Protection
and control

Sepam range

Sepam 1000

Substations

Busbars

Transformers

Motors

GROUPE SCHNEIDER

■ Merlin Gerin ■ Modicon ■ Square D ■ Telemecanique

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Sepam 1000 is a range of protection and measurement units designed for the protection and operation of 50 and 60 Hz machines and electrical distribution networks.

Applications

The **Sepam 1000** range includes different types of units, each of which corresponds to an application:
- **Sepam 1000 S01**: substation (incomers and feeders) protection,
- **Sepam 1000 T01**: transformer protection,
- **Sepam 1000 M01** and **Sepam 1000 M02**: motor protection,
- **Sepam 1000 B05** and **Sepam 1000 B06**: which comprise voltage measurement and protection functions for busbars.

Advantages

- very wide setting ranges,
- broad variety of curves,
- parameter setting of output contact latching (ANSI 86),
- all connections, including current circuits, are disconnectable on load.

Clear information
- fault indication,
- indication of the faulty phase by reading and storage of tripping currents in each phase,
- real primary value display of variables (A, kA, V, kV),
- instant indication whenever a setpoint is exceeded.

wide choice of sensors
- measurement of phase current:
  - with 1, 2 or 3 1 A or 5 A current transformers (selection by microswitch),
  - with 1, 2 or 3 special CSP Rogowski coil current sensors (no magnetic core), which offer the advantage of a wide dynamic range and outstanding linearity,
- residual current measurement:
  - without any additional sensors, by vectorial summation of phase currents,
  - by a special CHS core balance CT,
  - by a 1 A or 5 A core balance CT.

Parameterizable program logic
Each protection may be channeled by setting the parameters of a specific output relay on the optional ES1 board (1 input + 3 outputs).

Logic discrimination
Sepam utilizes logic discrimination, which ensures fast, discriminating overcurrent protection tripping.

Safe operation
- high degree of operational availability due to self-monitoring functions. Continuous monitoring of:
  - the analog/digital conversion channel,
  - the microprocessor,
  - all the memories,
  - the internal supply voltage,
  - the integrity of settings,
  - the software cycle.
- fail-safe position when failures are detected:
  - output contact controls and tripping signals are prohibited,
  - an internal fault signal appears on the front of the device,
  - the watchdog contact is disabled.
- a high level of immunity to electromagnetic disturbances:
Sepam is designed to operate safely in highly disturbed electromagnetic environments such as HV substations.

Sepam

The front of **Sepam 1000** includes:
■ a 7-key keyboard, used to:
□ call up of display of the different variables,
□ set or modify parameters;
■ a 16-character alphanumeric display,
for readout of:
□ measurements,
□ settings,
□ messages;
■ 3 indicator lights giving Sepam status:
□ **on** indicator: device on,
□ 🔧 indicator: device unavailable (initialization or internal failure),
□ **trip** indicator: tripping order.

The back of **Sepam 1000** includes:
■ input/output connections,
■ **P** key for access to parameter setting mode,
■ microswitches for input parameter setting.

Keyboard

keys	functions
meter	measurement display
status	display of characteristic general installation parameters
relay	display of protection parameters
data - (1) **data +** (1)	choice of settings
enter (1)	confirmation of settings
reset	output relay and annunciation acknowledgment, zero reset of peak demand and running hours counter

(1) Keys operational in parameter setting mode only.
Access to the parameter setting mode via the keyboard on the front of the device is protected. Only the **P** key, located on the back of Sepam, may be used to put Sepam into the parameter setting mode.

Selection table

Sepam 1000

functions	ANSI code		Sepam types					
			substations	transformers	motors		busbars	
			S01	**T01**	**M01**	**M02**	**B05**	**B06**
protection								
phase overcurrent	50/51	low set [1]	1	1				
		high set [2]	1	1	1	1		
earth fault	50N/51N	low set [1]	1	1				
		high set [2]	1	1	1	1		
thermal overload	49			1	1	1		
negative sequence / unbalance	46				1	1		
locked rotor / excessive starting time	48/51LR					1		
starts per hour	66					1		
phase undercurrent	37					1		
phase-to-phase overvoltage	59						2	1
positive sequence undervoltage	27D						2	
remanent undervoltage	27R						1	
phase-to-phase undervoltage	27						2	1
neutral voltage displacement	59N/64							2
overfrequency	81							1
underfrequency	81							2
metering								
phase current (I1, I2, I3)			■	■	■	■		
peak demand phase current (I1, I2, I3)			■	■	■	■		
tripping current (I1, I2, I3, Io)			■	■	■	■		
running hours counter				■	■	■		
thermal capacity used				■	■	■		
unbalance ratio / unbalance current					■	■		
start inhibit time delay / number of starts before inhibition						■		
voltages (U12, U23, U13)							■	■
positive sequence voltage							■	
frequency								■
control and monitoring								
watchdog			■	■	■	■	■	■
positive contact indication (parameterizable)			■	■	■	■	■	■
logic discrimination [3]			■	■	■	■		
5 adressable logic outputs [3]			■	■	■	■	■	■
Sepam models								
S05			LX	LX	LX	LX	TX	TX

Please note: The figures in the columns represent the number of similar protection devices.
For example, for phase overcurrent protection, "2" means : 2 separate overcurrent protection devices.
[1] Definite time or IDMT.
[2] Definite time.
[3] With optional ES1 board which includes 3 output relays and 1 input.

Metering

Presentation

Sepam 1000 provides the measurements required for operation.

The values are displayed directly, together with the related units: A, V …

Currents
Measurement of the circuit's 3 phase currents.

Peak demand currents
Measurement of the greatest average current value of the 3 phases. The peak demand currents give the current consumed at the time of peak loads.
The average is calculated over a 5-minutes period.
The **reset** key is used to reset the peak demand currents to zero when they are on the display unit.

Tripping current
Storage of the 3 phase currents and residual current at the time Sepam gave the last tripping order, in order to find the fault current (fault analysis).

The values are stored until the next tripping order is given.

Thermal capacity used
Measurement of the relative thermal capacity used by the load. It is displayed as a percentage of the nominal thermal capacity.

Unbalance ratio / unbalance current
Calculation of negative sequence current based on I1 and I3, considering residual current to be zero.
The value is displayed as a percentage of the basis current Ib.

Start inhibit time delay / number of starts before inhibition
Indicates :
■ the number of starts authorized before inhibition of starting, if the **starts per hour** protection has not yet tripped,
■ the remaining time during which starting is inhibited if the **starts per hour** protection has tripped.

Running hours counter
Cumulative total of the time during which the protected device (motor or transformer) has been running.
The cumulative value (0 to 99999h) is saved every 24h.
The **reset** key is used for zero resetting in the parameter setting mode.

Voltages
Measurement of phase-to-phase voltages U12, U32 and calculation of U13.
Calculation of positive sequence voltage.

Frequency
Measurement of frequency.

Characteristics

functions		range	accuracy [1]
ammeters		0.05 to 24 In [2]	±5% or ±0.03 In
peak demand currents		0.05 à 24 In [2]	±5% or ±0.03 In
tripping currents	phase	0.05 to 24 In [2]	±5% or ±0.03 In
	earth	0.02 to 10 Ino [3]	±5% or ±0.02 Ino or ±0.1 A
thermal capacity used		0 to 200% [4]	
unbalance ratio (unbalance current)		10 to 500% Ib [5]	±5% or ±0.02 In
running hours counter		0 to 99999h	±1% or ±0.5 h
voltmeter (ph.-to-ph. voltages)		0.015 to 1.5 Unp [6]	±3% or ±0.005 Un
voltmeter (positive seq. voltage)		0.025 to 1.5 Vnp [7] ($Un/\sqrt{3}$)	±5% or ±0.005 Un
frequency meter		50 Hz ±5 Hz 60 Hz ±5 Hz	±0.05 Hz

(1) Under reference conditions (IEC 60255-4).
(2) In: CT primary rated current or CSP sensor input rating.
(3) Ino: CSH core balance CT input rating or core balance CT primary rated current.
(4) 100% is the thermal capacity of the equipment being protected under its rated load: I = Ib.
(5) Ib: basis current of the equipment being protected.
(6) Unp: primary rated phase-to-phase voltage.
(7) Vnp: primary phase-to-neutral voltage, $Vnp = (Unp/\sqrt{3})$

Protection

Phase overcurrent (ANSI 50/51)
Three-phase equipment protection against overloads and short circuits between phases.

Substation and transformer applications:
The protection comprises two units:
- definite time or IDMT low set unit,
- instantaneous or time-delayed, definite time high set unit.

Different IDMT protection curves: standard inverse time, very inverse time, extremely inverse time, ultra inverse time and RI curve.

The wide time delay setting range even allows for the use of the long time inverse (LTI) curve.

Motor application:

The protection is limited to the definite time high set unit.
Recommations:
- set higher than starting current,
- instantaneous operation if the equipment is controlled by a circuit breaker or switch only,
- time-delayed operation if the equipment is controlled by a combined fuse-switch so that the fuse will act before the switch for fault currents that are greater than the swich's breaking capacity.

Earth fault (ANSI 50/51N or 50/51G)
Connection and equipment earth fault protection.
Earth faults may be detected by:
- current transformers on the three phases,
- a current transformer (1 A or 5 A), combined with a CSH30 interposing ring CT,
- a special core balance CT, CSH120 or CSH200 according to the required diameter; this method is the most accurate one. The two available ratings (2 A and 30 A) provide a very wide setting range.

Transformer and substation applications:
The protection comprises two units:
- definite time or IDMT low set unit,
- instantaneous or time-delayed, definite time high set unit.

The characteristic curves are the same as those for three-phase overcurrent protection.
Motor application:
The protection has a definite time high setting.
Recommendations:
- connection to special CSH core balance CT for greater sensitivity,
- definite time operation.

Thermal overload (ANSI 49)
Protection of equipment against thermal damage caused by overloads.
Thermal overload is calculated according to a mathematical model, which is adapted to suit each application.
The function comprises:
- an adjustable trip setting,
- adjustable starting authorization setting,
- fixed alarm setting.

Transformer application:
The model takes into account the transformer heating time constant.

Motor application:
The model uses two time constants: the heating time constant, used when the motor is running, and the cooling time constant, used when the motor is stopped. The model also takes into account the effect of negative sequence current on rotor heating.

Negative sequence / unbalance (ANSI 46)
Protection of eqipment against overheating caused by an unbalanced power supply,phase inversion or phase break, and against low levels of overcurrent between phases. Definite time characteristics.

Locked rotor / excessive starting time (ANSI 48/51LR)
Protection of motors that are liable to start with overloads or insufficient supply voltage and/or that drive loads that are liable to jam (e.g. crusher).

The **locked rotor** function is a form of overcurrent protection that is only confirmed after a time delay that corresponds to the normal starting time.
Recommendations:
- short time operation.

Starts per hour (ANSI 66)
Protection against overheating caused by too frequent starts.
Checking of:
- the number of starts per hour,
- the number of consecutive starts.

The protection inhibits motor energizing for a preset time period when the permissible limits have been reached.

Undercurrent (ANSI 37)
Protection of pumps against the consequences of priming loss.
The protection detects a time-delayed current drop which corresponds to motor no-load operation, characteristics of the loss of pump priming.

Overvoltage (ANSI 59)
Protection against abnormally high voltage, checking that there is sufficient voltage for power supply changeover (setting 1), checking of phase-to-phase voltages U32 and U21 (setting 2).

Positive sequence undervoltage (ANSI 27D)
Motor protection against malfunctioning due to insufficient or unbalanced supply voltage. In order for this protection to be used, voltage transformers must connected to Sepam to measure U21 et U32.

Remanent undervoltage (ANSI 27R)
Monitoring of the clearing of voltage sustained by rotating machines after circuit opening. The protection is used to prevent transient electrical and mechanical phenomena that are caused by fast re-energizing of motors.
It monitors phase-to-phase voltage U21.

Phase-to-phase undervoltage (ANSI 27)
Protection used either for automated functions (changeover, load shedding) or to protect motors aganst undervoltage. The protection monitors the drop in each of the phase-to-phase voltages being measured.

Neutral voltage displacement (ANSI 59N)
Detection of insulation faults in ungrounded systems by measurement of neutral voltage displacement. The protection is generally used with transformer incomers or busbars.

Overfrequency (ANSI 81)
Protection against abnormally high frequency.

Underfrequency (ANSI 81)
Detection of variances with respect to the rated frequency, in order to maintain high quality power supply. The protection may be used for overall tripping or for load shedding.

Current sensor sizing

The current sensors must be such that they will not be saturated by the current values that they are required to measure with accuracy:
■ for definite time protection (DT): setting current,
■ for IDMT protection: the working area of the curve.
In all cases, saturation current should be greater than 5In or 5Ino.
For further information, please refer to the "medium voltage protection guide" (CG0021X).

Available nominal current settings:
■ phase current:

In
A : 10 - 15 - 20 - 25 - 30 - 35 - 36 - 40 - 45 - 50 - 60 - 70 - 75 - 80 - 90 - 100 - 120 - 125 - 150 - 160 - 175 - 180 - 192 - 200 - 225 - 240 - 250 - 300 - 320 - 350 - 400 - 450 - 480 - 500 - 600 - 625 - 640 - 700 - 750 - 800 - 900 - 960
kA : 1 - 1.2 - 1,25 - 1,4 - 1,5 - 1,6 - 2 - 2,5 - 3 - 3,5 - 3,75 - 4 - 5 - 6 - 6,25

■ residual current:

Ino Tor 2A Tor 30A 3I
A : 1 - 2 - 3 - 4 - 5 - 6 - 10 - 15 - 20 - 25 - 30 - 35 - 36 - 40 - 45 - 50 - 60 - 70 - 75 - 80 - 90 - 100 - 120 - 125 - 150 - 160 - 175 - 180 - 192 - 200 - 225 - 240 - 250 - 300 - 320 - 350 - 400 - 450 - 480 - 500 - 600 - 625 - 640 - 700 - 750 - 800 - 900 - 960
kA : 1 - 1,2 - 1,25 - 1,4 - 1,5 - 1,6 - 2 - 2.5 - 3 - 3,5 - 3,75 - 4 - 5 - 6 - 6,25

Protection (cont'd)

Setting ranges

functions	settings		time delay
phase overcurrent			
definite time DT, low set	0.3 to 8 In		0.1 to 90 s
inverse time, low set	0.3 to 2.4 In		0.1 to 12.5 s at 10 Is
definite time DT, high set	1 to 24 In		25 ms at 2 s
earth fault		**type of sensors**	
definite time DT low set	0.05 to 2 In 0.1 to 4 A 1.5 to 60 A 0.05 to 2 Ino	Σ3Iph CSH, 2 A rating CSH, 30 A rating 1 A or 5 A CT	0.1 to 90 s
definite time DT high set	0.05 to 10 In 0.1 to 20 A 1.5 to 300 A 0.05 to 10 Ino	Σ3Iph CSH, 2 A rating CSH, 30 A rating 1 A or 5 A CT	25 ms to 2 s
inverse time low set	0.05 to 1 In 0.1 to 2 A 1.5 to 30 A 0.05 to 1 Ino	Σ3Iph CSH, 2 A rating CSH, 30 A rating 1 A or 5 A CT	0.1 to 12.5 s at 10 Iso
thermal overload			
	negative sequence factor : 0 (transformers); 4.5 (motors)		
	time constants	heating up	T1 : 5 to 200 min.
		cooling down	T2 : 5 to 600 min.
	alarm : 0.9 tripping setting		
	50% to 200% of nominal thermal capacity		
	starting authorization: 50% to 200% of nominal thermal capacity		
negative sequence overcurrent			
	0.2 to 0.5 Ib		
locked rotor / excessive starting time			
	1.5 Ib	start time delay ST locked rotor time delay LT	1 to 300 s 1 to 60 s
starts per hour			
	1 to 60 per hour 1 to 60 consecutive		
undercurrent			
	0.2 to 1 Ib		1 to 10 s
phase-to-phase overvoltage			
	5% to 150% of Unp		0.1 to 90 s
positive sequence undervoltage			
	30% to 100% of Vnp (Vnp = Unp/$\sqrt{3}$)		0.1 to 90 s
remanent undervoltage			
	5% to 100% of Unp		0,1 s fixe
phase-to-phase undervoltage			
	5% to 100% of Unp		0.1 to 90 s
neutral voltage displacement			
	5% to 80% of Unp		0.1 to 90 s
overfrequency			
	50 to 53 Hz or 60 to 63 Hz		0.1 to 90 s
underfrequency			
setting 1 setting 2	48 to 50 Hz or 58 to 60 Hz 45 to 48 Hz or 55 to 58 Hz		0.1 to 90 s

Reminder: In current, Unp rated voltage and Ino current are general parameters that are set at the time of Sepam commissioning.
In is the current sensor rated current (CT rating). **Unp** is the phase-to-phase voltage of the voltage sensor primary windings.
Ino is the core balance CT current rating, **Ib** is the current which corresponds to the motor power rating, adjustable from 0.4 to 1.3 In.

Output relay addressing
The parameters of protection output addressing on the output relays are set using the keyboard. However, each type of Sepam has default addressing which may be used for easy commissioning in most cases of standard use.

Program logic
Sepam is used to control breaking devices fitted with different types of closing and tripping coils:
■ circuit breakers with shunt or undervoltage trip unit,
■ latching contactors with shunt trip unit,
■ contactors controlled by impulse or latched orders.
The program logic parameters for each output releay (standard or with positive contact indication) may be set using the keyboard. By default, the logic is adapted to control of a circuit breaker with a shunt trip unit.

Latching / acknowledgment (ANSI 86)
Output relay latching parameters are set using the keyboard. Latching tripping orders are stored and acknowledgment is required in order to put the device back into service. The user may acknowledge using the keyboard or remotely via the logic input.

Inhibit closing (ANSI 69)
Sepam inhibits closing of the circuit breaker or contactor according to operating conditions. This function is implemented by appropriate wiring of the trip unit.

Logic discrimination (ANSI 68)
This function enables quick, discriminating tripping of the phase overcurrent and earth fault protection relays, whether definite time (DT) or IMDT.
The downstream relay transmits a blocking input signal (**START→**) if the protection settings are exceeded. The upstream relay's logic input (in blocking function) receives the blocking input signal.

Remote tripping
Circuit breakers and contactors may be remote controled via the logic input.

Annunciation (ANSI 30)
Sepam keeps the user informed by the display of messages.
There are two types of messages.
■ alarm messages (steady display),
■ tripping messages (blinking display), the trip indicator on the front of the device indicates circuit breaker tripping by a protection.

Watchdog
Indicates Sepam unavailablity.
The address parameters for this function may set on any output relay (AUX1 by default).

Output relay test
The test function may be used to activate the output relays.

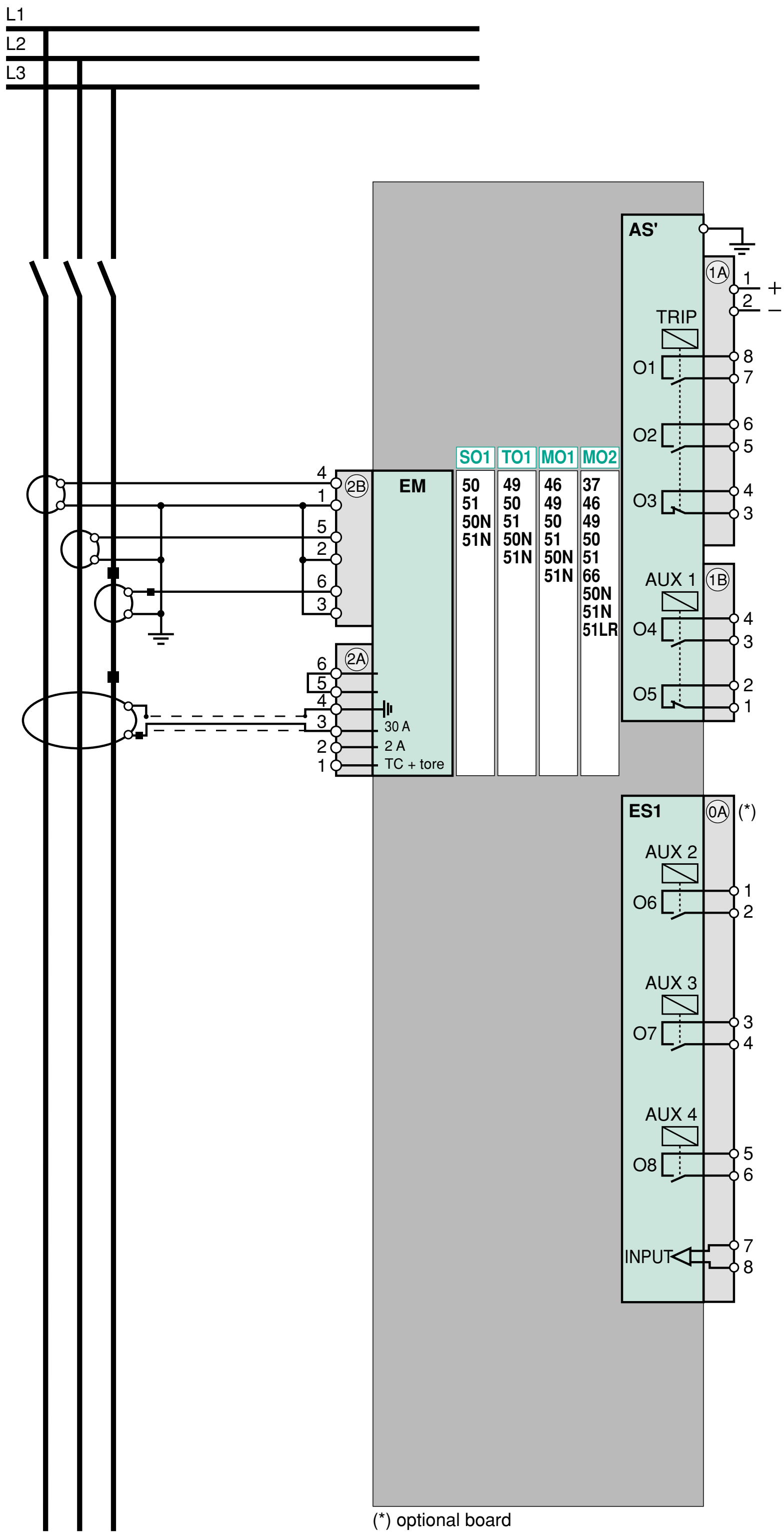
List of the different messages

functions	messages	alarm steady	tripping blinking
phase overcurrent	PHASE FAULT	■	■
earth fault	Io FAULT	■	■
thermal overload	THERMAL TRIP THERMAL ALARM	 ■	■
negative sequence unbalance	UNBALANCE	■	
locked rotor /	LOCKED ROTOR/		■
excessive starting time	LONG START		■
starts per hour	START INHIBIT.	■	
undercurrent	UNDERCURRENT	■	■
overvoltage (1)	OVERVOLTAGE	■	■
undervoltage	UNDERVOLTAGE	■	■
positive seq. undervoltage	UNDERVOLTAGE	■	■
remanent undervoltage (2)			
neutral voltage displacement	Vo FAULT	■	■
overfrequency	OVER FREQ.	■	■
underfrequency	UNDER FREQ.	■	■

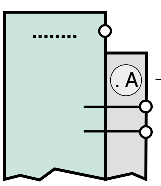
(1) No message associated with setting 1.
(2) No associcated messages or signals.

Functional and connection schemes

SO1, TO1, MO1, MO2, types



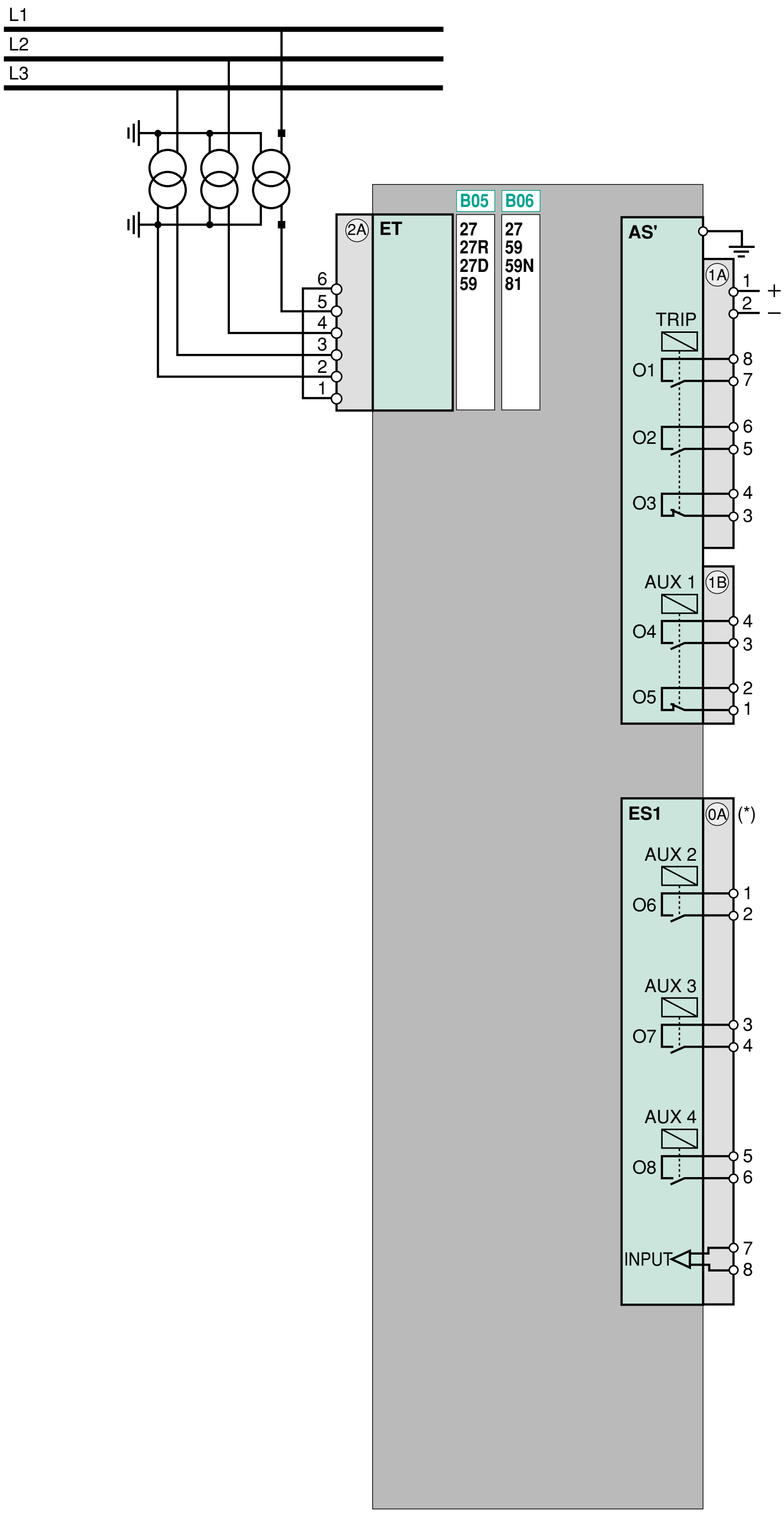
(*) optional board



Sepam 1000 terminal number

Nota :
For other connection
refer to "other connection schemes".

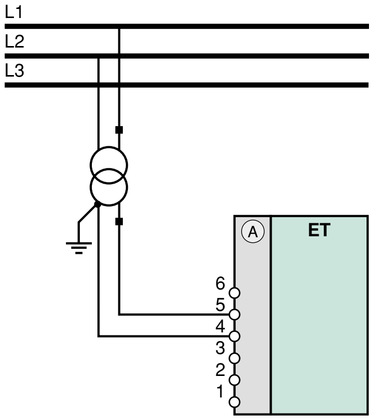
BO5, BO6, types



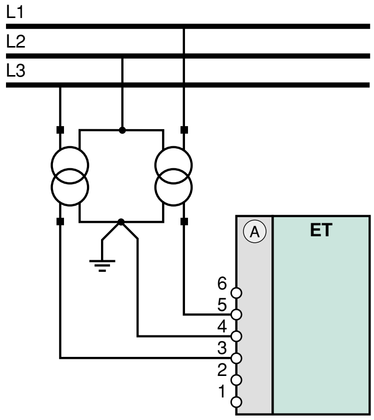
(*) optional board

Other connection schemes

Phase voltage

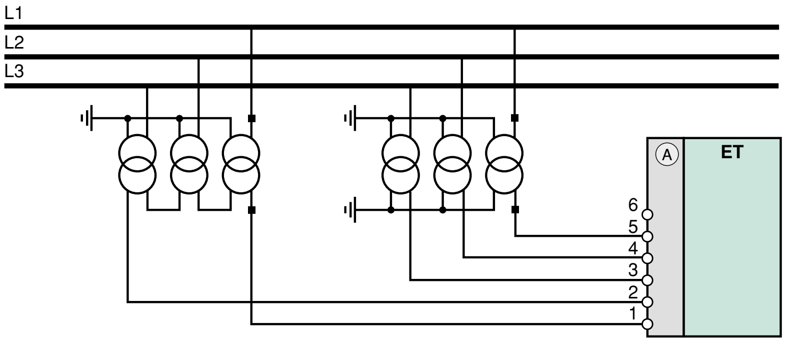


Connection of a voltage transformer (does not allow use of positive sequence overvoltage protection, neutral voltage displacement protection, or measurement).



Connection of 2 voltage transformers in V arrangement (does not allow use of neutral voltage displacement protection or residual voltage measurement.

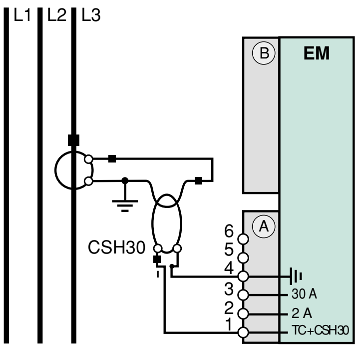
Phase and residual voltage

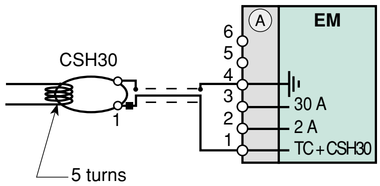


Broken delta connection of voltage transformers for residual voltage measurement.

Residual current

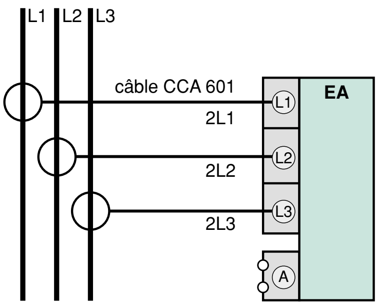
(recommended wiring)



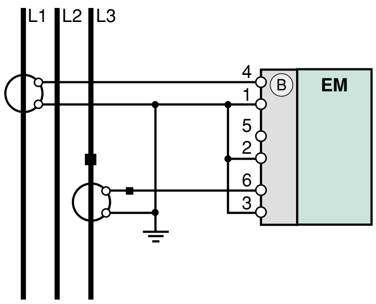


For connection of **1 A** transformers make 5 turns at the CSH30 primary

Phase current



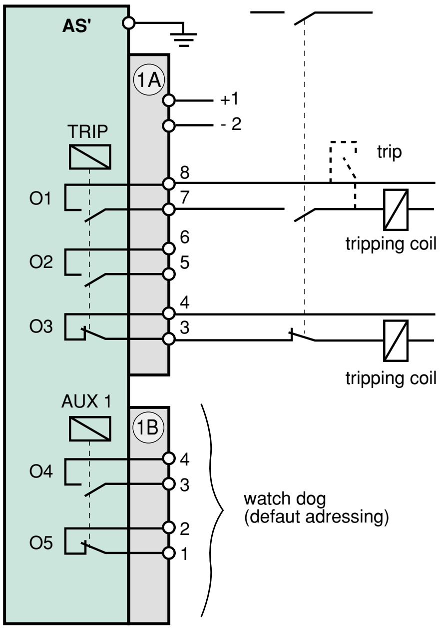
Connection of special CSP sensors.



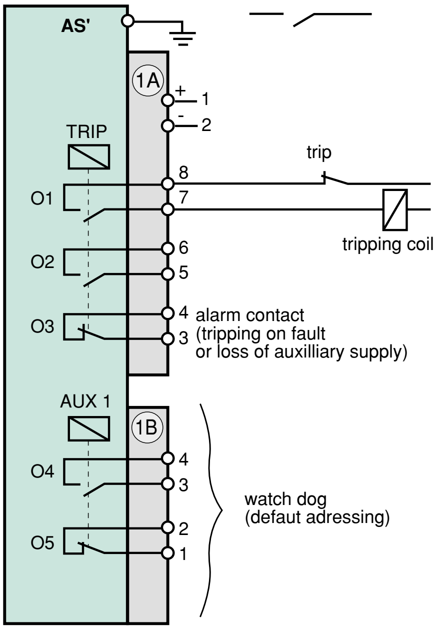
Connection of 2 current transformers.

▮ Correspondance between primary and secondary connection (i.e.: P1, S1).

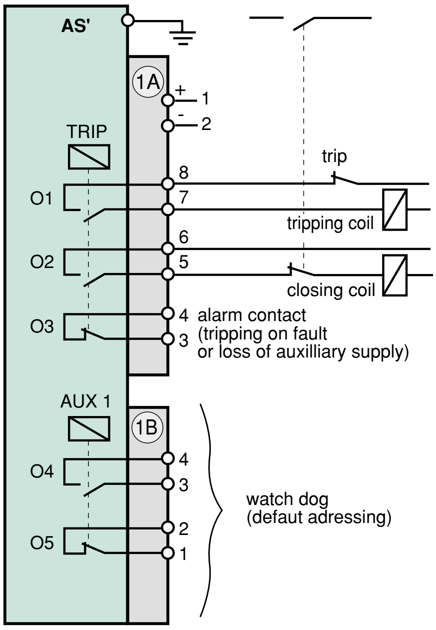
Logic input and output boards



Circuit breaker or latching contactor breaking by a shut trip unit.



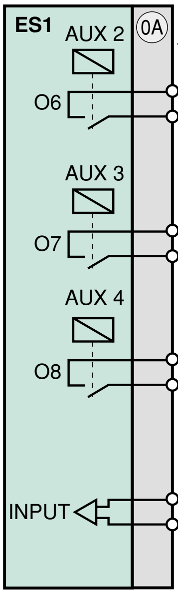
Tripping by the undervoltage coil of a contactor controlled by impulse or latched orders (TRIP relay set up for **positive contact indication**).



Circuit breaker tripping by an undervoltage release, (TRIP relay set up for **positive contact indication**).

ES1 board (optional)

Connected data
(default addressing parameter settings)



terminal	Sepam type SO1 TO1 MO1 MO2	BO5	BO6
1 2	blocking output **START→**	sufficient voltage **U>→**	neutral voltage desplacement tripping set point 2 **Vo>>→**
3 4	phase overcurrent tripping **I>→,I>>→**	undervoltage tripping set point 2 **U<<→,Vd<<→**	under frequency tripping set point 1 **F<→**
5 6	earth fault tripping **Io>→,Io>>→**	no remanent voltage **Ur<→**	
7 8	status readout function		

N.B. The inputs are potential-free and require an external suppy source.

Metering and protection functions

Phase current

Operation
This function gives the phase current RMS values:
■ I1: phase 1 current,
■ I2: phase 2 current,
■ I3: phase 3 current.

Readout
The measurements may be accessed via the dipslay unit by pressing the **meter** key.

Characteristics

measurement range	0.05 to 24 In [1]
unit	A or kA
accuracy [2]	±5% or ±0.03 In
refresh interval	< 2 s

[1] In rated current set in the **status** menu,***Device*** page.
[2] at In, under reference conditions (IEC 60255.6)

Maximum current demand

Operation
This function gives the greatest average RMS current value for each phase that has been obtained since the last reset.
The average is refreshed after each integration interval.
■ IM1 phase 1 current,
■ IM2 phase 2 current,
■ IM3 phase 3 current.

Readout
The measurements may be accessed via the display unit by pressing the **meter** key.
They may be reset to zero by pressing the **reset** key while the maximum current demand is displayed.

Characteristics

measurement range	0.05 to 24 In [1]
unit	A or kA
accuracy	±5% or ±0.03 In
refresh interval	5 min.

[1] In rated current set in the **status** menu, ***Device*** page.

Tripping currents

Operation
This function gives the RMS values of currents at the prospective tripping time (maximum RMS value measured during the 30 ms interval following the last tripping order):
■ TRIP1: phase 1 current,
■ TRIP2: phase 2 current,
■ TRIP3: phase 3 current,
■ TRIP0: residual current.

Readout
The measurements may be accessed via the display unit by pressing the **meter** key.
No reset possible.

Characteristics

	phase current	residual current
measurement range [2]	0.05 to 24 In [1]	0.02 to 10 Ino [1]
accuracy	± 5% or ± 0.03 In	± 5% or ± 0.03 In
unit	A or kA	A or kA

[1] In rated current set in the **status** menu, ***Device*** page.
[2] If the current is greater than the range, the display unit indicates **>.**

Running hours counter

The running hours counter informs the user of the number of hours for which the installation has been running.

Operation

■ the running hours counter increments whenever the current is greater than 5% of In.
■ the counter value is aved in non voltatile storage every 24 h.
■ the counter may be reset to zero using the **reset** key when the value is displayed, in parameter setting mode only.

Characteristics

measurement range	0 to 99999 h
unit	h
accuracy	± 1% or ± 0.5 h
refresh interval	1 h

System voltages

Operation

This function gives the system (phase-to-phase) voltage RMS values:
■ U21 phase 2 to 1 voltage,
■ U32 phase 3 to 2 voltage,
■ U13 phase 1 to 3 voltage.
Only the U21 and U32 voltages are measured. The U13 voltage is obtained by calculation of the vectorial sum.

Readout

The measurements may be accessed via the display unit by pressing the **meter** key.

Characteristics

measurement range	0.015 to 1.5 Unp (1)
unit	V or kV
accuracy (2)	±3% or ±0.005 Unp
primary refresh interval	< 2 s

(1) Unp rated voltage set in the **status** menu,***Device*** page.
(2) At Unp under reference conditions (IEC 60255.6).

Frequency

Operation

This function gives the frequency value.
Frequency is measured via positive sequence voltage. Sepam 1000 measures voltages U21 and U32.
The VT's parameter in the **status** menu, ***Device***page, should be set to U21 U32.
Frequency is not measured when:
■ U21 voltage is less than 35% of Unp,
■ positive sequency voltage is less than 20% of Vnp ($Unp/\sqrt{3}$).
■ the frequency is outside outside the measurement range.

Readout

The measurement may be accessed via the display unit by pressing the **meter** key.
N.B. If Sepam does not include measurement of U32, the frequency is measured via U21 (VT's in the **status** loop, ***Device*** page, set to U21). This method of measurement is less accurate.

Characteristics

rated frequency	50 Hz	60 Hz
range	45 to 55 Hz	55 to 65 Hz
accuracy (1) measured via U21, U32	± 0.05 Hz	± 0.05 Hz
refresh interval	< 2 s	< 2 s

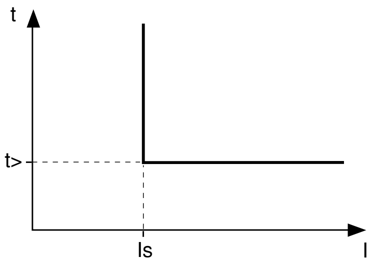
(1) At Unp, under reference conditions (IEC 60255.6).

Phase overcurrent

ANSI code 50-51

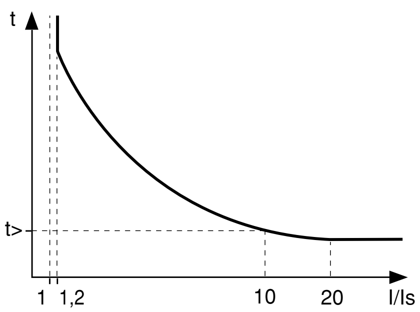
Operation
Phase overcurrent protection is three-pole. It picks up when one, two or three of the currents reaches the set point. It is time delayed. The time delay may be definite (definite, **DT**) or IDMT (standard inverse **SIT**, very inverse **VIT**, extremely inverse **EIT**, ultra inverse **UIT**, **RI** curve).
See curves in appendix.
■ the protection comprises two units:
□ IDMT or definite time low set unit,
□ instantaneous or time-delayed, definite time high set unit.

Definite time protection
Is is the set point expressed in A,
and t> is the protection time delay.



Definite time protection principle

IDMT protection
IDMT protection operates in accordance with the IEC 60255-3 and BS 142 standards.



IDMT protection principle

Is is the vertical asymptote of the curve,
and t> is the opreation time delay for 10 Is. The set point is situated at 1.2 Is.
The curve is defined according to the following equations:

■ standard inverse time **SIT**

$$t = \frac{0.14}{(I\ /\ Is)^{0.02} - 1} \cdot \frac{t>}{2.97}$$

■ very inverse time **VIT**

$$t = \frac{13.5}{(I\ /\ Is) - 1} \cdot \frac{t>}{1.5}$$

■ extremely inverse time **EIT**

$$t = \frac{80}{(I\ /\ Is)^{2} - 1} \cdot \frac{t>}{0.808}$$

■ ultra inverse time **UIT**

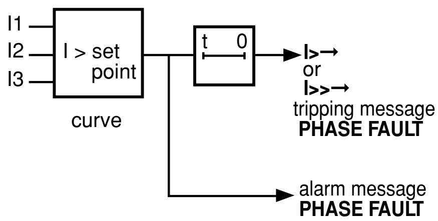
$$t = \frac{315\ .\ t>}{(1/Is)^{2} - 1}$$

■ **RI** curve
(tripping set point at Is).

$$t = \frac{0.315\ .\ t>}{0.339 - \frac{0.236}{I\ /\ Is}}$$

The function also takes into account current variations during the time delay interval (discrimination with electromechanical relays). For currents with a very large amplitude, the protection has a definite time characteristic:
■ if I > 20 Is, tripping time is the time that corresponds to 20 Is.
■ if I > 24 In, tripping time is the time that corresponds to 24 In.

Block diagram



Commissioning, settings
Check:
■ the connections,
■ the positions of microswitches SW2 associated with the current inputs,
■ the general parameters in the **status** menu.
Set the following:
■ low set:
□ type of time delay (**CURVE**):
definite time **DT** or **IDMT:** standard inverse time **SIT**, very inverse time **VIT**, extremely inverse time **EIT**, ultra inverse time **UIT**, **RI** curve,
□ Is current: Is is set in RMS, A or kA.
The protection can be inhibited by being set to 999 kA,
□ time delay t >: **DT** (t > is the operation time delay) or **SIT**, **VIT**, **EIT**, **UIT**, **RI** (t > is the operation time delay at 10Is).
■ high set:
□ I>> current: I>> is set in RMS, A or kA.
The protection can be inhibited by being set to 999 kA,
□ t >> time delay: t >> is the time delay.

Rated current In parameter setting (STATUS key)
Sepam needs to know the rated current of the installation in order to process the current values in amps. In is the current transformer primary rated current (magnetic CT) or the rating selected for the CSP sensors.

Settings

In
A : 10 - 15 - 20 - 25 - 30 - 35 - 36 - 40 - 45 - 50 - 60 - 70 - 75 - 80 - 90 - 100 - 120 - 125 - 150 - 160 - 175 - 180 - 192 - 200 - 225 - 240 - 250 - 300 - 320 - 350 - 400 - 450 - 480 - 500 - 600 - 625 - 640 - 700 - 750 - 800 - 900 - 960
kA : 1 - 1,2 - 1,25 - 1,4 - 1,5 - 1,6 - 2 - 2,5 - 3 - 3,5 - 3,75 - 4 - 5 - 6 - 6,25

Characteristics

parameters	settings
curve (**CURVE**)	DT - SIT - VIT - EIT - UIT - RI
setting current (Is) (1) (2) (5)	0.3 to 1 In in steps of 0.05 In 1 to 2 In in steps of 0.1 In 2 to 3 In in steps of 0.2 In 3 to 8 In in steps of 0.5 In
low set time delay (t >) (3)	100 ms to 4 s in steps of 100 ms 4 to 15 s in steps of 0.5 s 15 to 25 s in steps of 1 s 25 to 90 s in steps of 5 s
high set (I>>) (4) (5)	1 to 24 In by steps of 1 In
thigh set time delay (t >>)	**inst.**: instantaneous, typical tripping time 25 ms 50 to 300 ms in steps of 50 ms 300 ms to 2 s in steps of 100 ms
accuracy / performance (under reference conditions / IEC 60255-6)	
set points	±5% or ±0.03 In
definite time time delay	±5% or -0 +60 ms
IDMT time delay (IEC 60255-4/BS142)	class 5 or -0 +60 ms for Is > 0.5 In class 10 or -0 +60 ms for Is ≤ 0.5 In
% pick-up	93% ± 5% for Is > 0.5 In
storage time	< 60 ms
return time	< 70 ms
output relays available for program logic	
low set tripping	**I>→**
high set tripping	**I>>→**
blocking input transmission	**START→**

(1) The low set may be inhibited by setting Is to 999 kA.
(2) The Is setting range for all IDMT curves is limited to 2.4 In.
(3) The setting range for inverse time curves is limited to 12.5 s.
(4) The high set may be inhibited by setting I>> to 999 kA.
(5) Set in primary A or kA.

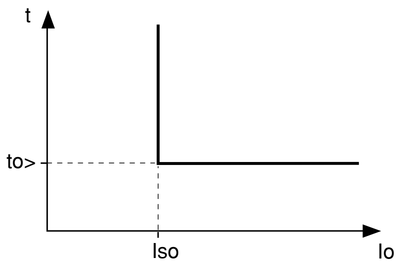
Earth fault

ANSI code	50N-51N or 50G-51G

Operation
Earth fault protection is single-pole.
It picks up when earth fault current reaches the set point. It is time delayed.
The time delay may be definite (**DT**) or IDMT (standard inverse **SIT**, very inverse **VIT**, extremely inverse **EIT**, ultra inverse **UIT**, **RI** curve).
See curves in appendix.

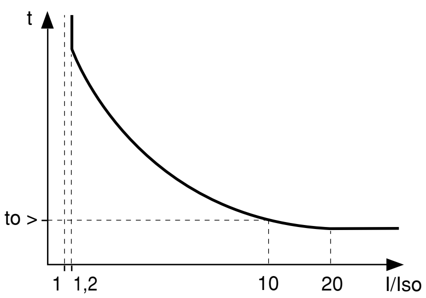
■ the protection comprises two units:
□ IDMT or definite time low set unit,
□ instantaneous or time-delayed, definite time high set unit.

Definite time protection
Iso is the set point expressed in A and to> is the protection time delay.



Definite time protection principle

IDMT protection
IDMT protection operate in accordance with the IEC 60255-3 and BS 142 standards.



IDMT protection principle

Iso is the vertical asymptote of the curve, and t> is the operation time delay for 10 Iso.

The curve is defined according to the following equations:

■ standard inverse time **SIT**

$$t = \frac{0,14}{(Io\ /\ Iso)^{0,02} - 1} \cdot \frac{to>}{2,97}$$

■ very inverse time **VIT**

$$t = \frac{13,5}{(Io\ /\ Iso) - 1} \cdot \frac{to>}{1,5}$$

■ extremely inverse time **EIT**

$$t = \frac{80}{(Io\ /\ Iso)^{2} - 1} \cdot \frac{to>}{0,808}$$

■ ultra inverse time **UIT**

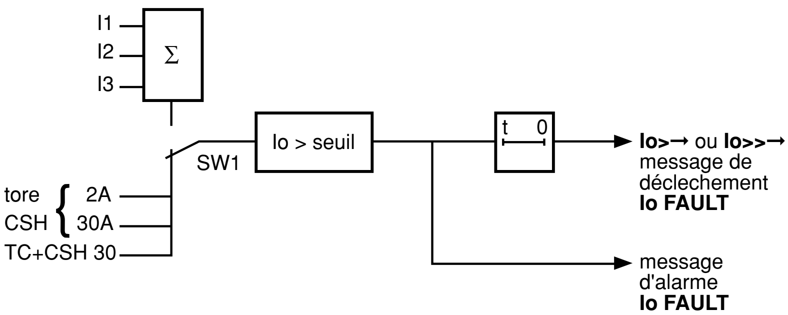
$$t = \frac{315\ .\ to>}{(Io/Iso)^{2,5} - 1}$$

■ **RI** curve
(tripping set point at Is).

$$t = \frac{0,315\ .\ to>}{0,339 - \frac{0,236}{Io\ /\ Iso}} \cdot s$$

The function also takes into account current variations during the time delay interval.
For current with a very large amplitude, the protection has a definite time characteristics:
■ if I > 20 Iso, tripping time is the time that corresponds to 20 Iso,
■ if I > 24 Ino, tripping time is the time that corresponds to 24 Ino.

Block diagram



Commissioning, settings
Earth fault current is measured:
■ by a CSH core balance CT throug which 3 phase conductors pass and whic directly detects the sum of the 3 currents. This solution is the most accurate one
■ by 1 A or 5 A current transformer, using a CSH 30 interposing ring CT which acts as an adapter,
■ by the phase CT ratios. The measurement is obtained by taking the internla vectorial sum of the three phase currents. It becomes falsified when the CTS are saturated. Saturation may be due either to overcurrent or to the presence of a DC componenet in a closing current or in a phase-to-phase fault current.

Check:

■ the connections,
■ the positions of the SW1 and SW2 microswitches associated with the current inputs,
■ the general parameters in the **status** menu.
Set the following:
■ low set:
□ type of time delay:
definite time (definite time **DT**) or IDMT standard inverse time **SIT**, very inverse time **VIT**, extremely inverse time **EIT**, ultra inverse time **UIT**, **RI** curve,
□ Iso current :
Iso is set in RMS, A or kA. The protection can be inhibited by being set to 999 kA,
□ time delay to >:
DT (to > is the operation time delay),or **SIT**, **VIT**, **EIT**, **UIT**, **RI** (t o> is the operation time delay at 10 Iso).
■ high set:
□ Io>> current:
Io>> is set in RMS, A or kA. The protection can be inhibited by being set to 999 kA.
□ to >> time delay:
t o>> is the time delay.

Rated earth fault current Ino setting parameter setting (STATUS key)
Sepam needs to know the rated residual current of the installation in order to process the current values in amps. If the current transformer residual current is measured by:
■ the sum of the phase current measurements: Ino is the rated primary current of the current transformers (magnetic CT) or the rating selected for the CSP sensors,
■ 1 A ou 5 A core balance CT, Ino is the rated primary current of the core balance CT,
■ special CSH CT, Ino being the rating to which the CT is connected: 2 A or 30 A.

Settings

Ino Tor 2A Tor 30A 3I
A : 1 - 2 - 3 - 4 - 5 - 6 - 10 - 15 - 20 - 25 - 30 - 35 - 36 - 40 - 45 - 50 - 60 - 70 - 75 - 80 - 90 - 100 - 120 - 125 - 150 - 160 - 175 - 180 - 192 - 200 - 225 - 240 - 250 - 300 - 320 - 350 - 400 - 450 - 480 - 500 - 600 - 625 - 640 - 700 - 750 - 800 - 900 - 960
kA : 1 - 1,2 - 1,25 - 1,4 - 1,5 - 1,6 - 2 - 2,5 - 3 - 3,5 - 3,75 - 4 - 5 - 6 - 6,25

Tor 2A Tor 30A correspond to the values of Ino from 2 A to 3 A.
3I signiifies that the residual current is measured by the sum of the three phase currents. Ino automatically returns to the value of In.

Characteristics

parameters	settings
curve (**CURVEo**)	DT - SIT - VIT - EIT - UIT - RI
setting current (Iso) (1) (2) (5)	0.05 to 1 Ino in steps of 0.05 Ino 1 to 2 Ino in steps of 0.1 Ino
low set time delay (t >) (3)	100 ms to 4 s in steps of 100 ms 4 to 15 s in steps of 0.5 s 15 to 25 s in steps of 1 s 25 to 90 s in steps of 5 s
high set (Io>>) (4) (5)	multiple of Ino: 0.05 - 0.1 - 0.15 - 0.2 - 0.25 - 0.3 - 0.35 - 0.4 - 0.45 - 0.5 - 0.6 - 0.8 - 1 - 1.5 - 2 - 2.5 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10
high set time delay (t >>)	**inst.**: instantaneous, typical tripping time 25 ms 50 to 300 ms in steps of 50 ms 300 ms to 2 s in steps of 100 ms
accuracy / performance (under reference conditions / IEC 60255-6)	
set points	±5% or ±0.02 Ino or ± 0.1 A
definite time delay	±5% or -0 +60 ms
IDMT time delay (IEC 60255-4/BS142)	class 5 or -0 +60 ms for Iso > 0.2 Ino class 10 or -0 +60 ms for Iso ≤ 0.2 Ino
% pick-up	93% ± 5% if Iso > 0.3 Ino 90% ± 10% if Iso ≤ 0.3 Ino
storage time	< 60 ms
return time	< 70 ms
output relays available for program logic	
low set tripping	**Io>→**
high set tripping	**Io>>→**
blocking input transmission	**START→**

(1) The low set may be inhibited by setting Iso to 999 kA.
(2) The Iso setting range for all IDMT curves is limited to 1 Ino.
(3) The setting range for definite time curves is limited to 12.5 s.
(4) The high set may be inhibited by setting Io>> to 999 kA.
(5) Set in primary A or kA, in multiples of 0.1A.

Thermal overload

ANSI code	49

Operation
This function simulates the heat rise in the protected equipment using the current measurements taken on two (I1 and I3) or three phases.
It complies with the IEC 60255-8 standard.
It monitors the heat rise and compares it with 3 set points
■ the **alarm setting** has a fixed value of 0.9 times the tripping set point.
Whenever the heat rise exceeds the alarm set point, a THERMAL ALARM message is displayed,
■ the E> tripping set point is adjustable. The protection trips whenever the heat rise exceeds the set point. A THERMAL TRIP message then apperas on the display unit,
■ the starting enable set point for E< adjustable.
It is the set point below which the heat rise must drop in order for the user to be able to acknowkedge the protection.
Heat rise protection is accessible,
even when if the function is inhibiteded.

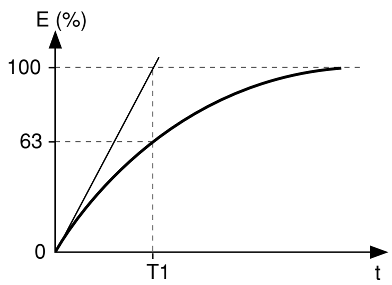
Influence of negative sequence
The negative sequence component is significant in calculating heat rise in rotary machines.
This is why the **thermal overload** protection set up in motor applications takes into account the following equivalent current in motor applictions:
$Ieq^2 = I^2 + K.Ii^2$
I is the maximum of phase 1, 2 and 3 currents. Ii is the current negative sequence.
K is the negative sequence factor (weighting coefficient). K = 4.5, K = 0 for transformer applications.

Heat rise calculation
Thermal overload protection monitors the heat rise variable. Heat rise is expressed
as a relative value with respect to the rated heat rise that corresponds to operation under rated load.
The function determines equipment heat rise E according to the thermal model defined the following differential equation:

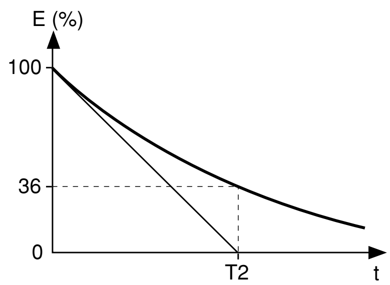
$$dE = \left(\frac{Ieq}{Ib}\right)^2 \times \frac{dt}{T} - E \times \frac{dt}{T}$$

with :
■ E: heat rise,
■ Ib: equipment basis current set in the **status** menu,
■ Ieq: equivalent current,
■ T: time constant.

Influence of the time constant
The time constant depends on the equipment's thermal characteristics.
It takes heat release and cooling into account. Motor cooling is more efficient when the motor is running than when it is stopped due to the ventilation caused by rotation. The time constant may therefore take on
2 values: T1 and T2 according to whether the equipment is running or stopped.
■ thermal time constant T1 is the time needed for the heat rise in equipment under rated load to reach 0.63 times the rated heat rise (obtained after an infinite time).
■ similarly, T2 is the time needed after stopping for the initial heat rise in the protected equipment to drop to 0.36 times the rated heat rise.
■ equipment running and stopping are calculated according to the current value:
□ **running** if I > 0,05In,
□ **stopped** if I < 0,05In.



Heat rise time constant



Cooling time constant

Cold curve
The cold curve gives the protection operation time according to current starting at zero heat rise (e.g. protection commissioning).
Starting from cold status, the heat rise varies according to the equation:

$$E = \left(\frac{Ieq}{Ib}\right)^2 \times \left(1 - e^{-\frac{t}{T1}}\right)$$

If E> is the tripping set point, the protection tripping time is:

$$t = T1 \times Log \frac{\left(\frac{Ieq}{Ib}\right)^2}{\left(\frac{Ieq}{Ib}\right)^2 - E>}$$

Hot curve
The hot curve gives the protection operation time according to current starting at rated heat rise (e.g. when an overload occurs in running equipment). Starting from rated hot status, the heat rise varies according to the following equation :

$$E = \left(\frac{Ieq}{Ib}\right)^2 - e^{-\frac{t}{T1}} \times \left[\left(\frac{Ieq}{Ib}\right)^2 - 1\right]$$

If E> is the tripping set point, the protection tripping time is:

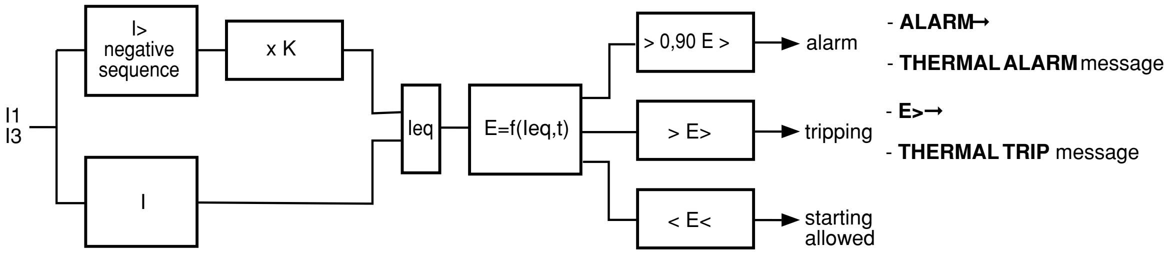
$$t = T1 \times Log \frac{\left(\frac{Ieq}{Ib}\right)^2 - 1}{\left(\frac{Ieq}{Ib}\right)^2 - E>} \times I$$

Cooling when stopped
After the equipment stops, the heat rise varies according to the following equation:

$$E = Eo \times e^{-\frac{t}{T2}}$$

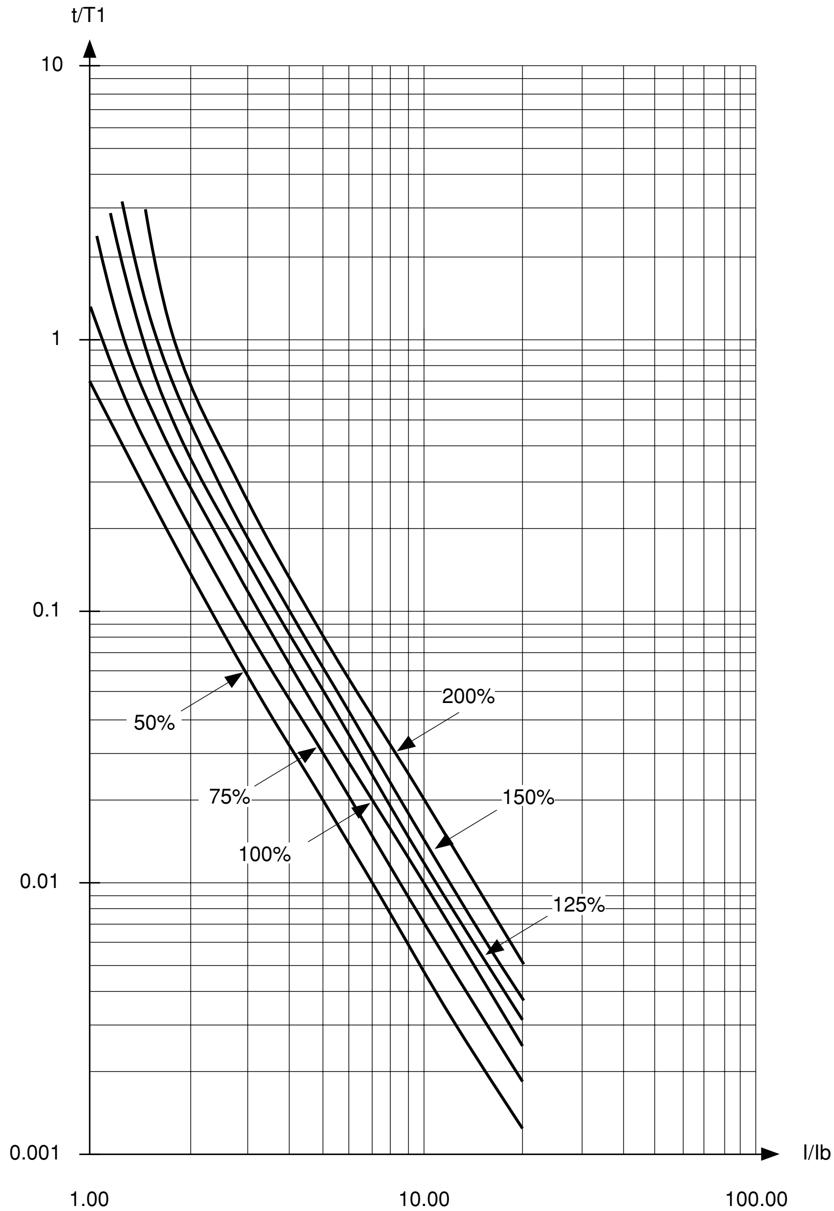
in which Eo is the heat rise value at the time of stopping.
For transformer application T2 is replaced by T1.

Block diagram



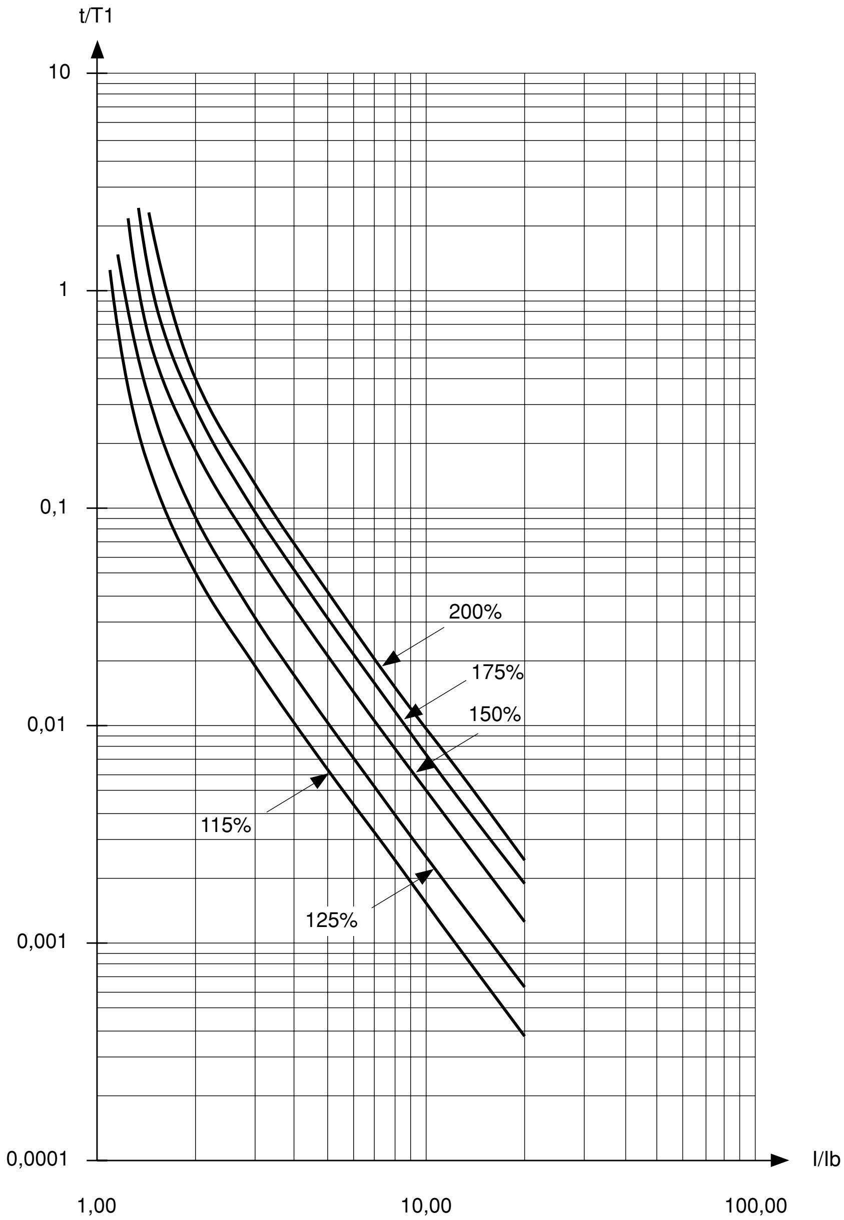
Cold curves: t/T1 = f(E>, I/Ib)
Example of curve use:
For an operation set point of E> set to 125% with a time constant T1 of 15 min., what is the operation time when cold at 3 Ib?
Using the cold curve chart
- 125% curve,
- read the value 3 in the I/Ib line,
- read at the intersection:

t/T1 = 0.11 hence, t = 0.11 x T1
i.e. t = 0.11 x 15 x 60 = 99 s.



Hot curves: t/T1 = f(E>, I/Ib)
Example of curve use:
For an operation set point of E> set to 125% with a time constant T1 of 15 min., what is the operation time when hot at 3 Ib?
Using the hot curve chart
- 125% curve,
- read the value 3 In the I/Ib line,
- read at the intersection:

t/T1 = 0.03 hence, t = 0.03 x T1,
i.e. t = 0.03 x 15 x 60 = 27 s.



Characteristics

parameters	settings
basis current of protected equipment (Ib) (1)	0.4 to 1 In in steps of 0.05 In 1 to 1.3 In in steps of 0.1 In
set point (E>) (2)	50 to 200% in steps of 5%
restart enable set point (E<)	50 to 200% in steps of 5%
alarm set point	non-adjustable value equal to 0.9 x E>
heat rise time constant (T1)	mn : 5 - 6 - 7 - 8 - 9 - 10 - 12 - 14 - 16 - 18 - 20 - 25 - 30 - 35 - 40 - 45 - 50 - 55 - 60 - 70 - 80 - 90 - 100 - 110 - 120
cooling time constant (T2) (3)	mn : 5 - 6 - 7 - 8 - 9 - 10 - 12 - 14 - 16 - 18 - 20 - 25 - 30 - 35 - 40 - 45 - 50 - 55 - 60 - 70 - 80 - 90 - 100 - 110 - 120 - 150 - 180 - 240 - 300 - 420 - 600
accounting for negative sequence factor K	motor application K = 4.5 transformer application K = 0
heat rise measurement E	0% to 200%
accuracy/ performance (under reference conditions / IEC 60255-6)	
operating current	class index according to IEC 60255-8 standard: 5% or ± 0.03 In
tripping time	class index according to IEC 60255-8 standard: 5%
output relays available for program logic	
thermal alarm	**ALARM→**
tripping	**E>→**

(1) Set in A or kA.
(2) The protection may be disabled by being set to 999%.
(3) Motor applications only.

Commissioning, settings
Check:
■ the connections,
■ the position of micro-switches SW associated with the current inputs,
■ the general parameters in the **status** loop, ***Device*** page.
Set the following:
■ E> set points as %. The protection can be inhibited by being set to 999 kA, but heat rise calculation can be read via the display,
■ time constants T1 and T2,

T1 and T2 setting
For motor T2 > T1 as there is no langer ventilation when the motor is stopped.

Negative sequence unbalance

ANSI code	46

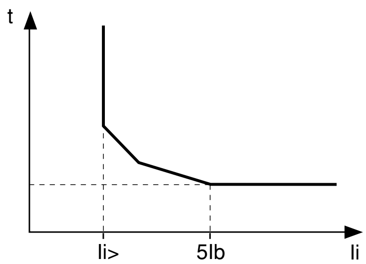
Operation
This functions is designed to protect equipment against unbalances:
■ it pickes up when the negative sequence component of phase currents is greater than the set point,
■ it is time delayed. The time delay may be definite or IDMT time (see curve).
Negative sequence current Ii is calculated for the 3 phase currents.

$$Ii = \frac{\sqrt{3}}{3} \times \left(I1 - a^2\, I3\right)$$

with $a = e^{j\frac{2\pi}{3}}$ when there is no residual current (earth fault).

The function may be used to display the negative sequence percentage on the display. It corresponds to the ratio Ii/Ib expressed as a percentage
(Ib: equipment basis current set in the **status** menu).

IDMT time delay
The time delay depends on the value of Ii/Ib.



IDMT protection principle
Tripping curve is defined according to the following equations :
■ for Ii>/Ib ≤ Ii/Ib ≤ 0.5,

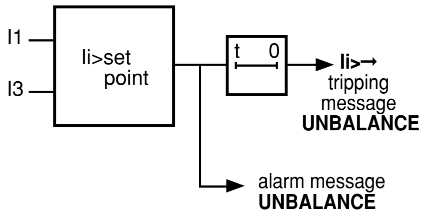
$$t = \frac{1.80}{(Ii\ /\ Ib)^{1.5}} \cdot s$$

■ for 0.5 ≤ Ii/Ib ≤ 5,

$$t = \frac{2.32}{(Ii\ /\ Ib)^{0.96}} \cdot s$$

■ for Ii/Ib > 5,
t = 0.5 s.
The negative sequence measurement expressed as a percentage of the basis current may be accessed via the display.
It is available even the protection is desabled.

Block diagram

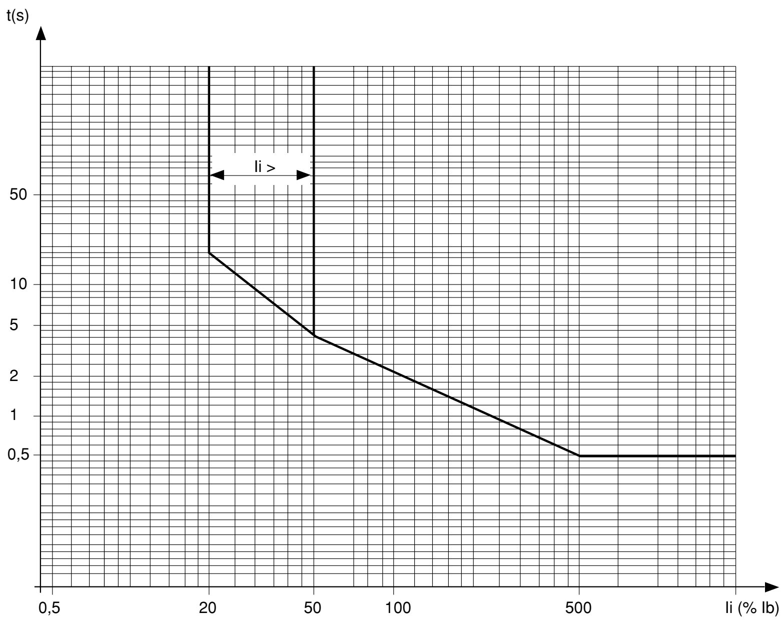


Characteristics

Ii> set point	
setting	20 to 50% Ib in steps of 5% of Ib (2)
accuracy (1)	± 5% or ±0.02 In
% pick-up	> 80%
time delay	
accuracy (1)	± 10% or ± 60 ms for Ii > 0.2 In
current unbalance % measurement (Ii)	
measurement range	10 to 500% Ib
accuracy (1)	± 5% at In
output relays available for program logic	
tripping	**Ii>→**

(1) Under reference conditions (IEC 60255.6).
(2) The protection may be disabled by being set to 999% of Ib.

IDMT tripping curve



Ii (%Ib)	t (s)
20	17.7
25	12.7
30	9.66
35	7.67
40	6.28
45	5.26
50	4.50
$100/\sqrt{3}$	3.92
60	3.77
70	3.26
80	2.87
90	2.56
100	2.32
150	1.57
200	1.20
250	0.970
300	0.813
350	0.702
400	0.618
450	0.552
≥ 500	0.500

Commissioning, settings
Check:
■ the connections,
■ the positions of the micro-switches SW associated with the current inputs,
■ the general parameters in the **status** loop, ***Device*** page.
Set the following:
■ inverse current Ii>:
Ii> is set as a percentage of the basis current Ib. Setting to 999 % disables the protection.
The negative sequence unbalance time delay setting must be greater than the earth fault protection setting so as to avoid unwanted tripping before the earth fault protection in the presence of earth fault current.

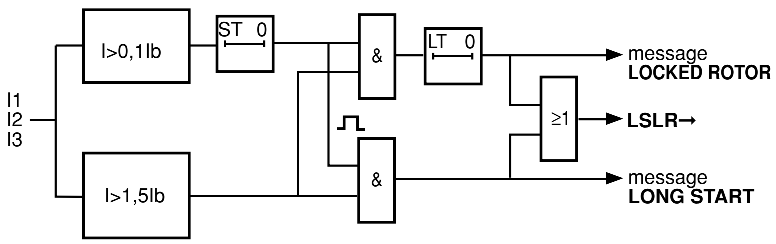
Locked rotor / excessive starting time

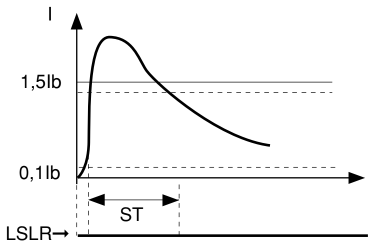
ANSI code	51LR

Operation
This function is three-phase.
It comprises two parts :
■ excessive starting time: during starting, this protection picks up when one of the 3 phase currents is greater than 1.5 Ib set point Is for a longer time period than the time delay ST (normal starting time),
■ locked rotor: at the normal operating rate (post starting), this protection picks up when one of the 3 phase currents is greater than the 1.5 Ib set point Is for a longer time period than the time delay LT of the definite time type.
Starting is detected when the absorbed current is 10% greater than the Ib current.

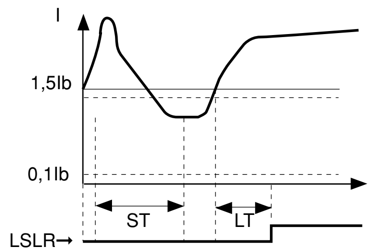
Commissioning, settings
Check:
■ the connections,
■ the position of the micro-switches SW2 associated with the current inputs,
■ the general parameters in the **status** loop, ***device*** page.
Set the following:
■ ST time delay: ST corresponds to the normal starting time,
■ LT time delay: LT is designed for reacceleration which is not detected as being a restart.

Block diagram

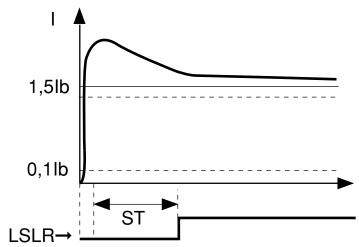




Case of normal starting



Case of a locked rotor



Case of excessive starting time

Characteristics

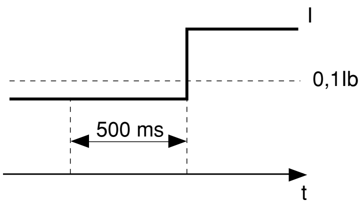
set point	
fixed value	1.5 Ib
accuracy (1)	±5%
% pick-up	93% ±5%
time delays	
setting (ST)	ms: 500 s: 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 - 12 - 14 - 16 - 18 - 20 - 25 - 30 - 35 - 40 - 45 - 50 - 55 - 60 - 70 - 80 - 90 - 100 - 110 - 120 - 150 - 180 - 240 - 300 - 999 (2)
setting (LT)	ms: 500 s: 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 - 12 - 14 - 16 - 18 - 20 - 25 - 30 - 35 - 40 - 45 - 50 - 55 - 60
output relays available for program logic	
tripping	**LSLR→**

(1) Under reference condiitions IEC 60255-6.
(2) The 2 functions: excessive starting time and locked rotor protection may be disabled by setting the ST time delay to 999 s.

Starts per hour

ANSI code	66

Operation
This function is three-phase.
It picks up when the number of starts reaches the following limits:
■ maximum number of starts allowed per hour,
■ maximum allowed number of consecutive hot starts.
The following indications are available on screen:
■ number of starts still allowed before the maximum, if the protection has not picked up,
■ waiting time before a start is allowed; if the protection has picked up.
Starting is detected when the absorbed current becomes greater than 10% of Ib current after having been lower during 500 ms time delay.

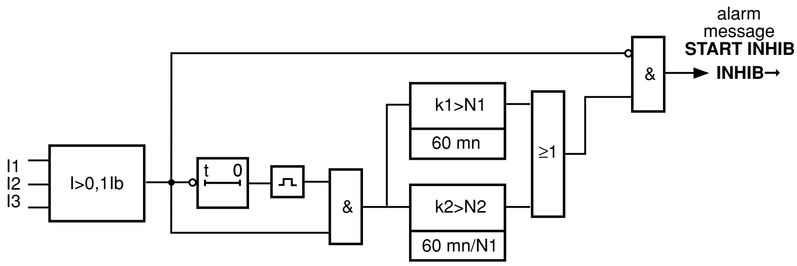


Detection of startin

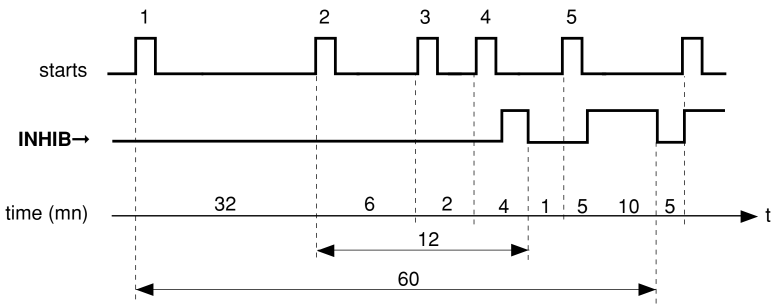
The number of start per hour is the number of starts counted during the last 60 min.
The number of consecutive starts is the number of starts counted during the last 60/N start minutes, N1 start being the number of starts allowed per hour.
The protection is active during motor stop intervals.
It allow to use O3 contact to avoid closing, instead of using dedicated output contact for that function.

Commissioning, settings
Check:
■ the connections,
■ the position of the micro-switches SW2 associated with the current inputs,
■ the general parameters in the **status** loop, ***device*** page.
Set the following:
■ starts per hour N1, protection may be disabled by setting the N1 to 999,
■ consecutive starts per hour N2.

Block diagram



Example
N1 = 5 and N2 = 3
Consecutive starts are counted over an interval of 60/N start, I.E. 12 minutes.



Characteristics

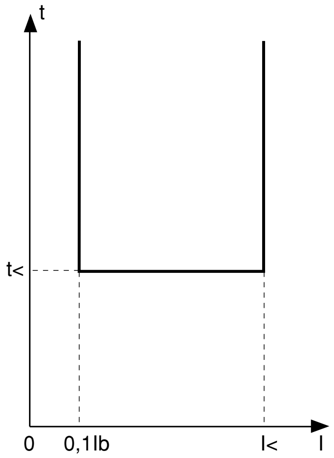
parameters	settings	
ntotal starts per hours (N1)	1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 - 12 - 14 - 16 - 18 - 20 - 25 - 30 - 35 - 40 - 45 - 50 - 55 -60 - 999 (1)	
number consecutive starts (N2)	1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 - 12 - 14 - 16 - 18 - 20 - 25 - 30 - 35 - 40 - 45 - 50 - 55 - 60	
inter-tripping time delay	500 ms	
measurement of remaining T	range	1 to 60 min.
	resolution	1 min.
	accuracy (2)	± 2 min.
measurement of remaining N	range	1 to 60
	resolution	1
output relays available for program logic		
disable restart	**INHIB→**	

(1) The function may be disabled by setting the ST time delay to 999 s.
(2) Under reference condiitions (IEC 60255-6).

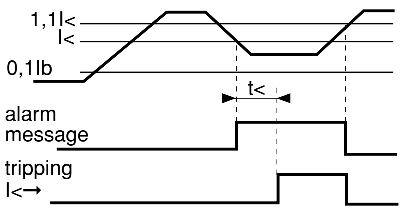
Undercurrent

ANSI code	37

Operation
This protection is single-phase,
■ it picks up when phase 1 current is less than the set point I<,
■ it is inactive when the current is less than 10% of Ib,
■ it includes a definite time delay t<.



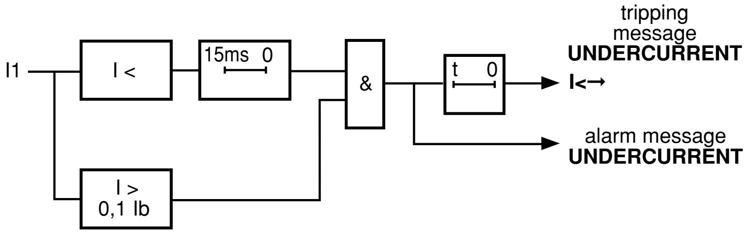
Protection principle



Case of a drop in current

Commissioning, settings
Check:
■ the connections,
■ the position of the micro-switches SW2 associated with the current inputs,
■ the general parameters in the **status** loop, ***Device*** page.
Set the following:
■ I< current: I< is set as a percentage of service current (Ib). Setting I< to 999% Ib disables the protection.
■ time delay t <.

Block diagram



Characteristics

I< set point	
setting [1]	20 to 100% of Ib in steps of 5% of Ib [2]
accuracy [1]	±5% or ±0.03 In
% pick-up	110% ± 5% for I< > 0.5 In
time delays	
setting	t<: 1 to 10 s in steps of 1 s
accuracy [1]	±5% or ±60 ms
output relays available for program logic	
tripping	**I<→**

[1] Under reference conditions IEC 60255-6.
[2] The protection may be disabled by setting I< to 999% of Ib.

Phase-to-phase overvoltage

ANSI code	59

Operation

This protection is two-phase.

■ it picks up when U21 or U32 phase-to-phase voltage is greater than the set point U> (or U>>).
Setting the VT's parameter to to 21 prevents the protection from reacting to voltage U32,

■ it includes a definite time delay,

■ set point 1 (U>) is designed to detect whether there is sufficient power voltage.
It does not transmit alarm messages or trip.
This limit may not be latched.

Commissioning, settings

Check:

■ the connections,

■ the general parameters in the **status** loop, ***Device*** page.

Set the following:

■ U> or U>> set point:
U> or U>> is set in RMS, V or kV.
The 999 kV setting disables the protection,

■ time delay tu> or tu>>.

Setting of rated voltages Unp and Uns (STATUS key)

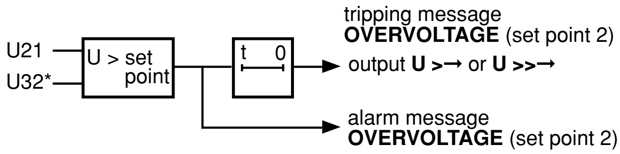
Sepam must know the primary and secondary rated voltages in order to process voltage values in volts.

Unp is the primary rated voltage of the voltage transformers (VT).
Uns is the secondary rated voltage.

Settings :

Unp	220 V to 500 V in steps of 5 V 500 V à 1 kV in steps of 10 V 1 kV à 2 kV in steps of 0,02 kV 2 kV à 5 kV in steps of 0,05 kV 5 kV à 10 kV in steps of 0,1 kV 10 kV à 20 kV in steps of 0,2 kV 20 kV à 50 kV in steps of 0,5 kV 50 kV à 100 kV in steps of 1 kV 100 kV à 250 kV in steps of 2 kV
Uns	100 V - 110 V - 115 V - 120 V

Block diagram



*if VT's = U21.U32

Characteristics

U> or U>> set point	
setting	50% to 150% Unp in steps of 5% Unp (2) (3)
accuracy (1)	±3%
% pick-up	97% ±2.5%
time delay tu> or tu>>	
setting	100 ms to 90 s: 100 ms to 4 s in steps of 100 ms 4 to 15 s in steps of 0.5 s 15 to 25 s in steps of 1 s 25 to 90 s in steps of 5 s
accuracy (1)	±5% or ±60 ms
output relays available for program logic	
sufficient power on, set point 1	**U>→**
tripping, set point 2	**U>>→**

(1) Under reference conditions (IEC 60255.4).
(2) Set in V or kV.
(3) The protection may be disabled by a set point of 999 kV.

Positive sequence undervoltage

ANSI code	27D

Operation
Positive sequence undervoltage
This protection picks up when the positive sequence component Vd of the three-phase system voltages is less than the set point Vd< (or Vd<<) with:

$$\mathbf{Vd} = (1/3)\left[\mathbf{V1} + a\,\mathbf{V2} + a^2\,\mathbf{V3}\right]$$

$$\mathbf{Vd} = (1/3)\left[\mathbf{U21} - a^2\,\mathbf{U32}\right]$$

$$V = \frac{U}{\sqrt{3}}$$

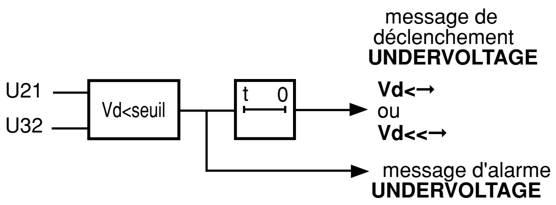
$$a = e^{j\frac{2\pi}{3}}$$

■ it includes a definite time delay tvd< (or tvd<<),
■ it allows drops in motor electrical torque to be detected.

Positive sequence voltage measurement
This protection also indicates the voltage positive sequence value on the display.
The voltage is expressed in V or kV.

Commissioning, settings
Check:
■ the connections,
■ the general parameters in the **status** loop, ***Device*** page.
In order to utilize positive sequence undervoltage protection, it is necessary to have measurement of the two phase-to-phase voltages (U21 and U32).
The VT's parameter in the **status** loop must therefore be set to U21 U32: otherwise, a **CHECK SETTINGS** message appears on the display.
Set the following:
■ Vd< or Vd<< set point: Vd< or Vd<< is set in RMS, V or kV. The 999 kV may be used to inhibit the protection,
■ time delay tvd< or tvd<<.

Block diagram



Characteristics

Vd< and Vd<< set points	
setting	30% to 100% Vnp in steps of 5% Vnp (2) (3)
accuracy (1)	±5%
% pick-up	103% ±2.5%
tvd< or tvd<< time delays	
setting	100 ms à 90 s: 100 ms à 4 s in steps of 100 ms 4 to 15 s in steps of 0.5 s 15 to 25 s in steps of 1 s 25 to 90 s in steps of 5 s
accuracy (1)	± 5% or 60 ms
Vd< or Vd<< measurement	
range	2.5 to 150%Vnp
accuracy	± 5% to Vnp
output available for program logic	
tripping set point 1	**Vd<→**
tripping set point 2	**Vd<<→**

$Vnp = Unp / \sqrt{3}$
(1) Under reference conditions (IEC 60255-6).
(2) Set in V or kV.
(3) The protection may be disabled by a set point of 999 kV.

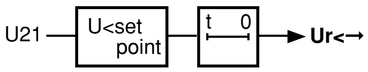
Remanent undervoltage

ANSI code	27R

Operation
This protection is single-phase,
■ it picks up when system voltage U21 is less than the set point Ur<,
■ it includes a definite 100 ms time delay.

Commissioning, settings
Check:
■ the general parameters in the **status** loop, ***Device*** page.
Set the following:
■ Ur< set point: Ur< is set in RMS Vor kV. The 999 kV setting may be used to inhibit the protection,
■ time delay tr.

Block diagram



Characteristics

Ur< set point	
setting [2]	5% to 100% Unp in steps of 5% Unp [3]
accuracy [1]	±5% or ±0,005 Unp
% of pick-up	106% ±4% for Ur< >10% Unp
time delay	
fixed value	100 ms ±60 ms
output available for program logic	
under remanent voltage	**Ur<→**

(1) Under reference condittions (IEC 60255.6). (for 20 ≤ f ≤ 65 Hz).
(2) The protection may be disabled by a set point of 999 kV.
(3) Set in V or kV.

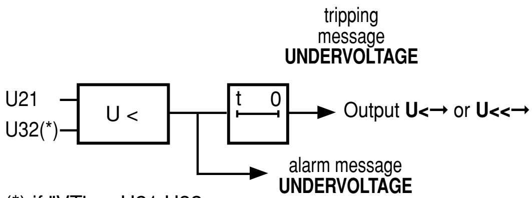
Phase-to-phase undervoltage

ANSI code 27

Operation
This protection is two-phase.
It comes in two versions:
■ it picks up when one of the phase-to-phase voltages U21 or U32 is less than the set point U< (or U<<),
■ if just one phase-to-phase voltage U21 is measured by the VT's. Setting the VT's parameter to 21 prevents the protection from reacting to voltage U32 (**status** loop, ***Device*** page),
■ the protection comprises a definite time delay.

Commissioning, settings
Check:
■ the connections,
■ the general parameters in the **status** loop, ***Device*** page.
Set the following:
■ U< or U<< set point : U< or U<< is set in RMS, V or kV. The 999 kV setting may be used to inhibit the protection,
■ time delay tvd< or tvd<<.

Block diagram



(*) if "VT's = U21.U32

Characteristics

U< or U<< set point	
setting	5% to 100% Unp in steps of 5% Unp (2) (3)
accuracy (1)	±3% or ± 0,005 Unp
% of pick-up	103% ±2.5% for U< or U<< ≥ 20% Unp
time delay tu< or tu<<	
setting	100 ms to 90 s: 100 ms to 4 s in steps of 100 ms 4 to 15 s in steps of 0.5 s 15 to 25 s in steps of 1 s 25 to 90 s in steps of 5 s
accuracy (1)	±5% or ±60 ms
output available for program logic	
tripping set point 1	**U<→**
tripping set point 2	**U<<→**

(1) Under reference conditions (IEC 60255.6).
(2) The protection may be disabled by a set point of 999 kV.
(3) Set in V or kV.

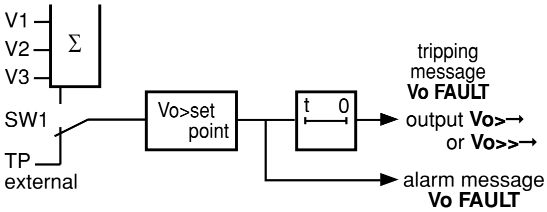
Neutral voltage displacement

ANSI code	59N

Operation
This protection picks up when the residual voltage is greater than a set point Vo> (or Vo>>).
■ it includes a definite time delay tvo> or tvo>>
■ residual voltage is either calculated from 3 phases voltages or measured by an external VT.

Commissioning, settings
Check:
■ the connections,
■ the position of the micro-switches SW1 associated with the current inputs,
■ the general parameters in the **status** loop, ***Device*** page.
Set the following:
■ Vo> or Vo>> set point : Vo is set in RMS, Vor kV. The 999 kV setting may be used to inhibit the protection,
■ time delay tvo> or tvo>>.

Block diagram



Characteristics

Vo> or Vo>> set point	
setting	5 to 80% Unp in steps of 5% Unp [2] [3]
accuracy [1]	±3% or ± 0.005 Unp
% of pick-up	97% ±2.5% for Vo> or Vo>> >10% Unp
time delay tvo> or tvo>>	
setting	100 ms to 90 s: 100 ms to 4 s in steps of 100 ms 4 to 15 s in steps of 0.5 s 15 to 25 s in steps of 1 s 25 to 90 s in steps of 5 s
accuracy [1]	±5% or ±60 ms
output available for program logic	
tripping set point 1	**Vo>→**
tripping set point 2	**Vo>>→**

(1) Under reference conditions (IEC 60255.6).
(2) The protection may be disabled by a set point of 999 kV.
(3) Set in V or kV.

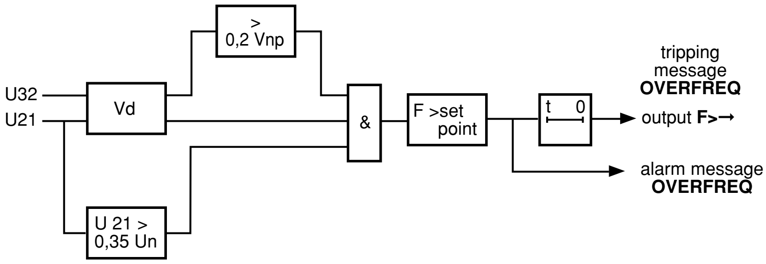
Overfrequency

ANSI code	81

Operation
This protection calculates frequency from positive sequence voltage.
To do so, Sepam 1000 needs to measure phase-to-phase voltages U21 and U32.
■ it picks up when the positive sequence voltage frequency is greater than the set point F>, if voltage U21 is greater than 35% of Un and its positive sequence voltage is greater than 20% of Vnp,
■ the protection comprises a definite time delay t f >.

Commissioning, settings
Check:
■ the connections,
■ the general parameters in the **status** loop, ***Device*** page
Set the following:
■ frequency F>: F> is set in Hz. The 999 Hz setting may be used to inhibit the protection,
■ time delay t f >.

Block diagram



Characteristics

set point F>	
setting	50 to 53 Hz or 60 to 63 Hz in steps of 0.1 Hz (2)
accuracy (1)	± 0.1 Hz
return variance	0.2 Hz ± 0.1 Hz
time delay t f >	
setting	100 ms to 90 s: 100 ms to 4 s in steps of 100 ms 4 to 15 s in steps of 0.5 s 15 to 25 s in steps of 1 s 25 to 90 s in steps of 5 s
accuracy (1)	±5% or ±60 ms
output available for program logic	
tripping set point	**F>→**

(1) Under reference conditions (IEC 60255.6) (df/dt < 3 Hz/s and measure from U21 et U32).
(2) The protection may be disabled by a set point of 999 Hz.
N.B. If Sepam does not include U32 measurement, frequency is calculated from U21 (VT's in the **status** loop, ***Device*** page set to U21). In such cases, the protection is less accurate).

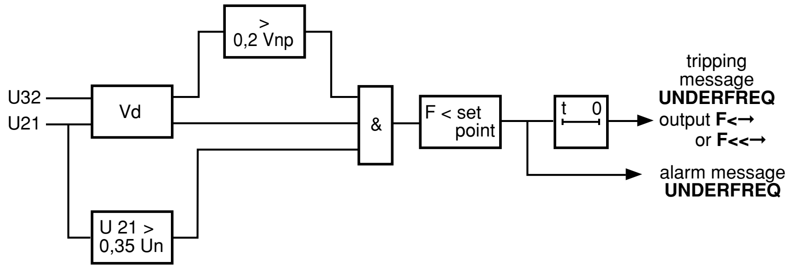
Underfrequency

ANSI code	81

Operation
This protection calculates frequency from positive sequence voltage. To do so, Sepam 1000 needs to measure phase-to-phase voltages U21 and U32.
■ it picks up when the positive sequence voltage frequency is less than the set point F< or F<<, if voltage U21 is greater than 35% of Un and its positive sequence voltage is greater than 20% of Vnp,
■ the protection comprises a definite time delay t f >.

Commissioning, settings
Check:
■ the connections,
■ the general parameters in the **status** loop, ***Device*** page.
Set the following:
■ F< or F<< frequency: F< or F<< is set in Hz. The 999 Hz setting disables the protection,
■ time delay tf< or tf<<.

Block diagram



Characteristics

F< or F<< set point		
setting	set point 1 (F<)	48 to 50 Hz or 58 to 60 Hz in steps of 0.1 Hz (2)
	set point 2 (F<<)	45 to 48 Hz or 55 to 58 Hz in steps of 0.1 Hz (2)
accuracy (1)		± 0.1 Hz
return variance		0.2 Hz ± 0.1 Hz
time delay tf< ou tf<<		
setting		100 ms to 90 s: 100 ms to 4 s in steps of 100 ms 4 to 15 s in steps of 0.5 s 15 to 25 s in steps of 1 s 25 to 90 s in steps of 5 s
accuracy (1)		±5% or ±60 ms
output available for program logic		
tripping set point 1		**F<→**
tripping set point 2		**F<<→**

(1) Under reference conditions (IEC 60255.6) (df/dt < 3 Hz/s and measure from U21 and U32).
(2) The protection may be disabled by a set point of 999 Hz.
N.B. If Sepam does not include U32 measurement, frequency is calculated from U21 (VT's in the **status** loop, ***Device*** page set to U21). In such cases, the protection is less accurate).

Appendix

Use of definite time functions

Operation time depends on the type of protection (phase current, earth fault current, …)

Operation is represented by a characteristic curve:

■ t = f(I) curve for the **phase overcurrent** function,

■ t = f(Io) curve for the **earth fault** function.

The rest of the document is based on t = f(I); the same reasoning may be extended to other variables Io…

The curve is defined by:

■ the type (standard inverse **SIT**, very inverse **VIT**, extremely inverse **EIT**, ultra inverse time **UIT**, **RI** curve),

■ the Is setting current which corresponds to the vertical asympote of the curve (exept **RI** curve),

■ the T time delay setting which corresponds to the operation time for I = 10 Is.

These 3 settings are made in the following chronological order: type, Is current, T time delay.

Changing the T setting by x% changes all the operation times in the curves by x%.

Examples of problems to be solved

Problem n°1

Knowing the type of IDMT time, determine the Is and T settings.

Theoretically, Is is set to the maximum current that may be permanent:

it is generally the rated current of the protected equipment (cable, motor, transformer).Time delay T is set to the operation point at 10Is on the curve.

This setting is determined taking into account the constraints involved in discrimination with the upstreman and downstream protections.

The discrimination constraint leads to the definition of point A on the operation curve (IA, tA), e.g. the point that corresponds to the maximum fault current affecting the downstream protection.

Problem n°2

Knowing the type of IMDT time,

the Is current setting and a point K (IK, tK) on the operation curve,

determine the T time delay setting.

On the standard curve of the same type, read the operation time tsK that corresponds to the relative curren:

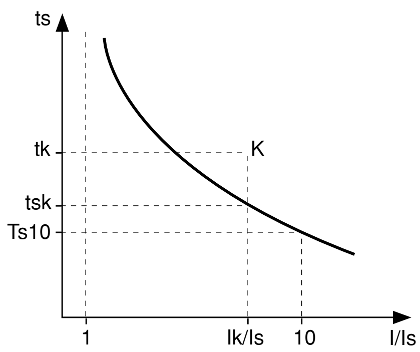
$$\frac{Ik}{Is}$$

And the operation time Ts10 that corresponds to the relative current:

$$\frac{I}{Is} = 10$$

The time delay setting that should be made in order for the operation curve to pass through the point K(IK, tK) is:

$$T = Ts\,10 \times \frac{t_k}{t_{sk}}$$



Another practical method:

The chart below gives the values of:

$$k = \frac{ts}{Ts\,10} \text{ as a function of } \frac{I}{Is}$$

In the column that corresponds to the type of time delay, read the value:

$$k = \frac{tsk}{Ts\,10}$$

in the line that corresponds to: $\frac{Ik}{Is}$

The time delay setting to be used so that the operation curve passes through the point K(IK, tK) is:

$$T = \frac{tk}{k}$$

Example:

Data:

■ type of time delay: standard inverse time (**SIT**),

■ set point: Is,

■ a point K on the operation curve: K (3.2IS; 4 s).

Question: What is the time delay T setting (operation time at 10Is) ?

Chart reading: **inverse** column line: $\frac{I}{Is} = 3,2$

k = 2,00

Answer:

The time delay setting is:

$$t> = \frac{4}{2} = 2\ s$$

Problem n°3

Knowing the settings of Is current and T time delay for a type of time delay (standard inverse, very inverse, extremely inverse), find the operation time for a current value of IA.

On the standard curve of the same read the operation time tsA that corresponds to the relative current:

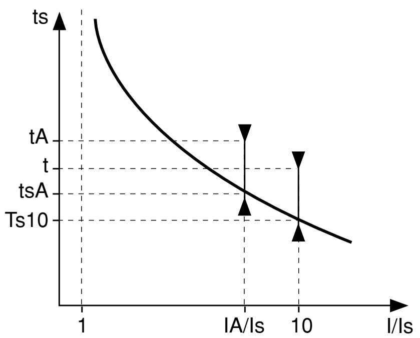
$\frac{IA}{Is}$

and the operation time Ts10 that corresponds to the relative current:

$\frac{I}{Is} = 10$

The operation time tA for current IA with the Is and T settings is:

$tA = tsA \times \frac{t>}{Ts\ 10}$



Another practical method:

the chart below gives the values of:

$k = \frac{ts}{Ts\ 10}$ as a function of $\frac{I}{Is}$

In the column that corresponds to the type of time delay,

read the value: $k = \frac{tsA}{Ts\ 10}$

in the line that corresponds to: $\frac{IA}{Is}$

The operation time tA for current IA with the Is and T settings is: tA = kT

Example:

Data:

- type of time delay: very inverse time (**VIT**),
- set point: Is,
- time delay t > = 0.8 s.

Question:

What is the operation time for current IA = 6Is ?

Chart reading: **very inverse** columne

line : $\frac{I}{Is} = 6$

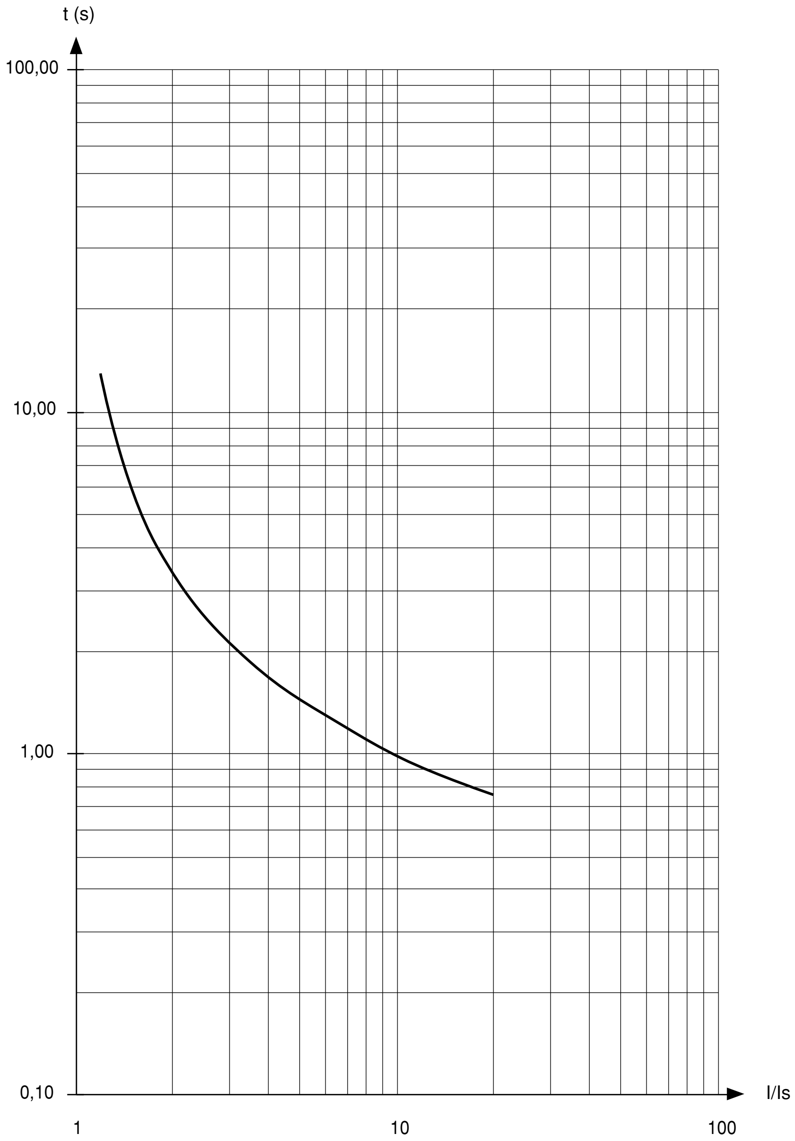
k = 1,80

Answer:

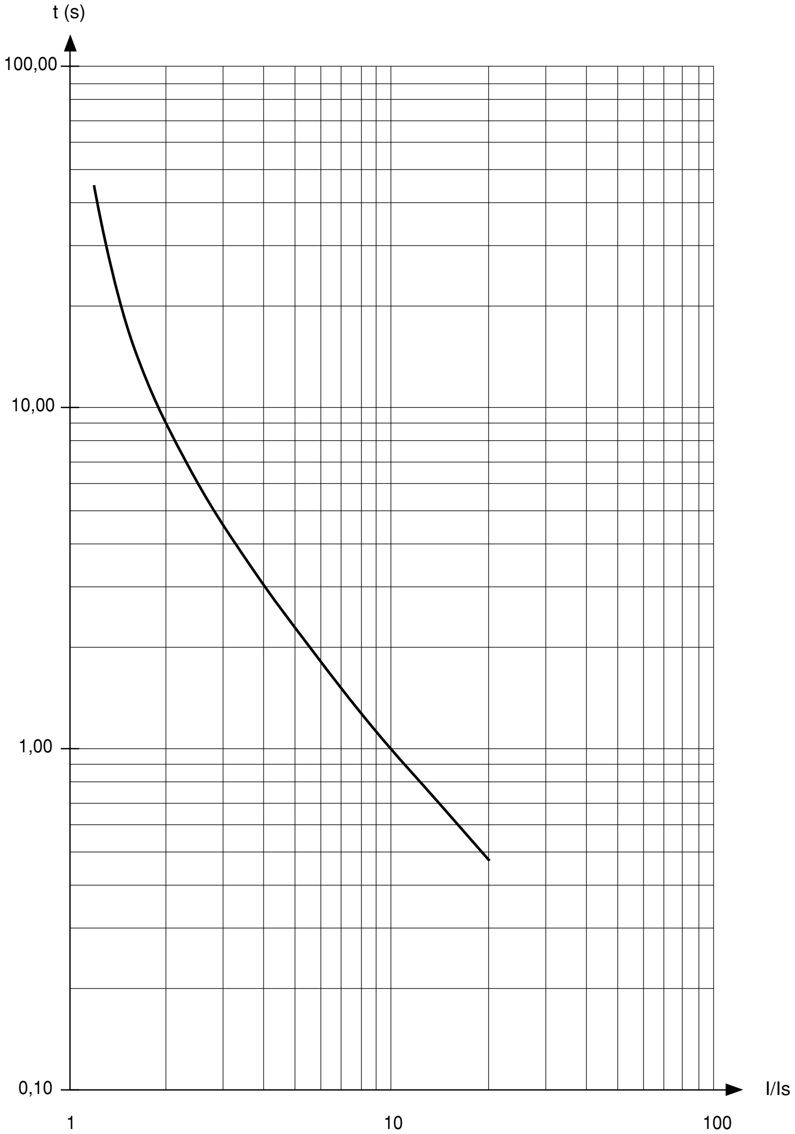
The operation time for current IA is: t = 1.80 x 0.8 = 1.44s.

I/Is	SIT	VIT	EIT	UIT	RI
1.0					3.06
1.2	12.90	45.0	225	545	2.21
1.4	6.92	22.5	103	239	1.85
1.6	4.95	15.0	63.5	141	1.64
1.8	3.95	11.2	44.2	94.1	1.52
2.0	3.35	9.00	33.0	67.6	1.42
2.2	2.94	7.50	25.8	51.0	1.36
2.4	2.64	6.43	20.8	39.8	1.31
2.6	2.44	5.62	17.2	31.8	1.27
2.8	2.24	5.00	14.5	26.0	1.24
3.0	2.10	4.50	12.4	21.6	1.21
3.2	1.98	4.09	10.7	18.2	1.19
3.4	1.88	3.75	9.38	15.5	1.17
3.6	1.80	3.46	8.28	13.4	1.15
3.8	1.73	3.21	7.37	11.6	1.14
4.0	1.66	3.00	6.60	10.2	1.12
4.2	1.60	2.81	5.95	8.96	1.11
4.4	1.55	2.65	5.39	7.95	1.10
4.6	1.51	2.50	4.91	7.10	1.09
4.8	1.47	2.37	4.49	6.37	1.09
5.0	1.43	2.25	4.12	5.74	1.08
5.2	1.39	2.14	3.80	5.20	1.07
5.4	1.36	2.04	3.52	4.72	1.07
5.6	1.33	1.96	3.26	4.30	1.06
5.8	1.31	1.87	3.03	3.94	1.06
6.0	1.28	1.80	2.83	3.61	1.05
6.2	1.26	1.73	2.64	3.33	1.05
6.4	1.23	1.67	2.48	3.07	1.04
6.6	1.21	1.61	2.33	2.84	1.04
6.8	1.19	1.55	2.19	2.63	1.04
7.0	1.12	1.50	2.06	2.45	1.03
8.0	1.10	1.29	1.57	1.75	1.02
9.0	1.04	1.12	1.24	1.30	1.01
10	1.00	1.00	1.00	1.00	1.00
11	0.951	0.900	0.825	0.787	0.992
12	0.916	0.818	0.691	0.633	0.986
13	0.887	0.750	0.589	0.518	0.982
14	0.862	0.692	0.507	0.430	0.978
15	0.839	0.642	0.441	0.362	0.974
16	0.819	0.600	0.388	0.308	0.971
17	0.801	0.562	0.344	0.265	0.969
18	0.784	0.529	0.306	0.229	0.967
19	0.769	0.500	0.274	0.200	0.965
≥20	0.756	0.474	0.248	0.176	0.963

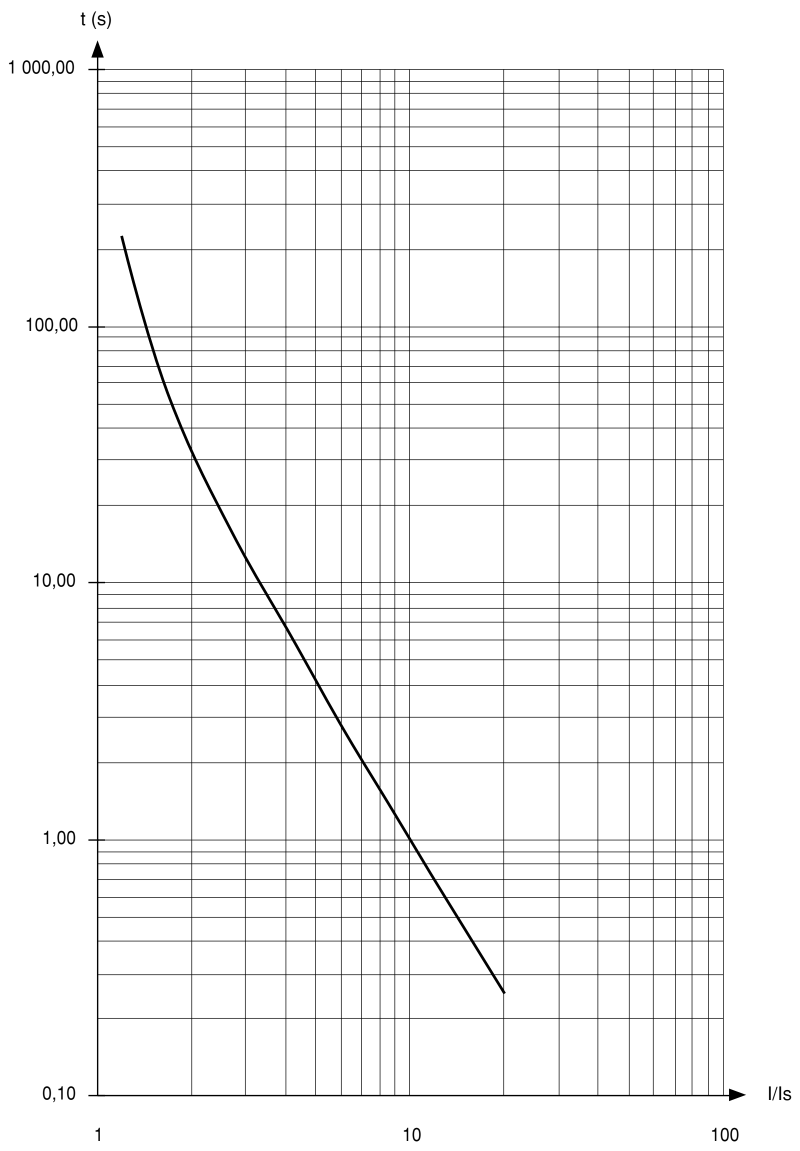
Standard inverse time curves



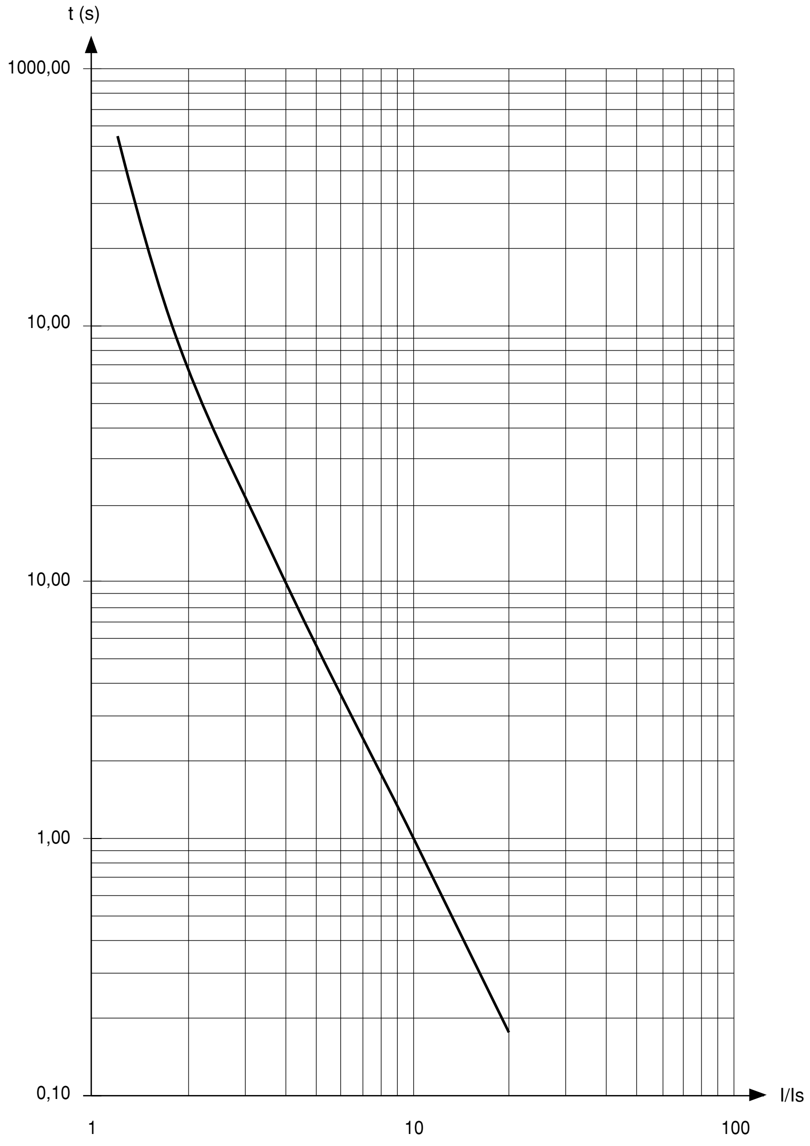
Very inverse time curves



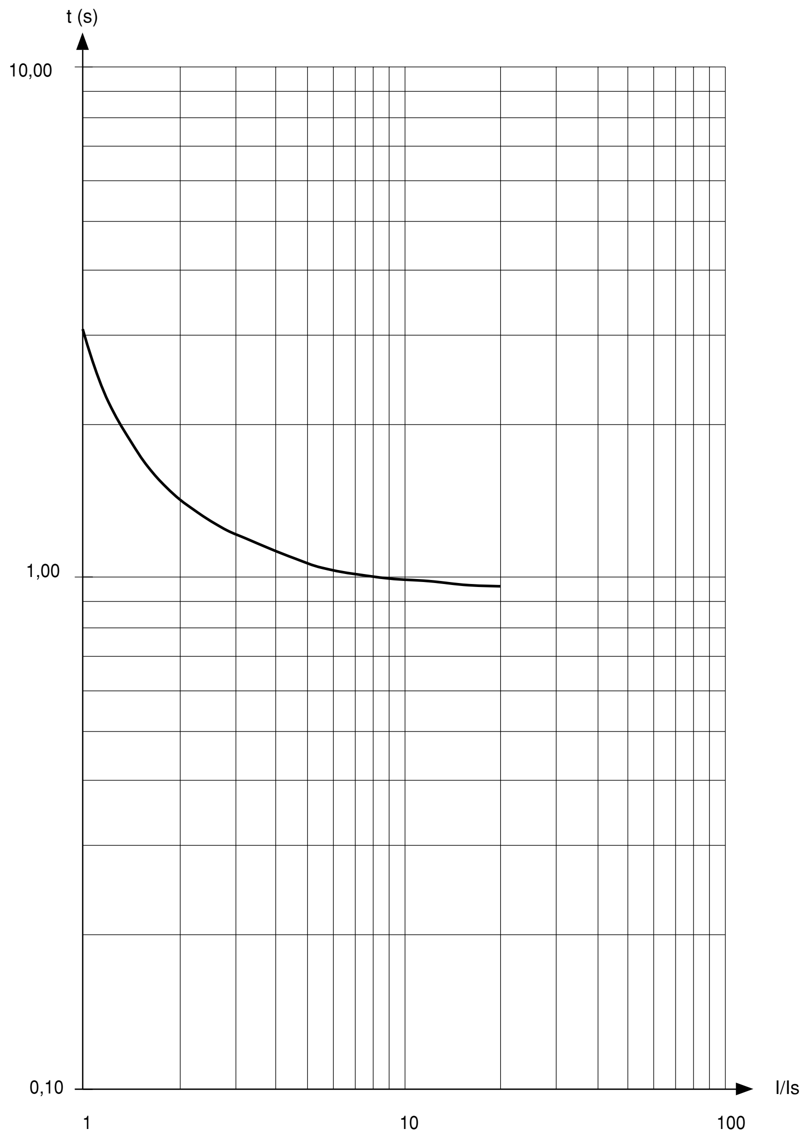
Extremely inverse time curves



Ultra inverse time curves



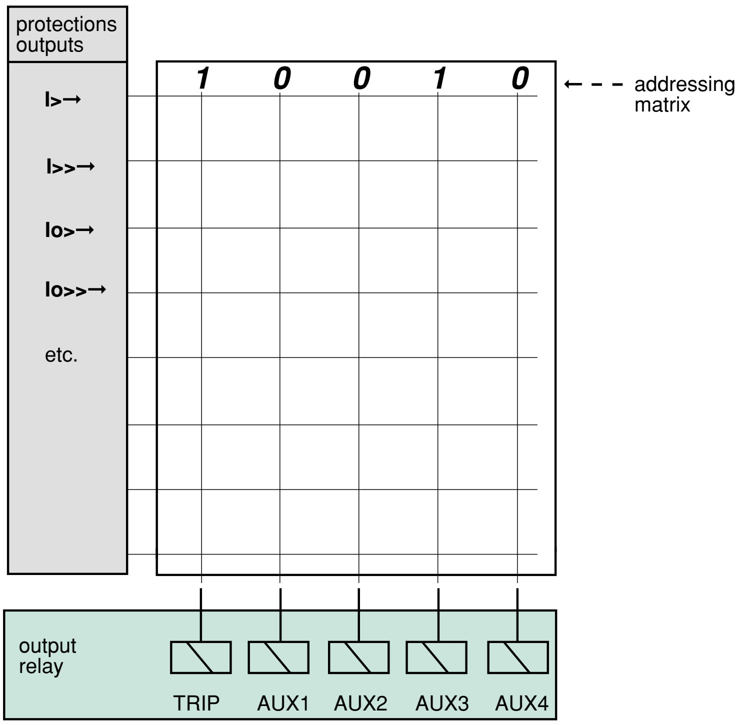
RI curves



Setting output operation parameters

The operation of Sepam 1000 outputs may be set entirely via the keyboard.
It is defined by:
■ laddressing of internal information on the output relays,
■ latching of relays (function 86),
■ program logic (with or without positive contact indication).
Sepam 1000's default settings are suitable for most applications.
In such cases, Sepam is ready to be used and the parameter changes described in this section are not necessary.
All the infromation detailed in this section is applicable, whatever the number of Sepam, outputs, 2 or 5 according to whether or not Sepam includes the optional ES1 input/ouput board.

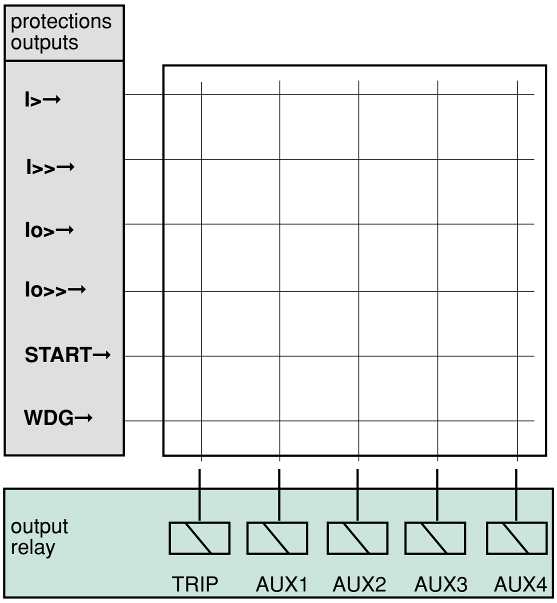
Addressing of output relays
Each Sepam 1000 protection comprises one or more outputs. These outpus may be addressed by parameter setting via the keyboard to any output relay.
Setting the addresses consists of filling in the addressing matrix shown below:



Example of addressing:
I>fi = 10010 means that the low set output of the phase overcurrent protection is addressed to theTRIP and AUX3 relays.

The lines in the matrix are made up of the protection outputs.
Each line has a parameter which has a name in the form of **xxx→**.
Example: for the low set of the phase overcurrent protection, the addressing parameter is **I>→**.
The 5 columns of the matrix correspond to Sepam's 5 relay outputs.
An ouput is addressed to a relay if the matrix contains a **1** at the intersection of the line and the corresponding column.
Otherwise the matrix contains a **0**.
All the addressing parameters may be accessed via the keyboard in the **status** loop, ***Input/output*** page.
They are to be set to the code value which corresponds to the desired address.
Remark: watchdog information (**WDG→**) is an output that may addressed to any relay.

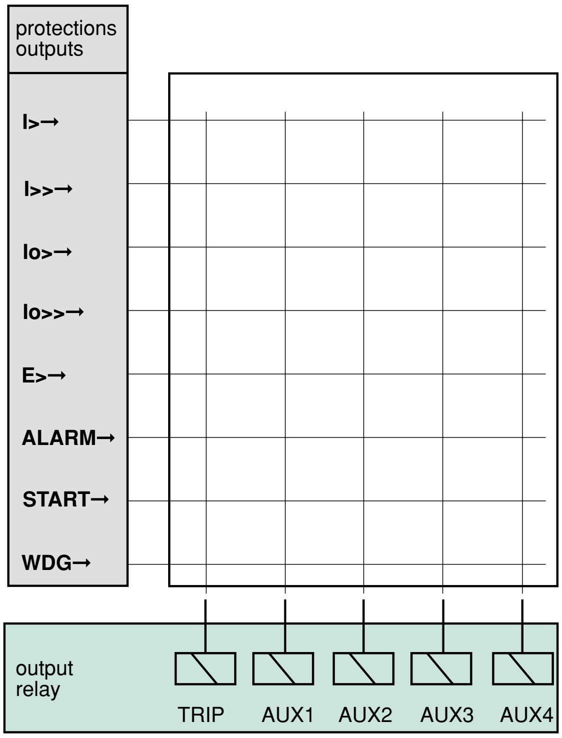
Sepam 1000 addressing matrix type S01



default addressing matrix:

1	0	0	1	0
1	0	0	1	0
1	0	0	0	1
1	0	0	0	1
0	0	1	0	0
0	1	0	0	0

Sepam 1000 addressing matrix type T01

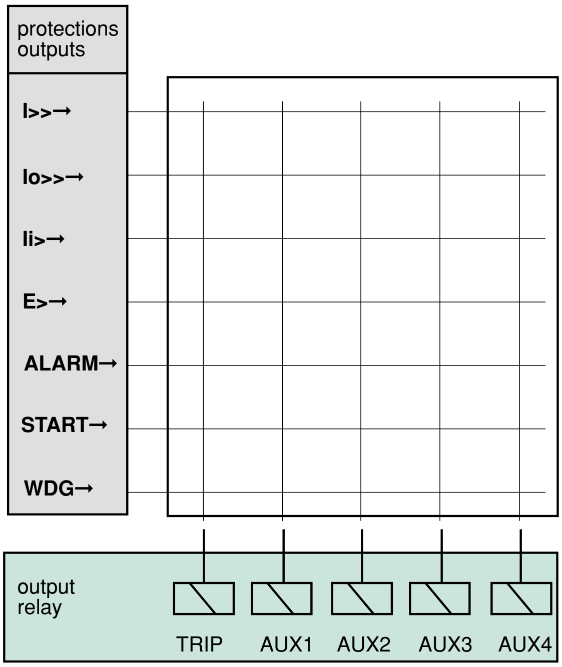


default addressing matrix:

1	0	0	1	0
1	0	0	1	0
1	0	0	0	1
1	0	0	0	1
1	0	0	0	0
0	0	0	0	0
0	0	1	0	0
0	1	0	0	0

Setting output operation parameters

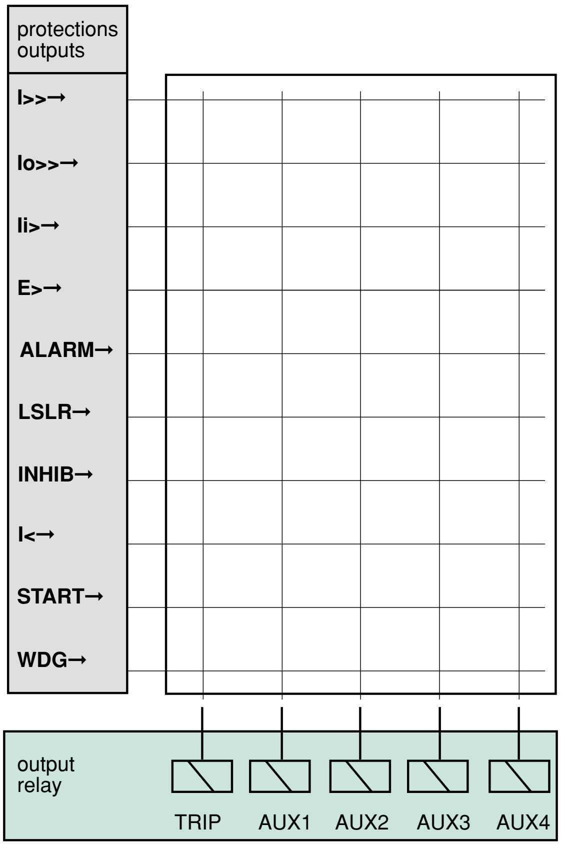
Sepam 1000 addressing matrix type M01



default addressing matrix:

1	0	0	1	0
1	0	0	0	1
1	0	0	0	0
1	0	0	0	0
0	0	0	0	0
0	0	1	0	0
0	1	0	0	0

Sepam 1000 addressing matrix type M02

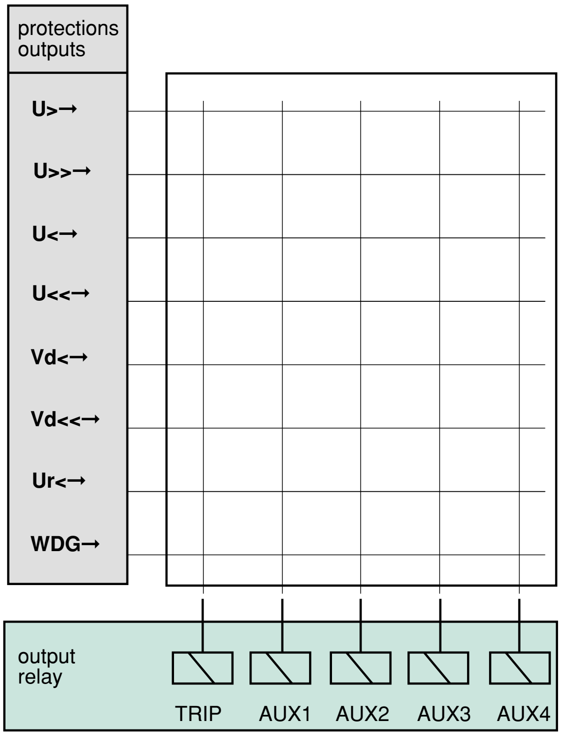


default addressing matrix:

1	0	0	1	0
1	0	0	0	1
1	0	0	0	0
1	0	0	0	0
0	0	0	0	0
1	0	0	0	0
1	0	0	0	0
1	0	0	0	0
0	0	1	0	0
0	1	0	0	0

Setting output operation parameters (cont'd)

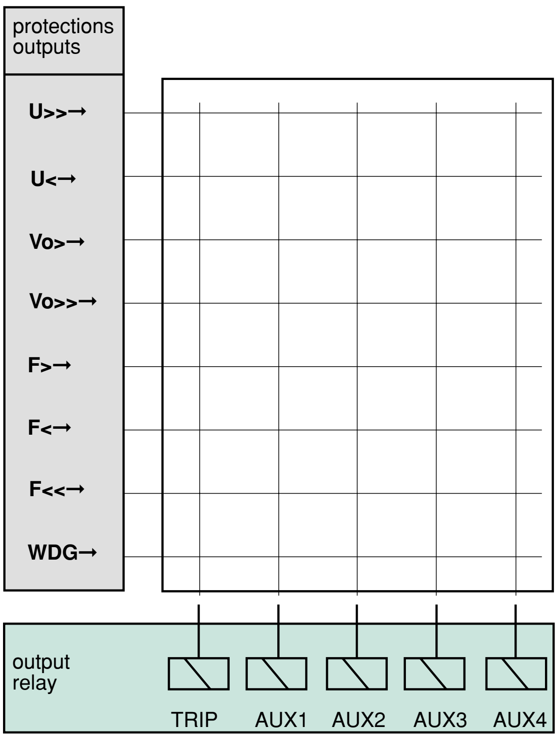
Sepam 1000 addressing matrix type B05



default addressing matrix:

0	0	1	0	0
1	0	0	0	0
1	0	0	0	0
0	0	0	1	0
1	0	0	0	0
0	0	0	1	0
0	0	0	0	1
0	1	0	0	0

Sepam 1000 addressing matrix type B06



default addressing matrix:

1	0	0	0	0
1	0	0	0	0
0	0	1	0	0
1	0	0	0	0
1	0	0	0	0
0	0	0	1	0
1	0	0	0	0
0	1	0	0	0

Setting output operation parameters (cont'd)

Relay latching and acknowledgment
■ latching:

Each of Sepam 1000's 5 relays may be set with or without latching. The choice is made by setting the **LATCH** parameter. A code containing 5 binary figures is used. The same applies to relay output addressing, the first figure in the code corresponding to the **TRIP** relay, the second to the **AUX1** relay, etc. A **1** means that the corresponding relay will be a latching one, a **0** means that it will not be a latching one.

Example: **LATCH = 10000** means that the **TRIP** relay is latching and the others not latching.
The default setting of the **LATCH** parameter is **10000**.
Some outputs are never latching ones, even if they are addressed as latching relays.
Those outputs are:
□ watchdog (**WDG→**),
□ logic discrimination output (**START→**),
□ inhibit starting (**INHIB→**),
□ thermal alarm (**ALARM→**),
□ remanent undervoltage protection output (**Ur<→**),
□ overvoltage protection set point 1 output (**U>→**).
■ acknowledgment:
Protection acknowledgment is only possible when the fault at the origin of tripping has disappeared. Acknowledgment consists of making the tripping order given by the protection drop again in order to control the output relays, the **TRIP** indicator and the message on the display unit.

Program logic for relays with positive contact indication
Program logic relays with positive contact indication are picked up in their normal state and dropped out when they trip.
This reverse program logic makes it possible for tripping to take place due to any type of Sepam fault (loss of power supply or internal failure).
It is customarily used with undervoltage releases.
Each of Sepam 1000 's five relays may be set with program logic with positive contact indication.
The choice is made by setting the **PS** parameter.
A code containing 5 binary figures is used.
A **1** means the relay is set with positive program logic.
Example : **PS = 10001** means that the **TRIP** and **AUX4** relays have positive contact indication.
The default setting of **PS** is **00000**: all the relays have standard program logic by default.
Special case: all relays to which a watchdog output is addressed (**WDG→**) have positive contact indication, whatever the **PS** setting.

Output relay testing

The output relays may be tested by the following two methods:
■ readout of output relay status: Output relay status may be accessed on the display unit via the **OUTPUT** parameter in the **meter** loop, ***Other data*** page. **OUTPUT** is a code which contains 2 or 5 binary figures that correspond to Sepam's 2 or 5 relays. **1** means that the relay is activated, **0** means that it is on standby.
Example 1: **OUTPUT = 01 - - -** the **TRIP** relay is standing by, the **AUX1** relay is activated. Sepam only has 2 output relays.
Example 2: **OUTPUT = 01011** the **TRIP** and **AUX2** relays are on standby, the **AUX1**, **AUX3** and **AUX4** relays are activated.
This function may be used to check addressing settings and program logic settings.
■ output relay testing: This function may be used to activate each output relay separately. A parameter named **TEST** appears in the **status** loop, ***Input/output*** page. The **data-** and **data+** may be used in parameter setting mode to designate a Sepam output relay (e.g. **TEST = AUX1**). Pressing the **enter** key will then change the relay status. This function is used to test each relay and circuit which contains it.

Setting the logic input operation parameter

The operation of Sepam 1000's logic input may be set via the keyboard.
The **INP1** parameter, which is accessed in the **status** loop, ***Input/output*** page allows the user to choose the function.

Status readout function: (default setting)
The **INP1** = **STATUS** setting gives the logic input the status readout function. Input status may be accessed on the display unit via the **INPUT** parameter, which may be called up in the **meter** loop, ***Other data*** page.
INPUT = 0: input in low status
INPUT = 1: input is high status
This function is always available, regardless of the input parameter.

Blocking function
The **INP1** = **BLOCK.** setting gives the logic input the blocking function.
This function is part of the logic discrimination system included in Sepam 1000 type S01 and T01.

Acknowledgment function
The **INP1** = **RESET** setting gives the logic input the remote acknowledgment function. When the input switches to high status, all the latched protections are acknowledged. If the fault at the origin of tripping is still present, it is impossible to acknowledge the corresponding protection. Unlike the **reset** key on the front of the device, the logic input does not allow maximum demands and the running hours counter to be reset to zero.

Remote tripping function
The **INP1** = **TRIP** setting gives the logic input the remote tripping function.
When the input switches to high status, **TRIP** relay control is triggered throughout the duration of high status, whether or not the relay is a latching one.
There is no annunciation related to tripping on the front of Sepam.

Control and monitoring functions (cont'd)

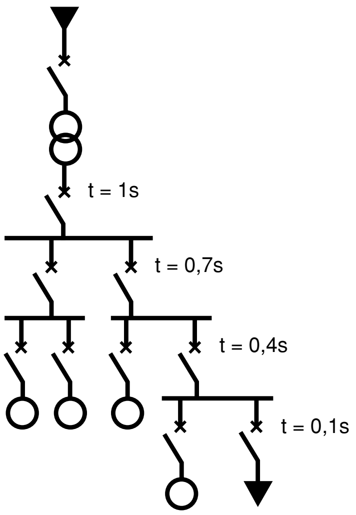
Annunciation

Alarm messages
An alarm message appears on the display unit whenever a protection set point is crossed.
Alarm messages are displayed steadily and disappear at the same time as the fault.
When several types of fault occur at the same time, only the last fault to appear triggers an alarm message.

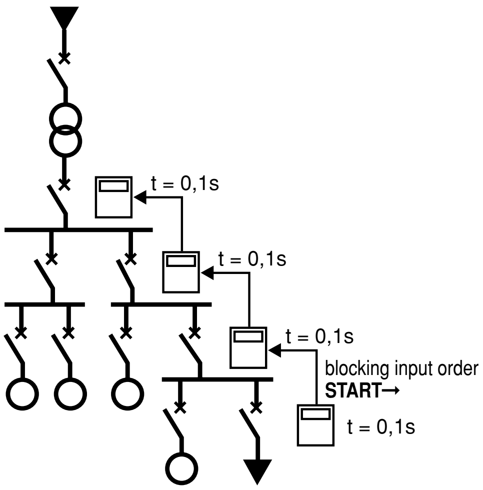
Tripping messages
A blinking tripping message indicating the type of fault appears on the display unit whenever a protection trips. Sepam stores all the tripping messages that are transmitted consecutively during operation.
Readout of the stored messages is obtained by pressing the **reset** key.
Tripping messages are always latched ones when they are transmitted by a protection that controls the **TRIP** output relay (tripping relay).
They are also latched when they are transmitted by a protection that controls one or more latching auxiliary relays.
Latched messages are saved in the event of an auxiliary power supply failure.

Logic discrimination

Use
This function is used to obtain:
■ full tripping discrimination,
■ a substantial reduction in delayed tripping of the circuit breakers located nearest to the source (drawback of the classical time-based discrimination fuction).
This system applies to the definite time (DT) and IDMT (standard inverse time SIT, very inverse time VIT, extremely inverse time EIT, ultra inverse time UIT, and RI curve) phase overcurrent and earth fault protections.



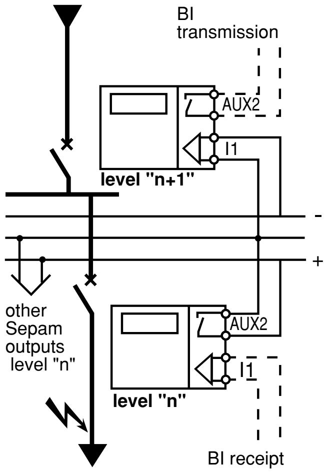
Radial distribution with use of time-based discrimination td: tripping time, definite time curves).



Radial distribution with use of the Sepam 1000 and Sepam 2000 logic discrimination system.

With this type of system, the time delays should be set with respect to the element to be protected without considering the discrimination aspect.

Operating principle



When a fault occurs in a radial network, the fault current flows through the circuit between the source and the location of the fault:

- the protections upstream from the fault are triggered,
- the protections downstream from the fault are not triggered,
- only the first protection upstream from the fault should trip.

Each Sepam is capable of transmitting and receiving blocking input (BI) orders.
When a Sepam is triggered by a fault current:

- it transmits a blocking input order from output AUX2 (**START→**) information,
- it trips the associated circuit breaker if it does not receive a blocking input order on input I1.

Transmission of the blocking input lasts for the time required to clear the fault.
It is interrupted after a 200ms time delay that takes into account the breaking device operating time and the protection returning time.
Phase overcurrent and earth fault protection include 2 sets of time delay:

- protection time delay (t >, t >>, to>, to>>),
- logic funtion time delay (t >Is, t >>Is, to>Is, to>>Is).

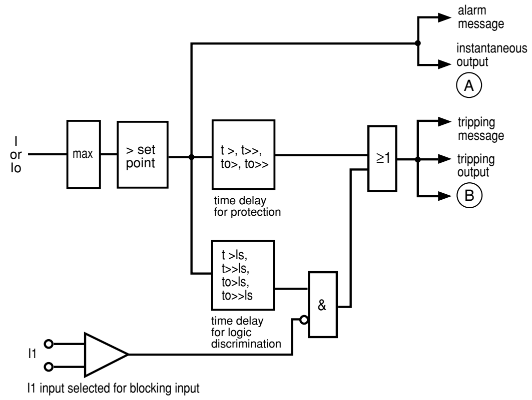
The last time delay group is activated by I1 input (when I1 is selected as blocking input).
This system makes it possible to minimize the duration of the fault, optimize discrimination and guarantee safety in downgraded situations (wiring or switchgear failures).

(*) Motor Sepam do not involve the receipt of blocking inputs.

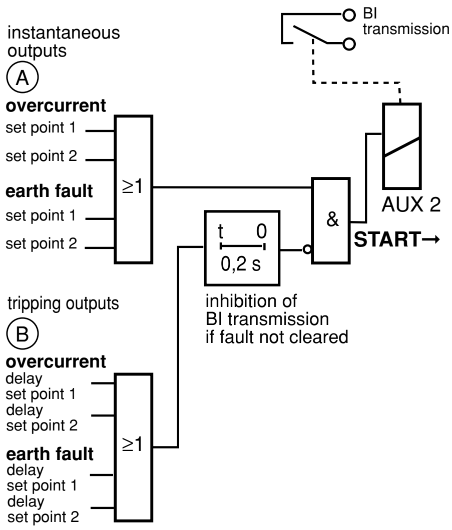
Logic discrimination (cont')

Block diagram, phase overcurrent and earth fault protection:

When I1 is selected for blocking input earth overcurrent and earth fault, protection is a follows:



Block diagram:Transmission of blocking information



Commissioning, settings

■ connect pilot wire from Sepam level n output **AUX2** to Sepam level **n+1** input I1 (**blocking input**),

■ rset protection set points.

N.B. Avoid time delay setting lower than 100 ms, or short time delay for IDMT curves and high current value.

Time delay are setted as follows:

function		selectivity
max.I /low set max.I /high set	t> t>>	time
max.Io /low set max.Io /high set	to> to>>	time
max.I /low set max.I /high set	t>Is t>>Is	logic
max.Io /low set max.Io /high set	to>Is to>>Is	logic

Pilot wire testing

The test function (in the **status** loop, ***input/outut*** page) allows to transmit a BI. Sepam that receive the BI will display the message INPUT=1 in the loop **meter** page ***other data***.

Characteristics

Electrical characteristics

analogic input				
current transformer 10 A to 6250 A ratings		CT 1 A CT 5 A	< 0.001 VA < 0.025 VA	
voltage transformer 220 V to 250 kV ratings		100 to 120 V	> 100 kΩ	
logic input				
voltage		24/ 250 Vdc	127/ 240 Vac	
consumption		6 mA	6 mA	
logic output (contacts O1, O6, O7, O8) [3]				
voltage		24/ 48 Vdc	127 Vdc/ Vac	220 Vdc/ Vac
rated current		8 A	8 A	8 A
breaking capacity	dc. résistive load	4 A	0.7 A	0.3 A
	ac. résistive load	8A	8 A	8 A
auxiliary power supply				
	range	typical consumption	max consumption	inrush current
24/30 Vdc	±20%	10 W	10 W	< 10 A for 10 ms
48/125 Vdc	±20%	5 W	10 W	< 10 A for 10 ms
220/250 Vdc	-20%, +10%	5 W	10 W	< 10 A for 10 ms
100/127 Vac	+20%	5 VA	12 VA	< 15 A for 10 ms
220/240 Vac	-20%, +10%	7 VA	12 VA	< 15 A for 10 ms
operating frequency	ac. supply	47.5 to 63 Hz		

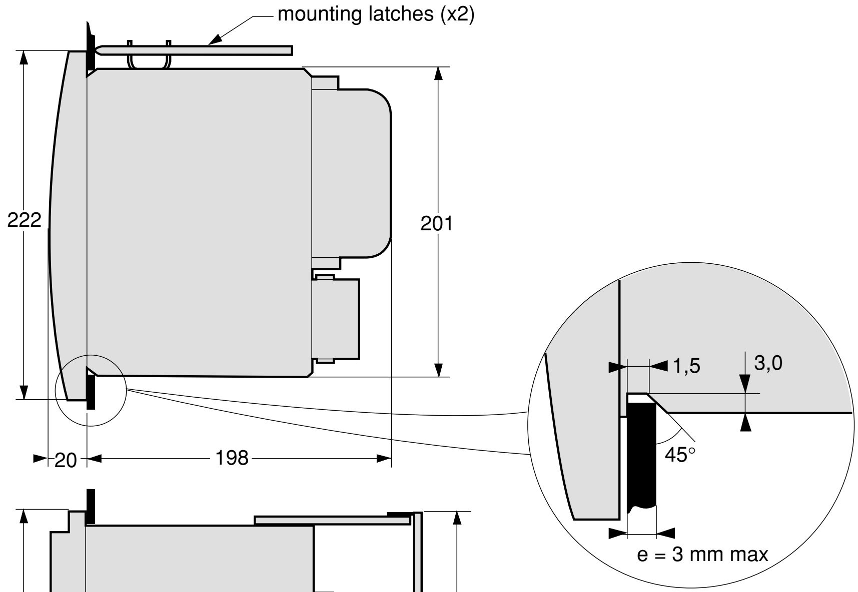
Environmental characteristics [3]

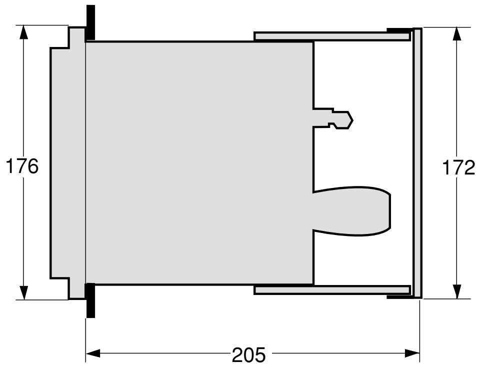
dielectric			
industrial frequency	IEC 60255-4 [1]		2 kV - 1 min.
climatic			
operation	IEC 60068-2		-5°C to 55°C
storage	IEC 60068-2		-25°C to 70°C
damp heat	IEC 60068-2		95% to 40°C
corrosion influence	IEC 60654-4	class I	
mechanical			
degree of protection	IEC 60529	IP.51	front face
vibrations	IEC 60255-21-1	class I	
shocks	IEC 60255-21-2	class I	
fire	NFC 20455		glow wire
electromagnetic			
radiation	IEC 60255-22-3	class x	30 V/m
electrostatic discharge	IEC 60255-22-2	class III	
electrical			
1.2/50 µs impulse wave withstand	IEC 60255-4 [1]		5 kV
damped 1 MHz wave	IEC 60255-22-1	class III	
5 ns fast transients	IEC 60255-22-4	class IV	

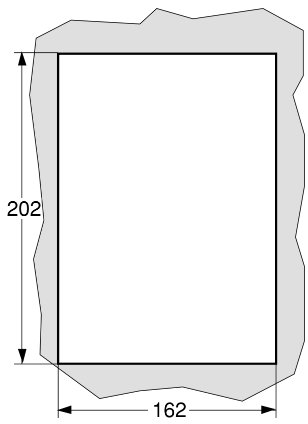
[1] Printed in 1976 and amended in 1979.
[2] Pending.
[3] For more information, refer to “General characteristics n° 3140752” document.

Size and weight

Sepam 1000







Sepam 1000 equiped with
rear cover "AMT 813"

weight : ~ 3.5 Kg

Connections

	type	wiring/ cabling
current transformer	screw for Ø4 eye lug	≤ 6 mm² ≥ AWG10
CSH core balance CTs	screw	≤ 2.5 mm² ≥ AWG12
CSP sensors	BNC connector	CCA601 cable: 4 m long
voltage transformer	screw	≤ 2.5 mm²
logic inputs	screw	≤ 2.5 mm²
logic outputs	screw	≤ 2.5 mm²
power supply	screw	≤ 2.5 mm²

Notes

Ordering information

When ordering, please enclose a photocopy of this page with your order, filling in the reguested quantities us the spaces provided ⌊____⌋ and ticking off the boxes ☐ to indicate your choices.

Sepam 1000

quantity ⌊____⌋

type of Sepam		
substation	SO1	☐
transformer	TO1	☐
motor	MO1	☐
	MO2	☐
busbars	BO5	☐
	BO6	☐
current sensors	1 A/ 5 A CT	☐
	CSP	☐
auxiliary power supply	24/ 30 Vcdc	☐
	48/ 125 Vdc	☐
	220/ 250 Vdc	☐
	100/ 127 Vac	☐
	220/ 240 Vac	☐
ES1 board (optional)		☐
user's manual	french	☐
	english	☐

Accessories

		quantity
residual current sensors	CSH 120	⌊____⌋
	CSH 200	⌊____⌋
interposing ring CT for residual current input	CSH 30	⌊____⌋
rear cover (lead sealing kit)	AMT 813	⌊____⌋

Schneider Electric SA

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