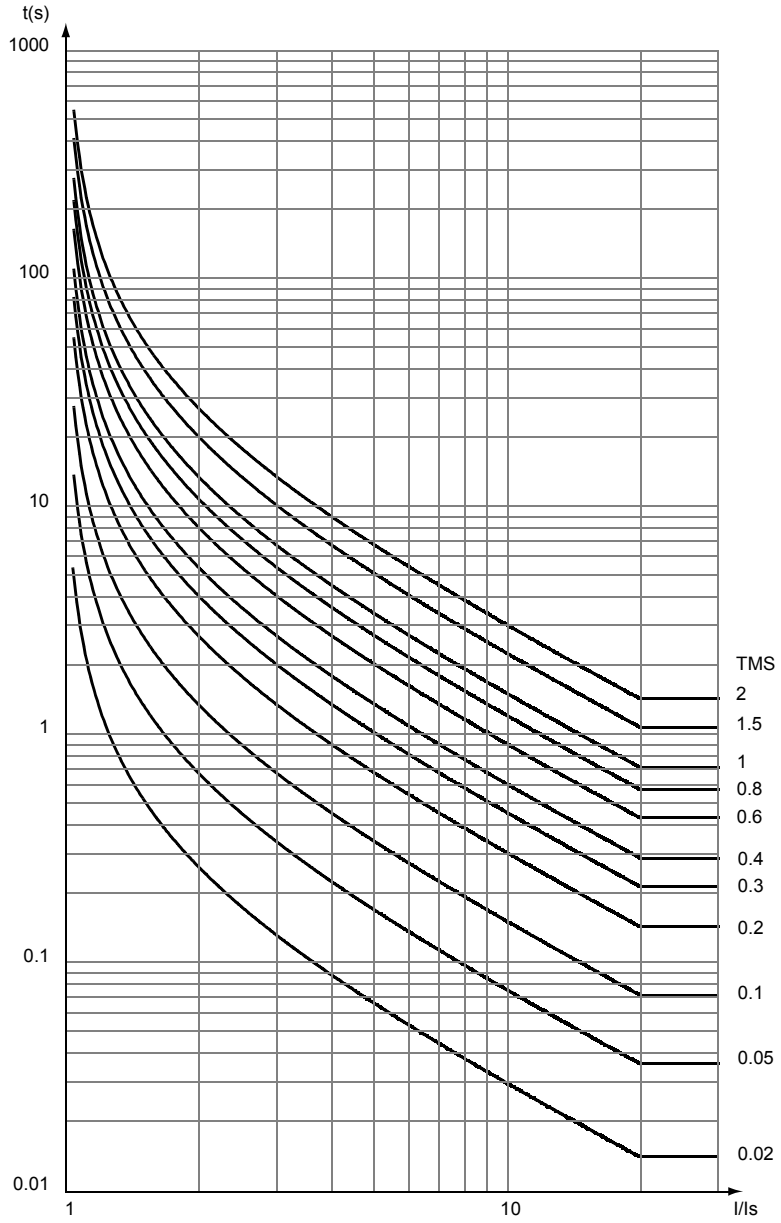
The timing diagram below explains the operation caused by the current-dependent reset time:



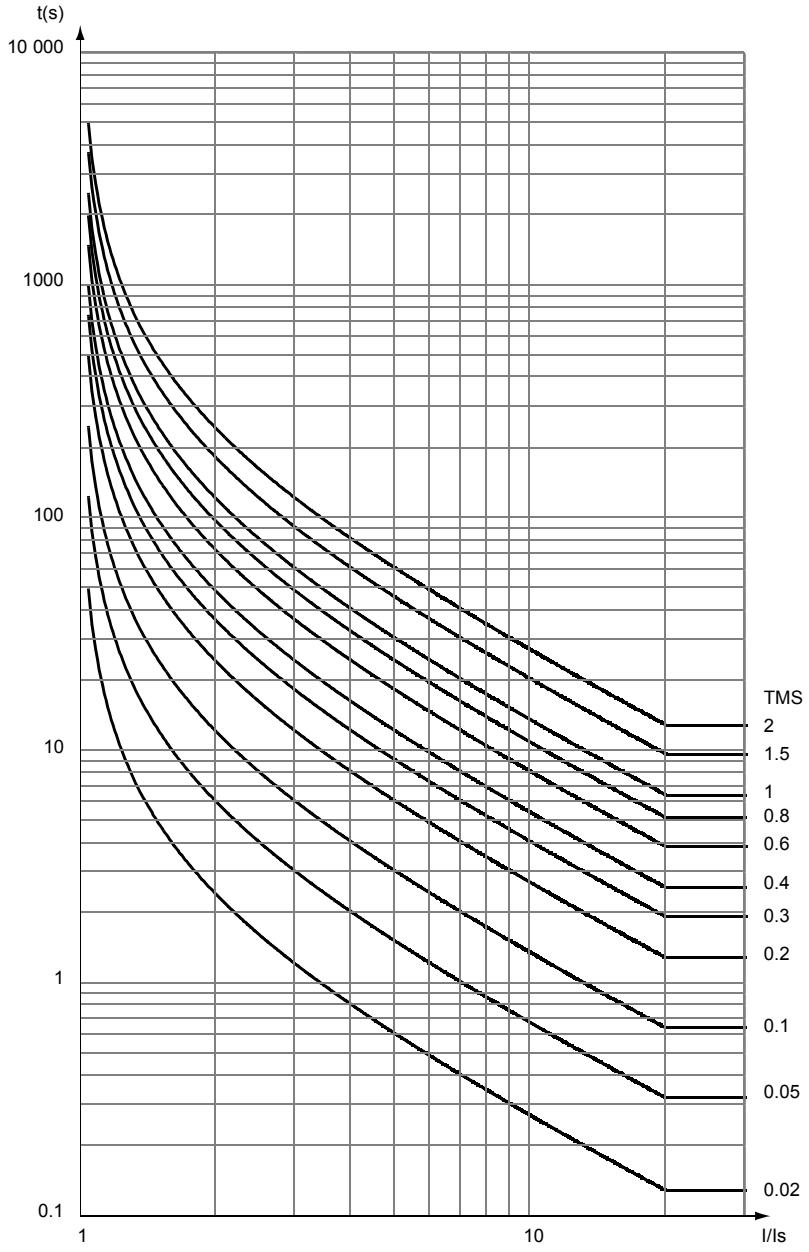
IEC Standard Inverse Time Curve (SIT/A)



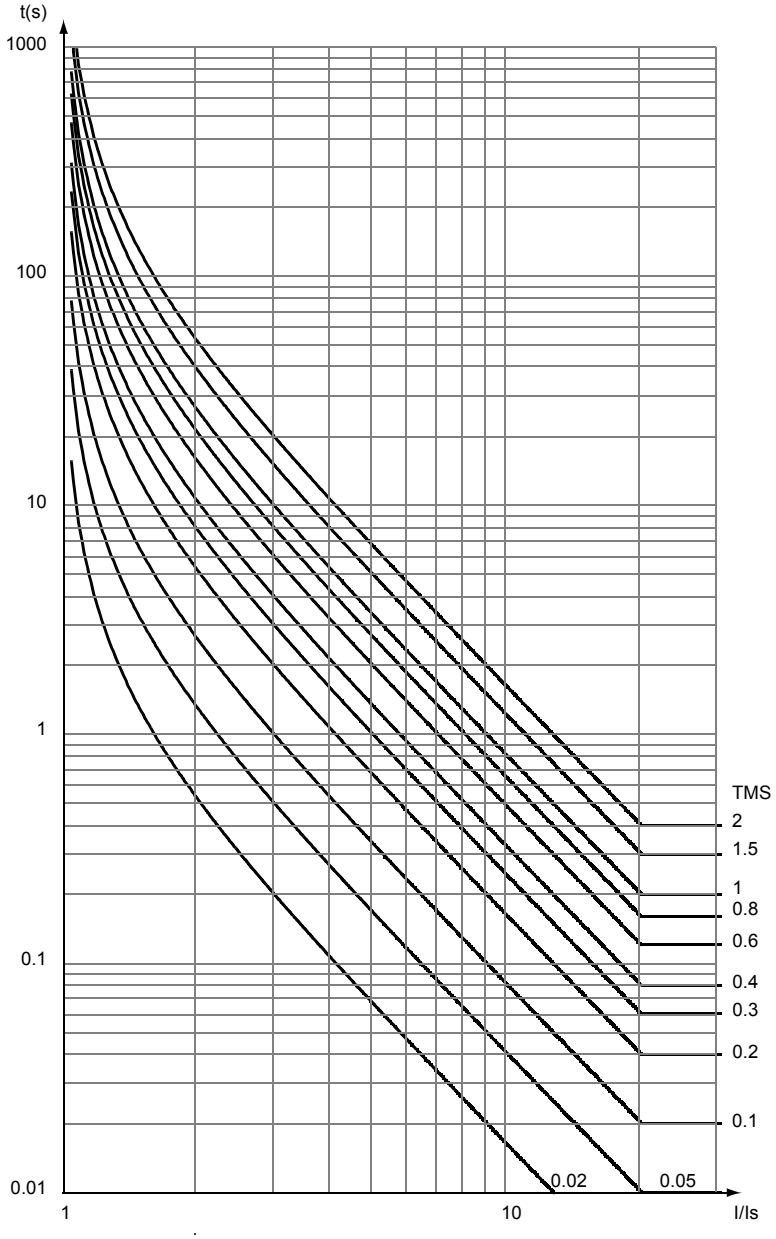
IEC Very Inverse Time Curve (VIT/B)



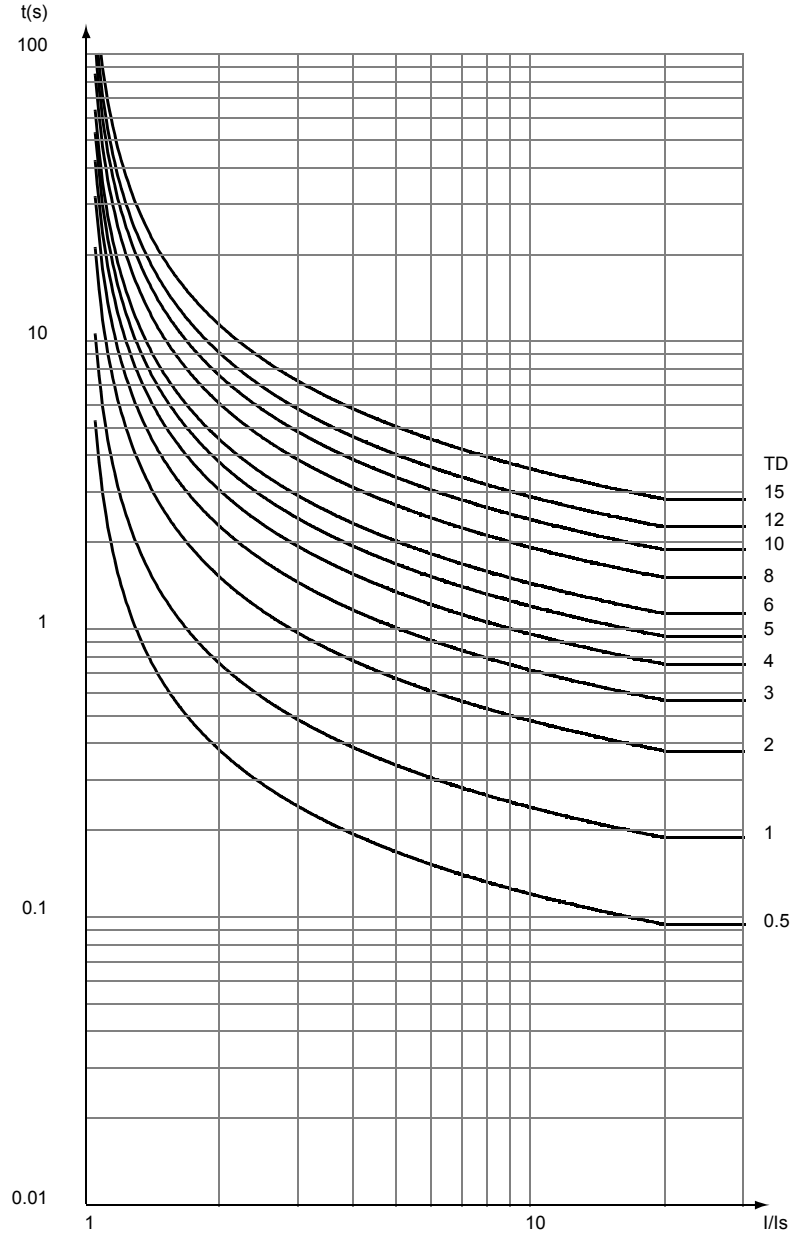
IEC Long Time Inverse Curve (LTI/B)



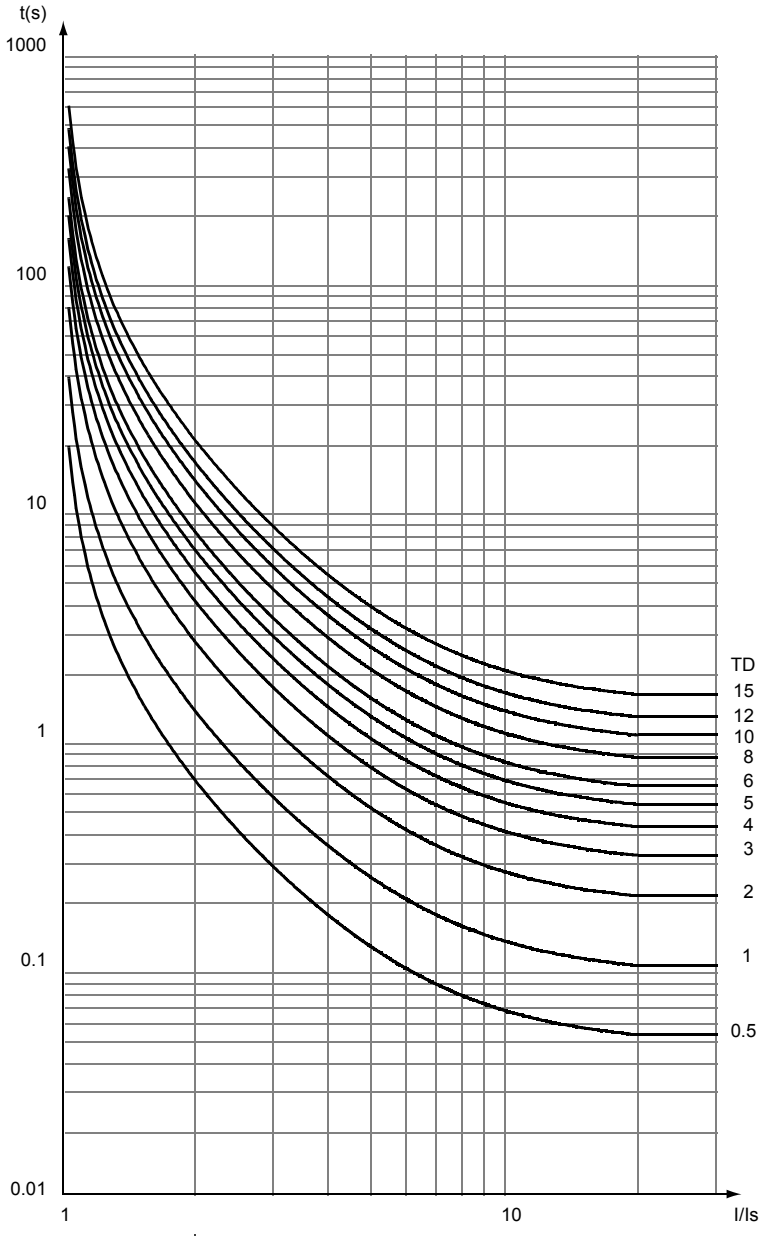
IEC Extremely Inverse Time Curve (EIT/C)



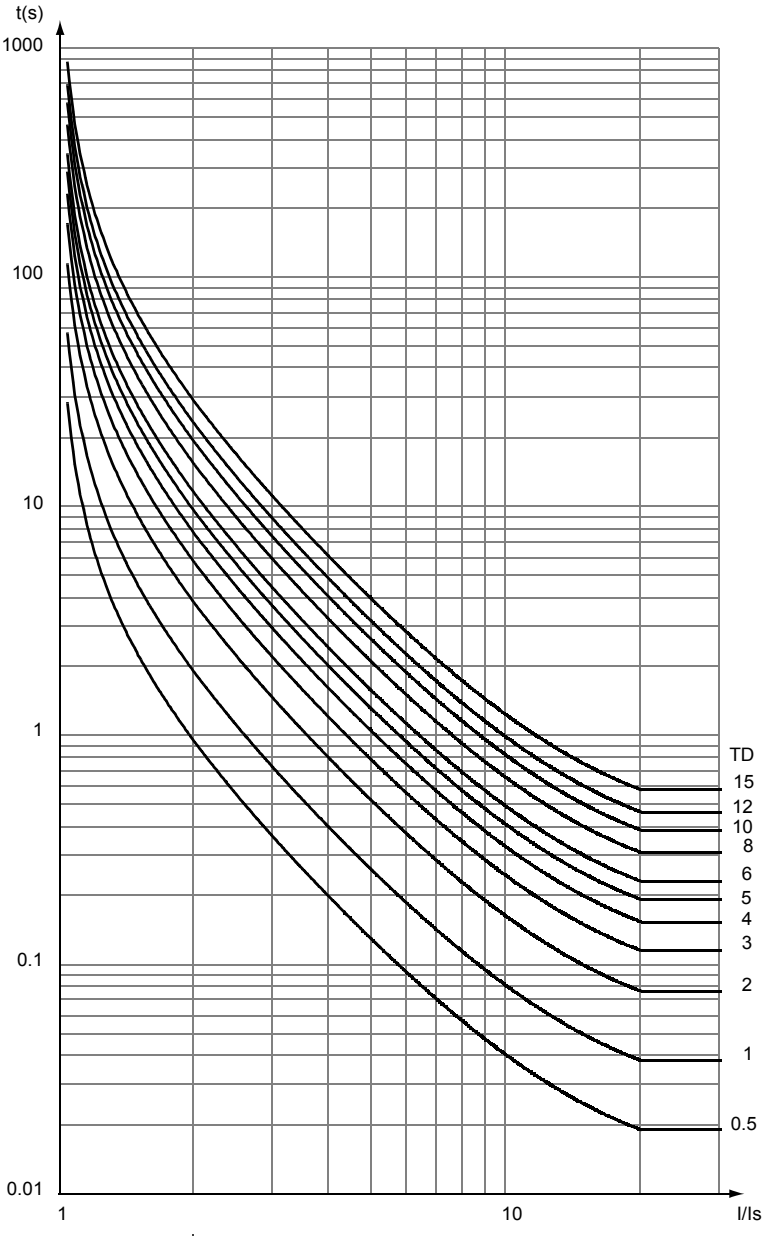
IEEE Moderately Inverse Curve (MI)



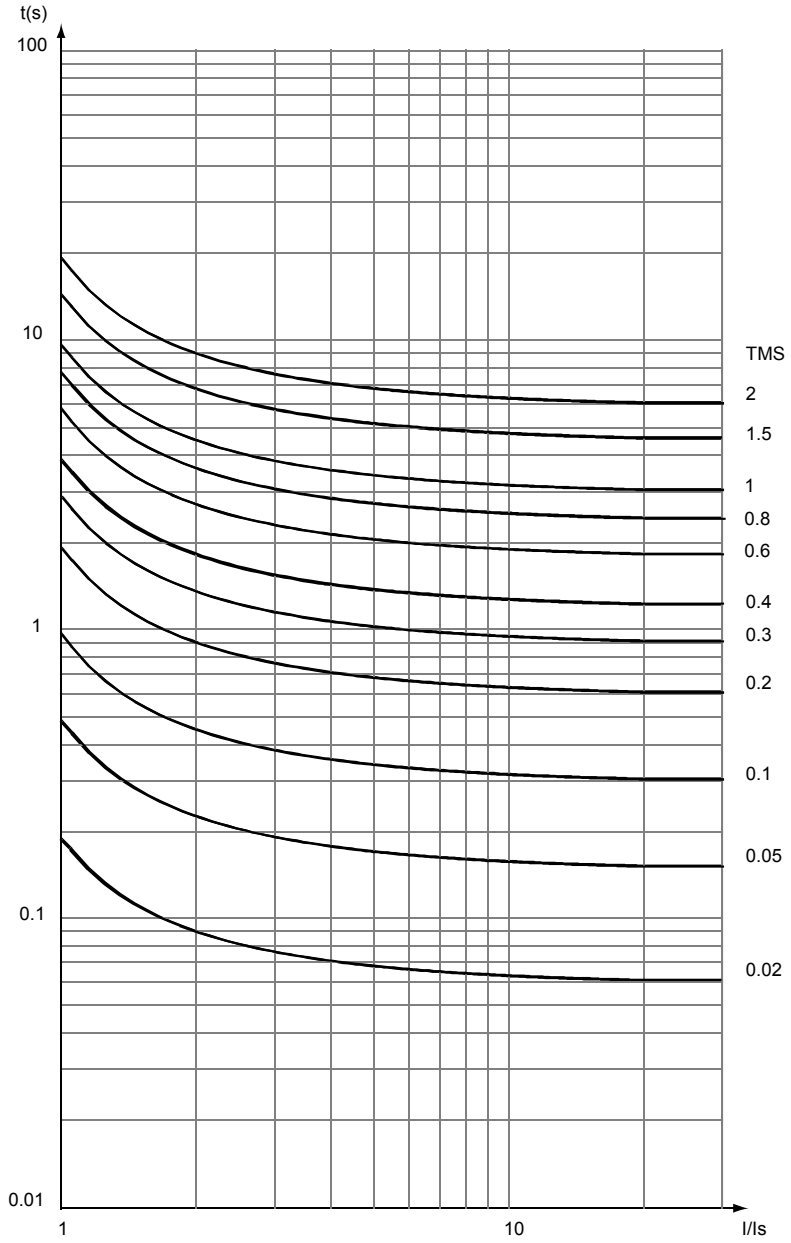
IEEE Very Inverse Curve (VI)



IEEE Extremely Inverse Curve (EI)



RI Curve



Phase Overcurrent Cold Load Pick-Up (Cold Load Pick-Up I)

Applicable to Sepam Series 10

~~N~~	B	A

Description

The phase overcurrent cold load pick-up function avoids nuisance tripping of the phase overcurrent protection (ANSI 50-51) during energization, after a long outage. It is used to increase the protection set point temporarily.

Depending on the installation characteristics, these operations can generate transient inrush currents likely to exceed the protection set points.

These transient currents may be due to:
- Simultaneous resetting of all the loads in an installation (air conditioning, heating, etc.)
- The power transformer magnetizing currents
- The motor starting currents

In normal circumstances, the protection settings should be defined so as to avoid tripping due to these transient currents. However, if this rule results in inadequate sensitivity levels or delays that are too long, this function can be used to increase or inhibit set points temporarily after energization. Use of this function maintains a good level of protection sensitivity, regardless of the constraints affecting energization.

Remark: In the rest of this manual, this function is referred to by its abbreviation CLPU I.

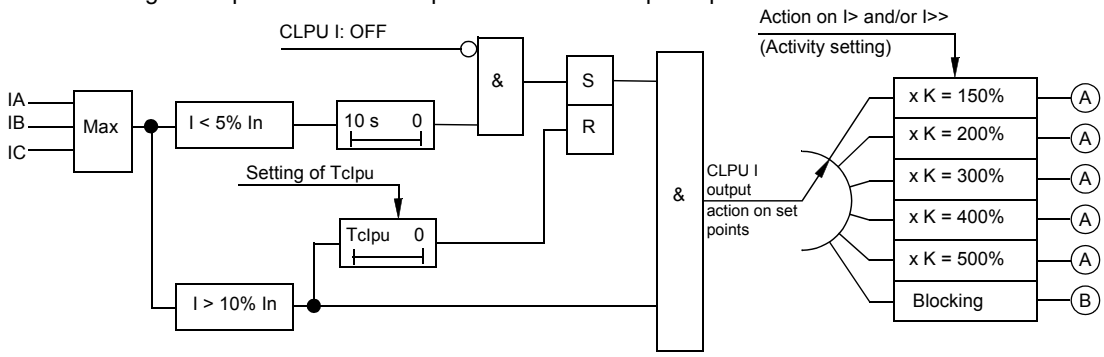
The CLPU I function automatically detects the appearance of a phase current after re-energization of the supply.

Setting the function parameters allows the user to:
- Choose which set points it acts on: the low set point I> or the high set point I>> or simultaneously on both set points
- Define the type of action on the chosen set points (I> and/or I>>):
  - Temporary multiplying factor applied to the set point (x1.5 to 5)
  - Temporary set point blocking
- Define for how long the set point increase or blocking is applied after detection

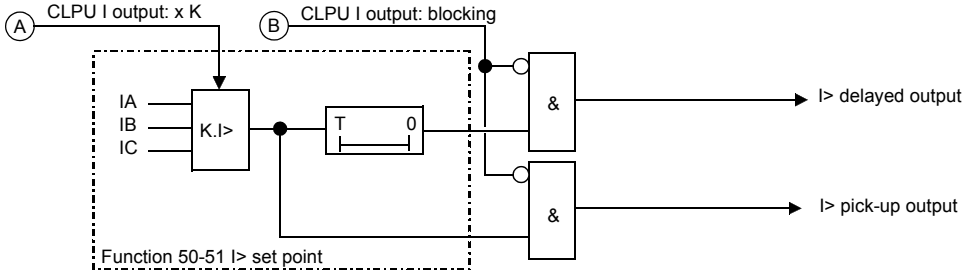
By default, this function is off.

Block Diagrams

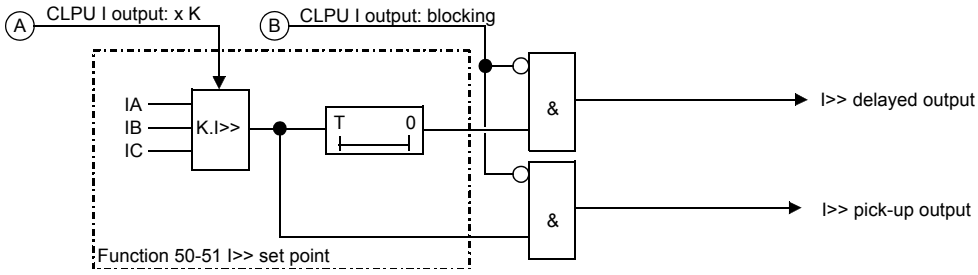
The block diagram of phase overcurrent protection cold load pick-up is shown below:



The CPLU I action on the I> set point (depending on Activity setting) is shown below:



The CPLU I action on the I>> set point (depending on Activity setting) is shown below:



Operation

The CLPU I function is made up of two modules:

- A module that automatically detects re-energization of the supply
- A module that acts on the I> and/or I>> set points of the ANSI 50-51 protection function

Detection of re-energization is based on the appearance of phase currents. To activate the CLPU I function, the following conditions must be met:

- Detection of the disappearance of the 3 phase currents (less than 5% In) for longer than 10 seconds (this information is memorized, while waiting for the current to reappear)
- Detection of the appearance of a phase current (more than 10% In). In this case, the CLPU I output is activated for a configurable duration Tclpu.

After detection of re-energization, the CLPU I output acts on the ANSI 50-51 protection set points, with two possible actions depending on the parameter setting:

- Multiplication of the set point (I> and/or I>>) by a configurable coefficient (1.5 to 5), or
- Blocking of the set point (I> and/or I>>)

After time delay Tclpu has elapsed, the CLPU action is interrupted, and the ANSI 50-51 protection set points revert to normal operation.

Settings

Settings	Authorized Values
Activity	● OFF: Off ● I> I>>: Action on I> and I>> ● I>: Action on I> only ● I>>: Action on I>> only
Action on set points	● 150%: Set point x 1.5 ● 200%: Set point x 2 ● 300%: Set point x 3 ● 400%: Set point x 4 ● 500%: Set point x 5 ● BLOCK.: Set point blocked
Time delay	● 1...60 s in steps of 1 s ● 1...60 min in steps of 1 min

Settings for Using the Function

Settings in the parameters menu:

- Cold Load Pick-Up I (***COLD LOAD I*** screen)

Earth Fault Cold Load Pick-Up (Cold Load Pick-Up Io)

Applicable to Sepam Series 10

N	B	A

Sepam with 4 current inputs and standard or sensitive earth fault protection only

(Sepam series 10 • 41• or Sepam series 10 • 42•).

Description

The earth fault cold load pick-up function avoids nuisance tripping of the earth fault protection (ANSI 50N-51N) during energization. Depending on the installation characteristics, such operations can generate transient inrush currents. If the earth fault current measurement is based on the sum of the 3 phase CTs, the aperiodic component of these transient currents can result in saturation of the phase CTs. This saturation can lead to measurement of an *incorrect* earth fault current likely to exceed the protection set points.

These transient currents are mainly due to the power transformer magnetizing currents or the motor starting currents. In normal circumstances, the protection settings should be defined so as to avoid tripping due to these transient currents. However, if this rule results in inadequate sensitivity levels or delays that are too long, the cold load pick-up function can be used to increase or inhibit set points temporarily after re-energization. In the specific case of transient currents linked to transformer energizing, this function can be used to activate restraint of the earth fault protection based on the detection of a second harmonic component in the phase currents.

Use of this function maintains a good level of protection sensitivity, regardless of the constraints affecting re-energization.

In the case of earth fault current measurement by an earth CT, there is less risk of measuring an *incorrect* earth fault current. If the sensor is used correctly, there is no need to activate this function.

Remark: In the rest of this manual, this function is referred to by its abbreviation CLPU Io.

The CLPU Io function automatically detects the appearance of a phase current after re-energization of the supply.

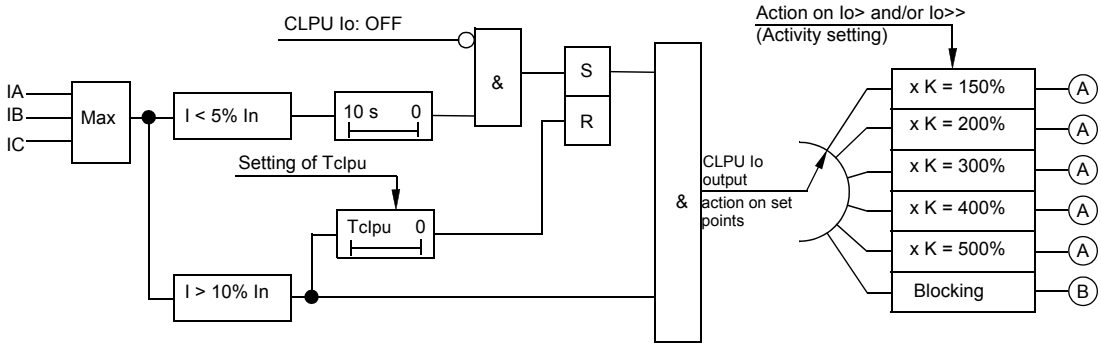
Setting the function parameters allows the user to:

- Choose which set points it acts on: The low set point Io> or the high set point Io>> or simultaneously on both set points
- Define the type of action on the chosen set points (Io> and/or Io>>):
  - Temporary multiplying factor applied to the set point (x 1.5 to 5)
  - Temporary set point blocking
  - Permanent activation of the second harmonic restraint
- Define for how long the set point increase or blocking is applied after detection of re-energization

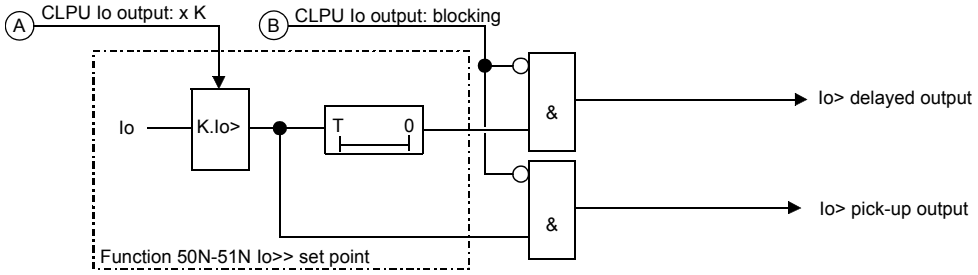
By default, this function is off.

Block Diagram for Picking up or Blocking the Protection

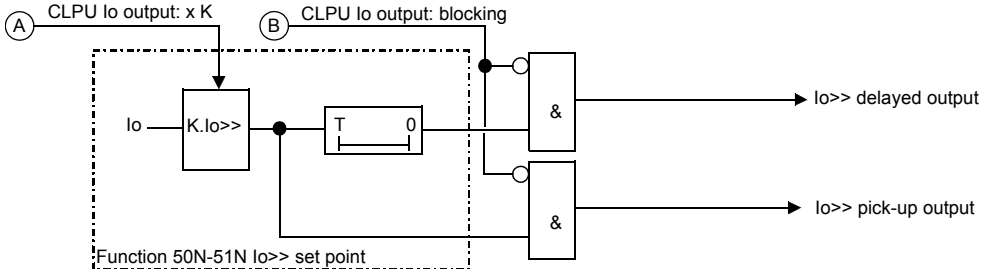
The block diagram for the earth fault cold load pick-up is shown below:



The CLPU Io action on the Io> set point (depending on Activity setting) is shown below:

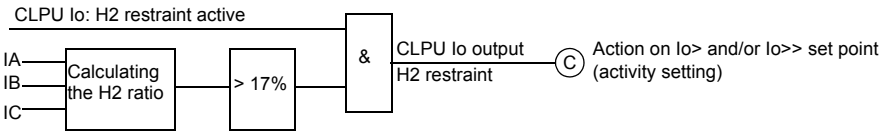


The CLPU Io action on the Io>> set point (depending on Activity setting) is shown below:

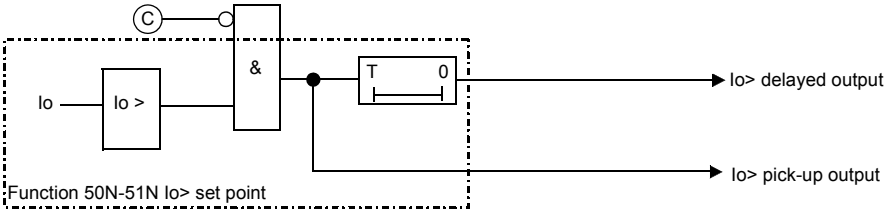


Block Diagram of Second Harmonic Restraint

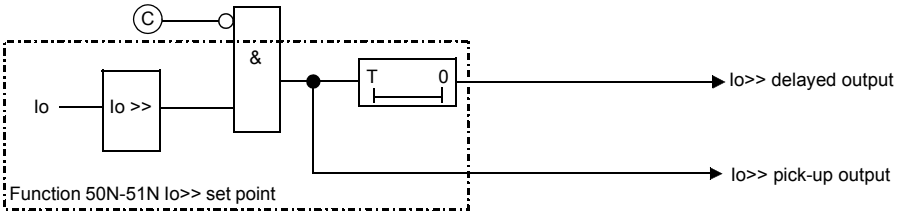
The block diagram for the second harmonic restraint is shown below:



The action on the Io> set point (depending on Activity setting) is shown below:



The action on the Io>> set point (depending on Activity setting) is shown below:



Operating Principle

Depending on the parameter setting, the CLPU Io operates according to one of two principles:
- The principle applicable to increasing or blocking set points (principle identical to the CLPU I)
- The principle applicable to the second harmonic restraint

Operation of Picking up or Blocking the Protection

The CLPU Io cold load pick-up by set point increase or blocking function is made up of two modules:
- One module automatically detects re-energization
- One module acts on the Io> and/or Io>> set points of the ANSI 50-51N protection function

Detection is based on the appearance of phase currents, in the conditions below:
- Detection of the disappearance of the 3 phase currents (less than 5% In) for longer than 10 s (this information is memorized, while waiting for the current to reappear)
- Detection of the appearance of a phase current (more than 10% In). In this case, the CLPU Io output is activated for a configurable duration Tclpu.

After detection of energization, the CLPU Io output acts on the ANSI 50-51N protection set points, with two possible actions depending on the parameter setting:
- Multiplication of the set point (Io> and/or Io>>) by a configurable coefficient (1.5 to 5)
- Blocking of the set point (Io> and/or Io>>)

After time delay Tclpu has elapsed, the CLPU Io action is interrupted, and the ANSI 50-51N protection set points revert to normal operation.

Operation of the Second Harmonic Restraint

The second harmonic restraint is based on the continuous calculation of the second harmonic restraint in all 3 phase currents. This ratio is calculated on the basis of the quadratic sums of the fundamental (H1) and second harmonic (H2) components.

$$H2\ ratio = \sqrt{\frac{IA_{H2}^2 + IB_{H2}^2 + IC_{H2}^2}{IA_{H1}^2 + IB_{H1}^2 + IC_{H1}^2}}$$

This ratio is compared to a fixed set point of 17%. If the set point is exceeded, the Io> and/or Io>> set points are inhibited, depending on the parameter setting of CLPU Io.

An increase in the H2 ratio in the phase currents is typical of saturation of the phase CTs. On transformer energizing, the aperiodic component of the magnetizing currents usually results in saturation of the CTs, and measurement of an incorrect earth fault current by the ANSI 50N-51N protection function. The second harmonic restraint can be used to inhibit the earth fault protection for as long as the CTs are saturated. This restraint automatically disables itself once the H2 ratio decreases.

To avoid this restraint becoming active in the event of a phase-to-earth fault, make sure that the phase-to-earth fault current remains less than the phase CT saturation current:

- In an impedant earthing system, since the earth fault current is limited, this operating condition is usually fulfilled.
- In a directly earthed system, the earth fault current is high. Since the set points can be set at high levels, there is no need to use the CLPU Io function.

Settings

Settings	Authorized Values
Activity	● OFF: Off ● Io> Io>>: Action on Io> and Io>> ● Io>: Action on Io> only ● Io>>: Action on Io>> only
Action on set points	● 150%: Set point x 1.5 ● 200%: Set point x 2 ● 300%: Set point x 3 ● 400%: Set point x 4 ● 500%: Set point x 5 ● BLOCK.: Set point blocked ● H2 RES.: Second harmonic restraint
Time delay	● 1...60 s in steps of 1 s ● 1...60 min in steps of 1 min
Second harmonic restraint set point (fixed set point)	17 %

Note: The time delay setting does not apply to the second harmonic restraint action. In the setting screens, if CLPU Io is set to ***H2 RES.***, the time delay setting does not appear.

Settings for Using the Function

Settings in the parameters menu:
- Cold Load Pick-Up Io setting (***COLD LOAD Io*** screen)

Thermal Overload Protection (ANSI 49 RMS)

Applicable to Sepam Series 10

~~N~~	B	A

Description

Thermal overload protection is used to protect the MV/LV cables and transformers against overloads, based on the measurement of the current taken. A prolonged overload causes heat rises that result in premature deterioration of the isolation. This premature ageing can lead, in time, to an insulation fault.

This protection is based on a thermal model which is used to calculate the thermal capacity used using the current measurements. The current used by this protection function is a 3-phase rms current that takes account of harmonic numbers up to 15 at 50 Hz (or up to 13 at 60 Hz).

The protection function requires three settings:

- Setting for the tripping set point or maximum permissible continuous current, which corresponds to the maximum thermal withstand for the device to be protected (this permissible continuous current corresponds to a thermal capacity used of 100%)
- Setting for the device heating/cooling time constant
- Setting for the alarm set point expressed as a % of the maximum permissible thermal capacity used (tripping set point)

The device thermal capacity used value expressed as a % can be accessed on the display. It can be reset from the keypad on the front panel. If a password is active, then it must be entered before this reset can be performed.

Thermal Capacity Used Calculation Principle

The thermal capacity used is calculated using the formula defined by the IEC 60255-3 standard. It is proportional to the square of the current taken and depends on the previous thermal capacity used status.

It is expressed using the equation below:

$$E(t) = E(t-\Delta t) + \left(\frac{I(t)}{Is}\right)^2 \cdot \frac{\Delta t}{T} - E(t-\Delta t) \cdot \frac{\Delta t}{T}$$

where:

- E(t): Thermal capacity used value at time t
- E(t–Δt): Thermal capacity used value at time t-Δt
- I(t): Current value measured at time t
- Is: Set point value expressed as permissible current
- T: Heating/cooling time constant

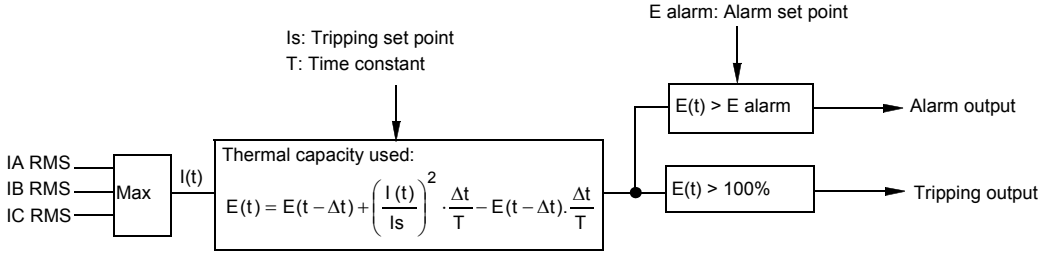
The term $\left(\frac{I(t)}{Is}\right)^2 \cdot \frac{\Delta t}{T}$ expresses the heat transfer of the current I(t).

The term $E(t-\Delta t) \cdot \frac{\Delta t}{T}$ expresses the device's natural cooling.

In steady state, for a current I, the thermal capacity used is: $E = \left(\frac{I}{Is}\right)^2$.

The protection trips if the thermal capacity used is more than 100%.

Block Diagram



Standard Operation

If the thermal capacity used value exceeds the alarm set point:

- The fault LED flashes quickly.
- The alarm output changes state. The state of this output is available via the communication (refer to *Communication, p. 169*). In standard mode, this information is not assigned to an output relay. This assignment is possible in custom mode.

If the thermal capacity used value exceeds the tripping set point (100%):

- The LED flashes slowly.
- Output relays O1, O2, O3 change state.
- The fault screen is displayed with the tripping current values.

If the thermal capacity used value drops back below the tripping set point, then output relays O1, O2, O3 and the display remain in the same state (latching function). Pressing the Reset key deactivates the latching function:

- The LED goes out.
- The output relays return to their initial state.
- The fault screen is replaced by the screen displayed prior to appearance of the fault.

Refer to *Fault Acknowledgement, p. 146*.

Customization Option

Sepam's custom mode can be used to modify standard operation:

- Latching of the fault LEDs can be deactivated.
- Assignment of the 49 RMS tripping output to output relays O1, O2, O3 can be modified.
- The 49 RMS alarm output can be assigned to one of output relays O2, O3, O5, or O6.
- Latching of output relays O1, O2, O3 can be deactivated.
- The activation logic of output relays O1, O2 is configurable (contact closed or open on fault detection).

Refer to *Custom operating mode, p. 147*.

Calculating the Operating Time

For a continuous current at least twice as high as the tripping set point, it is possible to calculate the tripping time for the ANSI 49 RMS protection function using the equation below:

$$t = T \cdot \ln\left(\frac{\frac{I^2}{Is^2} - E0}{\frac{I^2}{Is^2} - 1}\right)$$

where:

- I: Short-time current (maximum of the 3 phase currents)
- Is: Permissible current set point
- T: Heating/cooling time constant
- E0: Initial thermal capacity used prior to application of the overload
- ln( ): Natural logarithm function

If the initial thermal capacity used Eo is due to a constant load current Ich, then its value is given by the equation below:

$$E0 = \left(\frac{Ich}{Is}\right)^2$$

The table below indicates the thermal capacity used reached for a continuous load current Ich:

Ich/Is	Thermal Capacity Used (%)
1	100
0.9	81
0.8	64
0.7	49
0.6	36
0.5	25
0.4	16
0.3	9

The tripping curves are used to determine the tripping times for different initial thermal capacity used values. Refer to *Curves for an Initial Thermal Capacity Used of 0%, p. 112*.

Settings

Settings	Authorized Values
Activity	● OFF: Protection off ● ON: Protection on
Alarm set point	50...100% (as a % of the permissible thermal capacity used)
Tripping set point	0.1...2.4 In (permissible current value)
Time constant T	1...120 min

Remark: In is the phase CT primary rated current.

Settings for Using the Function

Compulsory settings in the protection menu:

- Phase CT ratio (***PHASE CT*** screen)
- Tripping and time constant set point for the ANSI 49 RMS function (***THERMAL 49 1*** screen)
- Network frequency (***FREQUENCY*** screen)

Additional settings in the protection menu:

- Alarm set point for the ANSI 49 RMS function (***THERMAL 49 2*** screen)
- ANSI 49 RMS function thermal capacity used reset (***THERMAL 49 2*** screen)

Typical Values for the Thermal Time Constant

For a cable:

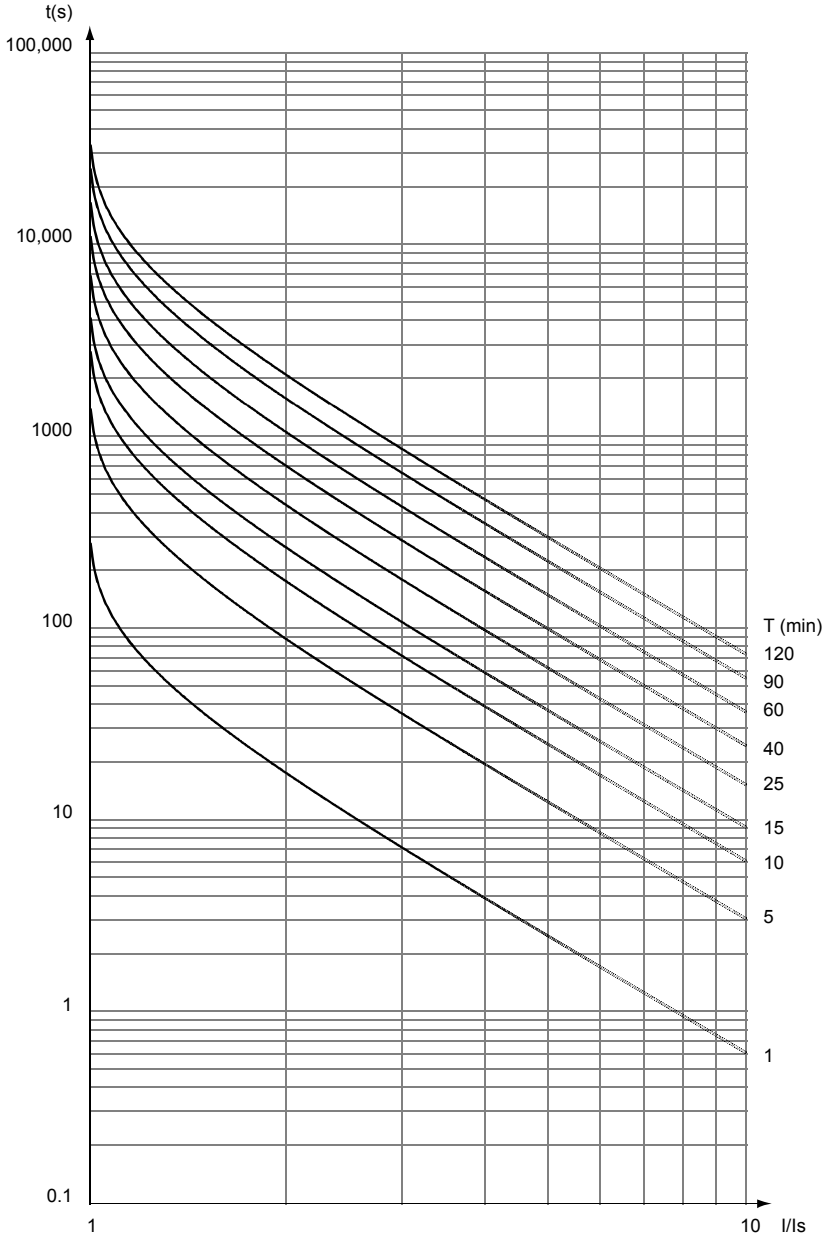
A cable's thermal time constant depends on its cross-section, operating voltage and installation method. The typical time constant values range from 20 to 60 minutes for buried cables, and 10 to 40 minutes for cables that are not buried.

For a transformer:

For medium-voltage network power transformers, the time constant typical values range from 20 to 40 minutes. This technical data should be supplied by the manufacturer.

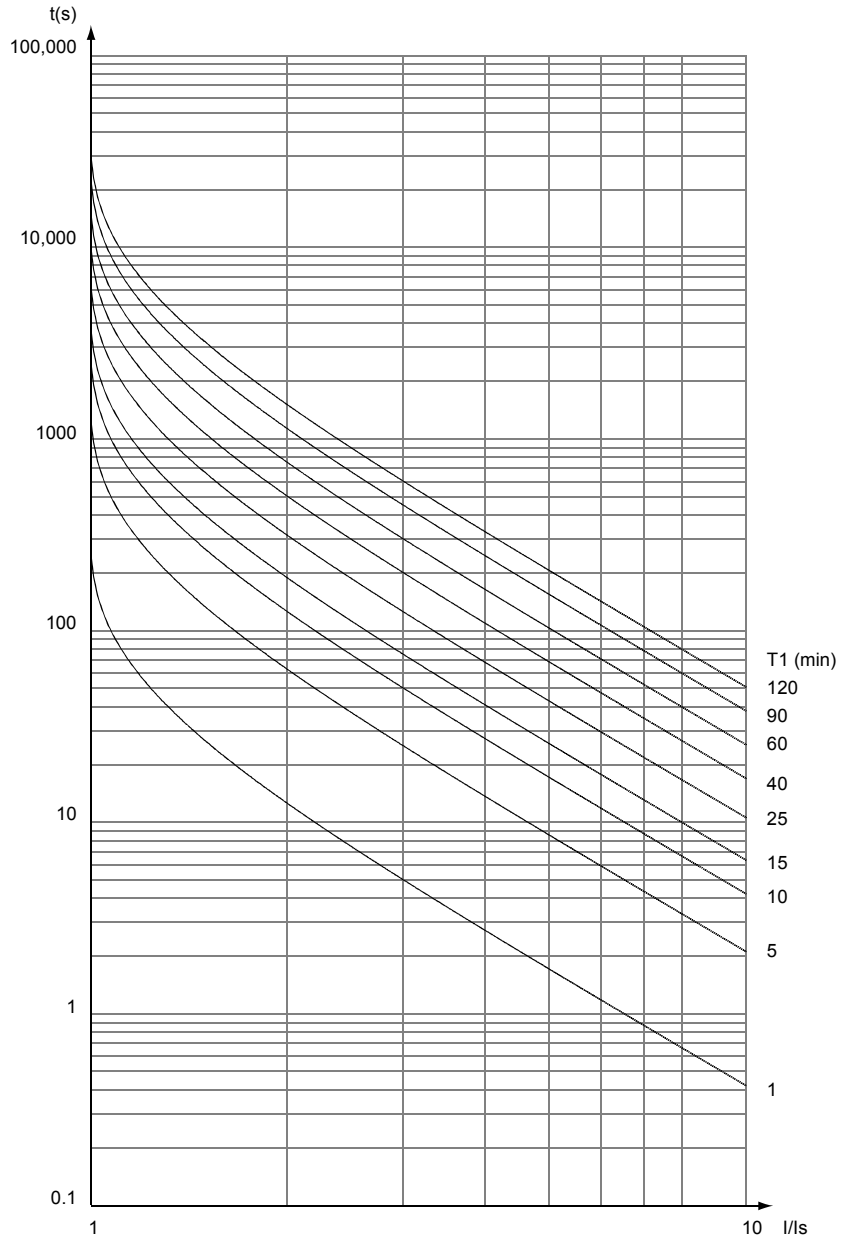
Curves for an Initial Thermal Capacity Used of 0%

The tripping curves for an initial thermal capacity used of 0% and different values for the time constant T are shown below:



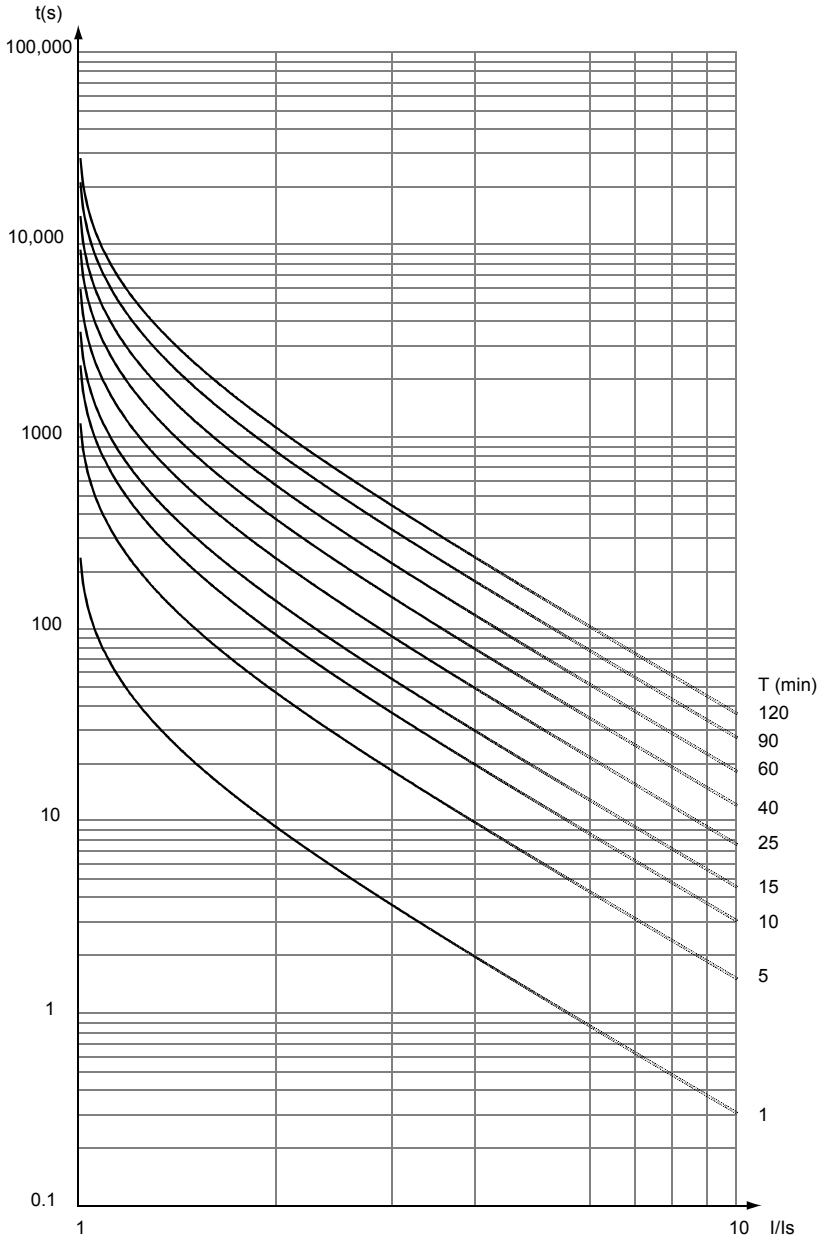
Curves for an Initial Thermal Capacity Used of 30%

The tripping curves for an initial thermal capacity used of 30% and different values for the time constant T are shown below:



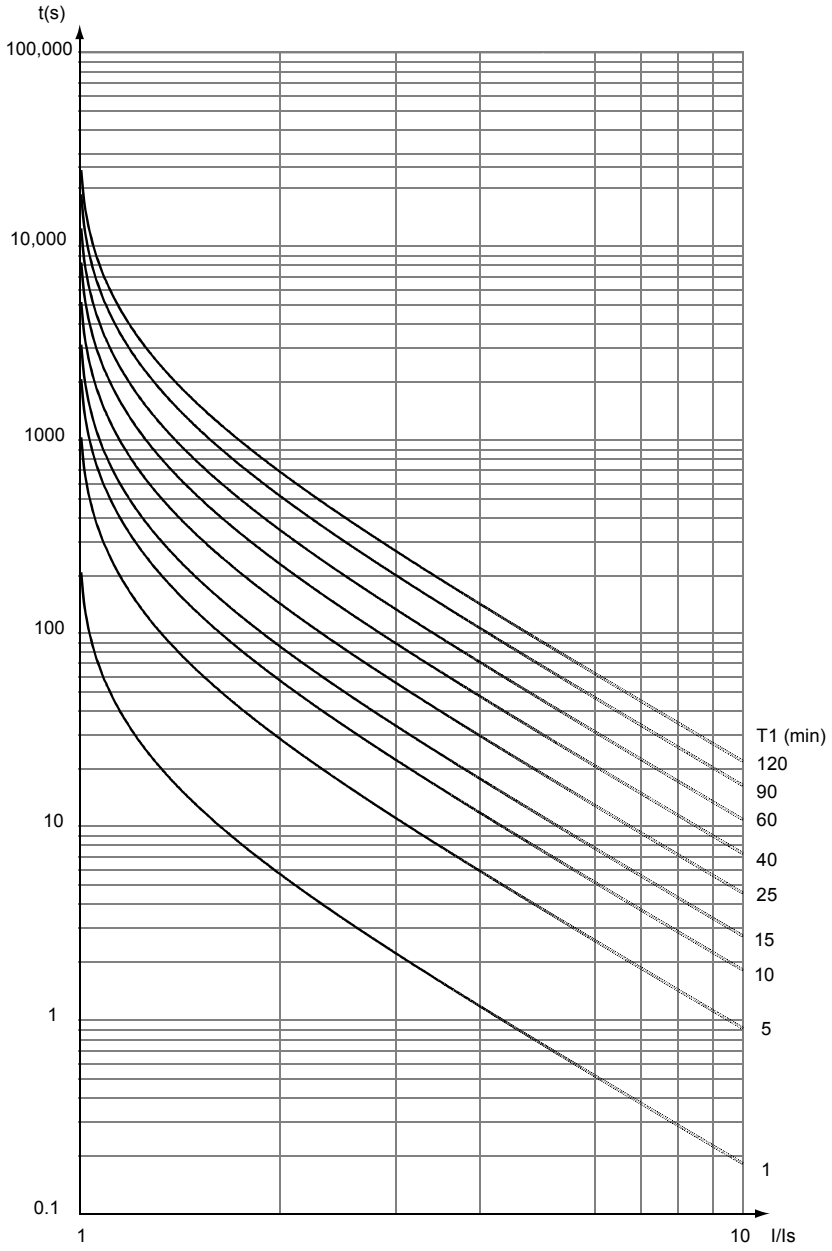
Curves for an Initial Thermal Capacity Used of 50%

The tripping curves for an initial thermal capacity used of 50% and different values for the time constant T are shown below:



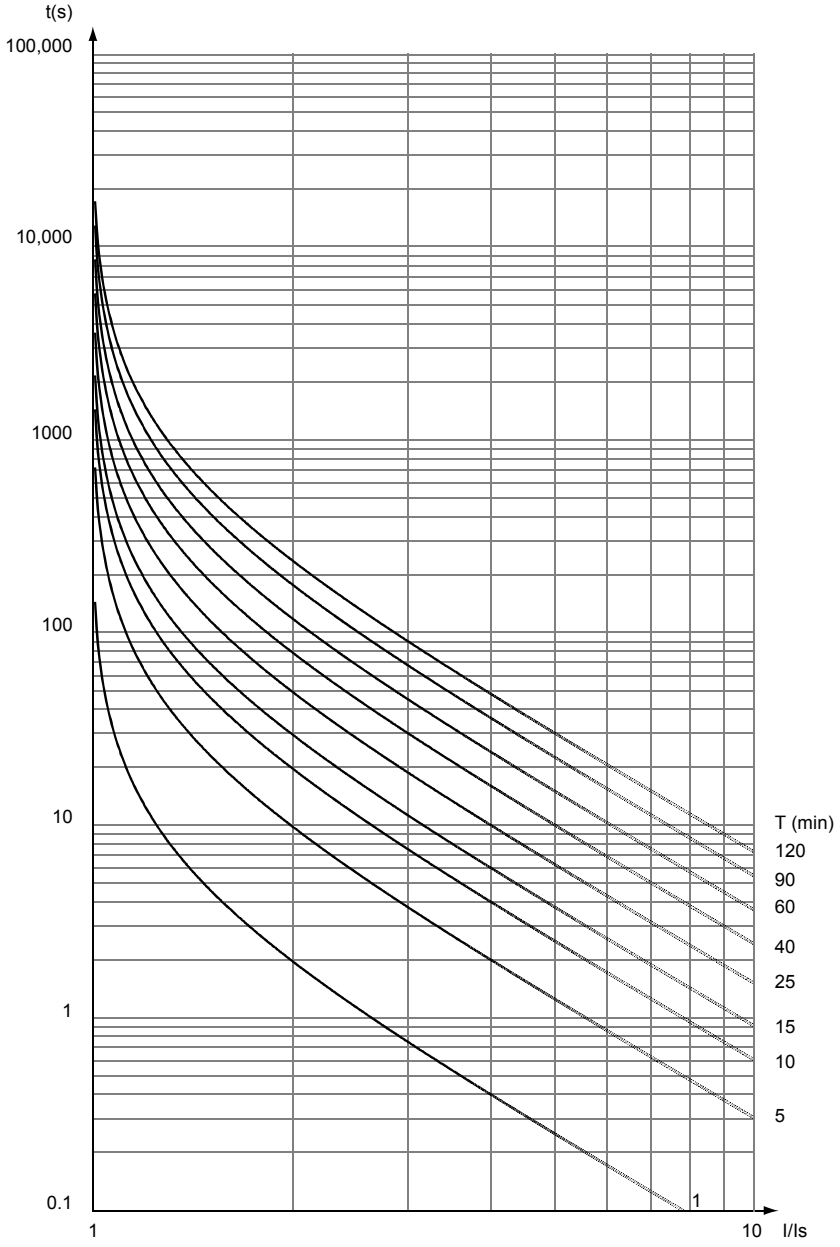
Curves for an Initial Thermal Capacity Used of 70%

The tripping curves for an initial thermal capacity used of 70% and different values for the time constant T are shown below:



Curves for an Initial Thermal Capacity Used of 90%

The tripping curves for an initial thermal capacity used of 90% and different values for the time constant T are shown below:



Circuit Breaker Control

Applicable to Sepam Series 10

N	B	A

Description

Sepam can be used for integration in any type of circuit breaker control diagram.

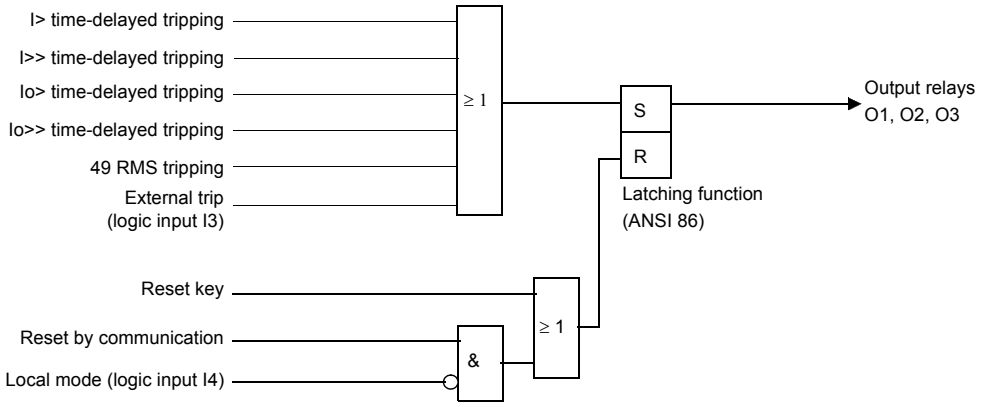
The output relays perform the following functions:

Sepam Output	Assignment
O1	Circuit breaker tripping in the event of detection of a fault
O2	Trip lockout in the event of detection of a fault
O3	Annunciation of tripping following action by the protection functions

Output relays O1 and O2 are equipped with a normally open contact (NO) and a normally closed contact (NC).

Block Diagram

Example with a Sepam series 10 A:



Standard Operation

The activation logic for the 3 output relays O1, O2 and O3 is identical:

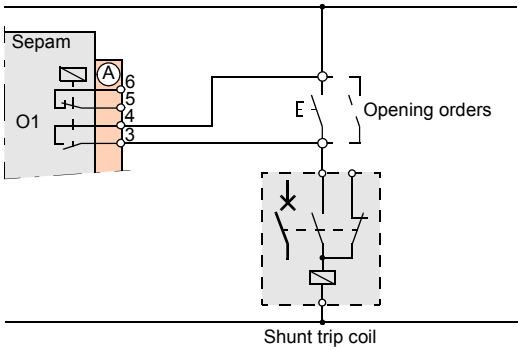
- The outputs are activated on an OR of the protection set points and the external trip logic input (Sepam series 10 A only)
- Tripping is memorized (ANSI 86 latching function), with the possibility of acknowledgment by the Reset key on the front panel or by a remote control order (authorized in remote mode, I4 = 0). This function is used to inhibit circuit breaker closing until the fault is acknowledged.

Output relay O1 can also be used to open the circuit breaker via the communication.

Refer to *Communication, p. 169*.

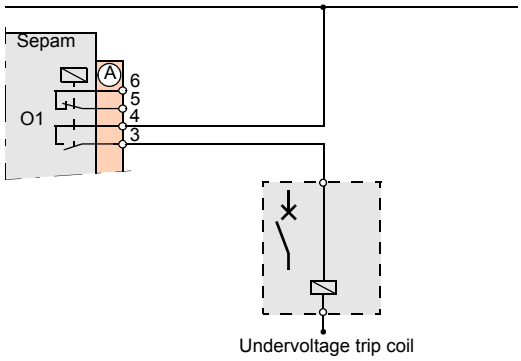
Connection of Output O1: Circuit Breaker Tripping

Shunt trip coil



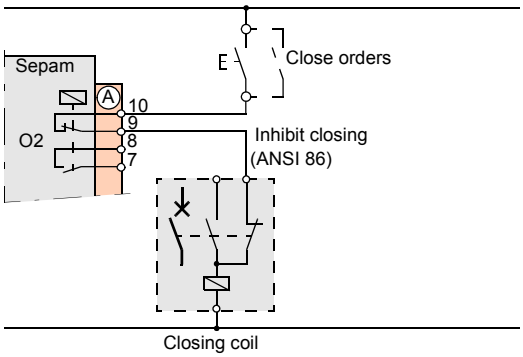
If Sepam detects a fault, closing of the output relay O1 normally open contact trips opening of the circuit breaker by supplying power to the shunt trip coil. This contact stays closed after the circuit breaker trips, until the fault is acknowledged.

Undervoltage trip coil



In this case, it is necessary to use Sepam's custom mode to invert the control logic for output relay O1. The normally open contact will be kept in the closed position continuously, until a fault appears. If Sepam detects a fault, opening of the contact trips opening of the circuit breaker by opening the undervoltage trip coil power supply circuit. This contact stays open after the circuit breaker trips, until the fault is acknowledged.

Connection of Output O2: Trip Lockout (ANSI 86 Function)



If Sepam detects a fault, opening of the O2 output relay normally closed contact cuts the shunt trip coil power supply circuit. This contact stays open after the trip order, until the fault is acknowledged. In this state, all closing orders are inhibited.

Customization Option

Because of the requirements for continuity of service and safety, it is possible to modify the standard operation of output relays O1 and O2. Refer to *Circuit breaker control and reliability, p. 161*.

Output relay O1: Tripping with undervoltage trip coil

Custom mode can be used to adapt the operating logic for output relay O1 to an undervoltage trip coil. The ***RELAYS INVER*** screen in the parameters menu can be used to invert the relay control logic, to keep the normally open contact (NO) in the closed position continuously, until a fault appears on the network.

Refer to *Custom operating mode, p. 147*.

Output relay O2: Trip lockout

With the standard block diagram, circuit breaker trip lockout – or inhibition – is not guaranteed if Sepam is unavailable, in the following two examples:

- Loss of the Sepam auxiliary power supply
- Internal Sepam failure (with changeover to fail-safe position)

If demanded by safety requirements, custom mode allows the operation of output relay O2 to be modified to ensure trip lockout if Sepam is unavailable.

Refer to *Custom operating mode, p. 147*.

External Trip

Applicable to Sepam Series 10

M B A

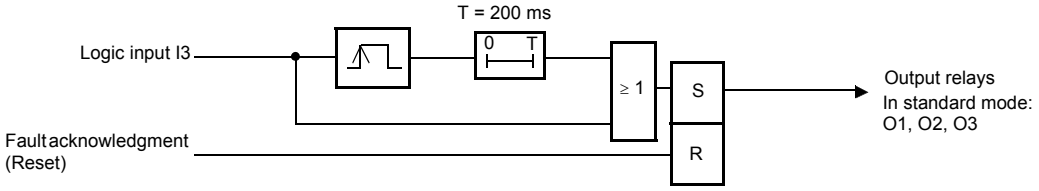
Description

Using a logic input, Sepam series 10 A relays can be used to take account of a trip order issued by an external protection device.

For example, specific protection devices for power transformers (Buchholz, gas-pressure-temperature detectors, etc.) can be hard-wired on a Sepam logic input to trip the circuit breaker.

The external devices can be hard-wired directly into the circuit breaker trip circuit, but there are three advantages in connecting a Sepam logic input:
- External trip orders will be memorized by the ANSI 86 function, integrated in the Sepam unit. Trip lockout will apply until the fault is acknowledged.
- The trip order and its origin will be indicated on the Sepam front panel. The trip will be saved and time-tagged in the log of the last 5 events.
- The circuit breaker trip circuit is simplified, and hence more reliable.

Block Diagram



Standard Operation

The external trip must be hard-wired on logic input I3.

After activation of input I3:
- The Ext fault LED flashes.
- Output relays O1, O2, O3 change state.
- The fault screen is displayed, with the tripping current values.

After deactivation of input I3, output relays O1, O2, O3 and the display remain in the same state (ANSI 86 latching function).

Pressing the Reset key deactivates the latching function (refer to *Fault Acknowledgement, p. 146*):
- The Ext LED goes out.
- The output relays return to their initial state.
- The fault screen is replaced by the screen displayed prior to appearance of the fault.

Remark: The time delay of 200 ms in the block diagram ensures the trip order will have a minimum duration. This time delay is only justified if the latching function has been deactivated, in custom mode.

Customization Option

Sepam's custom mode can be used to modify standard operation:
- Assignment of the External trip logic input to output relays O1, O2, O3 can be modified.
- The external trip can be assigned to logic input I3 or I4.
- Latching of output relays O1, O2, O3 can be disabled.
- The activation logic of output relays O1 and O2 is configurable (contact closed or open on fault detection).
- Latching of the Ext LED can be deactivated.

Refer to *Custom operating mode, p. 147*.

Settings for Using the Function

The external trip function does not require any setting.

Logic Discrimination (ANSI 68)

Applicable to Sepam Series 10

N	B	A

All Sepam series 10 N, series 10 B and series 10 A relays can send a blocking input order.

Only Sepam series 10 A relays can receive a blocking input order (in custom mode).

Description

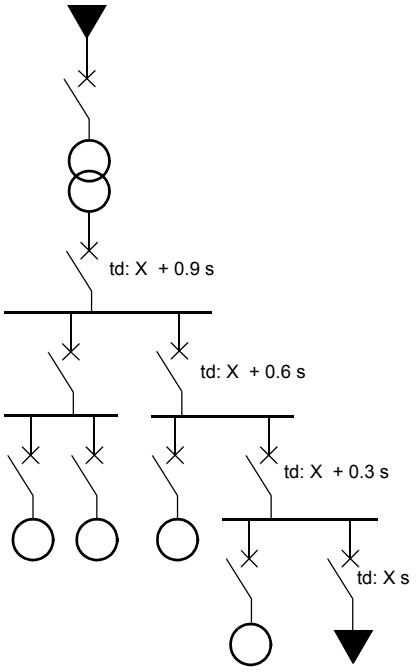
The logic discrimination function can achieve a significant reduction in tripping times for circuit breakers located right next to the source. It can mitigate the disadvantages of the conventional time discrimination process.

This function exploits the hard-wiring of a logic data item between the protection functions, making it possible to block the protection upstream by protection functions located downstream. With logic discrimination, the protection settings should be fixed in relation to the element to be protected without worrying about the discrimination aspect.

This system applies to the phase and earth fault overcurrent protections, either definite time (DT curve) or inverse definite minimum time (IDMT curves). It can be used on a network that uses different protection relays in the Sepam range (series 10, series 20, series 40, series 80). The operating principle for logic discrimination is identical for the whole Sepam range.

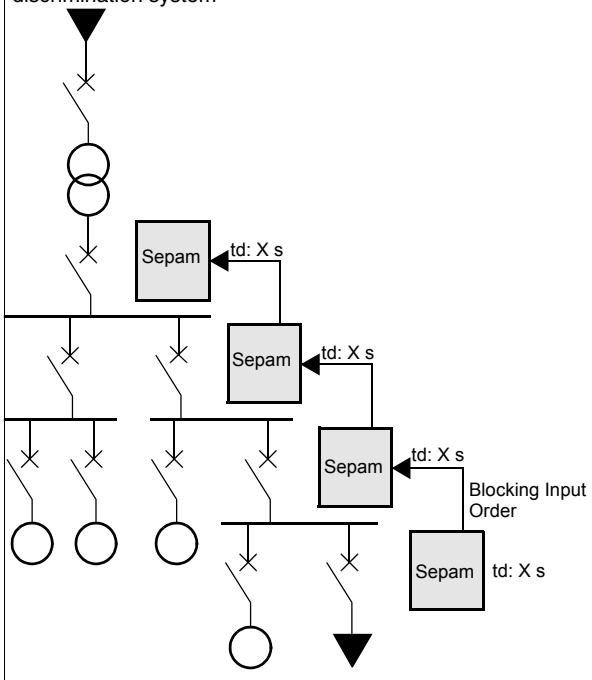
The two examples below illustrate the main advantage of logic discrimination:

Example 1: Single feeder distribution using time discrimination



td DT curve tripping time

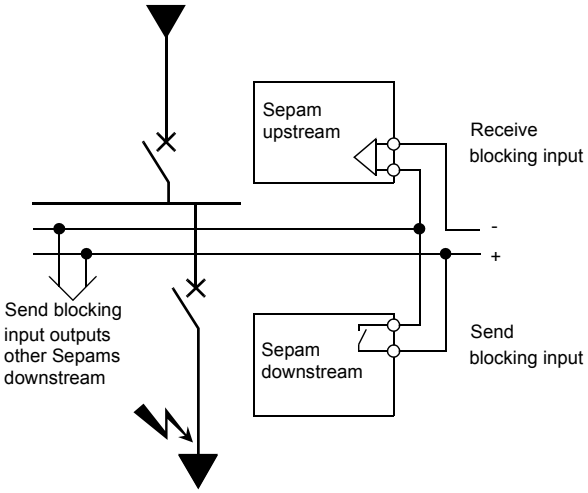
Example 2: Single feeder distribution using the Sepam logic discrimination system



td DT curve tripping time

Operation

The diagram below describes how logic discrimination works:



When a fault occurs on a radial network, the fault current runs through the circuit between the source and the point where the fault is:

- The protection elements upstream of the fault are invoked.
- The protection elements downstream of the fault are not invoked.
- Only the first protection element upstream of the fault needs to act.

When a Sepam relay detects a fault:

- It sends a blocking input order to an output relay.
- It causes the associated circuit breaker to trip if it does not receive a blocking input order on a logic input.

The logic discrimination blocking order lasts as long as it takes to clear the fault. It is interrupted after a delay that takes account of the switchgear operating time and the protection reset time. If the switchgear fails (non-opening of the circuit breaker on a fault), the blocking input order is interrupted 200 ms after the trip order is sent.

To minimize the effects of receiving an unwanted blocking input order, it is possible to set for each set point a backup time delay Tbu which is not blocked by the blocking input order. These time delays are designed for use with time discrimination in relation to downstream protection.

This system can be used to minimize the fault duration, to optimize discrimination and to ensure safety in downgraded situations (failure of the wiring or switchgear).

Implementing the Function

In standard mode:

Only Sepam series 10 A integrates a send blocking input on output relay O5 in standard mode. This output can be used to block the protection element located upstream.

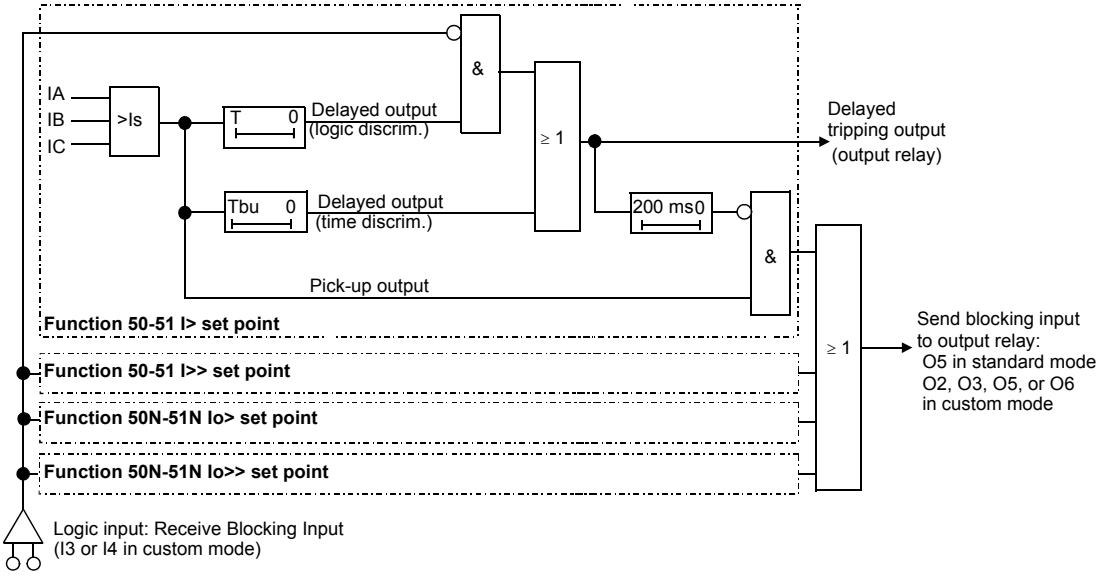
In custom mode:

- On Sepam series 10 N and series 10 B relays, sending a blocking input can be associated with output relays O2 or O3.
- On Sepam series 10 A relays:
  - Sending a blocking order can be associated with output relays O2, O3, O5 or O6.
  - Receiving a blocking input can be associated with logic inputs I3 or I4.

Refer to *Custom operating mode, p. 147*.

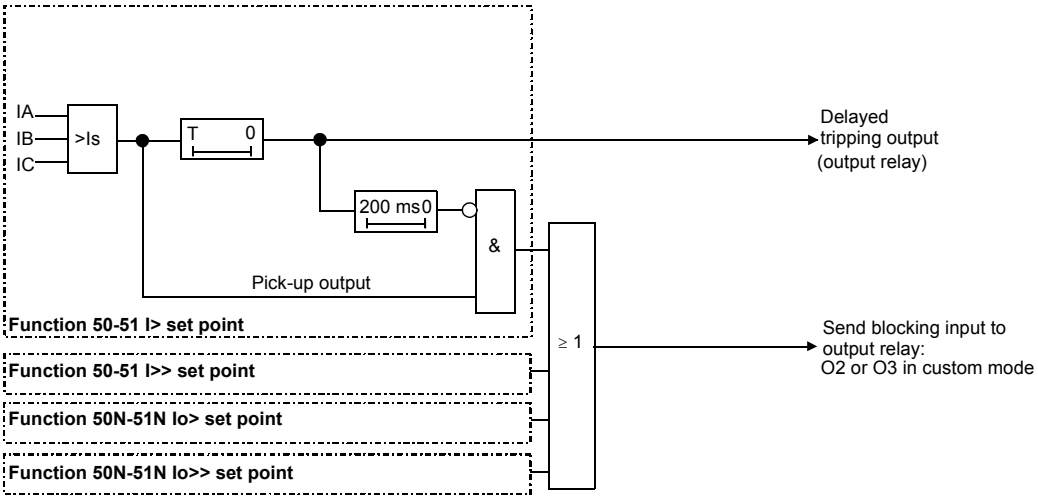
Block Diagram for Sepam Series 10 A Relays

The block diagram of logic discrimination with sending and receiving a blocking input is shown below:



Block Diagram for Sepam Series 10 N and Series 10 B Relays

The block diagram of logic discrimination with sending a blocking input only is shown below:



Setting Tbu Backup Time Delays

On Sepam series 10 A relays, which use a receive blocking input order, it is advisable to set the backup time delays associated with the I>, I>>, Io> and Io>> set points used. As these time delays are not blocked by the blocking input order, they can ensure tripping if an unwanted blocking input order is received. These time delays must be set by applying the time discrimination rules in relation to the downstream protection.

The backup time delays can be accessed in the parameters menu in custom mode in the 4 screens ***68 BKUP I>***, ***68 BKUP I>>***, ***68 BKUP Io>***, ***68 BKUP Io>>***.

For each set point, these screens offer three fields:

- First field: ***OFF*** or type of curve. There are 2 possible options:
  - ***OFF***: Backup time delay off
  - Type of curve: Backup time delay on

  This field, which cannot be modified, states the type of curve defined for the set point in the protection menu.

  If the set point is ***OFF*** in the protection menu, the corresponding backup set point is ***OFF***, and cannot be modified.
- Second field: This field cannot be modified. It contains the set point value set in the protection menu.
- Third field: Tbu time delay (modifiable field). It must be set by applying the time discrimination rules in relation to the downstream protection.

Note: After modifying the type of curve in the protection menu, the Tbu time delay automatically takes the default value. If the Tbu time delay is used, it is essential to reset the Tbu time delay according to the new type of curve.

Phase Current Measurement

Applicable to Sepam Series 10

N	B	A

Description

The phase current measurement function can be accessed in the metering menu. It displays the rms value of the phase currents, and takes account of harmonic numbers up to 15 at 50 Hz (or up to 13 at 60 Hz). On Sepam series 10 • 4••, this function displays all three phase currents. On Sepam series 10 • 3•• relays, which do not allow connection of phase B, this function displays the currents in phases A and C only. Sepam automatically returns to the screen displaying the phase current measurements 10 minutes after the last keystroke.

On Sepam series 10 A relays, the phase current measurements can also be accessed via the communication.

Setting

On Sepam series 10 • 4•• relays, in the parameters menu, it is possible to select the number of phase currents displayed.. If phase B is not equipped with a current transformer, this setting can be used to deactivate display of this phase to avoid giving the information IB = 0, which could lead to an error in interpretation by the user. For further details, refer to *Number of Phase Currents Displayed, p. 131*.

The parameter to be set is:

- Number of phase currents displayed (***I DISPLAY*** screen)

Earth Fault Current Measurement

Applicable to Sepam Series 10

N	B	A

Description

The earth fault current measurement function can be accessed in the metering menu. It displays the value of the earth fault current fundamental. Both the earth fault current measurement and the earth fault protection (ANSI 50N-51N) require the core balance input to be connected because Sepam does not calculate the earth fault current by an internal sum of the 3 phase current measurements. This input can be connected to the common point of the 3 phase CTs or to an earth CT or to a CSH120, CSH200 or GO110 core balance CT.

On Sepam series 10 A relays, the earth fault current measurement can also be accessed via the communication.

Each of the Sepam models is available in several versions depending on the desired sensitivity for the earth fault current measurement. The earth fault current measurement input connection diagram and associated settings depend on the Sepam type. For more information, refer to *Connection Diagrams, p. 30*.

Phase Peak Demand Current Values

Applicable to Sepam Series 10

N	B	A

Description

The phase peak demand current values function can be accessed in the metering menu. It displays the largest demand current value on each of the 3 phases and makes it possible to find out the current taken during the load peaks. Resetting is possible via the Reset key on the front panel. To do this, this key must be pressed for 2 seconds when the peak demand values function is selected on screen.

On Sepam series 10 A relays, measuring and resetting the peak demand current values can also be accessed via the communication.

Settings

In the parameters menu, it is possible to adapt the following setting:

- Demand calculation period (***PEAK DEMAND*** screen)

The default value is 5 minutes, with a setting range between 1 min and 60 min and setting intervals of 1 min.

Last Fault Record

Applicable to Sepam Series 10

N	B	A

Description

The last fault record function can be accessed in the metering menu. It indicates the origin of the trip order as well as the value of the 3 phase currents and the earth fault current at the time of tripping. Since the message length is more important than the size of the display, this function has a display that scrolls in a loop. The information is stored until the next trip and cannot be reset.

This function is not available on Sepam series 10 A relays, where it is replaced by the time-tagged record of the last 5 events function.

The recorded faults are as follows:

Fault	Message on the Display
Protection I> trip	I >
Protection I>> trip	I >>
Protection Io> trip	Io >
Protection Io>> trip	Io >>
Thermal overload protection trip	*THERMAL*

Remark: The measurement ranges are indicated in *Tripping Phase Currents, p. 245* and *Tripping Earth Fault Current, p. 246*. If the current values recorded at the time of the trip are not within the measurement ranges, the corresponding fields are filled with:

- ***> 40 In*** for phase currents
- ***> 40 Ino*** for the earth fault current
- ***> 400 A*** for the earth fault current measured by a core balance CT on the 2-240 A rating
- ***> 40 A*** for the earth fault current measured by a core balance CT on the 0.2-24 A rating

Settings

In the parameters menu, it is possible to adapt the following setting:

- Number of phase currents displayed (***I DISPLAY*** screen)

For further details, refer to *Number of Phase Currents Displayed, p. 131*.

Customization Option

Customizing Sepam can enable it, if necessary, to indicate faults without giving the trip order to the circuit breaker.

For example, when the network is used with sustained earth fault, custom mode allows both the following options:

- Not assigning earth fault protection to tripping
- Indicating the fault only via the LED on the front panel or via an output relay used as an alarm

Refer to *Custom operating mode, p. 147*.

Time-Tagged Record of Last 5 Events

Applicable to Sepam Series 10

N B A

Description

The time-tagged record of the last 5 events function can be accessed in the metering menu. It is used to display the characteristics of the last 5 events in 5 consecutive screens in the metering menu. For each event, Sepam indicates its origin, the date and time of the fault. The value of the 3 phase currents and the earth fault current is also indicated, except for the following events: circuit breaker closing via the communication and trip circuit fault. Since the message length is more important than the size of the display, this function has a display that scrolls in a loop. This information cannot be reset to zero.

So that they can be identified, each event has an absolute queue number which increments from 0 to 99999. After this, the queue number returns to 0.

With each new event, Sepam deletes the oldest in its list of 5. When a Sepam delivered from the factory has not yet saved 5 events, the number of corresponding screens in the metering menu is less than 5.

The recorded events are as follows:

Event	Message on the Display
Protection I> trip	I >
Protection I>> trip	I >>
Protection Io> trip	Io >
Protection Io>> trip	Io >>
Thermal overload protection trip	THERMAL
Tripping by external input	EXT TRIP
Trip circuit fault	TCS ALARM
Circuit breaker opening via the communication	TRIP BY COMM
Circuit breaker closing via the communication	CLOSE BY COMM
I> protection tripping of logic discrimination back-up	I> LD
I>> protection tripping of logic discrimination back-up	I> LD
Io> protection tripping of logic discrimination back-up	Io> LD
Io>> protection tripping of logic discrimination back-up	Io> LD

Remark: The measurement ranges are indicated in *Tripping Phase Currents, p. 245* and *Tripping Earth Fault Current, p. 246*. If the current values recorded at the time of the trip are not within the measurement ranges, the corresponding fields are filled with:

- *> 40 In* for phase currents
- *> 40 In0* for the earth fault current
- *> 400 A* for the earth fault current measured by a core balance CT on the 2-240 A rating
- *> 40 A* for the earth fault current measured by a core balance CT on the 0.2-24 A rating

Settings

Setting the time on the Sepam internal clock can be accessed in the parameters menu:

- Setting the date (***DATE*** screen)
- Setting the time (***TIME*** screen)

Customization Option

Customizing Sepam can enable it, if necessary, to indicate faults without giving the trip order to the circuit breaker.

For example, when the network is used with sustained earth fault, custom mode allows both the following options:

- Not assigning earth fault protection to tripping
- Indicating the fault only via the LED on the front panel or via an output relay used as an alarm

Refer to *Custom operating mode, p. 147*.

Operating Language

Applicable to Sepam Series 10

N	B	A

Description

The default language is English.

Settings

Selection of the operating language can be accessed in the parameters menu.

The parameter to be set is:

- Language selection (***LANGUAGE*** screen)
  The following languages can be selected:
  - English
  - US English
  - Spanish
  - French
  - Italian
  - German
  - Turkish
  - Portuguese

Remark: For Sepam relays certified GOST, the following languages can be selected:

- Russian
- English
- French

Number of Phase Currents Displayed

Applicable to Sepam Series 10

N	B	A

Description

Selection of the number of phase currents displayed is only available on Sepam series 10 • 4•• relays, which allow connection of 3 phase CTs. By default, these Sepam relays display measurement of all 3 phase currents. If phase B is not equipped with a current transformer, it is advisable to deactivate display of this phase to avoid giving the information IB=0, which could lead to an error in interpretation by the user. To do this, the ***I DISPLAY*** screen can be used to select display of all 3 phases IA, IB, IC or of the 2 phases IA and IC.

This parameter defines the display of 2 or 3 phases for all functions which deal with the current:
- Phase current measurement
- Phase peak demand current values
- Last fault record
- Time-tagged record of last 5 events

This parameter has no effect on operation of the protection functions.

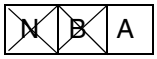
Settings

Selection of the number of phase currents displayed can be accessed in the parameters menu.

The parameter to be set is:
- Number of phase currents displayed (***I DISPLAY*** screen)

Communication

Applicable to Sepam Series 10



Communication Protocols

Sepam series 10 A relays are equipped with an RS 485 communication port.

By default they operate with Modbus protocol. The IEC 60870-5-103 protocol can also be selected.

Refer to *Communication, p. 169*.

Selecting the Communication Protocol

The communication protocol is selected in the parameters menu (***PROTOCOL*** screen).

The next screen in the parameters menu contains the setting parameters corresponding to the selected protocol.

Setting the Modbus Protocol Parameters

The Modbus protocol parameters are set in the parameters menu (***MODBUS*** screen).

These parameters are described in the table below:

Parameters	Authorized Values
Address	1...247
Transmission speed	● 4800 Baud ● 9600 Baud ● 19200 Baud ● 38400 Baud
Parity	● None (2 stop bits) ● Even (1 stop bit) ● Odd (1 stop bit)
Remote control order	● DIR: Direct mode remote control order ● SBO: Confirmed (Select Before Operate) mode remote control order

Setting the IEC 60870-5-103 Protocol Parameters

The IEC 60870-5-103 protocol parameters are selected in the parameters menu (***IEC 870-5-103*** screen).

These parameters are described in the table below:

Parameters	Authorized Values
Address	0...254
Transmission speed	● 4800 Baud ● 9600 Baud ● 19200 Baud ● 38400 Baud
Parity	● None (2 stop bits) ● Even (1 stop bit) ● Odd (1 stop bit)

Local/Remote Check

Sepam series 10 A manages local/remote mode, to authorize or inhibit actions by the communication port.

In standard mode, logic input I4 is assigned to the local/remote mode data item. If this input is active, remote control orders are not taken into account, except for remote opening orders. A setting in the parameters menu can be used, if necessary, to inhibit the remote opening order in local mode.

For more information, refer to *Operation of the Local/Remote Check, p. 139*.

In custom mode, the local/remote logic input can be assigned to logic inputs I3 or I4.

Circuit Breaker Control via the Communication

Sepam series 10 A relays can be used to control circuit breaker opening or closing via the communication port.

Two predefined remote control orders can be used to activate output relays O1 and O4:

- Circuit breaker opening activates output relay O1
- Circuit breaker closing activates output relay O4

In standard mode, output relays O1 and O4 are assigned to circuit breaker tripping and closing respectively.

In custom mode, circuit breaker tripping can be assigned to output relays O1, O2 or O3. However, circuit breaker opening via the communication is always performed by output relay O1.

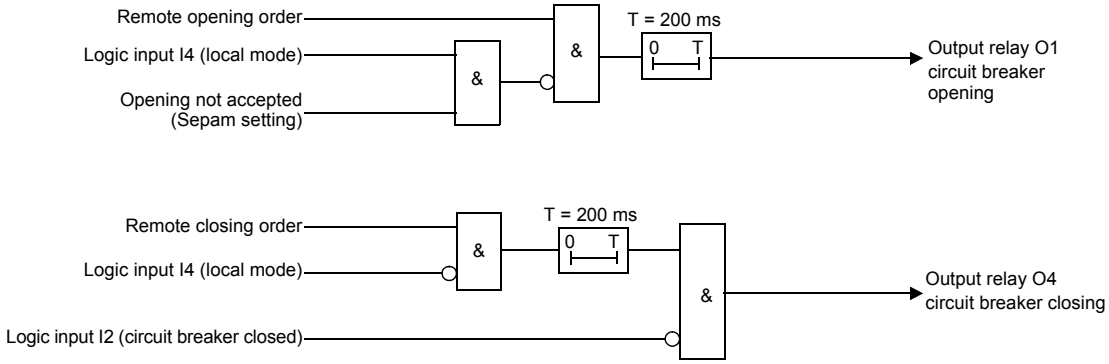
Remarks

- On receipt of a remote control order, activation of output relays O1 or O4 is maintained for a set period of 200 ms, to ensure that the command is taken into account by the undervoltage trip coil or shunt trip coil.
- Output relay O4 is not activated by a remote closing order if the circuit breaker is seen by Sepam to be in the closed position (logic input I2 at state 1).

These two characteristics are illustrated in the block diagram below.

Block Diagram - Circuit Breaker Control via the Communication

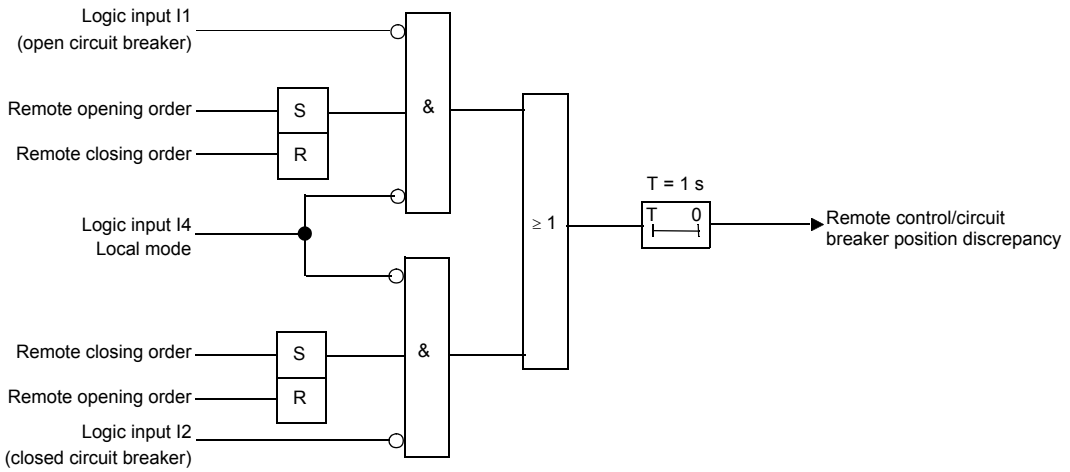
The block diagram dealing with remote opening/closing orders and local/remote mode is shown below:



Remote Control/ Circuit Breaker Position Discrepancy Fault

Sepam can be used to detect a discrepancy between the last remote control order received and the actual circuit breaker position. The information can be accessed via a remote indication. This information is used to identify a change in the circuit breaker position due to tripping on a fault (action by a protection function) or a local operation (manual action on the circuit breaker).

Block Diagram of Remote Control/ Circuit Breaker Position Discrepancy Fault



Reading the Circuit Breaker Position

Sepam series 10 A relays can be used to transmit the circuit breaker position via the communication port.

The circuit breaker position contacts must be hard-wired on two Sepam logic inputs:
- Logic input I1: open circuit breaker (C/O interlock)
- Logic input I2: closed circuit breaker (O/O interlock)

The circuit breaker position can be accessed by reading in the communication tables:
- The state of the Circuit breaker position remote indication (= 1 if circuit breaker is closed)
- The states of logic inputs I1 and I2

Sepam makes additional information available, relating to the circuit breaker position:
- The Remote control/circuit breaker position discrepancy remote indication
- The Matching fault or Trip Circuit Supervision (TCS) remote indication. Depending on the wiring of inputs I1 and I2, Sepam can monitor the continuity of the trip circuit or, more simply, matching of inputs I1 and I2. Refer to *Trip Circuit Supervision (TCS), p. 135*.

Trip Circuit Supervision (TCS)

Applicable to Sepam Series 10

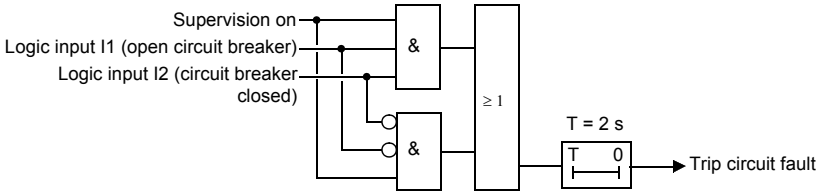
N B A

Description

Between the Sepam relay and the circuit breaker, the trip circuit passes along wires, terminals and connectors. If the function is active, Sepam monitors this circuit continuously to ensure that there are no breaks. The diagram below can be used to make a small current flow continuously around the trip circuit. Sepam constantly checks the presence of this current.

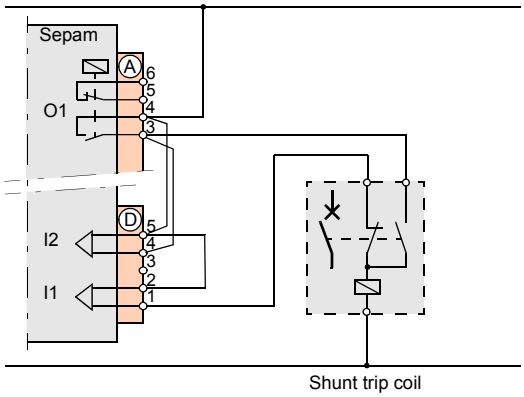
By default, the trip circuit supervision function is not active so as to avoid generating pointless messages if the circuit breaker position contacts are not connected. To use it, it must be activated in the parameters menu.

Block Diagram



On a Circuit Breaker with Shunt Trip Coil

The trip circuit supervision function uses both logic inputs I1 and I2 connected on two circuit breaker position contacts as shown in the diagram below:



Sepam uses both these logic inputs to read the circuit breaker position. These 2 inputs are normally matched. If Sepam detects that both these inputs are at 1 or 0 at the same time, this indicates a fault that may be due to the following causes:

- A break in the shunt trip coil power supply wiring, or a break in the coil (in this case, an opening order would be ineffective)
- A fault in the operation of the circuit breaker position contacts (in this case, the circuit breaker position readout is invalid)

In the event of a fault:

- A fault screen is displayed. This screen disappears temporarily when the operator uses the keypad, and returns automatically after 20 seconds as long as the fault persists.
- An event is recorded in the Time-tagged record of the last 5 events function.
- Output relay O6 indicates the fault (in standard mode).
- This information is also available via the communication.

The setting screen for this function in the parameters menu indicates the circuit breaker position. In the event of a discrepancy between inputs I1 and I2, indication of the position is replaced by a fault indication. After the maintenance intervention, this can be used to check that the repair has been made correctly.

Note: If inputs I1 and I2 are connected in accordance with a different diagram, supervision of the trip circuit continuity may not work. However, Sepam still makes sure that the circuit breaker position is read so that it can be transmitted via the communication. In addition, supervision of the matching of inputs I1 and I2 is also performed. This is used to ensure the information is valid.

Remark: Sepam delays taking account of the state of the circuit breaker positions by 2 seconds to avoid any discrepancy that might appear between I1 and I2 while the circuit breaker is operating.

On a Circuit Breaker with Undervoltage Trip Coil

In this case, supervision of the continuity of the trip wiring serves no purpose, since the circuit breaker will open before the break is indicated. The function is then only used to supervise matching of logic inputs I1 and I2.

Settings

Use of the function can be accessed in the parameters menu.

The parameter to be set is:

- Use of the trip circuit supervision function (***TCS*** screen)

Date and Time

Applicable to Sepam Series 10

N B A

Description

Sepam has an internal clock which can be used to assign a date and time:
- To events recorded by the time-tagged record of the last 5 events function
- To other time-tagged events, which can be accessed via the communication

In the event of failure of the Sepam auxiliary power supply, the internal clock is maintained by a battery. If the battery has been removed or is run down, the internal clock is powered by the auxiliary power supply. If the battery is removed or runs down while the auxiliary power supply is missing, the internal clock will reset itself to 01/01/2007 0:00:00.

Note: Operation of the protection functions is not affected by the presence or absence of the battery.

Settings

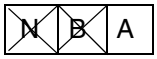
The date and time setting can be accessed in the parameters menu.

The parameters to be set are:
- Date setting (***DATE*** screen)
- Time setting (***TIME*** screen)

The date and time setting in the parameters menu is not taken into account when the Sepam date and time are synchronized via the communication.

Voltage Applied to the Logic Inputs

Applicable to Sepam Series 10



For Sepam series 10 A ••A and series 10 A ••E only. The Sepam series 10 A ••F logic inputs are only supplied with DC voltage.

Description

By default, the 4 logic inputs are programmed to detect the presence or absence of a DC voltage.

If they need to operate using a 50 Hz or 60 Hz voltage, their operation must be adapted to detect an AC voltage.

Settings

Selection of DC voltage or AC voltage can be accessed in the parameters menu.

The parameter to be set is:

- Voltage applied to the logic inputs (***LOGIC INPUTS*** screen)

Operation of the Local/Remote Check

Applicable to Sepam Series 10

N B A

Description

By default, on a Sepam series 10 A relay, logic input I4 is used to authorize or inhibit actions by the communication port.

The table below indicates those actions which are/are not possible from the communication port, depending on the status of I4:

	I4 = 0 Remote Mode	**I4 = 1 Local Mode**
Open circuit breaker	yes	yes
Close circuit breaker	yes	no
Acknowledge output relays and fault LEDs	yes	no
Peak demand values reset	yes	no

Note: If input I4 is not connected, its status is equivalent to 0. In this case, all the actions in the above table are authorized by the communication.

Settings

In the parameters menu, it is possible to modify Sepam operation so as to inhibit an opening order passing via the communication when Sepam is in local mode.

The parameter to be set is:

- Operation of local mode (***LOCAL MODE*** screen)

Select ***OPEN NOT ACCEPTED.***

In this case, the above table changes to:

	I4 = 0 Remote Mode	**I4 = 1 Local Mode**
Open circuit breaker	yes	**no**
Close circuit breaker	yes	no
Acknowledge output relays and fault LEDs	yes	no
Peak demand values reset	yes	no

Customization Option

The local/remote check function does not have any customization options.

However, in custom mode, I4 can be assigned to a different use than the local/remote check. If this is the case:

- Sepam operates in remote mode, and behaves as if I4 was still at 0 in the above tables.
- The operation of local mode screen (***LOCAL MODE*** screen) is present, but inoperative.

Password

Applicable to Sepam Series 10

N	B	A

Description

A 4-digit password is used to protect modification of the Sepam protection and parameter settings.

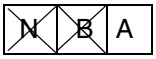
Password activation and definition are possible in the parameters menu. The parameter to be set is:

- NO PASSWORD or PASSWORD = xxxx (***SET PASSWORD*** screen)

For more information, refer to *Protecting the Settings with a Password, p. 56*.

Display the Status of the Logic Inputs

Applicable to Sepam Series 10



Description

The display the status of the logic inputs function can be accessed in the parameters menu. It is used to display the status of the 4 logic inputs. The logic input status is accessible in read mode only. The corresponding screen, ***INPUT STATUS***, does not have any modifiable parameters.

Display the Status of the Output Relays

Applicable to Sepam Series 10

N	B	A

Description

The display the status of the output relays function can be accessed in the parameters menu. It is used to display the status of the 4 output relays. A logic status 1 indicates that the corresponding output relay is in the on-position. The logic output status is accessible in read mode only. The corresponding screen, ***OUT STATUS***, does not have any modifiable parameters.

- For Sepam series 10 N and series 10 B relays, the output relays displayed are O1, O2, O3.
- For Sepam series 10 A, the output relays displayed are O1 to O6. The watchdog relay O7 cannot be displayed on this screen. Its status is indicated by the red LED on the front panel.

Watchdog Relay

Applicable to Sepam Series 10

N	B	A

Description

Sepam series 10 A

Sepam series 10 A relays are equipped as standard with a watchdog relay (O7). This is a changeover relay which is kept permanently in the on-position by Sepam. In the event of Sepam failure, or if the auxiliary power supply fails, the watchdog relay reverts to the off-position.

Sepam series 10 N and series 10 B

Sepam series 10 N and series 10 B relays are not equipped as standard with a watchdog relay.

Customization Option

On Sepam series 10 N and series 10 B relays, output relay O3 can be assigned to the watchdog function. Refer to *Custom operating mode, p. 147*.

Indicator LEDs on the Front Panel

Applicable to Sepam Series 10

N	B	A

Status LEDs

Depending on the model, Sepam relays have 2 or 3 status LEDs:

Pictogram	Color	Event
On	Green	The power supply voltage is present on the Sepam input.
	Red	Sepam has gone into the fail-safe position following detection by the embedded self-tests of the failure of one of its internal components. In this case, Sepam is no longer operational. (This LED may light up briefly when Sepam is energized: this is normal and does not indicate a failure.)
	Yellow flashing	An activity is present on the communication link. (Sepam series 10 A only)

Fault LEDs

Depending on the model, Sepam relays have between 1 and 4 red fault indicator LEDs. By default these LEDs are latched: they continue to indicate the fault, even when it has disappeared. They will go out after a fault acknowledgement action from the Reset key or the communication port (Sepam series 10 A).

These LEDs are as follows:

Pictogram	Slow Flashing
	Tripping by the phase protection or logic discrimination back-up protection.
	Tripping by the earth fault protection or logic discrimination back-up protection.
	Thermal overload protection trip.
Ext	An external trip order has been issued from logic input I3.

For the first 3 LEDs, faster flashing may occur before the protection trips, to indicate the following information:

Pictogram	Quick Flashing
	Overshoot of the instantaneous set point for phase overcurrent protection (I> or I>> pick-up output)
	Overshoot of the instantaneous set point for earth fault protection (Io> or Io>> pick-up output)
	Overshoot of the thermal overload protection alarm set point

Fault Screens on the Display

Whenever a fault is detected by Sepam, a screen corresponding to the fault appears on the display. This screen contains the same information as that memorized by the saving the last fault and time-tagged saving the last 5 events functions. If the operator presses a key while a fault screen is present, the screen disappears to allow the operator to use the keypad and the display. However, the information concerning the fault is still present on the fault LEDs and in the fault records which can be accessed in the metering menu.

Customization Option

In custom mode:

- Each of the fault LEDs can be programmed individually so that the latching function is not activated.
- It is possible to assign logic inputs I3 or I4 to other events. If no LEDs are assigned to external tripping, the Ext external trip LED will not be used.

Note: If assignment of the output relays has been modified in custom mode, the LEDs may indicate a fault, even though this fault does not give the opening order to the circuit breaker.

Refer to *Custom operating mode, p. 147*.

Fault Acknowledgement

Applicable to Sepam Series 10

N	B	A

Description

Faults can be acknowledged by:
- Pressing the Reset key
- The communication port (on Sepam series 10 A)

Fault acknowledgement includes:
- Extinction of the fault LEDs
- Replacement of the fault screen with the previously displayed screen
- Return of the output relays to their initial status so as to authorize circuit breaker closing

Note: Acknowledgement of a fault does not change the list of faults memorized by the saving the last fault and time-tagged saving the last 5 events functions.

Customization Option

With Sepam series 10 A relays in custom mode, a logic input I3 or I4 can be assigned to fault acknowledgement.

Refer to *Custom operating mode, p. 147*.

Custom operating mode

5

What's in this Chapter?

This chapter contains the following topics:

Introduction

Menu Organization

All the data available in the Sepam relay is divided between three menus:

- The metering menu contains the current measurements and records of the most recent events.
- The protection menu contains the essential settings for setting up the protection functions.
- The parameters menu contains the parameters that can be used to adapt the Sepam operation to particular applications. All these parameters have a default value. The protection functions are operational even with the parameters menu default values.

Operating Mode for the Output Relays, LEDs and Logic Inputs

There are 2 possible operating modes for the output relays, the fault indication LEDs on the front panel and the logic inputs:

- Standard mode (default mode) corresponds to the operation described in the *Functions and Parameters* chapter, for which the output relays, the fault indication LEDs on the front panel and the logic inputs are pre-assigned.
- Custom operating mode is used, if necessary, to modify operation of the output relays, the fault LEDs on the front panel and the logic inputs.

This chapter describes the customization options for each Sepam model with a block diagram and the description of the associated customization screens in the parameters menu.

The switches shown on the block diagrams are fictional switches, each of which represents an option in one of the customization screens. They are drawn in the default position (standard mode).

Selecting the Operating Mode

The ***I/O ASSIGN*** screen located at the end of the parameters menu is used to select the operating mode:

- ***STANDARD*** mode
- ***CUSTOM*** mode

After selection of custom mode, the screens required to customize Sepam operation appear in the parameters menu after the ***I/O ASSIGN*** screen.

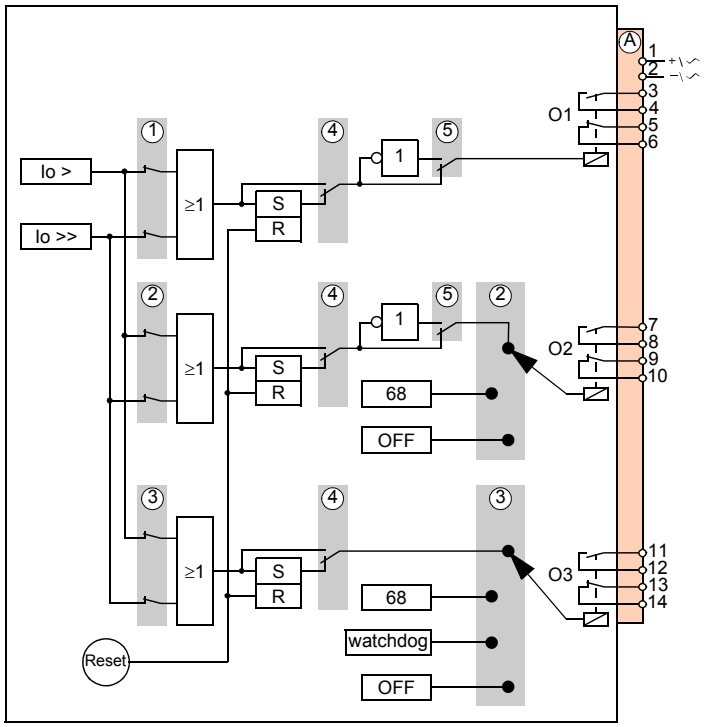
Storing the Custom Mode Parameters

After setting the parameters for the custom operating mode, it is possible to return to standard operating mode.

The custom operating mode parameters are then stored by Sepam. On returning to custom operating mode, the stored parameters are proposed.

Sepam Series 10 N - Customizing the Output Relays

Block Diagram



Label 1: Assignment of Output Relay O1

The ***O1 ASSIGN*** screen is used to select the outputs for the protection functions connected to output relay O1.

The screen contains 2 digits. Each digit is associated with the output for a protection function.

From left to right, the digits are associated with the following functions:
- Delayed output for the earth fault protection, Io> set point
- Delayed output for the earth fault protection, Io>> set point

If the digit value equals 1, the associated protection function output is connected to output relay O1.

During the setting operation, the function associated with the selected digit is indicated on the left side of the bottom line as a reminder.

Label 2: Assignment of Output Relay O2

The ***O2 ASSIGN*** screen is used to assign output relay O2 to one of the following functions:
- Protection functions output
- Sending a logic discrimination blocking order (ANSI 68)
- Not used (OFF)

If output relay O2 is assigned to the protection functions output, it is possible to select which protections will activate it. This operation is performed in the same way as for output relay O1.

Label 3: Assignment of Output Relay O3

The ***O3 ASSIGN*** screen is used to assign output relay O3 to one of the following functions:
- Protection functions output
- Sending a logic discrimination blocking order (ANSI 68)
- Watchdog
- Not used (OFF)

If output relay O3 is assigned to the protection functions output, it is possible to select which protections will activate it. This operation is performed in the same way as for output relay O1.

Label 4: Latching the Output Relays

The ***RELAYS LATCH*** screen is used to disable the latching function for each of output relays O1, O2 and O3.

The parameters to be set are:
- O1 latched: YES or NO
- O2 latched: YES or NO
- O3 latched: YES or NO

Meaning:
- YES means that the output relay is latched. In this case, it stays in the on-position after receiving a trip order, until acknowledged by the Reset key. This is default operation.
- NO means that the output relay reverts to its off-position as soon as the order given by the protection has disappeared.

Label 5: Inversion of Output Relay Operation

The ***RELAYS INVER*** screen is used to invert the operating logic for output relays O1 and O2.

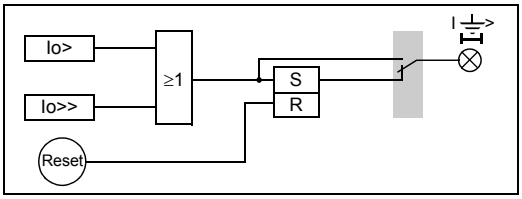
The parameters to be set are:
- O1 inverted: YES or NO
- O2 inverted: YES or NO

Meaning:
- NO means that the output relay operation is not inverted.
  In this case, it is normally in the off-position, and it changes to the on-position when the protection operates. This is default operation. Depending on the contact used, O1 can control a shunt trip coil or an undervoltage trip coil.
- YES means that the output relay operation is inverted.
  In this case, it is normally in the on-position, and it changes to the off-position after receiving a trip order.

Example of application:
- Inversion of output relay O1 operation should be used when the Sepam relay is controlling an undervoltage trip coil and the circuit breaker needs to open automatically in the event of Sepam failure.
- If output relay O2 is used for trip lockout (ANSI 86 function), inversion of output relay O2 operation should be used in particular cases where circuit breaker closing needs to be inhibited if the protection is unavailable.

Sepam Series 10 N - Customizing the Fault LED

Block Diagram



Latching the LED

The ***LEDS LATCH*** screen is used to disable the $I_{\perp}>$ earth fault LED latching function (Io> and Io>> set points).

The parameter to be set is:

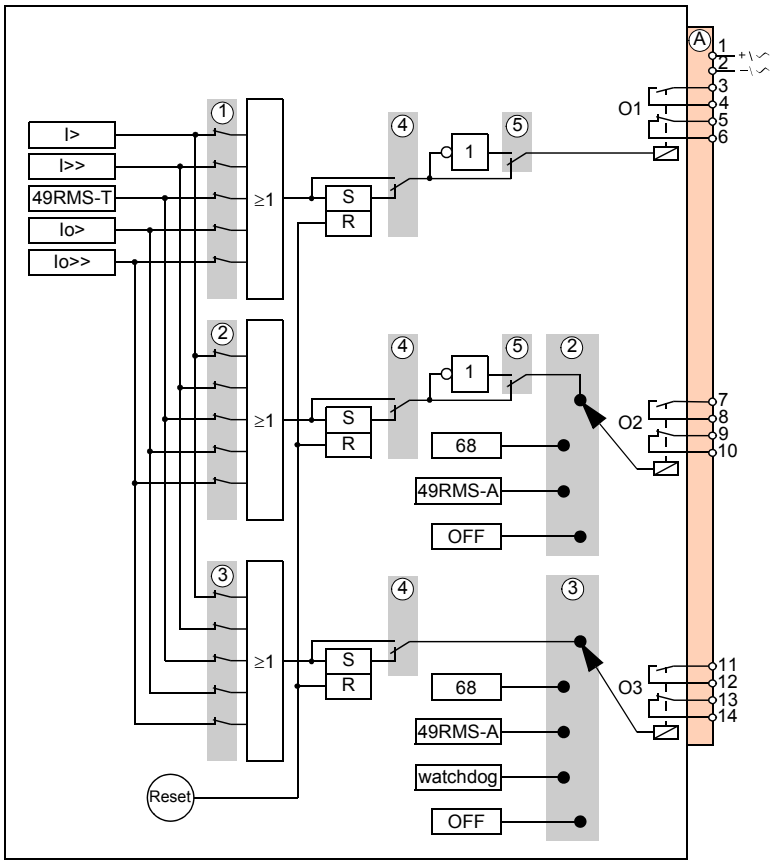
- LED latched: YES or NO

Meaning:

- YES means that the LED is latched.
  In this case, it flashes after detecting a fault, even a transient one, until acknowledged by the Reset key. This is default operation.
- NO means that the LED stops flashing as soon as the fault detected has disappeared.

Sepam Series 10 B - Customizing the Output Relays

Block Diagram



Label 1: Assignment of Output Relay O1

The ***O1 ASSIGN*** screen is used to select the outputs for the protection functions connected to output relay O1.

The screen contains 5 digits. Each digit is associated with the output for a protection function.

From left to right, the digits are associated with the following functions:

- Delayed output for the phase overcurrent protection, I> set point
- Delayed output for the phase overcurrent protection, I>> set point
- Delayed output for the earth fault protection, Io> set point
- Delayed output for the earth fault protection, Io>> set point
- Thermal overload protection tripping output (ANSI 49 RMS-T)

If the digit value equals 1, the associated protection function output is connected to output relay O1.

During the setting operation, the function associated with the selected digit is indicated on the left side of the bottom line as a reminder.

Label 2: Assignment of Output Relay O2

The ***O2 ASSIGN*** screen is used to assign output relay O2 to one of the following functions:

- Protection functions output
- Sending a logic discrimination blocking order (ANSI 68)
- Thermal overload protection alarm output (ANSI 49 RMS-A)
- Not used (OFF)

If output relay O2 is assigned to the protection functions output, it is possible to select which protections will activate it. This operation is performed in the same way as for output relay O1.

Label 3: Assignment of Output Relay O3

The ***O3 ASSIGN*** screen is used to assign output relay O3 to one of the following functions:
- Protection functions output
- Sending a logic discrimination blocking order (ANSI 68)
- Thermal overload protection alarm output (ANSI 49 RMS-A)
- Watchdog
- Not used (OFF)

If output relay O3 is assigned to the protection functions output, it is possible to select which protections will activate it. This operation is performed in the same way as for output relay O1.

Label 4: Latching the Output Relays

The ***RELAYS LATCH*** screen is used to disable the latching function for each of output relays O1, O2 and O3.

The parameters to be set are:
- O1 latched: YES or NO
- O2 latched: YES or NO
- O3 latched: YES or NO

Meaning:
- YES means that the output relay is latched.
  In this case, it stays in the on-position after receiving a trip order, until acknowledged by the Reset key. This is default operation.
- NO means that the output relay reverts to its off-position as soon as the order given by the protection has disappeared.

Label 5: Inversion of Output Relay Operation

The ***RELAYS INVER*** screen is used to invert the operating logic for output relays O1 and O2.

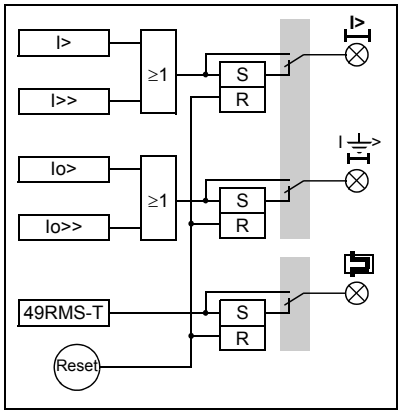
The parameters to be set are:
- O1 inverted: YES or NO
- O2 inverted: YES or NO

Meaning:
- NO means that the output relay operation is not inverted. In this case, it is normally in the off-position, and it changes to the on-position when the protection operates. This is default operation. Depending on the contact used, O1 can control a shunt trip coil or an undervoltage trip coil.
- YES means that the output relay operation is inverted. In this case, it is normally in the on-position, and it changes to the off-position after receiving a trip order.

Example of application:
- Inversion of output relay O1 operation should be used when the Sepam relay is controlling an undervoltage trip coil and the circuit breaker needs to open automatically in the event of Sepam failure.
- If output relay O2 is used for trip lockout (ANSI 86 function), inversion of output relay O2 operation should be used in particular cases where circuit breaker closing needs to be inhibited if the protection is unavailable.

Sepam Series 10 B - Customizing the Fault LEDs

Block Diagram



Latching the LEDs

The ***LEDS LATCH 1*** screen is used to disable the latching function for each of the following LEDs:

- Phase fault (I> and I>> set points)
- Earth fault (Io> and Io>> set points)

The ***LEDS LATCH 2*** screen is used to disable the thermal overload protection fault LED latching function (ANSI 49 RMS-T).

The parameter to be set for each LED is:

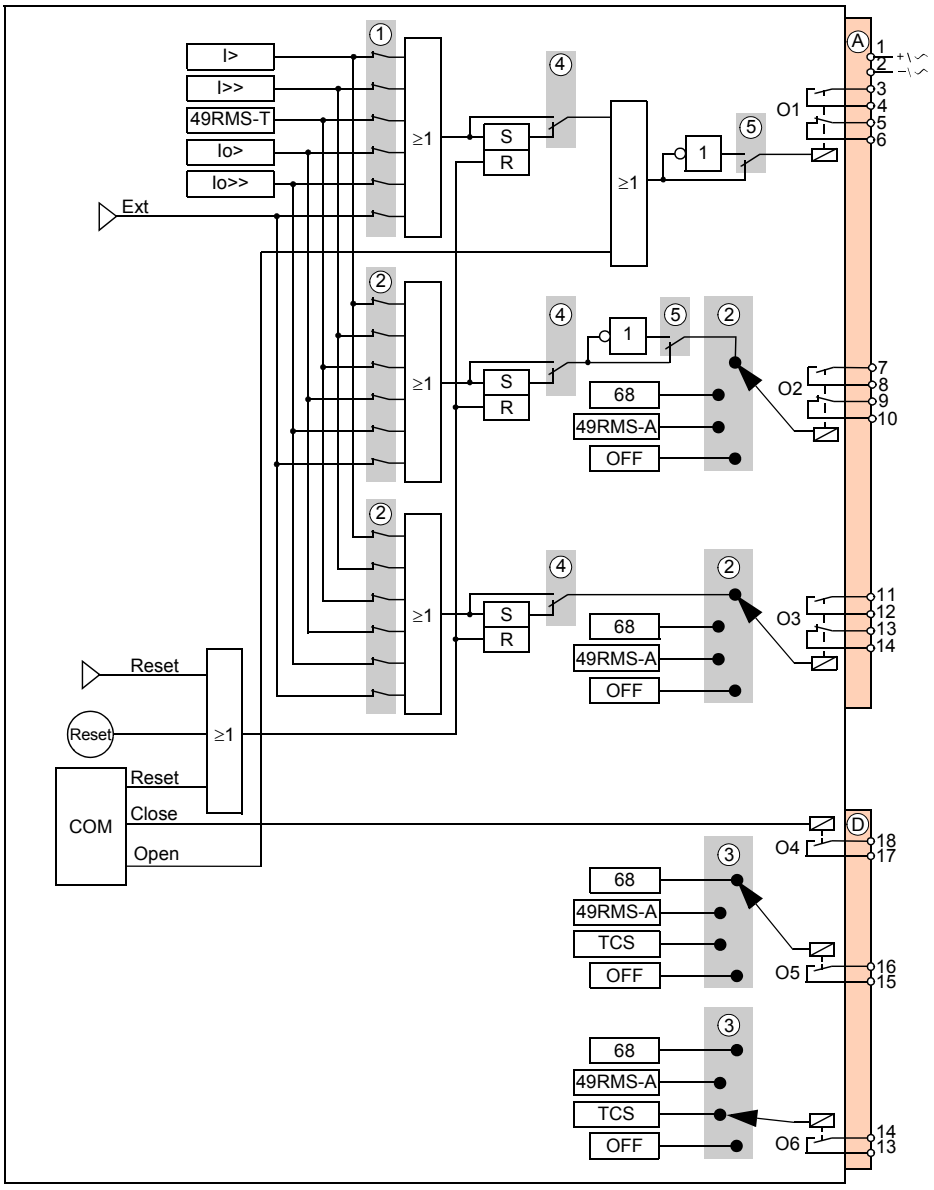
- LED latched: YES or NO

Meaning:

- YES means that the LED is latched. In this case, it flashes after detecting a fault, even a transient one, until acknowledged by the Reset key. This is default operation.
- NO means that the LED stops flashing as soon as the fault detected has disappeared.

Sepam Series 10 A - Customizing the Output Relays

Block Diagram



Label 1: Assignment of Output Relay O1

The ***O1 ASSIGN*** screen is used to select the outputs for the protection functions connected to output relay O1.

The screen contains 6 digits. Each digit is associated with the output for a protection function.

From left to right, the digits are associated with the following functions:

- Delayed output for the phase overcurrent protection, I> set point
- Delayed output for the phase overcurrent protection, I>> set point
- Delayed output for the earth fault protection, Io> set point
- Delayed output for the earth fault protection, Io>> set point
- Thermal overload protection tripping output (ANSI 49 RMS-T)
- External trip order connected to a logic input, I3 or I4 depending on the parameter setting

If the digit value equals 1, the associated protection function output is connected to output relay O1.

During the setting operation, the function associated with the selected digit is indicated on the left side of the bottom line as a reminder.

Label 2: Assignment of Output Relays O2 and O3

The ***O2 ASSIGN*** and ***O3 ASSIGN*** screens are used to assign output relays O2 and O3 to one of the following functions:

- Protection functions output
- Sending a logic discrimination blocking order (ANSI 68)
- Thermal overload protection alarm output (ANSI 49 RMS-A)
- Not used (OFF)

If either output relay O2 or O3 is assigned to the protection functions output, it is possible to select which protections will activate it. This operation is performed in the same way as for output relay O1.

Label 3: Assignment of Output Relays O5 and O6

The ***O5 ASSIGN*** and ***O6 ASSIGN*** screens are used to assign output relays O5 and O6 to one of the following functions:

- Sending a logic discrimination blocking order (ANSI 68)
- Thermal overload protection alarm output (ANSI 49 RMS-A)
- Annunciation of a trip circuit (TCS) continuity fault
- Not used (OFF)

Label 4: Latching the Output Relays

The ***RELAYS LATCH*** screen is used to disable the latching function for each of output relays O1, O2 and O3.

The parameters to be set are:

- O1 latched: YES or NO
- O2 latched: YES or NO
- O3 latched: YES or NO

Meaning:

- YES means that the output relay is latched.
  In this case, it stays in the on-position after receiving a trip order, until acknowledged by the Reset key, by a logic input or via the communication. This is default operation.
- NO means that the output relay reverts to its off-position as soon as the order given by the protection has disappeared.

Label 5: Inversion of Output Relay Operation

The ***RELAYS INVER*** screen is used to invert the operating logic for output relays O1 and O2.

The parameters to be set are:

- O1 inverted: YES or NO
- O2 inverted: YES or NO

Meaning:

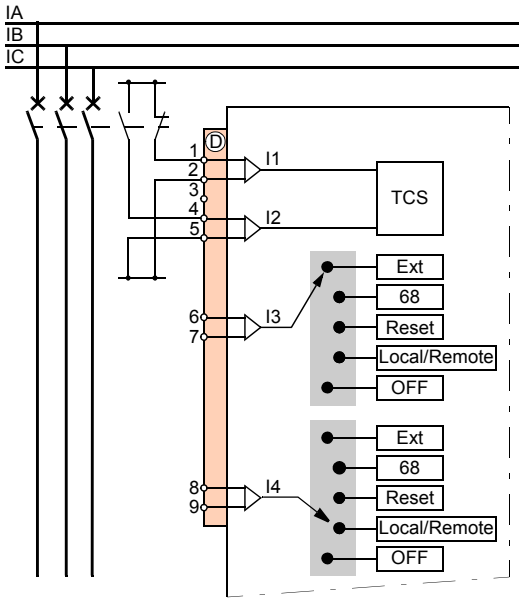
- NO means that the output relay operation is not inverted. In this case, it is normally in the off-position, and it changes to the on-position when the protection operates. This is default operation. Depending on the contact used, O1 can control a shunt trip coil or an undervoltage trip coil.
- YES means that the output relay operation is inverted. In this case, it is normally in the on-position, and it changes to the off-position after receiving a trip order.

Example of application:

- Inversion of output relay O1 operation should be used when the Sepam relay is controlling an undervoltage trip coil and the circuit breaker needs to open automatically in the event of Sepam failure.
- If output relay O2 is used for trip lockout (ANSI 86 function), inversion of output relay O2 operation should be used in particular cases where circuit breaker closing needs to be inhibited if the protection is unavailable.

Sepam Series 10 A - Customizing the Logic Inputs

Block Diagram



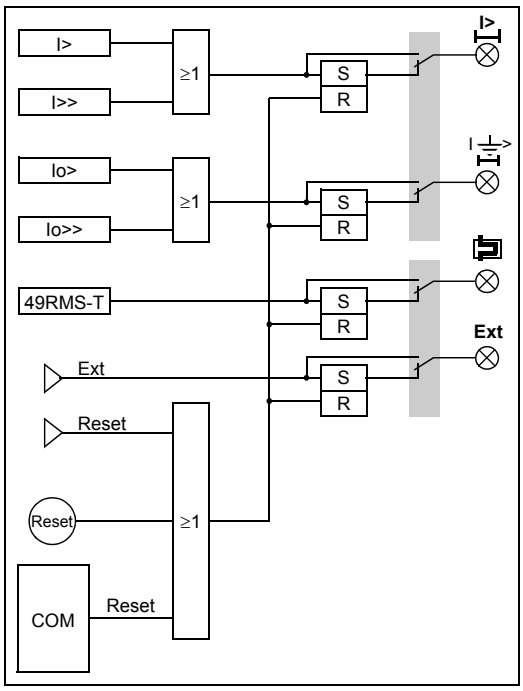
Assignment of Inputs I3 and I4

The ***I3 ASSIGN*** and ***I4 ASSIGN*** screens are used to assign logic inputs I3 and I4 to one of the following functions:

- Tripping by external order
- Blocking logic input, order from a downstream circuit breaker
- Fault acknowledgement (same function as the Reset key)
- Selection of the control mode: local (I=1) or remote (I=0); refer to *Operation of the Local/Remote Check, p. 139*
- Not used (OFF)

Sepam Series 10 A - Customizing the Fault LEDs

Block Diagram



Latching the LEDs

The ***LEDS LATCH 1*** screen is used to disable the latching function for each of the following LEDs:

- Phase fault (I> and I>> set points)
- Earth fault (Io> and Io>> set points)

The ***LEDS LATCH 2*** screen is used to disable the latching function for each of the following LEDs:

- Thermal overload protection fault
- Ext External trip

The parameter to be set for each LED is:

- LED latched: YES or NO

Meaning:

- YES means that the LED is latched.
  In this case, it flashes after detecting a fault, even a transient one, until acknowledged by the Reset key, by a logic input or via the communication. This is default operation.
- NO means that the LED stops flashing as soon as the fault detected has disappeared.

Sepam Series 10 A - Customizing Logic Discrimination

Backup Time Delay

The ***68 BKUP I>***, ***68 BKUP I>>***, ***68 BKUP Io>*** and ***68 BKUP Io>>*** screens are used to implement and set the backup time delay associated with the I>, I>>, Io> and Io>> set points used.

These time delays are not blocked by the logic discrimination blocking order so that tripping is guaranteed if an unwanted logic discrimination blocking order is received. These time delays must be set by applying the time discrimination rules in relation to the downstream protection.

To implement and set the backup time delays, refer to *Logic Discrimination (ANSI 68), p. 121*.

Circuit breaker control and reliability

6

What's in this Chapter?

This chapter contains the following topics:

General Principle

Taking Account of Protection Relay Failures

Operational reliability is the property that allows its users to have well-placed confidence in the service that Sepam delivers. For a Sepam protection relay, operational reliability consists of ensuring the safety and availability of the installation.

This means avoiding the following 2 situations:

- Nuisance tripping of the protection:
  Continuity of the electrical power supply is as vital for a manufacturer as it is for an electricity distribution company. Nuisance tripping caused by the protection can result in considerable financial losses. This situation affects the availability of the protection.
- Failure of the protection to trip:
  The consequences of a fault that is not eliminated can be catastrophic. For safety of operation, the protection relay must detect faults in the electrical network as quickly as possible, using discrimination. This situation affects the safety of the installation.

The reliability of an electrical supply must take account of the imperatives relating to safety and availability of people and property.

Electrical distribution networks consist of a set of components (cables, switchgear, protection relays, measurement transformers, MV/LV transformers, etc.) whose correct operation may be affected by failures. The consequences of failure of one of the network components are varied and depend on factors specific to each network.

These include:

- The network topology
- The type of connected users
- The load types
- The position of each component in the network
- The failure mode for each component, etc.

In case a network element fails, it is important to prioritize either continuity of the electricity supply, or shutdown of part of the network. While designing the network and its protection plan, knowledge of the failure modes for each element can be used to steer the failure into a particular state. This requires the failure mode for the network elements to be as deterministic as possible.

To comply with this approach, Sepam is equipped with self-tests that continuously check all its electronics and embedded software are operating correctly. The purpose of the self-tests is to put Sepam into a deterministic position, called the fail-safe position, in the event of failure or malfunction of one of its internal components. In fail-safe position, Sepam is no longer operational, all its output relays are forced into the off-position and the network is no longer protected. Note that, if the auxiliary power supply disappears, Sepam's output relays are also in the off-position.

Circuit Breaker Behavior in the Event of Sepam Failure

It is possible to choose whether the change to fail-safe position opens the circuit breaker or not, depending on the following priorities:

- Ensuring continuity of electrical distribution
- Or shutting down part of the network in the event of Sepam failure

The options concern:

- The circuit breaker shunt trip coil or undervoltage trip coil
- Circuit breaker control via the normally open contact (NO) or via the normally closed contact (NC) of output relay O2

The table below indicates the possible types of behavior in the event of Sepam failure. Use in standard mode or in custom mode is described in the sections below.

Circuit Breaker with Shunt Trip Coil	Circuit Breaker with Undervoltage Trip Coil
● The circuit breaker stays closed if Sepam goes into the fail-safe position. ● Monitoring is required to detect whether the protection is no longer operational.	● The circuit breaker opens automatically if Sepam goes into the fail-safe position. ● The circuit breaker opens if the substation auxiliary voltage disappears.

Need to Monitor Correct Operation of the Protection

When continuity of service is a priority, it is essential to monitor that the protection is effective. If so, Sepam's failure should not cause the circuit breaker to open. However, in the event of a failure, the protection is no longer operational and discrimination no longer occurs. This is not a problem while no other faults exist downstream and the network can be used temporarily as it is. When the next downstream fault occurs, the circuit breaker upstream will trip and a larger part of the network will be shut down. To avoid leaving the network permanently in this state, with a failure that has not been announced, it is essential to monitor that Sepam is operating correctly. This monitoring can be either periodic or continuous as the user requires, depending in particular on the estimated frequency of faults on the network.

Monitoring by the Status of the LED

The Sepam unavailable LED is off during normal operation and lights up when Sepam goes into the fail-safe position. It allows an operator to carry out regular monitoring, without taking any particular action. However, in the event of failure, the failure will not be detected until the operator's next visit.

When the circuit breaker opens automatically if the protection fails, the LED monitoring is of no help in warning that intervention is required. However, it can be used to locate the failure.

The table below describes the meaning of the Sepam unavailable LED depending on the status of the auxiliary power supply On LED.

	On LED On	**On LED Off**
LED off	The Sepam is supplied with power and operating normally.	Sepam: ● is not supplied with power ● or is in the fail-safe position after an internal power supply failure
LED on	Sepam is in the fail-safe position.	Sepam is in the fail-safe position.

Monitoring by the Status of the Watchdog Relay

The watchdog relay is in the on-position in normal operation and goes into the off-position if Sepam fails or if the auxiliary power supply disappears. It is mainly used for remote alarm transfer. Compared to simple Sepam unavailable LED monitoring, this system can reduce the intervention time. The watchdog relay can also be used to activate a backup protection system.

When the circuit breaker opens automatically if the Sepam fails, the watchdog relay is of no help in warning that intervention is required, but can be used to locate the failure.

Remarks:
- Sepam series 10 A is equipped as standard with a watchdog relay (O7).
- Sepam series 10 N and Sepam series 10 10 B relays do not have a watchdog relay as standard. If necessary, custom mode can be used to assign output relay O3 to the watchdog function.

Monitoring via the Communication

If Sepam goes into fail-safe position, communication via the serial port is no longer operational. This is a means of generating an alarm by the supervisor and thus summoning a maintenance engineer.

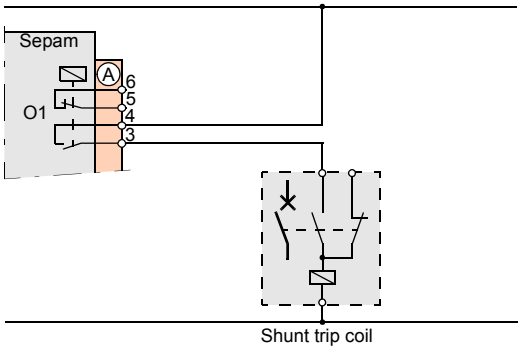
Circuit Breaker Control in Standard Mode

Output Relay O1: Tripping of a Circuit Breaker with a Shunt Trip Coil

The trip coil is wired in series with the normally open contact of output relay O1. If there is a fault on the network, closing of the normally open contact trips opening of the circuit breaker by supplying power to the shunt trip coil.

In the event of Sepam failure, all the output relays are forced into the off-position and the circuit breaker stays closed. The fail-safe position avoids sending an unwanted opening order. This diagram prioritizes continuity of service.

Connection diagram for a circuit breaker with a shunt trip coil

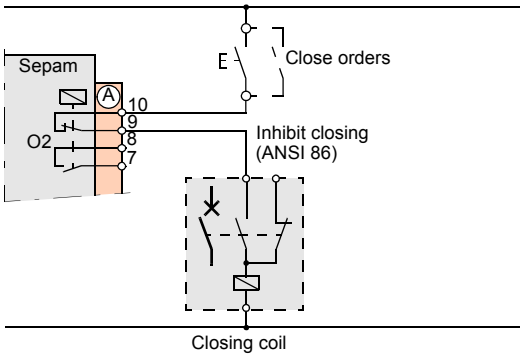


Output Relay O2: Circuit Breaker Trip Lockout

Trip lockout is achieved by hard-wiring the normally closed contact of output relay O2. The assembly below can be used to prevent a closing order going through until the fault has been acknowledged. Once Sepam has given the opening order to the circuit breaker, O2 switches to the on-position, and stays in this position until acknowledged by an operator.

If Sepam fails, it is possible to close the circuit breaker again. This type of assembly prioritizes continuity of service.

Connection diagram for output relay O2:



Watchdog Relay for Sepam Series 10 A

Sepam series 10 A is equipped as standard with a watchdog relay (O7). In normal operation, it is kept in the on-position. In the event of Sepam failure, or if the auxiliary power supply disappears, the watchdog relay O7 goes into the off-position.

The watchdog can be used to initiate a call to the preventive maintenance service when the user has chosen for the circuit breaker to stay closed if the protection relay fails. The aim is to leave the network with a non-discriminating protection plan for the shortest possible time.

The watchdog relay O7 cannot be customized.

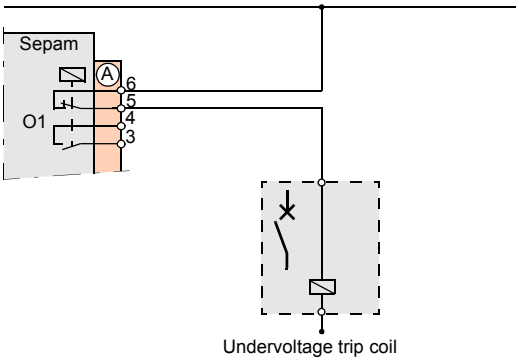
Watchdog Relay for Sepam Series 10 B and Series 10 N

As standard, Sepam series 10 B and series 10 N relays are not equipped with a watchdog relay. However, in custom mode, output relay O3 can be assigned to the watchdog function.

Exception When Using Output Relay O1

Certain applications may require both the circuit breaker to be controlled by an undervoltage trip coil and the circuit breaker to be kept closed in the event of Sepam failure. To do this, it is possible to use the Sepam in standard mode and to wire the opening coil on the normally closed contact of output relay O1.

In the event of Sepam failure, O1 is forced into the off-position and the circuit breaker stays closed.



This type of assembly is subject to restrictions. The normally closed contacts (NC) are not held by a magnetic force. As a result, they are sensitive to mechanical shocks and there may be micro-openings at their terminals. Note that, in this case, the Sepam series 10 conforms to standard IEC 60255-21-3 which tolerates contact micro-openings of 2 ms in the event of shocks. However, there is a risk of the circuit breaker opening, depending on the type of circuit breaker and undervoltage trip coil used.

If this type of assembly has to be used, we recommend the following:

- Avoid direct mounting on the circuit breaker or on a device likely to transmit switching impulses
- Avoid mounting on a cubicle door likely to generate a shock when closed by an operator

It is advisable to:

- Mount the Sepam on a chassis independent of the switchgear and away from shocks, vibrations and jolts
- If possible, mount a freewheel diode in parallel on the opening coil so as to slow down its operation in the event of a microbreak on its power supply

During operation, the installer must check that the Sepam is not subject to shocks or vibrations.

Circuit Breaker Control in Custom Mode

Customization Options

Custom mode can be used to program different operation of output relays O1 and O2 to invert their control logic individually. In this case, they are continuously in the on-position and change to the off-position in the event of a fault.

This is used to deal with scenarios such as:

- The circuit breaker is equipped with an undervoltage trip coil and needs to open automatically in the event of Sepam failure or loss of the substation auxiliary power supply.
- Circuit breaker closing needs to be prevented in the event of Sepam failure.

Custom mode can also be used to assign output relay O3 of Sepam series 10 B and series 10 N to the watchdog function.

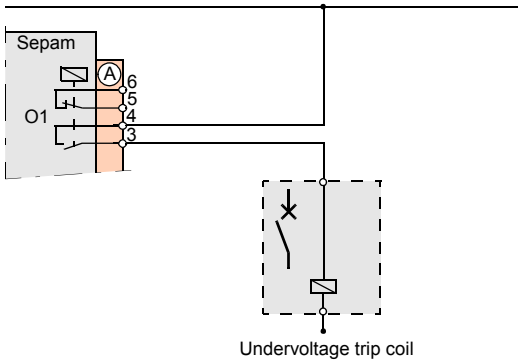
Output Relay O1: Tripping of a Circuit Breaker with an Undervoltage Trip Coil

The circuit breaker should be controlled via an undervoltage trip coil when the circuit breaker needs to open automatically in the event of Sepam failure or loss of the substation auxiliary power supply.

To do this, invert the output relay O1 control in the ***RELAYS INVER*** screen in custom mode, and use the normally open contact (NO) so that it can be kept in the closed position continuously, until a fault appears on the network.

In the event of Sepam failure, the circuit breaker opens automatically.

Connection diagram for a circuit breaker with an undervoltage trip coil:

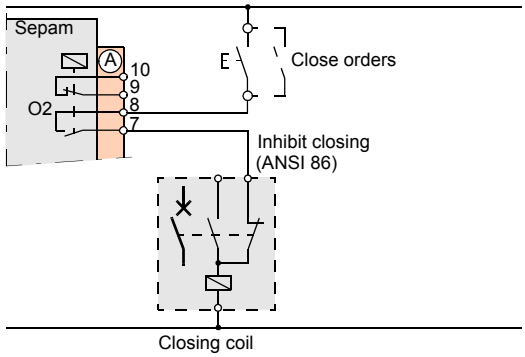


Output Relay O2: Trip Lockout

It may be necessary to prevent circuit breaker closing by an electrical order when Sepam is in the fail-safe position.

To do this, one solution consists of inverting the output relay O2 control in the ***RELAYS INVER*** screen in custom mode, and using the normally open contact (NO) so that it can be kept in the closed position continuously, until a fault appears on the network.

Connection diagram for output relay O2:



Watchdog for Sepam Series 10 B and Series 10 N

On Sepam series 10 B and series 10 N units in custom mode, output relay O3 can be assigned to the watchdog function.

When the circuit breaker opens automatically if Sepam fails, there is no point in assigning O3 to the watchdog function to trip a preventive maintenance action before disconnection of the MV. In fact, annunciation of the failure would arrive at the same time as the circuit breaker opens and would serve no purpose. In this case the status of the Sepam unavailable LED on the front panel is sufficient to announce the protection relay failure. However note that, in this case, the watchdog can be used to announce the failure.

Operation of the Self-test System

Purpose of the Self-test System

On initialization and cyclically during operation, Sepam runs a series of self-tests. These self-tests detect any hardware or software failure and can avoid random Sepam behavior. The main aim is to avoid nuisance tripping or failure to trip in the event of a fault.

When a failure is detected, Sepam goes into the fail-safe position:

- The output relays are in the off-position (normal)
- LED on
- An 8-digit code is displayed on the front panel: it allows Schneider Electric to make a diagnosis.
- Watchdog relay goes into the off-position
- The communication is inoperative

Remark: The behavior of the output relays and the watchdog is the same in the event of loss of the auxiliary power supply and when the Sepam is set to fail-safe position.

List of Self-tests

The self-tests are described in the table below.

Name	Description	Execution Period
Detection of incorrect operations	Detection of exception faults by the processor (division by 0, illegal instructions, etc.)	On energization and during operation
Software execution test	Detection of endless processing by the processor, OS processing errors, check of execution of periodic activities	On energization and during operation
Processor instruction set test	Processing sequence involving math and logic functions whose result is known	On energization and during operation
Processor frequency test	Measures the acquisition frequency and checks its tolerances	On energization and during operation
Memory test (SRAM)	Checks programming of the data pointers	On energization and during operation
Memory (SRAM) addressing test	Checks the memory bit-by-bit addressing	On energization
Used memory (SRAM) test	Checks the memory zone used by the program	On energization and during operation
Unused memory (SRAM) test	Checks the unused memory zone	During operation
Software queue test	Checks that the software queue has not overflowed	During operation
Used memory (Flash) test	Checks the memory zone reserved for the Sepam program	On energization and during operation
Unused memory (Flash) test	Checks the unused memory zone	On energization and during operation
Memory (EEPROM) test	Checks the data programmed by the user	On energization and during operation
Time base test	Checks that the Sepam real-time clock is working correctly	During operation
Relay control test	Checks the voltage to the output relay controls	On energization and during operation
Test that analog/digital conversion is working correctly	Checks that the various component functions are working correctly (sequencing, power supply, processor, memory, communication, etc.)	On energization and during operation
Logic input test (Sepam series 10 A)	Checks the validity of information on the logic inputs	On energization and during operation
Internal bus test	Checks operation of the internal bus	On energization and during operation
Reset detection	Detects resets of unknown origin	On energization and during operation

Communication

7

What's in this Chapter?

This chapter contains the following sections:

7.1 Modbus Protocol

What's in this Section?

This section contains the following topics:

Presentation

General

Each Sepam series 10 A has a communication port.

Modbus communication allows Sepam series 10 A relays to be connected to a supervisor or any other device with a master Modbus communication port. Sepam series 10 A relays are always slave stations.

Accessible Data

Modbus communication can be used to perform functions remotely such as:

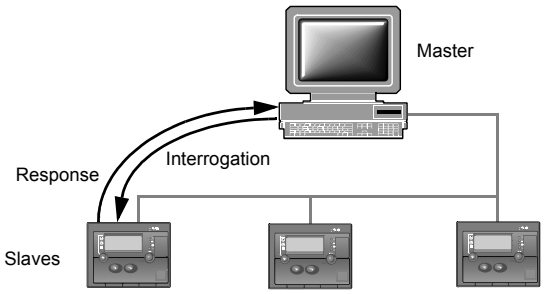
- Measurement readout and diagnosis
- Reading of status conditions and remote indications
- Transfer of time-tagged events
- Reading of Sepam identification
- Time-setting and synchronization

In addition, Modbus communication can be used to send remote control orders when they have been authorized.

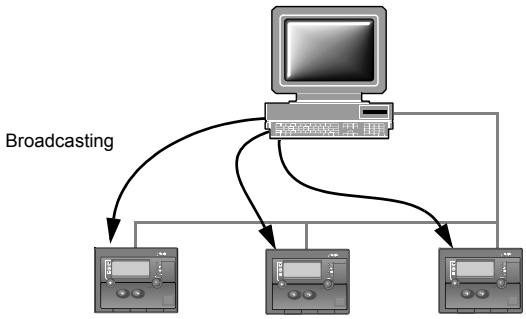
Modbus Protocol

Protocol Principle

The Modbus protocol is used to exchange data by means of a request-response type mechanism between one station called the master and one station called the slave. Exchange initialization (sending the request) is always initiated by the master station. The slave station (Sepam) can only respond to a request sent to it. When the network hardware infrastructure allows, several slave stations can be connected to the same master. The request contains a slave station number (address) to identify which is the destination. This number must be unique. Stations that are not destinations ignore the request received:



The master can also address all slave stations using the conventional address 0. This mechanism is called *broadcasting*. Slave stations do not respond to a broadcast message. Only messages that do not require data to be sent back by the slave stations can be broadcast:



Multi-Master Operation

When Sepam relays are connected by a gateway to a network that allows multiple access (Ethernet, Modbus+, etc.), several masters are likely to address the same Sepam on the same communication port.

It is the network designer's responsibility to resolve any conflicts that may occur.

For direct access data, no precautions are usually necessary.

For indirect access data, Sepam offers two exchange zones on each port, allowing two different masters to have independent simultaneous access.

Frame Structure

Each exchanged frame consists of a maximum of 255 bytes divided as follows (any frame with an error in format, parity, CRC 16, etc. is ignored):

Slave Number	Function Code	Data or Sub-Function Code	Control Word
1 byte	1 byte	n bytes	2 bytes
Request destination ● 0: broadcast (all) ● 1...247 (unique)	Refer to the next section below	Request or response data (addresses/bit or word values, number of bits/bytes/data words) Sub-function code	CRC 16 (for detection of transmission errors)

The first two fields in the response are usually identical to those in the request.

Supported Modbus Functions

The Sepam Modbus protocol is a subset of the Modbus RTU protocol:

- Data exchange functions
  - 1: Read n output or internal bits
  - 2: Read n input bits
  - 3: Read n output or internal words
  - 4: Read n input words
  - 5: Write 1 bit
  - 6: Write 1 word
  - 7: High-speed reading of 8 bits
  - 15: Write n bits
  - 16: Write n words
- Communication management functions
  - 8: Read Modbus diagnosis counters
  - 11: Read Modbus event counter
  - 43 with sub-function 14: Read identification

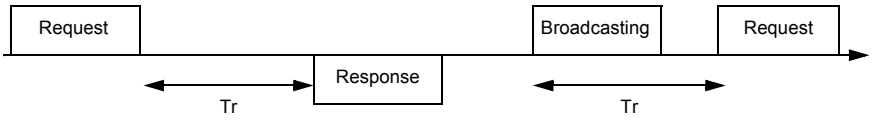
Structure of Exception Frames

An exception frame sent by the destination Sepam for the request consists of the following fields:

Slave Number	Exception Function Code	Exception Code	Control Word
1 byte	1 byte	n bytes	2 bytes
Request destination	Request function code + 128 (80h)	Possible codes ● 1: Unknown function code ● 2: Incorrect address ● 3: Incorrect data ● 4: Slave not ready (impossible to process request) ● 7: Non-acknowledgment (remote reading)	CRC 16 (for detection of transmission errors)

Turnaround Time

The *turnaround time* Tr is the time between the end of receipt of a request and sending the response:



Remark: Tr includes the silence between 2 frames and is usually expressed for a format of 8 bits, odd parity, 1 stop bit, at 9600 Bauds.

The Sepam turnaround time is less than 15 ms.

In indirect mode, the time required between a request (or an acknowledgement) and the availability of the corresponding data is linked to the Sepam non-priority cycle time. It can vary from a few tens to a few hundred milliseconds.

Synchronizing Exchanges

Any character received after a silence lasting more than 3.5 characters is deemed to be the start of a frame.

A minimum silence equivalent to 3.5 characters must always be kept between 2 frames.

A slave station ignores any frame:

- Received with a physical error on one or more characters (format, parity error, etc.)
- With an invalid CRC 16
- Which is not addressed to it

Commissioning and Diagnosis

Modbus Protocol Parameters

Parameters	Authorized Values	Default Value
Address	1...247	1
Transmission speed	● 4800 Baud ● 9600 Baud ● 19200 Baud ● 38400 Baud	19200
Parity	● None (2 stop bits) ● Even (1 stop bit) ● Odd (1 stop bit)	Even
Remote control order	● DIR: Direct mode remote control order ● SBO: Confirmed (Select Before Operate) mode remote control order	Confirmed mode

Modbus Link Diagnosis

To check that the link is operating correctly, the user can refer to:
1. The link activity LED, on the front panel
2. The test zone
3. The Modbus diagnosis counters and the Modbus event counter

Link Activity LED

The  LED is activated by the transmission or reception of frames on the Modbus network.

Remark: Flashing indicates that there is traffic to/from Sepam. It does not mean that the exchanges are valid.

Using the Test Zone

Run a read/write/re-read cycle in the test zone, for example:

Function	Frame Sent	Frame Expected in Response
Reading 2 words at address 0C00	01 03 0C00 0002 C75B	01 03 04 0000 0000 FA33
Writing a word with the value 1234 at address 0C00	01 10 0C00 0001 02 1234 6727	01 10 0C00 0001 0299
Reading 1 word at address 0C00	01 03 0C00 0001 B75A	01 03 02 1234 B539

Refer to *Test Zone, p. 179*.

Description of Counters

Sepam manages diagnosis counters CPT1 to CPT8 and the event counter CPT9:
- CPT1: Number of valid frames of 4 to 255 bytes received, whether the relevant Sepam relay is the destination or not
- CPT2: Number of request or broadcast frames received, with one or other of the following errors:
  - CRC error (but with a correct frame length) for frames addressed to the relevant Sepam relay
  - Incorrect length (< 4 or > 255 bytes) whether the relevant Sepam relay is the destination or not
- CPT3: Number of exception responses generated by the relevant Sepam relay (except after a broadcast)
- CPT4: Number of valid frames received by the relevant Sepam relay (except broadcast)
- 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 or overrun or framing, line break), whether the relevant Sepam relay is the destination or not
- CPT9: Number of requests (except function 11) received by the relevant Sepam relay, valid 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, sub-code 000Ah)
- When Sepam's auxiliary power is lost
- When communication parameters are modified

Using the Counters

The diagnosis counters are read using function 8 and sub-codes 000Bh to 0012h depending on the counter.

Function 8 can also be used in echo mode (sub-code 0000h):

Function	Frame Sent	Frame Expected in Response
8 in echo mode	01 08 0000 1234 ED7C	01 08 0000 1234 ED7C

Event counter CPT9 is read using function 11.

Even in echo mode, the Sepam relay 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.

Access to Data

Addressing a Word

All Sepam data that can be accessed by Modbus communication is organized into 16-bit words. Each word is identified by its address, coded on 16 bits, i.e. from 0 to 65535 (FFFFh).

In the rest of the document, all addresses are expressed in hexadecimal format.

Addressing a Bit

Some data can also be accessed in the form of a bit.

The bit address is then deducted from the word address by:

Bit address = (word address x 16) + bit number (0...15)

Example

Word address 0C00

Bit address 0 = C000

Bit address 14 = C00E

Undefined Addresses

Only addresses defined in this document should be used. If other addresses are used, Sepam can either respond with an exception message, or provide non-significant data.

Access Modes

There are two types of data:

- *Direct access data:* These are permanently identified by their Modbus address. These can be reached in a single read or write operation, applying to all or part of the relevant zone.
- *Indirect access* data: In this instance, the Modbus addresses indicated constitute an exchange zone which may be occupied by a variety of data, depending on the context. At least two operations are needed for each exchange. The protocol to be applied is explained for each zone processed in this way.

List of Address Zones

Similar data in terms of control and monitoring applications or their coding are grouped into adjacent address zones:

Address Zones	Word Address Range	Access Mode	Access Type
Synchronization	0002...0005	Direct	Word
Information	0006...0007	Direct	Word
Time-tagged events - First table	0040...0060	Indirect	Word
Time-tagged events - Second table	0070...0090	Indirect	Word
Remote controls	00F0...00F3	Direct	Word/Bit
Status conditions and remote indications	0100...0107	Direct	Word/Bit
Metering - 16NS format (x10)	0110...011B	Direct	Word
Metering - 32NS format	0130...0147	Direct	Word
Network diagnosis	0250...025B	Direct	Word
Test	0C00...0C0F	Direct	Word/Bit

Data Coding

Formats Used

Apart from exceptions mentioned in the text, Sepam data is encoded in one of the formats below:

- 32NS: Unsigned value, coded on 32 bits
- 16NS: Unsigned value, coded on 16 bits
- B: Bit or set of bits
- ASCII *n*c: String of n characters in ASCII code
- MMmm: Version number coded on 16 bits: Major revision number = most significant, minor revision number = least significant
- IEC: Time coding format on 4 words conforming to IEC 60870-5-4

Remark: For all formats, if a data item exceeds the maximum authorized value for the relevant format, the value read for this data item is the maximum value authorized by this format. The maximum value can also denote an incalculable value.

32NS Format

In 32NS format, the first word is the most significant.

Example

An IA current of 10,000 A is coded with a resolution of 0.1 A, and is therefore represented by the value 100,000 or 000186A0h, i.e.:

- At address 0130: 0001
- At address 0131: 86A0

ASCII Format

ASCII format is used to code the identification strings for a Sepam series 10 relay.

When the ASCII strings do not fill up the field entirely, they are completed with null bytes.

The first character occupies the least significant byte on the first word, the second the most significant byte on the first word, etc.

Example

"Sepam series 10" is coded as follows:

Word	Most significant byte		Least significant byte	
	Character	Hexadecimal value	Character	Hexadecimal value
1	e	65	S	53
2	a	61	p	70
3	SP	20	m	6D
4	e	65	s	73
5	i	69	r	72
6	s	73	e	65
7	1	31	SP	20
8	NULL	00	0	30

IEC Format

The date and time are coded on 4 words, in IEC 60870-5-4 format (bits at 0 in the table are not used: they are always read at 0 and ignored in write mode):

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Reserved (0 in read mode, variable in write mode)								0	Year (0...99)						
Word 2	0	0	0	0	Month (1...12)				0	0	0	Day (1...31)				
Word 3	0	0	0	Hour (0...23)					0	0	Minutes (0...59)					
Word 4	Milliseconds (0...59,999)															

Synchronization, Data, Metering, Network Diagnosis and Test Zones

Introduction

Synchronization, data, metering, network diagnosis and test zones are accessed directly and do not contain any events.

For each zone, a table contains the following information:
- Description of the addresses in the zone
- Codes for Modbus functions that can be used in read mode
- Codes for Modbus functions that can be used in write mode
- If necessary, the formats and resolution of the stored data

Synchronization Zone

The synchronization zone contains the 4 words used to code the absolute time required for time-tagging events:

Description	Address	Read	Write	Format
Binary time (year)	0002	3	16	IEC
Binary time (month + day)	0003	3		
Binary time (hours + minutes)	0004	3		
Binary time (milliseconds)	0005	3		

Note: The write operation affects the whole zone and uses address 0002.

Data Zone

The data zone contains 2 words, used to code the serial number of a Sepam relay:

Description	Addresses	Read	Write	Format
Serial number	0006 - 0007	3	–	32NS

The serial number is coded as follows (bits at 0 in the table are not used: they are always read at 0):

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0006	0	Year of manufacture (0...99)							0	0	Week of manufacture (1...52)					
0007	Queue number in week (1...65,535)															

x10 Metering Zone in 16NS Format

The x10 metering zone contains measurements coded on 16 bits:

Description	Address	Read	Write	Format	Units
Phase current IA (x 10)	0110	3, 4	–	16NS	1 A
Phase current IB (x 10)	0111	3, 4	–	16NS	1 A
Phase current IC (x 10)	0112	3, 4	–	16NS	1 A
Measured earth fault current Io (x 10)	0113	3, 4	–	16NS	1 A
Reserved	0114	–	–	–	–
Phase demand current ImA (x 10)	0115	3, 4	–	16NS	1 A
Phase demand current ImB (x 10)	0116	3, 4	–	16NS	1 A
Phase demand current ImC (x 10)	0117	3, 4	–	16NS	1 A
Phase peak demand current IMA (x 10)	0118	3, 4	–	16NS	1 A
Phase peak demand current IMB (x 10)	0119	3, 4	–	16NS	1 A
Phase peak demand current IMC (x 10)	011A	3, 4	–	16NS	1 A
Thermal capacity used	011B	3, 4	–	16NS	1%

Metering Zone in 32NS Format

The 32NS metering zone contains measurements coded on 32 bits:

Description	Addresses	Read	Write	Format	Units
Phase current IA	0130 - 0131	3, 4	–	32NS	0.1 A
Phase current IB	0132 - 0133	3, 4	–	32NS	0.1 A
Phase current IC	0134 - 0135	3, 4	–	32NS	0.1 A
Measured earth fault current Io	0136 - 0137	3, 4	–	32NS	0.1 A
Reserved	0138 - 0139	–	–	–	–
Phase demand current ImA	013A - 013B	3, 4	–	32NS	0.1 A
Phase demand current ImB	013C - 013D	3, 4	–	32NS	0.1 A
Phase demand current ImC	013E - 013F	3, 4	–	32NS	0.1 A
Phase peak demand current IMA	0140 - 0141	3, 4	–	32NS	0.1 A
Phase peak demand current IMB	0142 - 0143	3, 4	–	32NS	0.1 A
Phase peak demand current IMC	0144 - 0145	3, 4	–	32NS	0.1 A
Thermal capacity used	0146 - 0147	3, 4	–	32NS	1%

Network Diagnosis Zone

The network diagnosis zone contains the characteristics of the last trip:

Description	Addresses	Read	Write	Format	Units
Trip date and time	0250...0253	3	–	IEC	–
Phase A tripping current	0254 - 0255	3, 4	–	32NS	0.1 A
Phase B tripping current	0256 - 0257	3, 4	–	32NS	0.1 A
Phase C tripping current	0258 - 0259	3, 4	–	32NS	0.1 A
Measured earth fault current Io	025A - 025B	3, 4	–	32NS	0.1 A

Test Zone

The test zone contains 16 words used to simplify the communication tests at the time of commissioning or to test the connection. Refer to *Using the Test Zone, p. 174*.

Description	Addresses	Read	Write	Format
Test zone	0C00...0C0F	1, 2, 3, 4	5, 6, 15, 16	–

These words are reset when Sepam is initialized.

Remote Control Zone

Introduction

Remote control orders are transmitted to the Sepam relay via pulse type remote control orders using one of the following two modes, chosen via the settings:

- Direct mode
- Confirmed SBO (Select Before Operate) mode

Remote Control Zone

The remote control zone contains 4 words:

Description	Address	Read	Write	Format
Remote control no. 1 word	00F0	1, 2, 3, 4	5, 6, 15, 16	B
Reserved	00F1	–	–	–
Remote control no. 1 confirmation word	00F2	3	5, 6, 15, 16	B
Reserved	00F3	–	–	–

Remote Control No. 1 Words

The remote control order assigned to each bit in the remote control words (address 00F0) and remote control confirmation words (address 00F2) is predefined:

Bit	Remote Control Word	Confirmation Word	Remote Control Order
	Bit Address	Bit Address	
00	0F00	0F20	Open circuit breaker
01	0F01	0F21	Close circuit breaker
02	0F02	0F22	Reset
03	0F03	0F23	Reset phase peak demand current values
04...15	0F04...0F0F	0F24...0F2F	Reserved

Direct Mode

The remote control order is executed as soon as the remote control word is written in. Resetting is performed by the control logic after the remote control order has been taken into account.

Confirmed SBO Mode

The remote control order is executed in two steps:

1. Selection by the supervisor of the command to be sent by writing the bit in the remote control confirmation word and checking the selection if necessary by re-reading this word.
2. Execution of the command to be sent by writing the bit in the remote control no. 1 word.

The remote control order is executed if the remote control confirmation word bit and the associated remote control word bit are set, both word bits are reset by the control logic after the remote control order has been taken into account. Deselection of the confirmation word bit occurs:

- If the supervisor deselects it by writing in the confirmation word
- If the supervisor selects (writes) a different bit from that already selected
- If the supervisor sets a bit in the remote control word that does not correspond to that selected (in this case no remote control order will be executed)
- If the corresponding order is not sent within a period of 30 seconds

Inhibited Remote Control Orders in Local Mode

In standard operating mode, logic input I4 is assigned to local/remote mode. In local mode (I4 = 1), the following remote control orders are inhibited:

- Output relay and fault LED acknowledgement
- Phase peak demand current values reset
- Circuit breaker closing

Circuit breaker opening is inhibited in local mode if, in addition, the ***LOCAL MODE*** setting in the parameters menu is on ***OPEN NOT ACCEPTED***. Refer to *Operation of the Local/Remote Check, p. 139*.

Status Condition and Remote Indication Zone

Introduction

Status conditions and remote indications are pre-assigned to protection or control functions or to logic inputs or output relays. They can be read using bit or word functions.

Status Condition and Remote Indication Zone

The status condition and remote indication zone contains 8 words that group together status bits:

Description	Word Address	Bit Addresses	Read	Write	Format
Sepam series 10 control word	0100	1000...100F	1, 2, 3, 4, 7	–	B
Sepam series 10 status word	0101	1010...101F	1, 2, 3, 4	–	B
Remote indication no. 1 word	0102	1020...102F	1, 2, 3, 4	–	B
Remote indication no. 2 word (in reserve)	0103	1030...103F	1, 2, 3, 4	–	B
Remote indication no. 3 word	0104	1040...104F	1, 2, 3, 4	–	B
Remote indication no. 4 word (in reserve)	0105	1050...105F	1, 2, 3, 4	–	B
Logic inputs	0106	1060...106F	1, 2, 3, 4	–	B
Output relays	0107	1070...107F	1, 2, 3, 4	–	B

Control Word (Address 0100)

Bit	Bit Address	Status
00...09	1000...1009	Reserved
10	100A	Loss of information in the second event stack
11	100B	Events present in the second event stack
12	100C	Sepam time incorrect
13	100D	Sepam not synchronous
14	100E	Loss of information in the first event stack
15	100F	Events present in the first event stack

Note: A change on bits 11 and 15 does not generate time-tagged events.

Status Word (Address 0101)

Bit	Bit Address	Status
00	1010	Protection 50-51 I> set point activated (1)/deactivated (0)
01	1011	Protection 50-51 I>> set point activated (1)/deactivated (0)
02	1012	Protection 50N-51N Io> set point activated (1)/deactivated (0)
03	1013	Protection 50N-51N Io>> set point activated (1)/deactivated (0)
04	1014	Thermal overload protection activated (1)/deactivated (0)
05	1015	CLPU I activated (1)/deactivated (0)
06	1016	CLPU Io activated (1)/deactivated (0)
07	1017	TCS activated (1)/deactivated (0)
08	1018	Protection 50-51 I> set point back-up activated (1)/deactivated (0)
09	1019	Protection 50-51 I>> set point back-up activated (1)/deactivated (0)
10	101A	Protection 50N-51N Io> set point back-up activated (1)/deactivated (0)
11	101B	Protection 50N-51N Io>> set point back-up activated (1)/deactivated (0)
12	101C	IB current measurement activated (1)/deactivated (0)
13...15	101D...101F	Reserved

Remote Indication No. 1 Word (Address 0102)

Bit	Bit Address	Remote Indication
00	1020	Protection 50-51 delayed I> set point
01	1021	Protection 50-51 delayed I>> set point
02	1022	Protection 50-51 pick-up I> set point
03	1023	Protection 50-51 pick-up I>> set point
04	1024	Protection 50N-51N delayed Io> set point
05	1025	Protection 50N-51N delayed Io>> set point
06	1026	Protection 50N-51N pick-up Io> set point
07	1027	Protection 50N-51N pick-up Io>> set point
08	1028	Protection 49 RMS thermal alarm
09	1029	Protection 49 RMS thermal tripping
10	102A	Protection 50-51 delayed I> set point back-up
11	102B	Protection 50-51 delayed I>> set point back-up
12	102C	Protection 50N-51N delayed Io> set point back-up
13	102D	Protection 50N-51N delayed Io>> set point back-up
14	102E	Reserved
15	102F	Reserved

Remote Indication No. 3 Word (Address 0104)

Bit	Bit Address	Remote Indication
00	1040	Send blocking input
01	1041	Receive blocking input
02	1042	Local (1)/remote (0) mode
03	1043	Remote control/circuit breaker position discrepancy
04	1044	Non-matching of breaker position auxiliary contacts or failure of the trip circuit (TCS)
05	1045	Closed circuit breaker
06	1046	External reset by logic input
07	1047	External trip by logic input
08	1048	Sepam not reset after fault
09	1049	Tripping
10...15	104A...104F	Reserved

Note: Bits 08 and 09 are only significant in standard operating mode.

Logic Input Word (Address 0106)

Bit	Bit Address	Status
00	1060	I1 input
01	1061	I2 input
02	1062	I3 input
03	1063	I4 input
04...15	1064...106F	Reserved

Output Relay Word (Address 0107)

Bit	Bit Address	Status
00	1070	O1 output
01	1071	O2 output
02	1072	O3 output
03	1073	O4 output
04	1074	O5 output
05	1075	O6 output
06...15	1076...107F	Reserved

Time-Tagged Events

Event Types

A *logic event* is the change of state of a Sepam logic variable (bit in control, status or remote indication words).

It is characterized by:
- An address: for the associated bit
- A direction of change
- A date and time: The event is time-tagged (resolution: 1 ms)

Remark: By extension, an event also designates all the characteristics of the change in state.

An *analog event* is the record of a tripping current.

Time-Tagging

Time-tagging of events uses the Sepam internal clock. When an event is detected, the Sepam's current time is associated with it.

The clock accuracy depends mainly on the quality of synchronization of the Sepam internal clock: Refer to *Synchronization, p. 187*.

Description of How to Code an Event

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

Word	Information	Coding	
		Logic events	**Analog events**
1	Event type	0800h	0400h
2	Event address	Address of the bit that identifies it (1000...103F)	Word addresses 0254...025A
3 and 4	Associated information	Direction of the event: ● 00000000: deactivation/disappearance ● 00000001: activation/appearance	Current value in 32NS format
5...8	Date and time	in accordance with IEC 60870-5-4	

Event Stacks

For each of the two possible supervisors, Sepam manages an internal storage stack with a capacity of 100 events. The stack is the FIFO type.

The last recordable event concerns the stack itself. It marks saturation of the stack.

Initializing an Event Stack

The Sepam relay initializes each event stack as follows:
- When the ***PROTOCOL*** function parameters are taken into account, Sepam generates the following events in succession:
  - Appearance of the Information lost event
  - Appearance of the Incorrect time event
  - Appearance of the Not synchronous event
  - Disappearance of the Information lost event
- When a time frame is first broadcast by the master, Sepam generates the following events in succession:
  - Disappearance of the Incorrect time event
  - Disappearance of the Not synchronous event

Reading an Event Stack

If...	Then ...	And then ...
The supervisor extracts fewer events from the stack than Sepam generates.	The stack fills up faster than it can empty and ends up being saturated: the Appearance of the Information lost event is generated in sixty-fourth position.	This stack stops being filled and subsequent events are lost.
The supervisor extracts more events from the stack than Sepam generates.	The stack empties completely: The Disappearance of the Information lost and synchronization status events are generated.	Filling starts again with the events detected from this moment on.

Event Tables

Sepam makes two event tables available to the master(s) so that the event stack can be read in packets of 4 events maximum:

Time-tagged events - First table	Addresses	Read	Write
Exchange word	0040	3	6, 16
Event number 1	0041...0048	3	–
Event number 2	0049...0050		
Event number 3	0051...0058		
Event number 4	0059...0060		

Time-tagged events - Second table	Addresses	Read	Write
Exchange word	0070	3	6, 16
Event number 1	0071...0078	3	–
Event number 2	0079...0080		
Event number 3	0081...0088		
Event number 4	0089...0090		

Note: The read operation concerns the exchange word only or the whole table.

Exchange Word

The exchange word is used to check reading of events. It looks like this:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
–	Exchange number 0...255								Number of events 0...4							

The exchange number is initialized with the value 0 after energization and incremented on each transfer of a new packet of events.

When it reaches its maximum value (FFh), it automatically returns to 0.

The numbering of exchanges is generated by Sepam and acknowledged by the supervisor.

The number of events indicates how many significant events are actually present in the table. The rest of the table is irrelevant.

Sequence of an Exchange

The protocol ensures that no events are lost, even in the event of a communication problem. To do this, Sepam uses the 2 numbers coded in the exchange word:

- n: Exchange number
- m: Number of events

Phase	Description	Exchange word
1	If any events are present, Sepam transfers them to the table and records their number (m) in the exchange word.	n, m ≠ 0
2	The supervisor sends a read event request.	n, m
3	If the table is not empty, Sepam sends the data in the table.	n, m
4	The supervisor acknowledges the exchange by writing the exchange word with: ● Exchange number field: number of the last exchange performed ● Number of events field: 0	n, 0
5	Sepam sets the table to 0 and clears the acknowledged events.	n, 0
6	If any new events are present, Sepam transfers them to the table, records their number (m') and increments the exchange number.	n+1, m'
7	The process restarts at phase 2.	–

Remarks:

- As long as an event has not been acknowledged, the table remains in the same state and it is possible to read it.
- In the event of incorrect acknowledgement (incorrect exchange word value), it is ignored and the table remains in the same state.
- Writing a value FFh in the exchange word (any exchange number, number of events = FFh) causes reinitialization of the corresponding event stack. All events memorized and not yet sent are deleted.
- The supervisor itself is responsible for sorting the time-tagged data in chronological order.

Date and Time-Setting and Synchronization

Introduction

Sepam manages the date and time internally. If the auxiliary power supply fails, this information continues to be maintained, as long as a battery in good working order has been inserted in the device.

The Sepam internal time is used, in particular, to date alarms and events.

The date and time can be read on the display (parameters menu).

Sepam also delivers a Sepam time incorrect data item (bit 12) to the control word, indicating the need to set the time.

Time and Date-Setting

When Sepam is energized, the time is set automatically from the battery-backed clock, provided the battery is working.

The time and date are set:
- In local mode from the front panel (parameters menu)
- By writing, in a single block, the new date and time value in the synchronization zone (Modbus time frame)

Synchronization

The time frame is used both for setting the time and synchronizing the Sepam. In this case, it should be transmitted regularly at close intervals (10 to 60 seconds) to obtain a synchronous time. It is usually transmitted by broadcasting (slave number = 0).

In synchronous state, the absence of receipt of a time frame for more than 200 seconds causes a loss of synchronism (bit 13 of the control word at 1).

Synchronization Cycle

Each synchronization cycle is executed as follows:

Phase	Description
1	The supervisor writes its date and time in the synchronization zone.
2	Sepam changes to the non-synchronous state (bit 13 of the control word at 1) and resets its clock.
3	If the reset amplitude is less than 100 ms, Sepam changes back to synchronous state.

Clock Accuracy

The clock accuracy is linked to the master and its control of the time frame transmission delay on the communication network. Before sending a time frame, the supervisor must ensure that all the read requests sent have received a response. Synchronization of the Sepam relay is performed immediately after the frame is received.

If the frames pass through a gateway (multi-master operation), make sure that this does not slow down the frames.

Read Sepam Identification

Introduction

The Read Device Identification function can be used for standard access to the information required for unambiguous identification of a device.

Sepam processes the read identification function (conformity level: 02). For a complete description of the function, refer to the Modbus website (www.modbus.org). The description below is a subset of the function options, adapted to the example of Sepam.

Identification of Sepam Series 10

The Sepam identification consists of strings of ASCII characters called *objects*.

Sepam objects are divided into two groups:

Group	No.	Object	Value	Length
1	0	VendorName	"Schneider Electric"	18 (12h)
	1	ProductCode (reference coded in EAN 13 format)	"(EAN13)3 30343 •••••• •"	20 (14h)
	2	MajorMinorRevision (application version number)	"V*x.y*"	5
2	3	VendorURL	"www.schneider-electric.com"	26 (1Ah)
	4	ProductName	"Sepam series 10"	15 (0Fh)
	5	ModelName (short identification code)	"S10 - •••"	11 (0Bh)
	6	Not used	""	0

ProductCode

The EAN13 code identifies the reference for a Sepam unit universally in 13 digits:

Standards Organization	Manufacturer	–	Reference	Checksum
3	30343	0	598••	Calculated with reference to http://www.ean-int.org

Identification Codes and References

The ModelName character string is the short Sepam identification code. Each ModelName string has a corresponding ProductCode string (one only):

ModelName	ProductCode
"Unknown application"	"(EAN13)0 00000 000000 0"
"S10 - A 41A"	"(EAN13)3 30343 059808 4"
"S10 - A 42A "	"(EAN13)3 30343 059809 1"
"S10 - A 43A"	"(EAN13)3 30343 059810 7"
"S10 - A 43A DK"	"(EAN13)3 30343 059825 1"
"S10 - A 41E "	"(EAN13)3 30343 059811 4"
"S10 - A 42E "	"(EAN13)3 30343 059812 1"
"S10 - A 42E G "	"(EAN13)3 30343 059828 2"
"S10 - A 43E "	"(EAN13)3 30343 059813 8"
"S10 - A 43E DK "	"(EAN13)3 30343 059826 8"
"S10 - A 41F"	"(EAN13)3 30343 059814 5"
"S10 - A 42F"	"(EAN13)3 30343 059815 2"
"S10 - A 42F G"	"(EAN13)3 30343 059829 9"
"S10 - A 43F "	"(EAN13)3 30343 059816 9"

Remarks:

- The length of the "Unknown application" string is 19 characters.
- The spaces in the ProductCode column are not significant: The EAN13 code has no spaces between the digits.

Request Frame

The read identification request frame consists of the following fields:

Field	Size (Bytes)	Value
Slave number	1	1...247
Function code	1	43 (2Bh)
MEI type (sub-function code)	1	14 (0Eh)
Read type	1	01 or 02
Not used	1	00
CRC16	2	Calculated

Response Frame

The response frame consists of the following fields:

Field	Size (Bytes)	Value
Slave number	1	1...247
Function code	1	43 (2Bh)
MEI type (sub-function code)	1	14 (0Eh)
Read type	1	01 or 02
Conformity level	1	02
Not used	1	00
Not used	1	00
Number of objects	1	n = 3 or 7, according to the Read type field
First object number	1	obj1
First object length	1	lg1
First object ASCII string	lg1	txt1
...	...	...
*n*th object number	1	objn
*n*th object length	1	lgn
*n*th object ASCII string	lgn	txtn
CRC16	2	Calculated

Exception Frame

If an error occurs while processing the request, Sepam sends an exception frame, consisting of the following fields:

Field	Size (Bytes)	Value
Slave number	1	1...247
Function code increased by 80h	1	171 (ABh)
MEI type (sub-function code)	1	14 (0Eh) or other if MEI type received is incorrect
Exception Code	1	01: MEI type received is incorrect ($\neq$ 14) or read type incorrect (for example, 4) 03: Incorrect data (incorrect frame length)
CRC16	2	Calculated

7.2 IEC 60870-5-103 protocol

What's in this Section?

This section contains the following topics:

Presentation

General

Each Sepam series 10 A relay has a communication port.

IEC 60870-5-103 communication allows Sepam series 10 A relays to be connected to a supervisor or any other device with a master IEC 60870-5-103 communication port.

Communication is based on the master-slave principle:
- Sepam series 10 A relays are always slave stations.
- The master is the supervisor or another device.

Accessible Data

IEC 60870-5-103 communication can be used to perform functions remotely such as:
- Measurement readout
- Reading of status conditions and time-tagged events
- Time-setting and synchronization
- Transmission of remote controls

IEC 60870-5-103 Standard

Presentation of the IEC 60870-5-103 Standard

The IEC 60870-5-103 protocol is a companion standard for the informative interface of protection equipment.

Standard IEC 60870-5-103 was prepared by IEC technical committee 57 (Power system control and associated communications).

It is a companion standard for the main base standards in series IEC 60870-5.

As a companion standard, it adds semantics to the definitions and functional profiles specified in the base standards:

- Definition of the particular uses for information objects
- Definition of specialist information objects
- Definition of service procedures or additional parameters in respect of the base standards

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

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

IEC 60870-5-103 Communication Profile

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

IEC 60870-5-103 Protocol Principle

General

Standard IEC 60870-5-103 defines a multipoint communication protocol via which information can be exchanged between a control system (supervisor or RTU) and one or more protection devices. The control system is the master and the protection devices are the slaves. Each slave is identified by a unique address between 0 and 254. Address 255 is reserved for sending broadcast frames.

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

Direction of Communication

The protocol distinguishes between:
- The *monitoring direction*, for transmission of ASDUs sent by a protection device (slave device) to the control system (master device)
- The *control direction*, for ASDUs sent by the control system to a protection device

Monitoring Direction

Communication is based on the cyclic transmission of link-layer polling requests by the master in order to invite the slave to send its data:
- Class 1 data polling is usually used for event transmission (time-tagged states or annunciations)
- Class 2 data polling is used for the cyclic transmission of metering information

Control Direction

The master can send:
- A general interrogation request to obtain the current value of slave equipment status conditions and indications
- General commands (remote control orders)
- Time synchronization commands
- Commands to reset the IEC 60870-5-103 communication interface

Initializing Com munication

The slave communication interface only becomes operational after receipt of an initialization request sent by the master.

The absence of polling by the master is detected by the slave and this stops communication. To re-establish communication, the master device must send a reset request.

Information Characteristics

All information exchanged between the control system and the protection device features:
- A function number (FUN)
- An information number (INF)
- The ASDU number used to transmit the information
- The cause of the transmission (COT)

Commissioning and Diagnosis

IEC 60870-5-103 Protocol Parameters

Parameters	Authorized Values	Default Value
Address	0...254	1
Transmission speed	● 4800 Baud ● 9600 Baud ● 19200 Baud ● 38400 Baud	19200
Parity	● None (2 stop bits) ● Even (1 stop bit) ● Odd (1 stop bit)	Even

Standard parameters

The protocol defines the following standard parameters:

- *Cyclic ASDU period*: Period during which cyclic data (metering information) is generated and updated by the Sepam unit. It is expressed in seconds and is chosen to be consistent with the interval at which this data is scanned by the supervisor.
- *Inactivity time delay*:
  In normal operation, the supervisor sends scan requests to the Sepam units at regular intervals. Each Sepam monitors the activity of the supervisor by checking that scan requests are being received regularly. If a Sepam fails to receive requests during a period called the inactivity time delay, this Sepam unit will lock its communication port and cease to respond to requests sent subsequently by the supervisor. To re-establish communication with a locked Sepam, the supervisor must reset it.
- *Times sync. required delay* :
  The time synchronization is transmitted by ASDU 6. If ASDU 6 has not been received at the end of a period called the times sync. required delay, the slave will assume that its clock setting may be inaccurate and will assign the Invalid time information (invalidity bit: refer to *Status Information (ASDU 1, ASDU 2), p. 204*) to time-tagged data.
- *Blocking of Monitoring direction*:
  A slave is able to suspend sending data in the monitoring direction, in accordance with the procedure specified by IEC 60870-5-103. Sepam does not have this option.

For Sepam, the standard IEC 60870-5-103 protocol parameters are predefined:

Standard Parameters	Values Allowed by the Protocol	Predefined Value
Cyclic ASDU period	0...60 s	5 s
Inactivity time delay	0...60,000 s	0 (infinite)
Times sync. required delay	0...60,000 min	0 min
Blocking of monitoring direction	no/yes	no

Link Activity LED

The  LED is activated by the sending or receiving of frames on the network.

Remark: Flashing indicates that there is traffic to/from Sepam. It does not mean that the exchanges are valid.

Access to Data

Introduction

Sepam is a multifunctional digital protection relay, which supplies a great deal of information. Sepam data is categorized on the basis of function number.

A detailed description of the Sepam data table, including function number and information number, appears in *Sepam Data Table, p. 201*.

List of IEC 60870-5-103 Standard Functions

Sepam supports the subset of standard functions listed below. For these functions, Sepam uses the standard FUN and INF numbers:

FUN	Function Name
255	System
160	Overcurrent protection

List of Sepam-Specific Functions

For specific functions, Sepam uses the private FUN and INF numbers:

FUN	Function Name
21	Switchgear and network
31	Logic inputs
106	Thermal overload protection
11	Additional measurements

List of Standard ASDUs

Sepam supports the subset of standard ASDUs listed below:

ASDU	Function	Monitoring Direction	Control Direction
1	Time-tagged message	•	
2	Time-tagged message with relative time (Sepam does not manage relative time: the corresponding fields are at 0 in the ASDU)	•	
5	Identification message	•	
6	Time synchronization	•	•
7	General interrogation		•
8	End of general interrogation	•	
9	Measurands II	•	
20	General command		•

Sepam Communication Profile

Introduction

The Sepam communication profile defines how the options of standard IEC 60870-5-103 are implemented by Sepam.

The presentation format and numbering used in this section are intentionally based on the **Interoperability** clause in standard IEC 60870-5-103.

☒ Indicates that Sepam supports the option from the standard

☐ Indicates that Sepam does not support the option

Physical Layer

Electrical interface

☒ EIA RS-485

☒ Number of loads .....1..... for a protection device

NOTE - The EIA RS-485 standard defines unit loads in such a way that 32 of them can be used on a single line. For more details, refer to clause 3 of the EIA RS-485 standard.

Optical interface

☐ Glass fiber

☐ Plastic fiber

☐ Connector type: F-SMA

☐ Connector type: BFOC/2.5

Transmission speed

☒ 9600 bps

☒ 19200 bps

Link Layer

There are no choices for the link layer.

Application Layer

Transmission mode for application data

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

COMMON ADDRESS OF ASDU

☒ One COMMON ADDRESS OF ASDU (identical to the station address)

☐ More than one COMMON ADDRESS OF ASDU

Selection of standard information numbers in monitoring direction

System functions in monitoring direction

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

Status indications in monitoring direction

	INF	Semantics
☐	<16>	Recloser in service
☐	<17>	Teleprotection on
☐	<18>	Protection on
☒	<19>	LED reset
☐	<20>	Monitoring direction transmission blocked
☐	<21>	Test mode
☐	<22>	Local parameter setting
☐	<23>	Characteristic 1
☐	<24>	Characteristic 2
☐	<25>	Characteristic 3
☐	<26>	Characteristic 4
☐	<27>	Auxiliary input 1
☐	<28>	Auxiliary input 2
☐	<29>	Auxiliary input 3
☐	<30>	Auxiliary input 4

Supervision indications in monitoring direction

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

Earth fault indications in monitoring direction

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

Fault indications in monitoring direction

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

Auto-recloser indications in monitoring direction

	INF	Semantics
☐	<128>	CB "on" by AR
☐	<129>	CB "on" by delayed AR
☐	<130>	AR blocked

Measurands in monitoring direction

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

Generic functions in monitoring direction

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

Selection of standard information numbers in control direction

System functions in control direction

	INF	Semantics
☒	<0>	Initiation of general interrogation
☒	<0>	Time synchronization

General commands in control direction

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

Generic functions in control direction

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

Basic application functions

- ☐ Test mode
- ☐ Blocking of transmission in monitoring direction
- ☐ Disturbance data
- ☐ Generic services
- ☒ Private data

Miscellaneous

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

Measurand	**Max. MVAL = Rated Value Multiplied by:**	
	1.2	**2.4**
Current L1	☒	☐
Current L2	☒	☐
Current L3	☒	☐
Voltage L1-E	☐	☐
Voltage L2-E	☐	☐
Voltage L3-E	☐	☐
Active power P	☐	☐
Reactive power Q	☐	☐
Frequency f	☐	☐
Voltage L1-L2	☐	☐

Sepam Data Table

Introduction

All Sepam data that can be exchanged with a supervisor, in accordance with the IEC 60870-5-103 protocol, is listed in two tables:
- The monitoring direction data table, which lists all Sepam data to be transmitted to the supervisor
- The control direction data table, which lists all supervisor data to be transmitted to Sepam

Description of the Sepam Data Table

The following information is provided for each data item:
- The ASDU (Application Service Data Unit) number
- The value of the FUN (Function) and INF (Information) identifiers
- The value of the COT (Cause Of Transmission) field
- A GI (General Interrogation) marker
- The Sepam data tag

The effective availability of a Sepam data item also depends on the Sepam parameters.

ASDU (Application Service Data Unit)

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

FUN (Function) and INF (Information)

Each Sepam data item is identified by:
- The number of the function to which the data belongs: FUN (Function)
- The information number of the basic data: INF (Information)

COT (Cause Of Transmission)

The COT value indicates the reason for the data transmission.

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

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

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

COT	Reason for Transmission	Description
8	Time synchronization	Time synchronization command
9	General interrogation	Initialization of a General Interrogation cycle
20	General command	Command from the supervisor such as open/close circuit breaker, enable/disable a function, etc.

GI (General Interrogation)

The GI (General Interrogation) marker indicates whether the data item is produced in response to a general interrogation request (COT = 9).

For this data, each change of state (OFF to ON and ON to OFF) is also transmitted spontaneously.

Monitoring Direction Data Table

Monitoring direction data is grouped by the FUN identifier.

FUN = 255: System functions

ASDU	FUN	INF	COT	GI	IEC 60870-5-103 Semantics
8	255	0	10		End of general interrogation
6	255	0	8		Time synchronization
5	255	2	3		Reset frame count bit (FCB)
5	255	3	4		Reset communication unit (CU)
5	255	4	5		Start/restart

FUN = 160: Overcurrent protections

ASDU	FUN	INF	COT	GI	IEC 60870-5-103 Semantics	Sepam Semantics
1	160	19	1, 12, 20, 21		LED reset	Sepam not reset after fault
1	160	36	1, 9	•	Trip circuit supervision	Trip circuit supervision (TCS) or Non-matching of I1 and I2
2	160	68	1		General trip	Trip
2	160	90	1		Trip I>	Protection I> tripping
2	160	91	1		Trip I>>	Protection I>> tripping
2	160	92	1		Trip IN>	Protection Io> tripping
2	160	93	1		Trip IN>>	Protection Io>> tripping

FUN = 21: Switchgear and network

ASDU	FUN	INF	COT	GI	Sepam Semantics
1	21	13	1		External trip
1	21	21	1		Send blocking input

FUN = 31: Logic inputs

ASDU	FUN	INF	COT	GI	Sepam Semantics
1	31	1	1, 9	•	Logic input I1
1	31	2	1, 9	•	Logic input I2
1	31	3	1, 9	•	Logic input I3
1	31	4	1, 9	•	Logic input I4

FUN = 106: Thermal overload protection

ASDU	FUN	INF	COT	GI	Sepam Semantics
1	106	1	1		Protection 49 RMS alarm set point
1	106	2	1		Protection 49 RMS tripping set point

FUN = 160: Standard measurements

ASDU	FUN	INF	COT	GI	Sepam Semantics
9	160	148	2		Information elements
					MEA1: Phase current IA
					MEA2: Phase current IB
					MEA3: Phase current IC

FUN = 11: Additional measurements 1

ASDU	FUN	INF	COT	GI	Sepam Semantics
9	11	1	2		Information elements
					MEA2: Measured earth fault current Io

Control Direction Data Table

Control direction data is grouped by the FUN identifier.

FUN = 255: System functions

ASDU	FUN	INF	COT	GI	Sepam Semantics
7	255	0	9		Initiation of general interrogation
6	255	0	8		Time synchronization

FUN = 160: General commands

ASDU	FUN	INF	COT	GI	Sepam Semantics
20	160	19	20		Sepam reset (ON)

FUN = 21: Switchgear and network commands

ASDU	FUN	INF	COT	GI	Sepam Semantics
20	21	1	20		Closing (ON)
					Opening (OFF)

ASDU 1, 2, 5, 9, 20 Frames and Information Coding

Presentation

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

ASDU	COT	Monitoring Direction	Control Direction	Description
1	1	•		Changes in state
1	9			States in response to General interrogation
2	1	•		Protection equipment tripping annunciation
5	3, 4, 5	•		Identification
9	2	•		Metering
20	20		•	Commands

Status Information (ASDU 1, ASDU 2)

After scanning class 1 data, Sepam sends an ASDU 1:

Byte Number	Field	Value
1	ASDU number	1
2	Structure qualifier	81h
3	COT	1/9
4	ASDU common address (Sepam address)	0...254
5	Function number	FUN
6	Information number	INF
7	DPI (Double Point Information)	1 = OFF/2 = ON
8	Time-tagged label	Milliseconds (least significant byte)
9		Milliseconds (most significant byte)
10		Minutes + invalidity bit (most significant bit)
11		Hours + summer time bit (most significant bit)
12	Additional information (COT = 1) or general interrogation number (COT = 9)	0 if COT = 1, otherwise general interrogation number

Or an ASDU 2:

Byte Number	Field	Value
1	ASDU number	2
2	Structure qualifier	81h
3	COT	1
4	ASDU common address (Sepam address)	0...254
5	Function number	FUN
6	Information number	INF
7	DPI (Double Point Information)	1 = OFF/2 = ON
8	REL (relative time elapsed between appearance of the fault and tripping)	00 (not supported)
9		
10	FAN (fault number)	00 (not supported)
11		
12	Time-tagged label	Milliseconds (least significant byte)
13		Milliseconds (most significant byte)
14		Minutes + invalidity bit (most significant bit)
15		Hours + summer time bit (most significant bit)
16	Additional information	0 because COT = 1

Sepam Identification (ASDU 5)

ASDU 5 is generated by Sepam in response to initialization commands sent by the master:
- Reset CU (Communication Unit)
- Reset FCB (Frame Count Bit)

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

Command	Message No. 1	Message No. 2
Reset CU	COT = 4 (Reset CU) INF = 3	COT = 5 (Start/restart) INF = 4
Reset FCB	COT = 3 (Reset FCB) INF = 2	COT = 5 (Start/restart) INF = 4

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

Note: As the inactivity timer is infinite, Sepam does not detect that there has been no request from the master (Sepam does not stop communication).

ASDU 5 is broken down as follows:

Byte Number	Field	Value
1	ASDU number	5
2	Structure qualifier	81h
3	COT	3/4/5
4	ASDU common address (Sepam address)	0...254
5	Function number	FUN
6	Information number	INF
7	Compatibility level	2 (Sepam does not support generic services)
8	Manufacturer identification	S
9		E
10		
11		S
12		e
13		p
14		a
15		m
16	Application software identification	S
17		1
18		0
19		

Measurements (ASDU 9)

Measurements are coded using ASDU 9. They are obtained by a class 2 data scan request. The size of ASDU 9 depends on the number of measurements provided. The number of measurements is indicated in the structure qualifier field:

Byte Number	Field	Value
1	ASDU number	9
2	Structure qualifier	n
3	COT	2
4	ASDU common address (Sepam address)	0...254
5	Function number	FUN
6	Information number	INF
7	Measurement 1	Refer to the information below
8		
...	...	
...		
...	Measurement n	Refer to the information below
8 + 2 x (n-1)		

Remark: ASDU 9s are not compacted: they contain blanks (measurements marked invalid) when the measurements do not exist for Sepam. They are, however, truncated after the last useful measurement.

Each measurement is coded on 2 bytes in a standard way:

Bit No.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
–	IEC standardized, signed, 13-bit, 2's complement value													RES	ERR	OV

The first 3 bits are:
- Bit 0: Overflow bit OV
- Error bit ERR
- Reserved bit RES (always at 0)

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

Measured value = 1.2 x rated value x (IEC standardized value +1)/2^{12}

Example:

If the rated current is set at 630 A, the current value coded as 3251 represents a measured current of 600 A.

The value 3251 (0CB3h) is coded:

Bit No.	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
–	IEC standardized signed 13-bit value													RES	ERR	OV
Bit	0	1	1	0	0	1	0	1	1	0	0	1	1	0	0	0
HEX	0	C				B				3				0	0	0

Commands (ASDU 20)

Commands are sent to Sepam (reset, open/close) via ASDU 20.

ASDU 20 contains an RII identification number chosen arbitrarily by the master.

The command value is coded in the DCI byte:

Byte Number	Field	Value
1	ASDU number	20
2	Structure qualifier	81h
3	COT	20
4	ASDU common address (Sepam address)	0...254
5	Function number	FUN
6	Information number	INF
7	DCI (Double Command Information)	1 = OFF/2 = ON
8	RII (Return Information Identifier)	0...255

Commissioning

8

What's in this Chapter?

This chapter contains the following topics:

Safety Precautions

Before Starting

You are responsible for compliance with all the existing international and national electrical codes concerning protective grounding of any device.

You should also carefully read the safety precautions described below. These instructions must be followed strictly when installing, servicing or repairing electrical equipment.

⚠ 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, and carefully inspect the work area for tools and objects that may have been left inside the equipment.
- The successful operation of Sepam depends upon proper installation, setting, and operation.
- Setting the Sepam relay requires relevant expertise in the field of electrical network protection. Only competent people who have this expertise are allowed to set this product.

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

⚠ CAUTION

HAZARD OF DAMAGE TO SEPAM

- 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 may damage electronic components contained in the relay.
- Do not open the Sepam case. The Sepam relay contains components that are susceptible to electrostatic discharge. It is assembled in specially equipped premises. The only permitted operation is the removal of the depleted battery from its compartment on a Sepam series 10 A relay.

Failure to follow these instructions can result in injury or equipment damage.

Principles

Sepam Tests

Protection relays are tested prior to commissioning, with the dual aim of maximizing availability and minimizing the risk of malfunction of the assembly being commissioned. The question is to define the list of tests required at the time of commissioning.

Protection relays based on electromechanical and solid state technologies, whose performance cannot be fully reproduced, must be systematically submitted to detailed testing, not only to test their operational performance, but also to check that they are in good working order and have the required level of performance.

These tests are not necessary for relays based on digital technology:
- The use of this technology ensures reproducibility of the stated performances.
- An internal self-testing system provides continuous information on the state of the electronic components and the integrity of the functions, thereby ensuring a high level of availability.

Each of the Sepam functions has undergone full factory performance testing. The Sepam relay is therefore ready to operate without requiring any additional performance testing that concerns it directly.

Commissioning Sepam Relays

The preliminary Sepam commissioning tests can therefore be limited to a commissioning check, i.e.:
- Only carrying out the checks specific to the hardware configuration and the functions activated
- Checking compliance with BOMs and hardware installation diagrams and rules during a preliminary general check
- Checking compliance of the general settings and protection settings entered with the preliminary studies
- Checking connections of the current inputs by secondary injection tests
- Checking the CT ratio
- Checking connection of the logic inputs and output relays by simulating input data and forcing the output relay status
- Validating the complete protection chain
- Using the test sheet provided to record the results of the commissioning tests

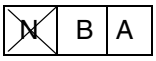
The Commissioning chapter describes the simple but exhaustive procedure to apply when performing these checks.

It is no longer essential to test each individual protection or control and monitoring function. However, if it is does prove necessary to test a function, the test procedures are described in this chapter.

Which Tests Do You Need to Perform?

Not all the checks and tests described in this chapter apply to all Sepam models (series 10 N, series 10 B or series 10 A). Each check or test begins with indicating which Sepam models it applies to: it does not apply to models whose identifier (N, B or A) has a bar over it.

Example



means that the check or test only applies to Sepam series 10 B and series 10 A.

Testing and Metering Equipment Required

Current Generator

To check the current input connections, use a sinusoidal AC current generator of the following type:
- 50 or 60 Hz frequency (according to the country of use)
- Single-phase, adjustable from 0 to 50 A RMS
- With injection-controlled digital chronometer, accurate to 10 ms
- With connector suited to the built-in test terminal box in the current input connection diagram

If the installation does not include a test terminal box, it is possible to disconnect shorting connector B and connect the current generator directly on the Sepam using cordsets fitted with another shorting connector.

If the current generator is equipped with electronic on/off controls, check that the current is definitely zero in the automatic stop position (depending on the cursor position, the solid state contactor can allow more than 5% of the current to flow through).

Voltage Generator

To check that the Sepam series 10 A logic inputs are connected correctly, use one of the following:
- A DC voltage generator, adjustable from 12 to 200 V DC for adaptation to the voltage level of the tested input
- A DC voltage auxiliary power supply the same as the Sepam auxiliary supply voltage

Accessories

Accessories are required for the following connections:
- A plug with cord corresponding to the test terminal box for installed currents
- An electric cord with clamps, wire grip or touch probes

Metering Devices

Class 1 metering devices are required:
- An ammeter (0 to 50 A RMS)
- A voltmeter (0 to 250 V RMS)

Documents

The set of installation documents includes:
- The complete Sepam connection diagram, showing:
  - Connection of the phase current inputs to the corresponding CTs via the test terminal box
  - Connection of the earth fault current input
  - Connection of the logic inputs and output relays
- The hardware bill of material and installation rules
- The settings sheet with all the Sepam parameters and settings
- The test sheet

Tolerances and Injection Limits

The current generator must satisfy the following conditions:
- Minimum injection current: 1.5% of the CT secondary rated current (15 mA or 75 mA)
- Maximum injection current:
  - Continuous: 4 times the CT secondary rated current (20 A)
  - For 3 seconds: 40 times the CT secondary rated current (200 A)
- Frequency: 50 Hz +/- 10% or 60 Hz +/- 10%

Energization

Checks to be Performed Prior to Energization

Apart from the mechanical state of the equipment, use the diagrams and BOMs provided by the contractor to check:

- The Sepam label
- Correct earthing of Sepam via the ⏚ terminal
- Conformity of the Sepam power supply voltage (indicated on the identification label on the front panel) with the power supply voltage of the switchboard (or cubicle)
- Correct connection of the auxiliary power supply:
  - Terminal 1: AC or positive polarity
  - Terminal 2: AC or negative polarity
- Whether an earth CT is present
- The presence of test terminal boxes upstream from the current inputs
- Conformity of connections between the Sepam terminals and the test terminal boxes

Checking the Connections

With the equipment de-energized, check that the connections are tightened.

The Sepam connectors must be correctly plugged in and locked.

Energization Procedure

1. Switch on the auxiliary power supply.
2. Check that the On LED lights up. If the Sepam relay has a watchdog, check that it changes status.

The default screen is displayed (phase current measurement for Sepam series 10 A and series 10 B, earth fault measurement for Sepam series 10 N).

Sepam Identification

Record the Sepam serial number (found on the identification label on the front panel) on the test sheet.

Record the Sepam software version number (***SEPAM*** screen in the parameters menu) on the test sheet.

Validation of the Complete Protection Chain

Principle

The complete protection chain is validated during the simulation of a fault that causes tripping of the switchgear by Sepam.

Simply testing one function can ensure that the whole system is working correctly, provided it has been installed correctly.

Procedure

To validate the complete protection chain, proceed as follows:

Step	Description
1	Select one of the protection functions that trips the switchgear.
2	Depending on the function(s) selected, inject a current corresponding to a fault and note whether the switchgear trips.
3	Put the covers back on the test terminal boxes.

Checking Settings

Determining Parameter and Protection Settings

All the Sepam parameter and protection settings are determined beforehand by the design department in charge of the application and should be approved by the customer.

It is presumed that the study has been carried out with all the attention necessary, or even consolidated by a discrimination study.

All the Sepam parameter and protection settings should be available for commissioning in the form of a dossier.

Checking Parameter and Protection Settings

Checks should be made when the Sepam parameter and protection settings have not been entered during commissioning tests, to confirm the conformity of the parameter and protection settings entered with the values determined during the study.

These checks consist of:

- Going through all the Sepam parameter and protection setting screens
- For each screen, comparing the values entered in the Sepam relay with the values recorded in the parameter and protection settings file
- Correcting any parameter and protection settings that have not been entered correctly. Refer to *Setting, p. 56*.

Note: Once the checks are complete, as of that phase, the parameter and protection settings should not be changed any further and are considered to be final.
The tests which follow must be performed with these parameter and protection settings. It will not be possible to modify any values, even temporarily. The only exception to this is the disabling of protection functions in order to isolate the protection function being tested.

Checking the CT Ratio

Purpose of the Check

In the context of checking the complete protection chain, checking each CT ensures that its transformation ratio conforms to expectations and is identical for the 2 or 3 phase CTs.

Procedure

The CT conformity certificates can be used as a basis for the check. If these documents are missing, proceed as follows:

Step	Action
1	Check that the CT primary circuit is accessible, de-energized and completely isolated.
2	Using documents (diagrams, etc.), determine the expected ratio and check the corresponding Sepam setting.
3	Make sure that the CT secondary is connected to the Sepam relay or short-circuited and install a clamp ammeter on the secondary circuit of the first CT.
4	Connect the generator to the CT primary circuit.
5	Inject a current of at least 0.2 In (In: CT primary rated current) if possible and measure the injected current.
6	Read the current measured in the secondary circuit by the clamp ammeter and check that the transformation ratio conforms to expectations. If the CT is connected to Sepam, check that the current displayed by Sepam is the same as the current injected in the CT primary.
7	Repeat steps 3 to 6 for the other phase CT(s) and check that the results obtained are identical for both or all 3 CTs.
8	If the earth fault current is measured by a 1 A or 5 A CT, repeat steps 3 to 6 to check its transformation ratio.
9	Record your measurements on the test sheet.

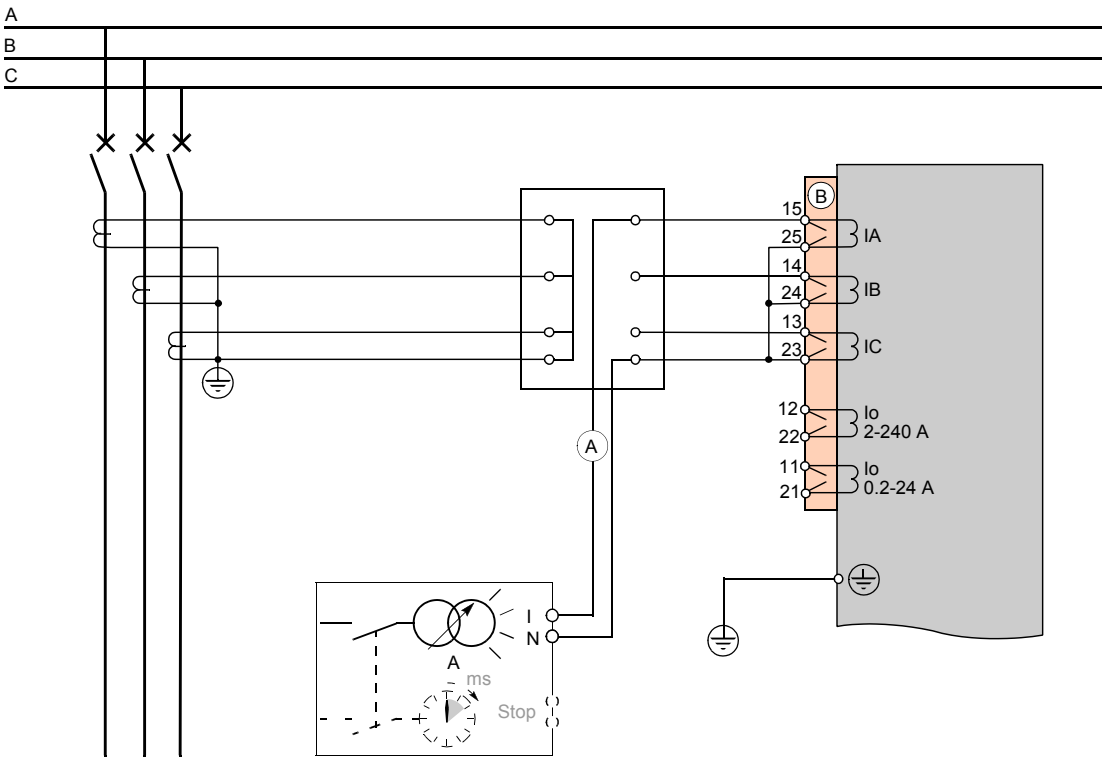
Checking the Phase Current Input Connections

Applicable to Sepam Series 10

M	B	A

Wiring Diagram

To inject a current into the phase A current input, connect the single-phase current generator to the test terminal box, as shown in the diagram below:



Procedure

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS

- Never leave the current transformer secondary in open circuit. The high voltage that would result from opening the circuit is dangerous for the operator and for the equipment.
- Never undo the ring lugs on the cables of the CT secondaries when there is current on the primary.

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

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS

- Wear insulating gloves to avoid any contact with a conductor that has accidentally been energized.
- Unplug shorting connector B without disconnecting the wires from it. This connector ensures continuity of the current transformer secondary circuits.

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

Step	Action
1	Connect the current generator to inject a current into a phase current input.
2	Turn on the generator.
3	Inject the CT secondary rated current (1 A/5 A).
4	On the Sepam display, check that the value of the phase A current is approximately equal to the CT primary rated current.
5	Turn off the generator.
6	Repeat steps 1 to 5 for the other 2 phase current inputs.
7	Replace the cover on the test terminal box.

Checking the Earth Fault Current Inputs

Applicable to Sepam Series 10

N	B	A

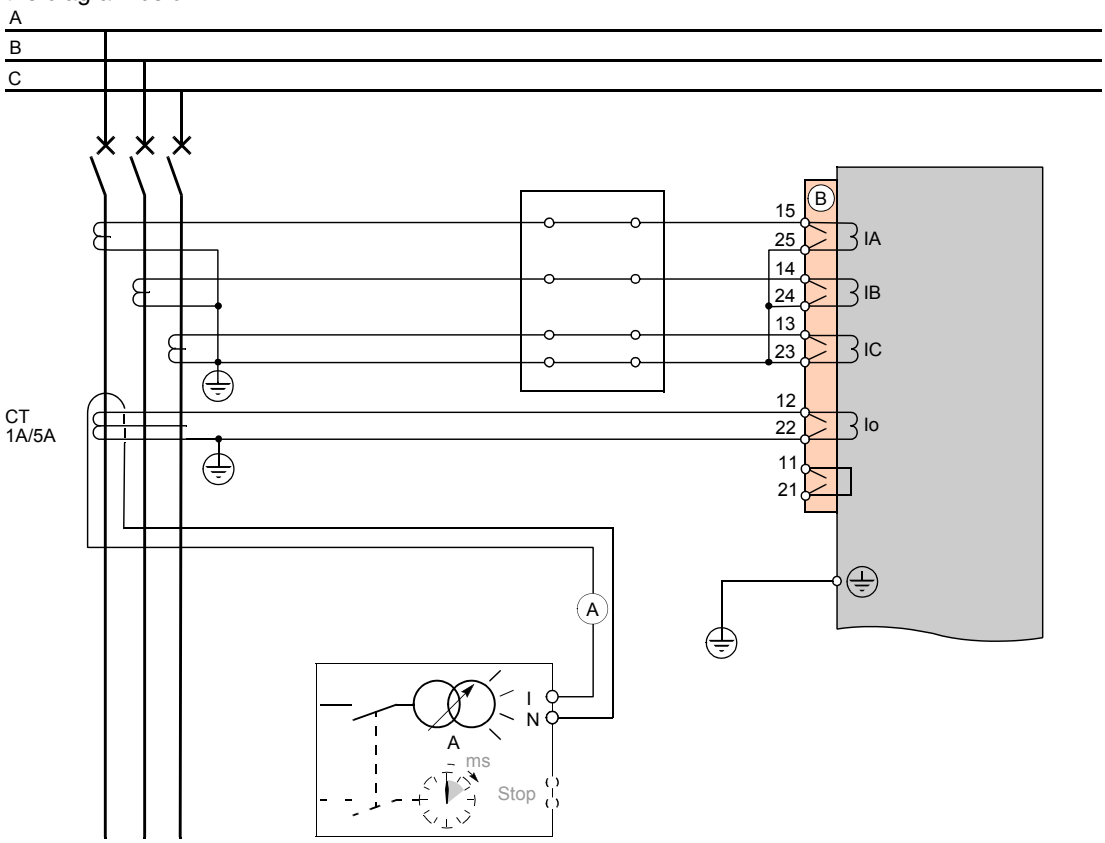
Two Checking Methods

There are two possible checking methods:

- A standard method, for checking the connection of the earth fault current sensor (earth fault CT or core balance CT) to the Sepam earth fault current input
- A complete method, for checking in addition that the connection to earth of the earthing shields at the cable ends goes back into the sensor

Standard Method - Wiring Diagram

Connect the single-phase current generator to inject current into the sensor primary circuit as shown in the diagram below:

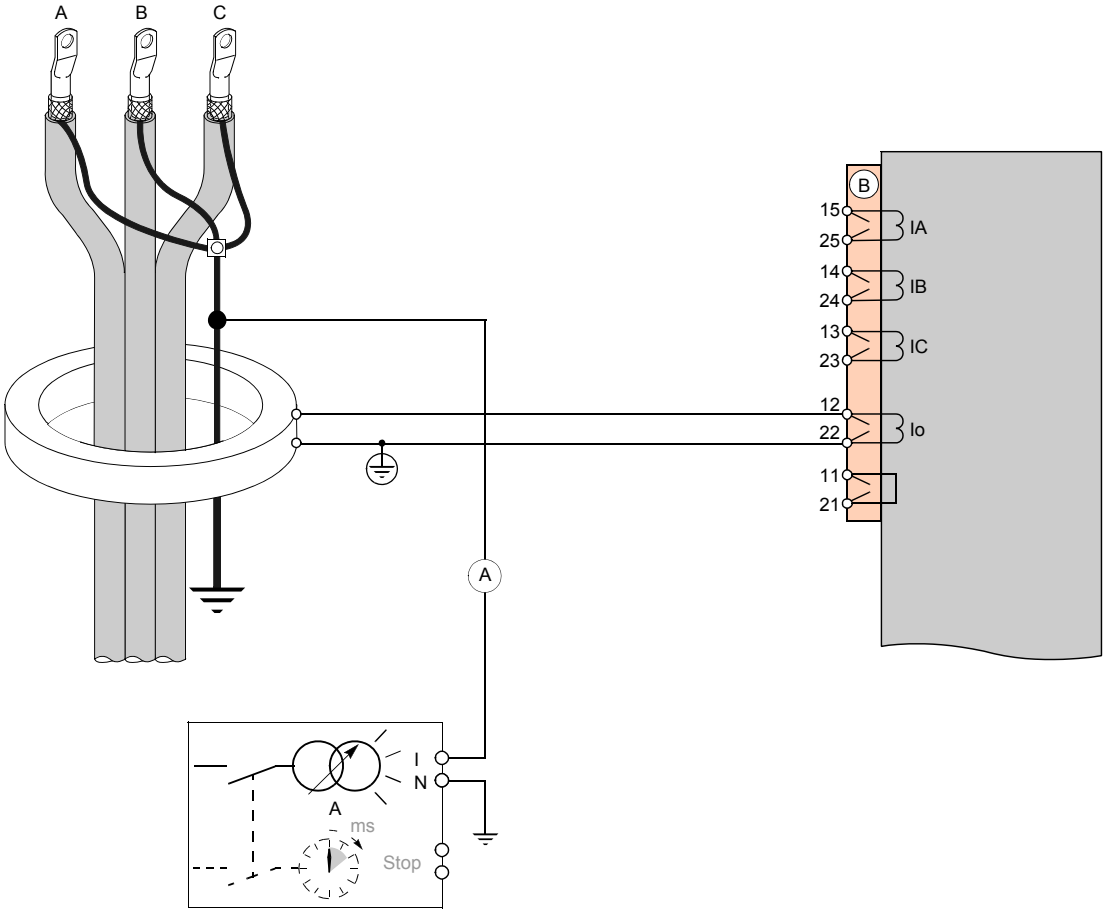


Standard Method - Procedure

Step	Action
1	Turn on the generator.
2	Inject a 5 A primary earth fault current.
3	Check on the Sepam display that the earth fault current value is approximately equal to 5 A.
4	Turn off the generator.

Complete Method - Wiring Diagram

To check in addition that the connection to earth of the earthing shields at the cable ends goes back into the sensor, inject the current not directly into the sensor, but via the wire linking the earthing shields at the ends of the medium-voltage cables to earth as shown in the diagram below:



Complete Method - Procedure

Step	Action
1	Turn on the generator.
2	Inject a primary earth fault current of at least 20 A.
3	Check on the Sepam display that the value of the earth fault current is approximately equal to the current injected. If not, check: ● That the generator actually injects the current requested (if the generator is saturated, it is possible that the current injected may not cross the medium-voltage cable shielding: check that the shield is actually connected to earth) ● That the shield actually goes into the sensor ● That the shield goes into the sensor in the correct direction ● That the shield is actually connected to earth ● That the shield is not in contact with earth before it goes into the sensor
4	Turn off the generator.

Phase Overcurrent Protection (ANSI 50-51) Test

Applicable to Sepam Series 10

N	B	A

Purpose of the Test

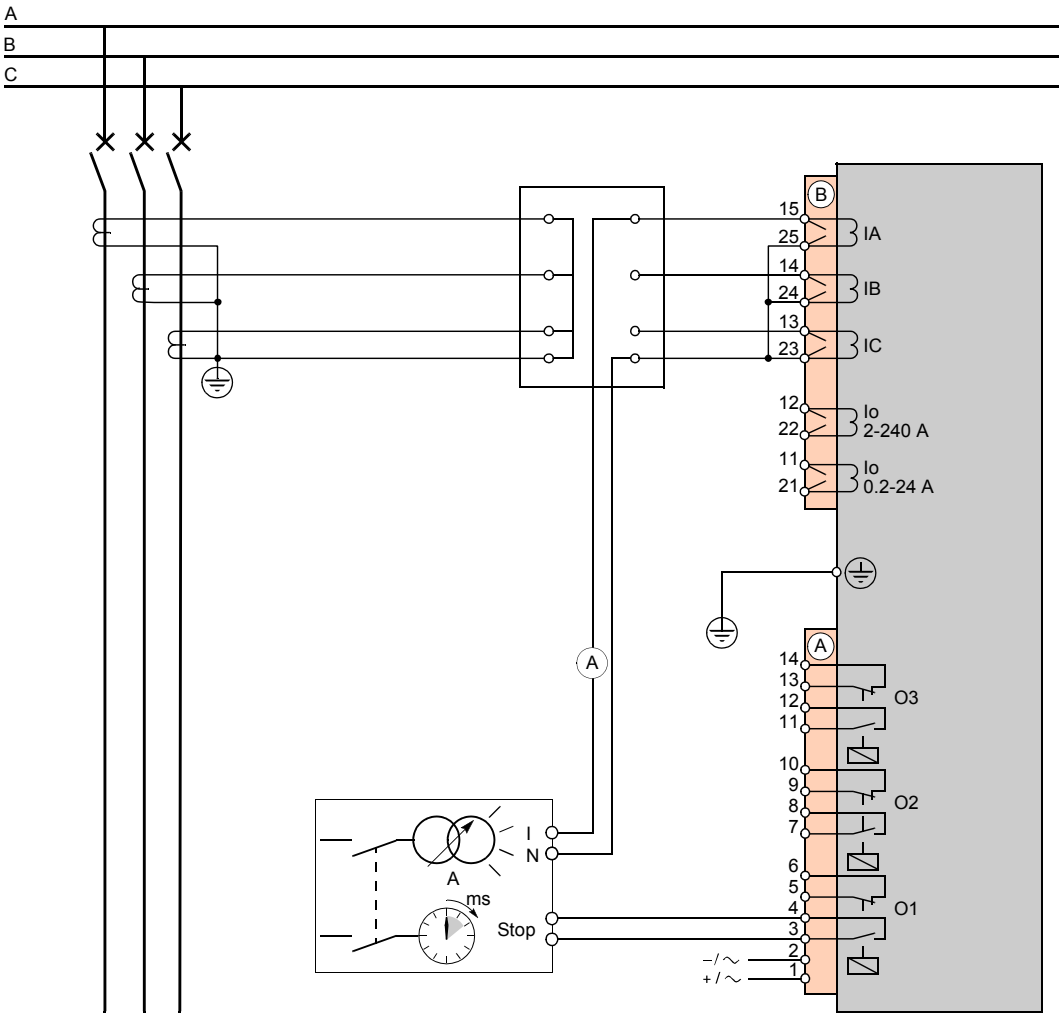
The phase overcurrent protection test is used to check the setting values for the following protection functions:

- Tripping set point
- Tripping time delay

Wiring Diagram

To inject current onto the phase A current input, connect the single-phase current generator as shown in the diagram below.

Use one of the Sepam output relays to stop the chronometer. If you are using a circuit breaker contact to stop the chronometer, the measured time includes the circuit breaker operating time.



Definite Time Protection Test

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS

- Never leave the current transformer secondary in open circuit. The high voltage that would result from opening the circuit is dangerous for the operator and for the equipment.
- Never undo the ring lugs on the cables of the CT secondaries when there is current on the primary.

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

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS

- Wear insulating gloves to avoid any contact with a conductor that has accidentally been energized.
- Unplug shorting connector B without disconnecting the wires from it. This connector ensures continuity of the current transformer secondary circuits.

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

A definite time protection function uses two settings that are independent of one another:
- The current set point (I> or I>>)
- The time delay

Two checks are therefore required:

Set point check:

Step	Action
1	Disable the earth fault protections, if they are based on the sum of the 3 phase CTs, and also the thermal overload protection and the phase overcurrent protection cold load pick-up function (CLPU I) if necessary.
2	Inject a current approximately equal to 80% of the set point value.
3	Increase the current slowly until the Sepam relay trips or until the phase fault LED flashes quickly.
4	Record the current value at the time of tripping on the test sheet and compare it with the value on the settings sheet.
5	Reset Sepam (Reset key).
6	If you are not performing any other checks: ● Re-enable the protections and functions required by the settings sheet. ● Reset the thermal capacity used to 0%. Refer to *Method for Resetting the Thermal Capacity Used, p. 59*. ● When a blocking input is used, re-enable the back-up time delays associated with each set point.

Time delay check:

Step	Action
1	Disable the earth fault protections, if they are based on the sum of the 3 phase CTs, and also the thermal overload protection and the phase overcurrent protection cold load pick-up function (CLPU I) if necessary.
2	Short-circuit the generator to avoid injecting current into the Sepam relay.
3	Prepare to inject a current at least twice as high as the tripping current measured in the set point check.
4	Re-establish the injection circuit in the Sepam relay and set the chronometer to zero.
5	Start current injection and the chronometer simultaneously and use the ammeter to make sure the injected current is stable. When Sepam trips, the chronometer stops.
6	Record the time elapsed on the test sheet and compare it with the value on the settings sheet.
7	Reset Sepam (Reset key).
8	If you are not performing any other checks: ● Re-enable the protections and functions required by the settings sheet. ● Reset the thermal capacity used to 0%. Refer to *Method for Resetting the Thermal Capacity Used, p. 59*. ● When a blocking input is used, re-enable the back-up time delays associated with each set point.

IDMT Protection Test

IDMT protection uses a standardized curve (I, t).

The test consists of testing a few points on the curve, in the tripping zone for set point I>.

Checking a point on the curve:

Step	Action
1	Disable the earth fault protections, if they are based on the sum of the 3 phase CTs, and also the thermal overload protection and the phase overcurrent protection cold load pick-up function (CLPU I) if necessary.
2	Choose a point (I/I>, t) to be tested in the set point tripping zone, using the *Method for Resetting the Thermal Capacity Used, p. 59 and subsequent ones.*
3	Set the generator for the current determined in step 2.
4	Reset the chronometer to zero and reset Sepam if necessary (Reset key).
5	Start current injection and the chronometer simultaneously and use the ammeter to make sure the injected current is stable. When Sepam trips, the chronometer stops.
6	Record the time elapsed on the test sheet and compare it with the expected value.
7	Reset Sepam (Reset key).
8	If you are not performing any other checks: ● Re-enable the protections and functions required by the settings sheet. ● Reset the thermal capacity used to 0%. Refer to *Method for Resetting the Thermal Capacity Used, p. 59*. ● When a blocking input is used, re-enable the back-up time delays associated with each set point.

Earth Fault Protection (ANSI 50N-51N) Test

Applicable to Sepam Series 10

N	B	A

Purpose of the Test

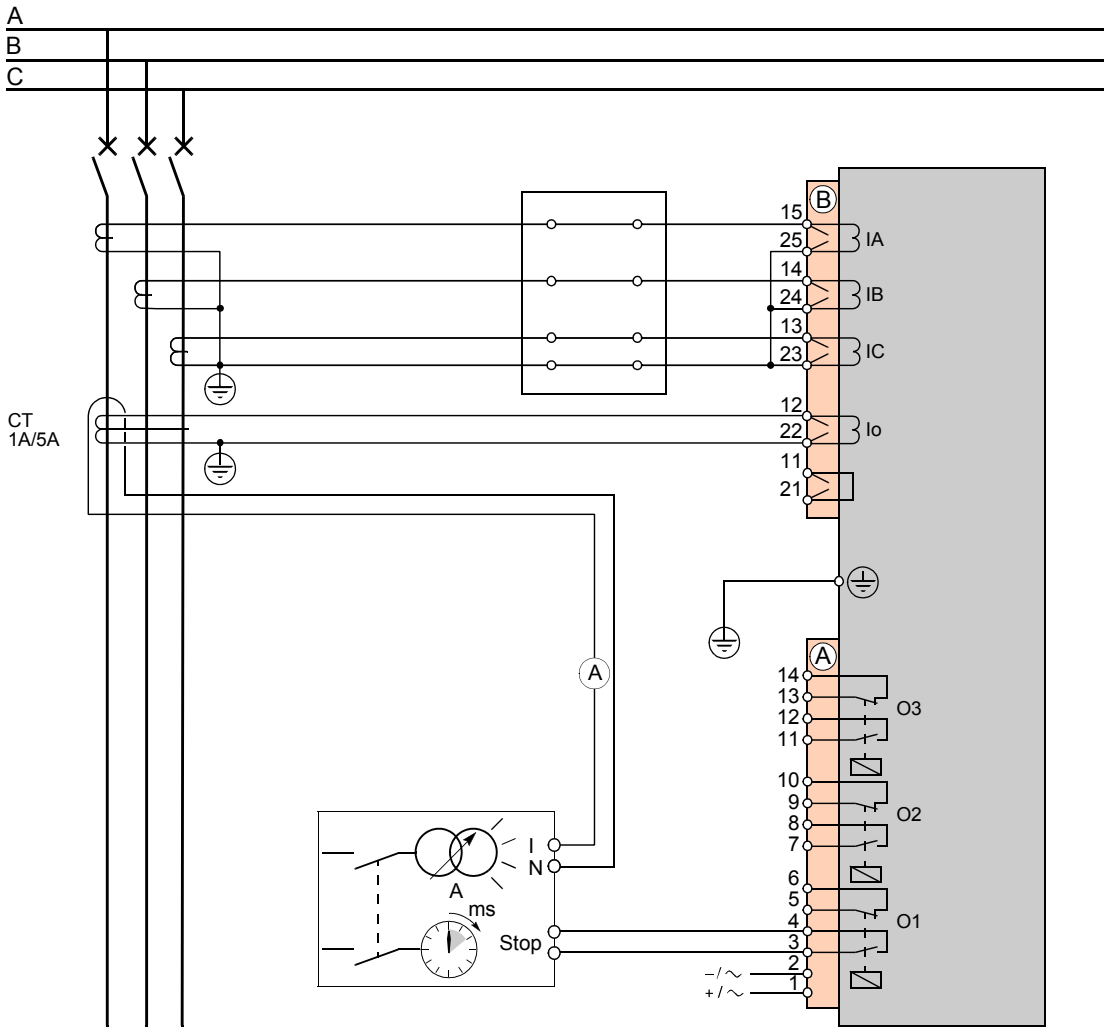
The earth fault protection test is used to check the setting values for the following protection functions:
- Tripping set point
- Tripping time delay

There are two possible wiring diagrams, depending on whether the earth fault current is being measured:
- Using an earth fault current sensor (earth CT or core balance CT)
- Using the sum of the currents measured by the 3 phase CTs

Wiring Diagram with Earth Fault Current Sensor

To inject current into the sensor primary current, connect the single-phase current generator as shown in the diagram below.

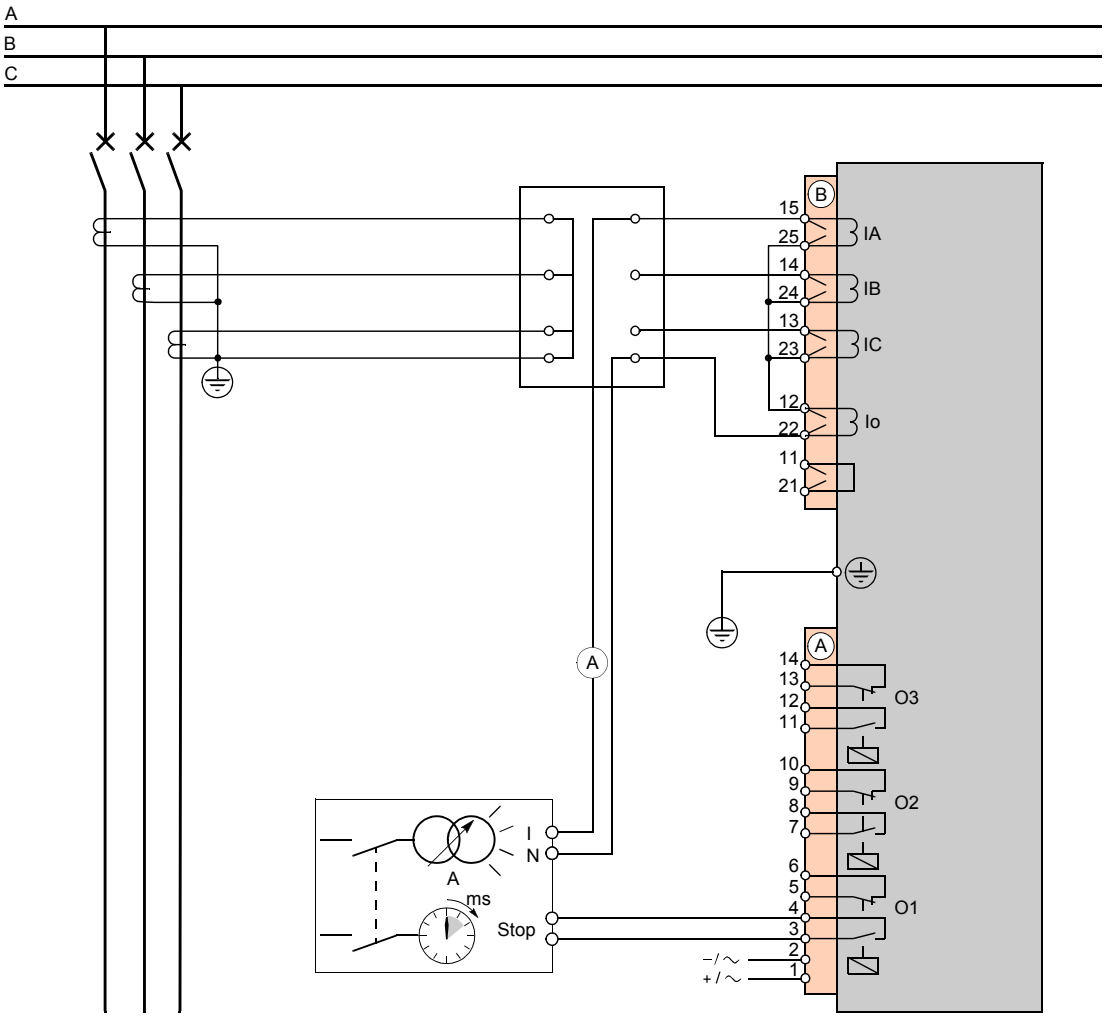
Use one of the Sepam output relays to stop the chronometer. If you are using a circuit breaker contact to stop the chronometer, the measured time includes the circuit breaker operating time.



Wiring Diagram with 3 Phase CTs

To inject current into the phase A current input, connect the single-phase current generator as shown in the diagram below.

Use one of the Sepam output relays to stop the chronometer. If you are using a circuit breaker contact to stop the chronometer, the measured time includes the circuit breaker operating time.



Definite Time Protection Test

A definite time protection function uses two settings that are independent of one another:
- The current set point (Io> or Io>>)
- The time delay

Two checks are therefore required:

Set point check:

Step	Action
1	As necessary, disable the phase overcurrent protections, the thermal overload protection and the overcurrent protection cold load pick-up functions (CLPU I and CLPU Io).
2	Inject a current approximately equal to 80% of the set point value.
3	Increase the current slowly until the Sepam relay trips or until the earth fault LED flashes quickly.
4	Record the current value at the time of tripping on the test sheet and compare with the value on the settings sheet.
5	Reset Sepam (Reset key).
6	If you are not performing any other checks: ● Re-enable the protections and functions required by the settings sheet. ● Reset the thermal capacity used to 0%. Refer to *Method for Resetting the Thermal Capacity Used, p. 59*. ● When a blocking input is used, re-enable the back-up time delays associated with each set point.

Time delay check:

Step	Action
1	As necessary, disable the phase overcurrent protections, the thermal overload protection and the overcurrent protection cold load pick-up functions (CLPU I and CLPU Io).
2	Short-circuit the generator to avoid injecting current into the Sepam relay.
3	Prepare to inject a current at least twice as high as the tripping current measured in the set point check.
4	Re-establish the injection circuit in the Sepam relay and set the chronometer to zero.
5	Start current injection and the chronometer simultaneously and use the ammeter to make sure the injected current is stable. When Sepam trips, the chronometer stops.
6	Record the time elapsed on the test sheet and compare it with the value on the settings sheet.
7	Reset Sepam (Reset key).
8	If you are not performing any other checks: ● Re-enable the protections and functions required by the settings sheet. ● Reset the thermal capacity used to 0%. Refer to *Method for Resetting the Thermal Capacity Used, p. 59*. ● When a blocking input is used, re-enable the back-up time delays associated with each set point.

IDMT Protection Test

IDMT protection uses a standardized curve (Io, t).

The test consists of testing a few points on the curve, in the tripping zone for the set point Io>.

Checking a point on the curve:

Step	Action
1	As necessary, disable the phase overcurrent protections, the thermal overload protection and the overcurrent protection cold load pick-up functions (CLPU I and CLPU Io).
2	Choose a point (Io/Io>, t) to be tested in the set point tripping zone, using the *Overcurrent Protection Tripping Curves, p. 90 and subsequent ones.*
3	Set the generator for the current determined in step 2.
4	Reset the chronometer to zero and reset Sepam if necessary (Reset key).
5	Start current injection and the chronometer simultaneously and use the ammeter to make sure the injected current is stable. When Sepam trips, the chronometer stops.
6	Record the time elapsed on the test sheet and compare it with the expected value.
7	Reset Sepam (Reset key).
8	If you are not performing any other checks: ● Re-enable the protections and functions required by the settings sheet. ● Reset the thermal capacity used to 0%. Refer to *Method for Resetting the Thermal Capacity Used, p. 59*. ● When a blocking input is used, re-enable the back-up time delays associated with each set point.

ANSI 49 RMS Thermal Overload Protection Test

Applicable to Sepam Series 10

N	B	A

Purpose of the Test

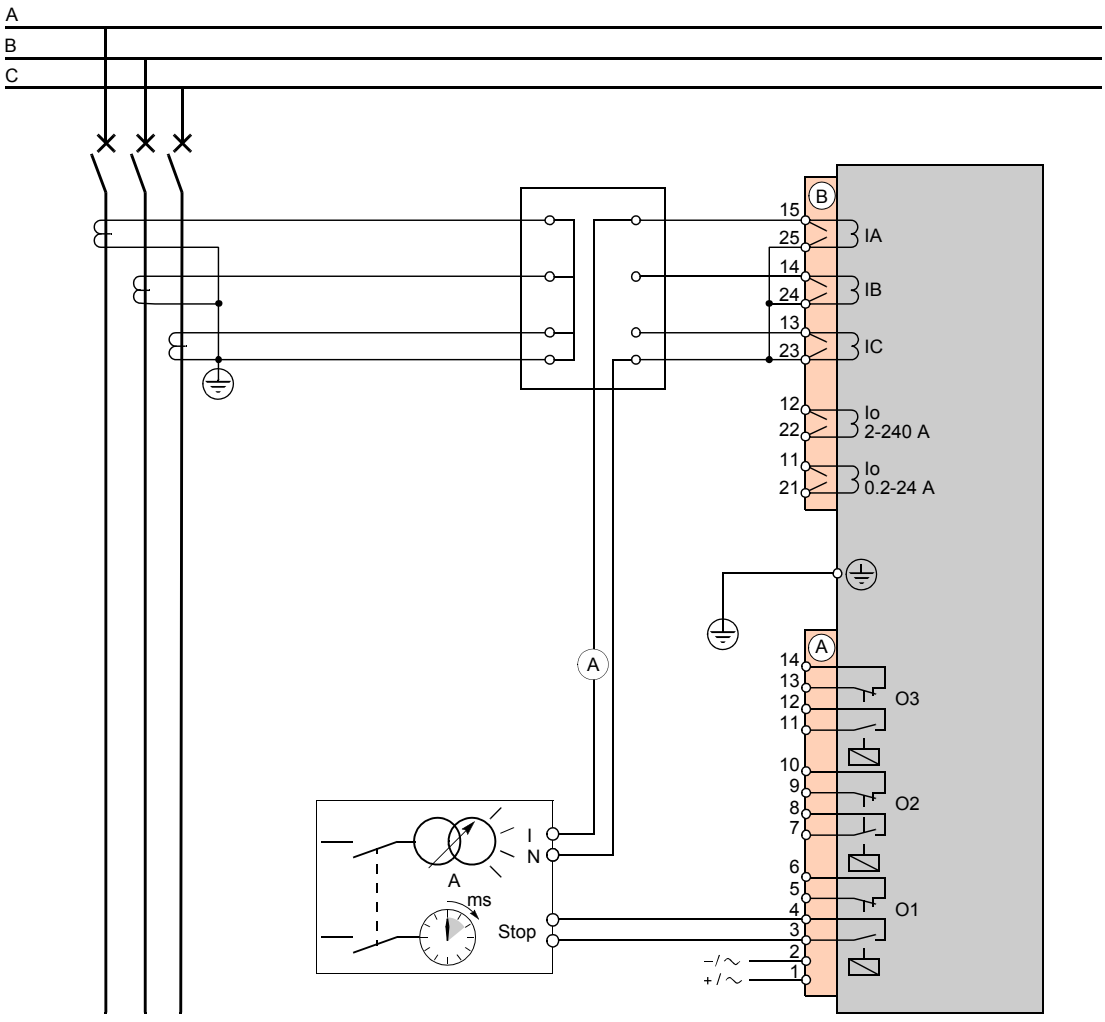
The thermal overload protection test is used to check the operation and setting values of this protection function:

- Calculation of the thermal capacity used
- Alarm set point
- Tripping time delay

Wiring Diagram

To inject current onto the phase A current input, connect the single-phase current generator as shown in the diagram below.

Use one of the Sepam output relays to stop the chronometer. If you are using a circuit breaker contact to stop the chronometer, the measured time includes the circuit breaker operating time.



Thermal Overload Protection Test

Thermal overload protection uses a curve (I, t).

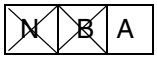
The test consists of testing a few points on the curve, in the tripping zone for the set point.

Checking a point on the curve:

Step	Action
1	Disable the phase and earth fault overcurrent protections.
2	Out of the *Curves for an Initial Thermal Capacity Used of 0%, p. 112 and subsequent ones*, use the curve that approximates most closely to the Sepam settings and determine the coordinates for a point (I/Is, t) to be tested.
3	Set the generator for the current determined in step 2.
4	Reset the chronometer to zero and reset Sepam if necessary (Reset key).
5	Reset the thermal capacity used to 0%. Refer to *Method for Resetting the Thermal Capacity Used, p. 59*.
6	Start current injection and the chronometer simultaneously and use the ammeter to make sure the injected current is stable. When Sepam trips, the chronometer stops.
7	Record the time elapsed on the test sheet and compare it with the expected value.
8	Reset Sepam (Reset key).
9	If you are not performing any other checks: ● Re-enable the protections and functions required by the settings sheet. ● Reset the thermal capacity used to 0%. ● When a blocking input is used, re-enable the back-up time delay associated with each set point.

Checking the Logic Input Connections

Applicable to Sepam Series 10



Checking the Logic Inputs

To check the logic inputs, proceed as follows for each input:

Step	Action
1	Display the ***INPUT STATUS*** screen in the parameters menu.
2	● If the input power supply voltage is available, use an electric cord to short-circuit the contact that delivers logic data to the input. ● If the input power supply voltage is not available, apply a voltage supplied by the DC voltage generator to the terminal of the contact linked to the chosen input. To adjust the voltage level: refer to *Connecting the Logic Inputs, p. 42*.
3	Note any change in the display.
4	If necessary, reset the Sepam (Reset key).

Special Case of I1 and I2

Logic inputs I1 and I2 indicate the circuit breaker position.

To check that Sepam is reading the circuit breaker position, operate the breaker and note any changes in the display.

Operational Commissioning

Final Check

When the tests are complete, proceed as follows for the final check:

Step	Action
1	Put the covers back on the test terminal boxes.
2	Look through all the screens relating to the Sepam protection functions and check that only the desired protections are active.
3	Check the conformity of the validated parameters in Sepam against the settings sheet.
4	Record the last event recorded by Sepam on the test sheet so that you can distinguish between the values attributable to the tests and those due to subsequent activation of the protections by a fault on the installation. The Sepam relay is now operational.

Sepam Test Sheet

Use

This test sheet can be used to record the results of the commissioning tests.

Each test is described in detail in the Commissioning chapter.

Only carry out the tests required, depending on the Sepam type and the functions in use.

Check the box ☐ when the check has been made and is conclusive.

Identification

Workstation		Tests Conducted on:	By:
Cubicle		Comments	
Type of Sepam series 10			
Serial number			
Software version			
(to be read in the ***SEPAM*** screen in the parameters menu)			

Overall Checks

Type of Check	
Preliminary inspection, prior to energizing	☐
Energizing	☐
Checking parameters and settings	☐
Connecting the logic inputs (Sepam series 10 A only)	☐
Validation of the complete protection chain	☐

Checking the CT Ratio

CT Checked	**Theoretical Transformation Ratio**	**Primary Injection Current (Ip ≥0.2 In)**	**Current Measured at the Secondary (Is)**	**Measured Transformation Ratio (Ip/Is)**	
Phase CT A					☐
Phase CT B					☐
Phase CT C					☐
Earth CT					☐

Checking the Current Inputs

Type of Check	**Test Performed**	**Result**	**Display**	
Connecting the phase current inputs	Secondary injection of the CT rated current, i.e. 1 A or 5 A.	CT primary rated current	IA = ... IB = ... IC = ...	☐
Connecting the earth fault current inputs	Standard method: Injection of 5 A into primary circuit of core balance CT or CT	Injected current value	Io = ...	☐
	Complete method: Injection of 20 A into the cable earthing shield	Injected current value	Io = ...	☐

Phase Overcurrent Protection (ANSI 50-51) Tests

Low set point with definite time curve

Current Set Point Test ☐		**Time Delay Test** ☐	
Set point set	Set point measured	Time delay set	Time delay measured

Low set point with IDMT curve

	Injected Current Measured	**Tripping time delay**		
		Theoretical	**Measured**	
Point 1				☐
Point 2				☐
				☐
				☐

High set point with definite time curve

Current Set Point Test ☐		**Time Delay Test** ☐	
Set point set	Set point measured	Time delay set	Time delay measured

Earth Fault Protection (ANSI 50N-51N) Tests

Low set point with definite time curve

Current Set Point Test ☐		**Time Delay Test** ☐	
Set point set	Set point measured	Time delay set	Time delay measured

Low set point with IDMT curve

	Injected Current Measured	**Tripping time delay**		
		Theoretical	**Measured**	
Point 1				☐
Point 2				☐
				☐
				☐

High set point with definite time curve

Current Set Point Test ☐		**Time Delay Test** ☐	
Set point set	Set point measured	Time delay set	Time delay measured

Thermal Overload Protection (ANSI 49 RMS) Test

	Injected Current Measured	**Tripping time delay**		
		Theoretical	**Measured**	
Point 1				☐
Point 2				☐
				☐
				☐

Operational Commissioning

Last trip/event recorded during commissioning:

Number	**Message**	**Date and Time**	**IA**	**IB**	**IC**	**Io**

Maintenance

9

What's in this Chapter?

This chapter contains the following topics:

Preventive Maintenance

Introduction

To obtain maximum availability of the installation, it is essential to ensure that Sepam is operational at all times. The Sepam internal self-tests, described in *Operation of the Self-test System, p. 168*, and the watchdog relay alert the user in the event of internal Sepam failure.

Nonetheless, elements outside the Sepam are not subject to these self-tests and it is therefore necessary to carry out regular preventive maintenance.

Apart from the battery, which can be accessed on the front panel, nothing inside the Sepam requires preventive maintenance, nor can anything be replaced by the user.

List of Interventions

The table below gives the typical frequency of interventions. The intervals between visual inspections depends on the installation operating conditions.

Intervention	Frequency
Routine check	Weekly
LED and display unit test Inspection of the rear panel Check of the battery status (Sepam series 10 A)	Annual
Check of the complete trip chain	Every 5 years

Routine Check

- Make sure that the phase currents and the earth fault current measured by Sepam are appropriate for the load being powered.
- Check that the Sepam unavailable LED is off.

LED and Display Unit Test

The LED and display unit test is used to check that each LED on the front panel and in each segment of the display is working correctly.

To perform the test, press and hold down the menu selection key. After 2 seconds, all LEDs on the front panel and all segments of the display light up.

Inspection of the Rear Panel

Check that the connections are tight and free from corrosion, paying particular attention to the earth terminal and the CT connections.

If the CT connections are not tightened properly, this generates excessive heat rise which can lead to the destruction of connector B and the CTs.

Checking the Battery Status

The Sepam series 10 A relay is equipped with a battery which backs up the internal clock. When the Reset key is pressed, the 4 red fault LEDs light up. To check that the battery is in good working order, press the Reset key for 2 to 3 seconds. The LEDs should remain on clearly without fading for the whole time the key is pressed. If not, replace the battery: refer to *Replacing the Battery in the Sepam Series 10 A, p. 240*.

Check of the Trip Chain

It is important to check that the complete trip chain regularly, from the CTs to the Sepam and through to the trip coil, is always operational.

For details of the operations to be performed, refer to *Validation of the Complete Protection Chain, p. 214*.

Troubleshooting Assistance

Introduction

The paragraphs below list the actions to be taking after observing abnormal Sepam behavior. In the event of an anomaly, do not cut off the auxiliary power supply before making a diagnosis.

LEDs and Display Unit Off

Symptom	Possible Causes	Action/Remedy	Refer to...
All the LEDs are off, as well as the display unit	Auxiliary power supply connector not plugged in properly	Plug in connector A.	*Identification of the Connectors on the Rear Panel, p. 27*
	Auxiliary power supply absent	Check that the auxiliary power supply level is within the permissible range.	*Power Supply Voltage , p. 14*
	Internal failure	Change the Sepam unit.	*Removing Sepam, p. 239*

Sepam Unavailable LED On

Lighting up of the LED indicates that Sepam has gone into the fail-safe position following detection by the embedded self-tests of the failure of one of its components. Refer to *Operation of the Self-test System, p. 168*.

Remark: (This LED may light up briefly when Sepam is energized. This is normal and does not indicate a failure.

The fail-safe position is characterized by:

- LED on
- Watchdog relay, if it exists, in the off-position
- Output relays in the off-position (normal position)
- Display of an 8-digit code on the front panel
- Communication inoperative

In this case, Sepam is no longer operational. Read the code and change the Sepam (refer to *Removing Sepam, p. 239*).

No Display or Incomplete Display

Symptom	Possible Causes	Action/Remedy	Refer to...
The ON LED is on, but the display does not appear or is incomplete	Failure of the display unit	Change the Sepam unit.	*Removing Sepam, p. 239*

Communication Problem (Sepam Series 10 A)

During normal operation, the LED flashes at the same rate as frames are exchanged with the supervisor.

If the Sepam relay is not communicating with the supervisor, check:
- That the supervisor is sending frames to the relevant Sepam
- All the Sepam communication parameters
- The wiring of each Sepam
- The tightness of the screw terminals on connector C of each Sepam
- The bus polarization, at a single point, in general by the master
- The line matching at the ends of the RS 485 network

If the problem persists, connect the Sepam relays one by one on the communication network to determine which Sepam relay is responsible for the problem.

Incorrect Time (Sepam Series 10 A)

Symptom	Possible Causes	Action/Remedy	Refer to...
The time displayed is incorrect	Auxiliary power supply cut off with an empty battery	Test the battery.	*Checking the Battery Status , p. 236*
	Wrong time sent by the communication	Check the supervisor setup.	–

Lost Password

If you lose the password, read the serial number on the Sepam front panel and contact your local Schneider Electric after-sales service.

Removing Sepam

Introduction

If the Sepam relay cannot be repaired by following the instructions in *Troubleshooting Assistance, p. 237*, it must be replaced. The connectors can be left in the cubicle with the wires connected.

Removing Sepam

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS

- Wear insulating gloves to avoid any contact with a conductor that has accidentally been energized.
- To disconnect the Sepam current inputs, unplug the shorting connector B without disconnecting the wires connected to it. This connector ensures continuity of the current transformer secondary circuits.
- If you need to disconnect the wires connected to the shorting connector, short-circuit the current transformer secondary circuits.

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

The procedure for removing the Sepam relay is as follows:

Step	Action
1	If the Sepam allows you to, read and make a note of the last trips/events that have occurred.
2	Make a note of the symptoms observed, in particular the failure codes displayed.
3	Switch off the device.
4	Unscrew and unplug all the connectors.
5	Disconnect the Sepam protective earth.
6	Open the settings protective flap.
7	Undo the screws on the 2 fixing catches and check that they pivot in order to release the Sepam.
8	Re-close the flap.
9	Remove the Sepam.

Return for Expert Assessment

If returning the Sepam for expert assessment, use the original packaging or packaging offering level 2 protection against vibrations (standard IEC 60255-21-1) and against shocks (standard IEC 60255-21-2).

The Sepam relay must be returned accompanied by its settings sheet and the following information:

- Name and address of the initiator
- Sepam type and serial number
- Date of the incident
- Description of the incident
- LED status and message displayed at the time of the incident
- List of stored events

End of Life

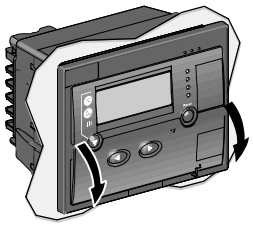
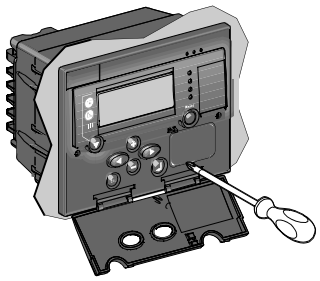
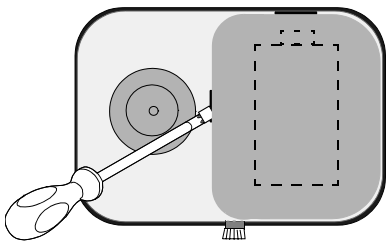
If the Sepam is not repairable:

Step	Action
1	Remove the battery: refer to *Procedure, p. 240*.
2	Remove the Sepam as indicated above.
3	Dismantle the Sepam in accordance with the *End-of-Life Recycling for the Sepam Series 10* document.

Replacing the Battery in the Sepam Series 10 A

Procedure

The battery should be removed when depleted and at the end of life of the Sepam relay. It can be removed with the Sepam energized.

Step	Action	Illustration
1	Open the settings protective flap.	
2	Lift the removable cover shielding the battery compartment using a flat blade screwdriver.	
3	Pull the battery compartment forward with the screwdriver.	
4	Remove the battery.	–

Battery Recycling

⚠ WARNING

HAZARD OF EXPLOSION

- Do not recharge the battery.
- Do not short circuit the battery.
- Do not crush the battery.
- Do not disassemble the battery.
- Do not heat the battery above 100°C (212°F).
- Do not throw the battery into fire or water.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

The used battery should be disposed of by an approved certified recycling company in compliance with current regulations.

Battery Characteristics

- 1/2 AA 3.6 V lithium battery
- Recommended model: Saft LS14250
- Storage conditions: as defined in EN 60086-4

Replacement Procedure

When depleted, the battery is replaced as follows:

Step	Action
1	Insert a battery with the above characteristics, respecting the polarity (+ facing up).
2	Re-close the battery compartment.
3	Replace the cover shielding the battery compartment.
4	Close the settings protective flap.
5	Test the battery by pressing the Reset key for 2 to 3 seconds: The LEDs should remain on clearly without fading for the whole time the key is pressed.
6	Reset the time on the Sepam if the battery was replaced with the power off.

Characteristics

10

What's in this Chapter?

This chapter contains the following topics:

Function Characteristics

General Remarks

In the tables below:
- In is the phase CT primary rated current.
- Ino is the earth CT primary rated current.
- The primary rated current Ino for CSH120, CSH200, GO110 core balance CTs is 470 A.
- A full explanation is given in the reference conditions (IEC 60255-6), apart from details of the sensors.

CT Transformation Ratio

Sensors	Characteristics	Values
Phase CT	Primary rated current (In)	1...6300 A
	Step	● 1 A up to 130 A ● 10 A from 130 A to 6300 A
	Secondary rated current	1 A/5 A
Earth CT	Primary rated current (Ino)	1...6300 A
	Step	● 1 A up to 130 A ● 10 A from 130 A to 6300 A
	Secondary rated current	1 A/5 A
Core balance CT (very sensitive version)	Rating	● 0.2... 24 A ● 2... 240 A

Phase Currents

Characteristics	Values
Measuring range	0.02...40 In
Accuracy	● +/- 1% typical at In ● +/- 2% at 0.3...1.5 In ● +/- 5% at 0.1...0.3 In
Unit	A or kA
Resolution	0.1 A...1 kA depending on the value
Display format	3 significant digits
Display refresh period	1 s

Earth Fault Current

Characteristics	Versions		Values
Measuring range	Standard		0.05...40 Ino (or In)
	Sensitive		0.005...4 Ino (or In)
	Very sensitive	0.2-24 A rating	0.00025...0.085 Ino (0.1...40 A primary)
		2-240 A rating	0.0025...0.85 Ino (1...400 A primary)
Accuracy	Standard		● +/- 1% typical at Ino (or In) ● +/- 2% at 0.3...1.5 Ino (or In) ● +/- 5% at 0.1...0.3 Ino (or In)
	Sensitive		● +/- 1% typical at 0.1 Ino (or In) ● +/- 2% at 0.03...0.15 Ino (or In) ● +/- 5% at 0.01...0.03 Ino (or In)
	Very sensitive	0.2-24 A rating	● +/- 1% typical at 0.01 Ino ● +/- 2% at 0.003...0.015 Ino ● +/- 5% at 0.0005...0.003 Ino
		2-240 A rating	● +/- 1% typical at 0.1 Ino ● +/- 2% at 0.03...0.15 Ino ● +/- 5% at 0.005...0.03 Ino
Unit			A or kA
Resolution			0.1 A...1 kA depending on the value
Display format			3 significant digits
Display refresh period			1 s

Phase Peak Demand Current Values

Characteristics	Values
Measuring range	0.02...40 In
Accuracy	● +/- 1% typical at In ● +/- 2% at 0.3...1.5 In ● +/- 5% at 0.1...0.3 In
Unit	A or kA
Resolution	0.1 A...1 kA depending on the value
Display format	3 significant digits
Display refresh period	1 s

Tripping Phase Currents

Characteristics	Values
Measuring range	0.1...40 In
Accuracy	+/- 5% or +/- 0.02 In
Unit	A or kA
Resolution	0.1 A...1 kA depending on the value
Display format	3 significant digits

Tripping Earth Fault Current

Characteristics	Versions		Values
Measuring range	Standard		0.1...40 Ino (or In)
	Sensitive		0.01...4 Ino (or In)
	Very sensitive	0.2-24 A rating	0.2...40 A
		2-240 A rating	2...400 A
Accuracy			+/- 5% or +/- 0.02 Ino
Unit			A or kA
Resolution			0.1 A...1 kA depending on the value
Display format			3 significant digits

Phase Overcurrent Protection

Characteristics of I> Set Point		Values
Tripping curve		● OFF: Set point off ● DT: Definite time (DT) ● SIT/A: IEC standard inverse time ● VIT/B: IEC very inverse time ● LTI/B: IEC long time inverse ● EIT/C: IEC extremely inverse time ● MI: IEEE moderately inverse ● VI: IEEE very inverse ● EI: IEEE extremely inverse ● RI
I> set point	DT curve	0.1...24 In (minimum: 1 A)
	IDMT curves	0.1...2.4 In (minimum: 1 A)
	Accuracy	+/- 5% or +/- 0.03 In
	Drop-out/pick-up ratio	95% +/- 3% or > (1-0.015 In/I>) x 100%
	Transient overshoot	< 10%
Time delay	DT curve	0.05...300 s in steps of: ● 0.01 s, from 0.05 to 9.99 s ● 0.1 s, from 10.0 to 99.9 s ● 1 s, from 100 to 300 s
	IEC, RI curves	TMS: 0.02...2 (step: 0.01)
	IEEE curves	TD: 0.5...15 (step: 0.1)
	Accuracy	● DT curve: +/- 2% or -15 ms / +25 ms ● IDMT curves: ± 5% or -15 ms / +25 ms in accordance with IEC 60255-3
	Reset time	Setting common to I> and Io> set points: ● OFF: Reset time off ● ON: Reset time on
Characteristic times	Instantaneous operating time (pick-up)	< 40 ms at 2 I> (typical value: 25 ms)
	Overshoot time	< 40 ms at 2 I>
	Reset time	< 50 ms at 2 I>

Characteristics of I>> Set Point		Values
Tripping curve		● OFF: Set point off ● DT: Definite time (DT)
I>> set point	DT curve	0.1...24 In (minimum: 1 A)
	Accuracy	+/- 5% or +/- 0.03 In
	Drop-out/pick-up ratio	95% +/- 3% or > (1-0.015 In/I>>) x 100%
	Transient overshoot	< 10%
Time delay	DT curve	Instantaneous (pick-up) or 0.05...300 s in steps of: ● 0.01 s, from 0.05 to 9.99 s ● 0.1 s, from 10.0 to 99.9 s ● 1 s, from 100 to 300 s
	Accuracy	+/- 2% or -15 ms / +25 ms
Characteristic times	Instantaneous operating time (pick-up)	● < 40 ms (typical value: 25 ms) if I>> set point greater than 0.7 In ● < 70 ms if I>> set point less than 0.7 In
	Overshoot time	< 40 ms at 2 I>>
	Reset time	< 50 ms at 2 I>>

Earth Fault Protection

Characteristics of Io> Set Point				Values
Tripping curve				● OFF: Set point off ● DT: Definite time (DT) ● SIT/A: IEC standard inverse time ● VIT/B: IEC very inverse time ● LTI/B: IEC long time inverse ● EIT/C: IEC extremely inverse time ● MI: IEEE moderately inverse ● VI: IEEE very inverse ● EI: IEEE extremely inverse ● RI
Io> set point	DT curve	Standard version		0.1...24 Ino (minimum: 1 A)
		Sensitive version		0.01...2.4 Ino (minimum: 0.1 A)
		Very sensitive version	0.2-24 A rating	0.0004...0.05 Ino (0.2...24 A)
			2-240 A rating	0.004...0.5 Ino (2.0...240 A)
	IDMT curves	Standard version		0.1...2.4 Ino (minimum: 1 A)
		Sensitive version		0.01...0.24 Ino (minimum: 0.1 A)
		Very sensitive version	0.2-24 A rating	0.0004...0.005 Ino (0.2...2.4 A)
			2-240 A rating	0.004...0.05 Ino (2.0...24 A)
	Accuracy	Standard version		+/- 5% or +/- 0.03 Ino
		Sensitive version		+/- 5% or +/- 0.003 Ino
		Very sensitive version	0.2-24 A rating	+/- 5% or +/- 0.00015 Ino (+/- 0.07 A)
			2-240 A rating	+/- 5% or +/- 0.0015 Ino (+/- 0.7 A)
	Drop-out/ pick-up ratio	Standard version		95% +/- 3% or > (1-0.015 Ino/Io>) x 100%
		Sensitive version		95% +/- 3% or > (1-0.0015 Ino/Io>) x 100%
		Very sensitive version		95% +/- 3%
	Transient overshoot			< 10%
Time delay	DT curve			0.05...300 s in steps of: ● 0.01 s, from 0.05 to 9.99 s ● 0.1 s, from 10.0 to 99.9 s ● 1 s, from 100 to 300 s
	IEC, RI curves			TMS: 0.02...2 (step: 0.01)
	IEEE curves			TD: 0.5...15 (step: 0.1)
	Accuracy			● DT curve: +/- 2% or -15 ms / +25 ms ● IDMT curves: +/- 5% or -15 ms / +25 ms in accordance with IEC 60255-3
	Reset time			Setting common to I> and Io> set points: ● OFF: Reset time off ● ON: Reset time on
Characteristic times	Instantaneous operating time (pick-up)			< 40 ms at 2 Io> (typical value: 25 ms)
	Overshoot time			< 40 ms at 2 Io>
	Reset time			< 50 ms at 2 Io>

Characteristics of Io>> Set Point				Values
Tripping curve				● OFF: Set point off ● DT: Definite time (DT)
Io>> set point	DT curve	Standard version		0.1...24 Ino (minimum: 1 A)
		Sensitive version		0.01...2.4 Ino (minimum: 0.1 A)
		Very sensitive version	0.2-24 A rating	0.0004...0.05 Ino (0.2...24 A)
			2-240 A rating	0.004...0.5 Ino (2.0...240 A)
	Accuracy	Standard version		+/- 5% or +/- 0.03 Ino
		Sensitive version		+/- 5% or +/- 0.003 Ino
		Very sensitive version	0.2-24 A rating	+/- 5% or +/- 0.00015 Ino (+/- 0.07 A)
			2-240 A rating	+/- 5% or +/- 0.0015 Ino (+/- 0.7 A)
	Drop-out/ pick-up ratio	Standard version		95% +/- 3% or > (1-0.015 Ino/Io>>) x 100%
		Sensitive version		95% +/- 3% or > (1-0.0015 Ino/Io>>) x 100%
		Very sensitive version		95% +/- 3%
	Transient overshoot			< 10%
Time delay	DT curve			Instantaneous (pick-up) or 0.05...300 s in steps of: ● 0.01 s, from 0.05 to 9.99 s ● 0.1 s, from 10.0 to 99.9 s ● 1 s, from 100 to 300 s
	Accuracy			+/- 2% or -15 ms / +25 ms
Characteristic times	Instantaneous operating time (pick-up)			● < 40 ms (typical value: 25 ms) if Io>> set point greater than 0.7 Ino ● < 70 ms if Io>> set point less than 0.7 Ino
	Overshoot time			< 40 ms at 2 Io>>
	Reset time			< 50 ms at 2 Io>>

Phase Overcurrent Cold Load Pick-up

Characteristics		Values
Activity		● OFF: Off ● I> I>>: Action on I> and I>> ● I>: Action on I> only ● I>>: Action on I>> only
Action on set points		● 150%: Set point x 1.5 ● 200%: Set point x 2 ● 300%: Set point x 3 ● 400%: Set point x 4 ● 500%: Set point x 5 ● BLOCK.: Set point blocked
Set point accuracy after CLPU I function action		Same as accuracy on I> and I>> set points
Time delay	Setting ranges	1...60 s in steps of 1 s
		1...60 min in steps of 1 min
	Accuracy	+/- 2% or +/- 20 ms

Earth Fault Cold Load Pick-up

Characteristics		Values
Activity		● OFF: Off ● Io> Io>>: Action on Io> and Io>> ● Io>: Action on Io> only ● Io>>: Action on Io>> only
Action on set points		● 150%: Set point x 1.5 ● 200%: Set point x 2 ● 300%: Set point x 3 ● 400%: Set point x 4 ● 500%: Set point x 5 ● BLOCK.: Set point blocked ● H2 RES.: Second harmonic restraint
Set point accuracy after CLPU Io function action		Same as accuracy on Io> and Io>> set points
Time delay	Setting ranges	1...60 s in steps of 1 s
		1...60 min in steps of 1 min
	Accuracy	+/- 2% or +/- 20 ms
Second harmonic restraint set point (fixed set point)		17% +/- 5%

Thermal Overload Protection

Characteristics			Values
Activity			● OFF: Protection off ● ON: Protection on
Set points	Alarm	Setting range	50...100% of the permissible thermal capacity used (tripping set point)
		Accuracy	+/- 5%
	Tripping	Setting range	0.1...2.4 In (minimum: 1 A)
		Accuracy	+/- 5%
Time constant		Setting range	1...120 min
		Resolution	1 min
Tripping time delay		Accuracy	+/- 2% or +/-2 s in accordance with IEC 60255-8

Technical Characteristics

General Characteristics

Characteristics		Values
Dimensions		180 x 140 x 90 mm/7.09 x 5.51 x 3.54 in
Weight	Sepam series 10 N	1.15 kg/2.5 lb
	Sepam series 10 B	1.28 kg/2.8 lb
	Sepam series 10 A	1.46 kg/3.2 lb
Type of battery	Sepam series 10 A	$^1/_2$ AA Li 3.6 V
Typical battery life		10 years
Maximum internal clock drift		+/- 10 min a year

Auxiliary Power Supply

The Sepam relay should be powered by DC or AC voltage. The supply voltage depends on the Sepam version:

Characteristics		DC values	AC values
Rated voltage	Sepam series 10 • ••A	24...125 V +/– 20%	100...120 V +/– 20%
	Sepam series 10 • ••E	110...250 V +/– 20%	100...240 V +/– 20%
	Sepam series 10 • ••F	220...250 V +/– 20%	–
Ripple content		< 15%	–
Frequency		–	47...63 Hz
Typical consumption (only watchdog relay active)		< 3 W	< 4.5 VA
Maximum consumption		< 8 W	< 13 VA
Inrush current		< 20 A for 100 µs	
Acceptable momentary outages (IEC 60255-11)		100%, 100 ms	

Current Inputs

Current inputs for current transformer (phase CT or earth CT)

Characteristics	Values
Input impedance	< 0.004 Ω
Consumption	< 0.004 VA at 1 A
	< 0.1 VA at 5 A
Continuous thermal withstand	4 In
Overload in accordance with IEC 60255-6	100 In at 1 s
	40 In at 3 s

Current inputs for CSH120, CSH200 or GO110 core balance CT

Characteristics	Values
Continuous thermal withstand at the primary	300 A
Overload in accordance with IEC 60255-6	20 kA at 1 s

Logic Inputs

Sepam series 10 A logic inputs are independent and volt-free.

Characteristics	Applicable to ...	DC values	AC values
Maximum voltage	series 10 A ••A	125 V + 20%	120 V + 20%
	series 10 A ••E	250 V + 20%	240 V + 20%
	series 10 A ••F	250 V + 20%	–
Frequency	series 10 A •••	–	47...63 Hz
Typical switching threshold	series 10 A ••A	14 V	12 V
	series 10 A ••E	82 V	58 V
	series 10 A ••F	154 V	–
State 1	series 10 A ••A	> 19 V	> 80 V
	series 10 A ••E	> 88 V	> 80 V
	series 10 A ••F	> 176 V	–
State 0	series 10 A ••A	< 6 V	< 8 V
	series 10 A ••E	< 75 V	< 22 V
	series 10 A ••F	< 137 V	–
Typical consumption	series 10 A •••	3 mA	

Output Relays

O1, O2, O3 control relays and O4 control relay on Sepam series 10 A

Characteristics		DC values	AC values
Maximum voltage		250 V + 20%	240 V + 20%
Frequency		–	47...63 Hz
Continuous current		5 A	
Breaking capacity (1)	Resistive load	5 A/24 V 4 A/48 V 0.7 A/127 V 0.3 A/220 V	5 A/100...240 V
	Load L/R < 40 ms	5 A/24 V 1 A/48 V 0.1 A/220 V	–
	Load p.f. > 0.3	–	5 A/100...240 V
Making capacity in accordance with ANSI C37.90, clause 6.7 (duration: 0.2 s)		30 A	

(1) Making capacities are indicated for use of either the normally open (NO) contact or the normally closed (NC) contact. There must not be any electrical link between the 2 contacts.

O5, O6, O7 annunciation relays on Sepam series 10 A

Characteristics		DC values	AC values
Maximum voltage		250 V + 20%	240 V + 20%
Frequency		–	47...63 Hz
Continuous current		2 A	
Breaking capacity	Load L/R < 20 ms	2 A/24 V 1 A/48 V 0.5 A/127 V 0.15 A/220 V	–
	Load p.f. > 0.3	–	1 A/100...240 V

Communication Port

Characteristics	Values
Type	2-wire RS 485
Line impedance	150 Ω

Environmental Characteristics

Electromagnetic Compatibility

Electromagnetic Compatibility		Standard	Level/ Class	Value
General		EN 50263	–	–
		IEC 60255-26	A	–
Emission	Radiated disturbances	CISPR 22	A	–
		EN 55022	–	–
		IEC 60255-25	–	–
	Conducted disturbances	CISPR 22	A	–
		EN 55022	–	–
		IEC 60255-25	–	–
Immunity tests	Radiated radiofrequency fields	IEC 61000-4-3	3	10 V/m; 80...1000 MHz
		IEC 60255-22-3	–	10 V/m; 80...1000 MHz; 1.4 ...2.7 GHz
		ANSI C37.900.2	–	20 V/m; 80...1000 MHz
	Electrostatic discharge	IEC 61000-4-2 IEC 60255-22-2	3	8 kV air; 6 kV contact
		ANSI C37.900.3	–	
	Magnetic fields at power frequencies	IEC 61000-4-8	4	30 A/m continuous, 300 A/m for 1 to 3 s
	Conducted radiofrequency disturbances	IEC 61000-4-6	3	10 V MC; 0.15...80 MHz
		IEC 60255-22-6	–	
	Electrical fast transients/ burst	IEC 61000-4-4 IEC 60255-22-4	4	4 kV; 5 kHz
		ANSI C37.90.1	–	4 kV MC and MD; 5 kHz
	Slow damped oscillating wave	IEC 61000-4-18	3	2.5 kV MC, 1 kV MD; 100 kHz and 1 MHz
		IEC 60255-22-1	–	
		ANSI C37.90.1	–	2.5 kV MC and MD
	Surges	IEC 61000-4-5	3	2 kV MC, 1 kV MD; 1.2/50 μs and 10/700 μs
		IEC 60255-22-5	–	
	Logic inputs at power frequencies	IEC 61000-4-16	4	300 V MC, 150 V MD
		IEC 60255-22-7	–	

Mechanical Robustness

Mechanical Robustness		Standard	Level/ Class	Value
Energized	Vibration response	IEC 60255-21-1	2	1 Gn; 10...150 Hz; 1 cycle
	Shock response	IEC 60255-21-2	2	10 Gn for 11 ms, when using normally open (NO) contacts
	Seismic response	IEC 60255-21-3	2	2 Gn horizontal, 1 Gn vertical
De-energized	Vibration withstand	IEC 60255-21-1	2	2 Gn; 10...150 Hz; 20 cycles
	Shock withstand	IEC 60255-21-2	2	30 Gn for 11 ms
	Jolt withstand	IEC 60255-21-2	2	20 Gn for 16 ms
Enclosure protection	Tightness	IEC 60529		Front panel: IP54 Other parts: IP40
		NEMA	Type 12	–
	Shocks on front panel	IEC 62262		IK7; 2 J

Climatic Withstand

Climatic Withstand		Standard	Level/ Class	Value
During operation	Exposure to cold	IEC 60068-2-1	Ad	–40°C (–40°F); 96 hrs
	Exposure to dry heat	IEC 60068-2-2	Bd	+70°C (+158°F); 96 hrs
	Exposure to damp heat	IEC 60068-2-78	Cab	93% RH; 40°C (104°F); 56 days
	Temperature variation	IEC 60068-2-14	Nb	5°C/min at –40...+70°C (–40...+158°F)
Stored in its original packaging	Exposure to cold	IEC 60068-2-1	Ab	–40°C (–40°F); 96 hrs
	Exposure to dry heat	IEC 60068-2-2	Bd	+70°C (+158°F); 96 hrs
	Exposure to damp heat	IEC 60068-2-78	Cab	93% RH; 40°C (104°F); 56 days
	Temperature variation	IEC 60068-2-14	–	5°C/min at –40...+70°C (–40...+158°F)
Corrosive atmosphere	Salt mist	IEC 60068-2-52	Kb/2	3 cycles
	2-gas test	IEC 60068-2-60	Ke	Method 1; 0.5 ppm H_2S, 1 ppm SO_2

Safety

Safety	Standard	Value
General	IEC 60255-27	–
Power frequency dielectric withstand	IEC 60255-27 IEC 60255-5	2 kV for 1 min: logic inputs and output relays, 2 kV power supply for 1 min: RS 485 port rated insulation voltage: 300 V
	ANSI C37.90	1.5 kV between control output relay contacts for 1 min
Surge	IEC 60255-27	Wavelength: 1.2/50 µs; 5 kV: logic inputs and relay outputs, power supply; 3 kV: RS485 port
	IEC 60255-5	
Insulation resistance	IEC 60255-27	500 V in common and differential mode R > 100 MΩ (A); R > 10 MΩ (B)
Fire withstand	IEC 60695-2-11	650°C (1200°F)

Power Supply

Power Supply	Standard	Value
Acceptable ripple content (AC component)	IEC 61000-4-17	15%; 100...120 Hz, criterion A
	IEC 60255-11	
Voltage interruption	IEC 61000-4-11	100 ms; 0%; 3 energized output relays, criterion A
	IEC 61000-4-29	
	IEC 60255-11	
Polarity reversal	IEC 60255-11	–

Certification

Certification	Standard	Reference document

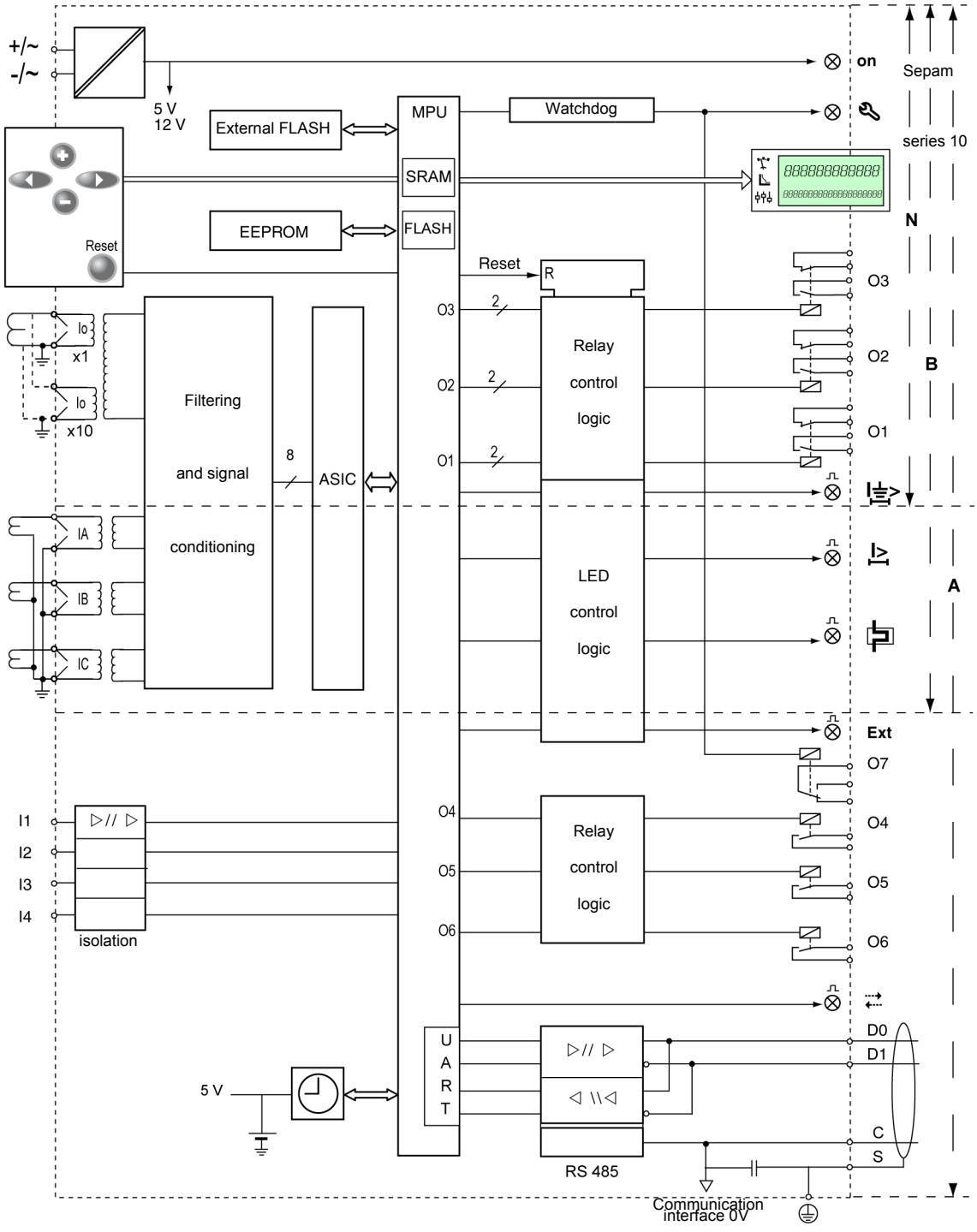
CE	Harmonized standard: EN 50263	Directives and amendments:
		● 89/336/EEC EMC directive
		  ● 92/31/EEC Amendment
		  ● 93/68/EEC Amendment
		● 73/23/EEC Low Voltage Directive
		  ● 93/68/EEC Amendment

UL c UL us	–	Available on request
CSA	–	Available on request

Internal Operation

Block Diagram

Sepam is a multifunctional digital protection relay with an auxiliary power supply.



Electronic Components

The control electronics consists of the following items:
- An ASIC component, responsible mainly for acquisition and analog/digital conversion of the current inputs
- A microprocessor, responsible for all processing operations:
  - Protection, metering, control and monitoring
  - Alarm and annunciation
  - Communication
  - Management of the user-machine interface
  - Self-tests
- An SRAM memory, integrated in the microprocessor, that contains all the Sepam working data. This data is not saved if the auxiliary power supply fails.
- A Flash memory, containing the processing program
- A standard EEPROM memory, that mainly contains the user's parameters and settings, as well as the fault log.
  These values are saved if the auxiliary power supply fails.

A watchdog function is activated regularly by the microprocessor. In the event of failure:
- It lights up the LED.
- It changes the state of the watchdog relay (O7 for Sepam series 10 A).

Current Inputs

Each current input has an interposing ring CT, consisting of a primary winding and a secondary winding.

This CT provides:
- The interface between the current sensor and the electronics
- Electrical isolation

Remark: The earth current input interposing ring CT on Sepam series 10 • 3•• has 2 primary windings corresponding to 2 measurement ratings x1 and x10.

The electronic circuit linked to the interposing ring CT secondary is responsible for:
- Operation on 1 A/5 A ratings
- Low-pass filtering that allows harmonics up to the 13th order to pass through
- Adaptation of the CT signal for processing by an analog to digital converter (ASIC)

Remark: Digital filtering picks up the earth current inputs at the third harmonic.

Power Supply

There are:
- Sepam versions powered by 24-125 V DC or 100-120 V AC supply
- Sepam versions powered by 110-250 V DC or 100-240 V AC supply

For Sepam series 10 A, there are also versions powered by 220-250 V DC supply that allow high-set logic inputs.

The converter is responsible for:
- Electrical isolation
- Supplying the voltage levels required by the electronic circuits

Logic Inputs

The logic input electrical characteristics depend on the supply voltage range accepted by the Sepam series 10 A version used (refer to *Logic Inputs, p. 252*).

To avoid adverse effects on Sepam's reliability, the switching thresholds can only be modified by a manual operation.

The logic inputs provide the following functions:
- Electrical isolation
- Protection against polarity reversals

Signal adaptation according to the AC or DC voltages applied is performed by the software. The logic input functions are predefined (standard mode), but can be modified via the UMI in custom mode.

Output Relays

Both the tripping relays and the watchdog relay have normally open (NO) or normally closed (NC) contacts. Hence, the user can prioritize either safety or availability of the installation. Refer to *Circuit breaker control and reliability, p. 161*.

The annunciation relays only have a normally open (NO) contact.

For improved safety, two microprocessor commands, both independent of one another, must be given to change the state of the tripping relays.

In the event of failure of the microprocessor, the watchdog function causes the watchdog relay to change state. The watchdog relay can thus be used to monitor the microprocessor operation.

Display

The segmented display consists of 2 lines of characters (1 line of 12 characters, 1 line of 20 characters).

Its robust technology can withstand several years of operation in a harsh environment (–40 °C to +70 °C or –40 °F to +158 °F).

The display is managed directly by the microprocessor.

It is back-lit, and bright enough to ensure that it can easily be read in poorly lit environments. To maximize the life of the Sepam relay, the display backlighting is automatically switched off when the keypad has not been used for 10 minutes.

Communication

The microprocessor processes frames for the protocols supported by Sepam series 10 A.

The communication interface conforms to the TIA/EIA RS 485 standard.

For improved electromagnetic compatibility, the common (C) and shielding (S) reference voltages are kept separate.

Internal Clock and Battery

Sepam series 10 A relays have a real-time clock. This manages the time (date, hour, second and ms). In the event of failure of the auxiliary power supply, it is powered by a battery so that it keeps the correct time.

The battery life is more than 10 years in normal use. Absence or failure of the battery has no effect on the Sepam protection functions.

Electrical Isolation

The user is permanently protected from hazardous voltages, both on the front panel and on the communication port. This is achieved with a double isolation barrier between the hazardous live voltages and the accessible parts.

The inputs and outputs are isolated from one another by single isolation.

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