Sepam series 60

Selection table

Protection	ANSI code	Substation S60	Substation S62	Transformer T60	Transformer T62	Motor M61	Generator G60	Generator G62	Cap. C60
Phase overcurrent (1)	50/51	4	4	4	4	4	4	4	4
Earth fault / Sensitive earth fault (1)	50N/51N 50G/51G	4	4	4	4	4	4	4	4
Breaker failure	50BF	1	1	1	1	1	1	1	1
Negative sequence / unbalance	46	2	2	2	2	2	2	2	2
Thermal overload for cables	49RMS		1						
Thermal overload for machines (1)	49RMS			2	2	2	2	2	
Thermal overload for capacitors	49RMS								1
Restricted earth fault	64REF			2	2				
Directional phase overcurrent (1)	67		2		2			2	
Directional earth fault (1)	67N/67NC		2		2	2		2	
Directional active overpower	32P		2		2	2	2	2	
Directional reactive overpower	32Q					1	1	1	
Directional active underpower	37P						2	2	
Phase undercurrent	37					1			
Excessive starting time, locked rotor	48/51LR/14					1			
Starts per hour	66					1			
Field loss (underimpedance)	40					1	1	1	
Overspeed (2 set points) (2)	12					□	□	□	
Underspeed (2 set points) (2)	14					□	□	□	
Voltage-restrained overcurrent	50V/51V						1	1	
Underimpedance	21B						1	1	
Undervoltage (L-L or L-N)	27	2	2	2	2	2	2	2	2
Positive sequence undervoltage	27D	2	2	2	2	2	2	2	2
Remanent undervoltage	27R	2	2	2	2	2	2	2	2
Overvoltage (L-L or L-N)	59	2	2	2	2	2	2	2	2
Neutral voltage displacement	59N	2	2	2	2	2	2	2	2
Negative sequence overvoltage	47	2	2	2	2	2	2	2	2
Overfrequency	81H	2	2	2	2	2	2	2	2
Underfrequency	81L	4	4	4	4	4	4	4	4
Rate of change of frequency	81R	2	2				2	2	
Recloser (4 cycles) (2)	79	□	□						
Thermostat / Buchholz (2)	26/63			□	□	□	□	□	
Temperature monitoring (16 RTDs) (3)	38/49T			□	□	□	□	□	□
Synchro-check (4)	25	□	□	□	□		□	□	
Control and monitoring									
Circuit breaker / contactor control (2)	94/69	□	□	□	□	□	□	□	□
Automatic transfer (AT) (2)		□	□	□	□		□	□	
Load shedding / automatic restart (2)						□			
De-excitation (2)							□	□	
Genset shutdown (2)							□	□	
Logic discrimination (2)	68	□	□	□	□	□	□	□	□
Latching / acknowledgement	86	■	■	■	■	■	■	■	■
Annunciation	30	■	■	■	■	■	■	■	■
Switching of groups of settings		■	■	■	■	■	■	■	■
Adaptation using logic equations		■	■	■	■	■	■	■	■

The figures indicate the number of relays available for each protection function.
■ standard, □ options.
***(1)** Protection functions with 2 groups of settings.*
***(2)** According to parameter setting and optional MES120 input/output modules.*
***(3)** With optional MET148-2 temperature input modules.*
***(4)** With optional MCS025 synchro-check module.*

***(1)** Protection functions with 2 groups of settings.*

Selection table

Metering	Substation S60	Substation S62	Transformer T60	Transformer T62	Motor M61	Generator G60	Generator G62	Cap. C60
Phase current I1, I2, I3 RMS	■	■	■	■	■	■	■	■
Residual current Io, sum Io	■	■	■	■	■	■	■	■
Demand current I1, I2, I3	■	■	■	■	■	■	■	■
Peak demand current IM1, IM2, IM3	■	■	■	■	■	■	■	■
Voltage U21, U32, U13, V1, V2, V3	■	■	■	■	■	■	■	■
Residual voltage V0	■	■	■	■	■	■	■	■
Positive sequence voltage Vd / rotation direction	■	■	■	■	■	■	■	■
Negative sequence voltage Vi	■	■	■	■	■	■	■	■
Frequency	■	■	■	■	■	■	■	■
Active power P, P1, P2, P3	■	■	■	■	■	■	■	■
Reactive power Q, Q1, Q2, Q3	■	■	■	■	■	■	■	■
Apparent power S, S1, S2, S3	■	■	■	■	■	■	■	■
Peak demand power PM, QM	■	■	■	■	■	■	■	■
Power factor	■	■	■	■	■	■	■	■
Calculated active and reactive energy (±Wh, ±VARh)	■	■	■	■	■	■	■	■
Active and reactive energy by pulse counting (2) (± Wh, ± VARh)	□	□	□	□	□	□	□	□
Temperature (16 RTDs) (3)			□	□	□	□	□	
Rotation speed (2)					□	□	□	
Network and machine diagnosis								
Tripping context	■	■	■	■	■	■	■	■
Tripping current Trip I1, Trip I2, Trip I3, Trip Io	■	■	■	■	■	■	■	■
Phase fault and earth fault trip counters	■	■	■	■	■	■	■	■
Unbalance ratio / negative sequence current Ii	■	■	■	■	■	■	■	■
Harmonic distortion (THD)	■	■	■	■	■	■	■	■
Current and voltage Ithd, Uthd	■	■	■	■	■	■	■	■
Phase displacement φ1, φ2, φ3	■	■	■	■	■	■	■	■
Disturbance recording recorded	■	■	■	■	■	■	■	■
Motor start report (MSR)					■			
Motor start trend (MST)					■			
Data log (DLG)	■	■	■	■	■	■	■	■
Thermal capacity used		■	■	■	■	■	■	■
Remaining operating time before overload tripping		■	■	■	■	■	■	■
Waiting time after overload tripping		■	■	■	■	■	■	■
Running hours counter / operating time			■	■	■	■	■	■
Starting current and time					■			
Start inhibit time					■			
Number of starts before inhibition					■			
Cable arcing fault detection	■	■	■	■	■	■	■	■
Apparent positive sequence impedance Zd	■	■	■	■	■	■	■	■
Apparent phase-to-phase impedances Z21, Z32, Z13	■	■	■	■	■	■	■	■
Third harmonic voltage, neutral point or residual						■	■	
Difference in amplitude, frequency and phase of voltages compared for synchro-check (4)	□	□	□	□		□	□	

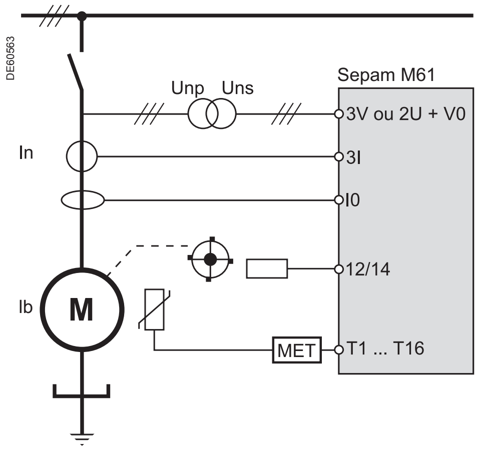
Switchgear diagnosis	ANSI code	S60	S62	T60	T62	M61	G60	G62	C60
CT / VT supervision	60/60FL	■	■	■	■	■	■	■	■
Trip circuit supervision (2)	74	□	□	□	□	□	□	□	□
Cumulative breaking current		■	■	■	■	■	■	■	■
Number of operations, operating time, charging time, number of racking out operations (2)		□	□	□	□	□	□	□	□

Additional modules	S60	S62	T60	T62	M61	G60	G62	C60
8 temperature sensor inputs - MET148-2 module (2)			□	□	□	□	□	□
1 low level analog output - MSA141 module	□	□	□	□	□	□	□	□
Logic inputs/outputs - MES120/MES120G/MES120H (14I/6O) module	□	□	□	□	□	□	□	□
Communication interface - ACE949-2, ACE959, ACE937, ACE969TP-2, ACE969FO- 2, ECI850, ACE850TP or ACE850FO	□	□	□	□	□	□	□	□

■ standard, □ options.
***(2)** According to parameter setting and optional MES120 input/output modules.*
***(3)** With optional MET148-2 temperature input modules.*
***(4)** With optional MCS025 synchro-check module.*

3

Sensor inputs



Sepam M61 sensor inputs.

Sepam series 60 has analog inputs that are connected to the measurement sensors required for applications:

■ main analog inputs, available on all types of Sepam series 60:
□ 3 phase current inputs I1, I2, I3
□ 1 residual current input I0
□ 3 phase voltage inputs V1, V2, V3 or 2 phase voltage and 1 residual voltage input V0.

The table below lists the analog inputs available according to the type of Sepam series 60.

		S60, S62	T60, T62, M61, G60, G62, C60
Phase current inputs	Main channel	I1, I2, I3	I1, I2, I3
Residual current inputs	Main channel	I0	I0
Unbalance current inputs for capacitor bank			I0
Phase voltage inputs	Main channel	V1, V2, V3 or U21, U32 (1)	V1, V2, V3 or U21, U32 (1)
Residual voltage inputs	Main channel	V0	V0
Temperature inputs (on MET148-2 module)			T1 to T16

***(1)** See VT connections diagram for Sepam series 60.*

3

General settings

The general settings define the characteristics of the measurement sensors connected to Sepam and determine the performance of the metering and protection functions used. They are accessed via the SFT2841 setting software “General Characteristics”, “CT-VT Sensors” and “Particular characteristics” tabs.

General settings		Selection	Value
In	Rated phase current (sensor primary current)	2 or 3 1 A / 5 A CTs	1 A to 6250 A
		3 LPCTs	25 A to 3150 A (1)
	Unbalance current sensor rating (capacitor application)	CT 1 A / 2 A / 5 A	1 A to 30 A
Ib	Base current, according to rated power of equipment		0.2 to 1.3 In
	Base current on additional channels (not adjustable)	Applications with transformer	I’b = Ib x Un1/Un2
		Other applications	I’b = Ib
In0	Rated residual current	Sum of 3 phase currents	See In(I’n) rated phase current
		CSH120 or CSH200 core balance CT	2 A or 20 A rating
		1 A/5 A CT + CSH30 interposing ring CT	1 A to 6250 A
		Core balance CT + ACE990 (the core balance CT ratio 1/n must be such that 50 y n y 1500)	According to current monitored and use of ACE990
Unp	Rated primary phase-to-phase voltage (Vnp: rated primary phase-to-neutral voltage Vnp = Unp/√3)		220 V to 250 kV
Uns	Rated secondary phase-to-phase voltage	3 VTs: V1, V2, V3	90 to 230 V
		2 VTs: U21, U32	90 to 120 V
		1 VT: U21	90 to 120 V
		1 VT: V1	90 to 230 V
Uns0	Secondary zero sequence voltage for primary zero sequence voltage Unp/√3		Uns/3 or Uns/3
Vntp	Neutral point voltage transformer primary voltage (generator application)		220 V to 250 kV
Vnts	Neutral point voltage transformer secondary voltage (generator application)		57.7 V to 133 V
fn	Rated frequency		50 Hz or 60 Hz
	Phase rotation direction		1-2-3 or 1-3-2
	Integration period (for demand current and peak demand current and power)		5, 10, 15, 30, 60 min
	Pulse-type accumulated energy meter	Increments active energy	0.1 kWh to 5 MWh
		Increments reactive energy	0.1 kVARh to 5 MVARh
P	Rated transformer power		100 kVA to 999 MVA
Ωn	Rated speed (motor, generator)		100 to 3600 rpm
R	Number of pulses per rotation (for speed acquisition)		1 to 1800 (Ωn x R/60 y 1500)
	Zero speed set point		5 to 20 % of Ωn

***(1)** In values for LPCT, in Amps: 25, 50, 100, 125, 133, 200, 250, 320, 400, 500, 630, 666, 1000, 1600, 2000, 3150.*

Metering and diagnosis
Description

Metering
Sepam is a precision metering unit.
All the metering and diagnosis data used for commissioning and required
for the operation and maintenance of your equipment are available locally
or remotely, expressed in the units concerned (A, V, W, etc.).

Phase current
RMS current for each phase, taking into account harmonics up to number 13.
Different types of sensors may be used to meter phase current:
■ 1 A or 5 A current transformers
■ LPCT type current sensors.

Residual current
Two residual current values are available depending on the type of Sepam and sensors connected to it:
■ residual current I0S, calculated by the vector sum of the 3 phase currents
■ measured residual current I0.
Different types of sensors may be used to measure residual current:
■ CSH120 or CSH200 specific core balance CT
■ conventional 1 A or 5 A current transformer
■ any core balance CT with an ACE990 interface.

Demand current and peak demand currents
Demand current and peak demand currents are calculated according to the 3 phase currents I1, I2 and I3:
■ demand current is calculated over an adjustable period of 5 to 60 minutes
■ peak demand current is the greatest demand current and indicates the current drawn by peak loads.
Peak demand currents may be cleared.

Voltage and frequency
The following measurements are available according to the voltage sensors connected:
■ phase-to-neutral voltages V1, V2, V3
■ phase-to-phase voltages U21, U32, U13
■ residual voltage V0 or neutral point voltage Vnt
■ positive sequence voltage Vd and negative sequence voltage Vi
■ frequency measured on the main voltage channels.

Power
Powers are calculated according to the phase currents I1, I2 and I3:
■ active power
■ reactive power
■ apparent power
■ power factor (cos φ).
According to the sensors used, power calculations may be based on the 2 or 3 wattmeter method.
The 2 wattmeter method is only accurate when there is no residual current and it is not applicable if the neutral is distributed.
The 3 wattmeter method gives an accurate calculation of 3-phase and phase by phase powers in all cases, regardless of whether or not the neutral is distributed.

Peak demand powers
The greatest demand active and reactive power values calculated over the same period as the demand current. The peak demand powers may be cleared.

Energy
■ 4 accumulated energies calculated according to voltages and phase currents I1, I2 and I3 measured: active energy and reactive energy in both directions
■ 1 to 4 additional accumulated energy meters for the acquisition of active or reactive energy pulses from external meters.

Temperature
Accurate measurement of temperature inside equipment fitted with Pt100, Ni100 or Ni120 type RTDs, connected to the optional remote MET148-2 module.

Rotation speed
Calculated by the counting of pulses transmitted by a proximity sensor at each passage of a cam driven by the rotation of the motor or generator shaft.
Acquisition of pulses on a logic input.

Phasor diagram
A phasor diagram is displayed by SFT2841 software and the mimic-based UMI to check cabling and assist in the setting and commissioning of directional protection functions.
According to the connected sensors, all current and voltage information can be selected for display in vector form.

Data log (DLG)
This function is used to record and back up a set of measurements (1 to 15) available in the Sepam relay. The number of backed-up files and the number of measurements per file depend on the type of cartridge installed (extended cartrige available for Sepam 80 only). The recording mode and selection of measurements can be configured by the user via the SFT2841 software.

All trip of the function results from an external event (TC for example). The stop condition and file management differ according to which of the following 2 modes is used:
a) Limited: the DLG function stops automatically when the end of recording time is reached or on receipt of an external event (TC for example).
b) Circular: the file content is managed in a FIFO memory: when the file is full, the write operation continues and starts again at the start of the file. Stopping the write operation only results from an external event (TC for example). In the absence of the stop command, recording is continuous.

Using the DLG function does not affect the quality of service of Sepam's active protection functions.

Characteristics

Configuration parameters	
Content of a COMTRADE file	■ Configuration file (*.CFG) : date, variable characteristics, transformation ratio of the selected variable values ■ Samples file(*.DAT): recorded variables
Total file duration	1 s to 30 days
Sampling period	1 s to 24 hours
Variables available for recording	See the table of available data p.99/100.
Number of files	1 à 20
Number of variables per file	1 à 15
Source of starting and stopping	■ SFT 2841 software ■ Logic equation or Logipam ■ TC ■ Logic or GOOSE input
File format	COMTRADE 9

Nota : These parameters are configured with the SFT2841 software.

Metering and diagnosis
Description

Network diagnosis assistance
Sepam provides network power quality metering functions, and all the data on network disturbances detected by Sepam are recorded for analysis purposes.

Tripping context
Storage of tripping currents and I0, Ii, U21, U32, U13, V1, V2, V3, V0, Vi, Vd, F, P, Q and Vnt values when tripping occurs. The values for the last five trips are stored.

Tripping current
Storage of the 3 phase currents and earth fault current at the time of the last Sepam trip order, to indicate fault current.
The values are stored in the tripping contexts.

Number of trips
2 trip counters:
- number of phase fault trips, incremented by each trip triggered by ANSI 50/51, 50V/51V and 67 protection functions
- number of earth fault trips, incremented by each trip triggered by ANSI 50N/51 and 67N/67NC protection functions.

Negative sequence / unbalance
Negative sequence component of phase currents I1, I2 and I3, indicating the degree of unbalance in the power supplied to the protected equipment.

Total harmonic distortion
Two THD values calculated to assess network power quality, taking into account harmonics up to number 13:
- current THD, calculated according to I1
- voltage THD, calculated according to V1 or U21.

Phase displacement
- phase displacement φ1, φ2, φ3 between phase currents I1, I2, I3 and voltages V1, V2, V3 respectively
- phase displacement φ0 between residual current and residual voltage.

Disturbance recording
Recording triggered by user-set events:
- all sampled values of measured currents and voltages
- status of all logic inputs and outputs logic data: pick-up, …

Recording characteristics		
Number of recordings in COMTRADE format		Adjustable from 1 to 19
Total duration of a recording		Adjustable from 1 to 11 s
Number of samples per period		12 or 36
Duration of recording prior to occurrence of the event		Adjustable from 0 to 99 periods
Maximum recording capability		
Network frequency	**12 samples per period**	**36 samples per period**
50 Hz	22 s	7 s
60 Hz	18 s	6 s

Voltage comparison for synchro-check
For the synchro-check function, the MCS025 module continuously measures the amplitude, frequency and phase differences between the 2 voltages to be checked.

Out-of-sync context
Storage of amplitude, frequency and phase differences between the 2 voltages measured by the MCS025 module when a closing order is inhibited by the synchro-check function.

3

Metering and diagnosis
Description

Machine diagnosis assistance

Sepam assists facility managers by providing:

- data on the operation of their machines
- predictive data to optimize process management
- useful data to facilitate protection function setting and implementation.
- recording data during motor start (MSR) and create trend graphics (MST).

Thermal capacity used

Equivalent temperature buildup in the machine, calculated by the thermal overload protection function.
Displayed as a percentage of rated thermal capacity.

Remaining operating time before overload tripping

Predictive data calculated by the thermal overload protection function.
The time is used by facility managers to optimize process management in real time by deciding to:

- interrupt according to procedures
- continue operation with inhibition of thermal protection on overloaded machine.

Waiting time after overload tripping

Predictive data calculated by the thermal overload protection function.
Waiting time to avoid further tripping of thermal overload protection by premature re-energizing of insufficiently cooled down equipment.

Running hours counter / operating time

Equipment is considered to be running whenever a phase current is over 0.1 Ib.
Cumulative operating time is given in hours.

Motor starting / overload current and time

A motor is considered to be starting or overloaded when a phase current is over 1.2 Ib. For each start / overload, Sepam stores:

- maximum current drawn by the motor
- starting / overload time.

The values are stored until the following start / overload.

Number of starts before inhibition/start inhibit time

Indicates the number of starts still allowed by the starts per hour protection function and, if the number is zero, the waiting time before starting is allowed again.

Apparent positive sequence impedance Zd

Value calculated to facilitate the implementation of the underimpedance field loss protection (ANSI 40).

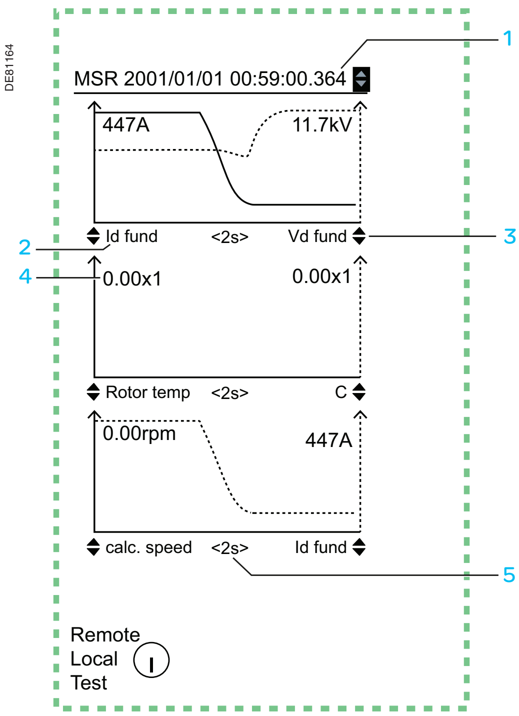
Apparent phase-to-phase impedances Z21, Z32, Z13

Values calculated to facilitate the implementation of the backup underimpedance protection function (ANSI 21B).

Capacitance

Measurement, for each phase, of the total capacitance of the connected capacitor bank. This measurement is used to monitor the condition of the capacitors.

Visualisation of 3 graphics MSR via an integrated synoptic HMI.



1 Time tagging of the selected file and file selection zone

2 Name of the 1st variable associated with the Y-axis

3 Selection zone for the variable to be associated with the Y-axis

4 Maximum value observed for the recorded

Motor Start Report (MSR)

This function, available only in motor applications, can stock during a configured duration multiple files of 144 data samples selected.

Read

The files can be viewed:

a) after downloading, on a PC screen, using the WaveWin software
b) on the Sepam display using the Diagnosis menu.

Metering and diagnosis
Description

Caractéristiques	
Paramètres de configuration	
Content of a COMTRADE file	■ Fichier de configuration (*.CFG): date, variable characteristics, transformation ratio of the selected variable values ■ Samples file (*.DAT) : recorded variables
Total file duration	2 s to 144 s
Sampling frequency	Depends on the configured duration (144 s maximum). Example: For a duration of 144 s the frequency is 1 Hz, for a duration of 2 s the frequency is 72 Hz.
Variables available for recording	See the table of available data . p. 99 /100
Number of files	■ 1 to 5 with standard cartridge ■ 1 to 20 with extended cartridge
Number of variables per file	■ 1 to 5 with standard cartridge ■ 1 to 10 with extended cartridge
Source of starting and stopping	■ SFT 2841 software ■ Logic equation or Logipam ■ TC ■ Logic or GOOSE input
File format	COMTRADE 97

Nota : These parameters are configured with the SFT2841 software.

Motor Start Trend (MST)

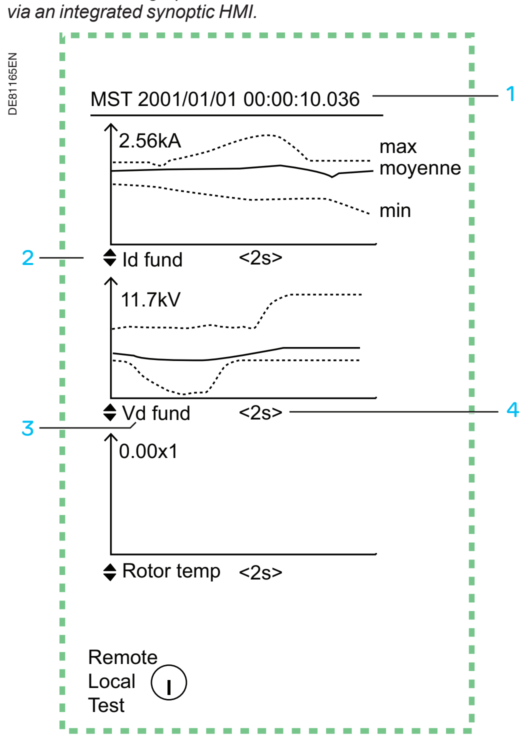
This function, only available for motor applications, is related to the Motor start trend function. It is used to calculate and display in the form of curves the minimum, demand and maximum values for each value.

These recalculated values which are stored in a file of 144 samples covering a 30-day period. When the current 30-day period has ended, it is automatically archived in COMTRADE format and will no longer be able to be viewed on the Sepam display

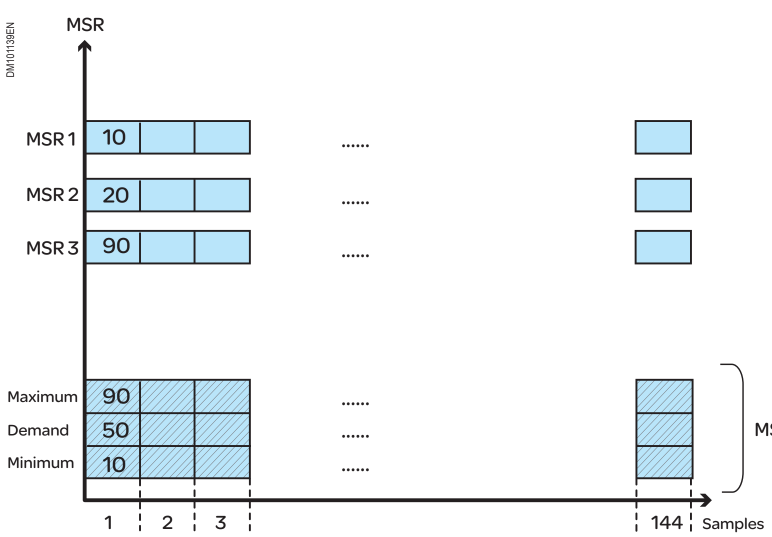
The number of files available varies between 12 and 18 depending on the type of memory cartridge (standard or extended) installed on Sepam

The trends are only recalculated at the end of each Motor start report.

Visualisation of 3 graphics MST via an integrated synoptic HMI.



1 Time tagging of the current file
2 Selection of the variable to be associated with the Y-axis
3 Name of the analyzed variable
4 Duration of read time for each file



Calculating an MST using the available MSRs.

Metering and diagnosis

Description

Sepam self-diagnosis

Sepam includes a number of self-tests carried out in the base unit and optional modules. The purpose of the self-tests is to:
- ■ detect internal failures that may cause nuisance tripping or failed fault tripping
- ■ put Sepam in fail-safe position to avoid any unwanted operation
- ■ alert the facility manager of the need for maintenance operations.

Internal failure

Two categories of internal failures are monitored:
- ■ major failures: Sepam shutdown (to fail-safe position).

The protection functions are inhibited, the output relays are forced to drop out and the "Watchdog" output indicates Sepam shutdown
- ■ minor failures: downgraded Sepam operation.

Sepam's main functions are operational and equipment protection is ensured.

Battery monitoring

Monitoring of battery voltage to guarantee data is saved in the event of an outage.
A battery fault generates an alarm.

Detection of plugged connectors

The system checks that the current or voltage sensors are plugged in. A missing connector is a major failure.

Configuration checking

The system checks that the optional modules configured are present and working correctly.
The absence or failure of a remote module is a minor failure, the absence or failure of a logic input/output module is a major failure.

Switchgear diagnosis assistance

Switchgear diagnosis data give facility managers information on:
- ■ mechanical condition of breaking device
- ■ Sepam auxiliaries

and assist them for preventive and curative switchgear maintenance actions.
The data are to be compared to switchgear manufacturer data.

ANSI 60/60FL - CT/VT supervision

Used to monitor the entire metering chain:
- ■ CT and VT sensors
- ■ connection
- ■ Sepam analog inputs.

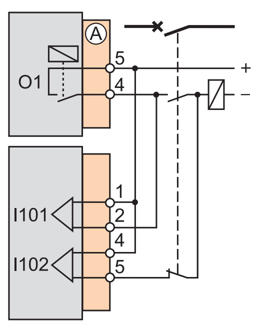
Monitoring includes:
- ■ consistency checking of currents and voltages measured
- ■ acquisition of phase or residual voltage transformer protection fuse blown contacts.

In the event of a loss of current or voltage measurement data, the assigned protection functions may be inhibited to avoid nuisance tripping.

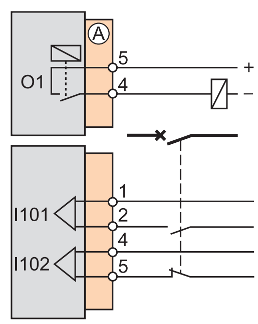
ANSI 74 - Trip/closing circuit supervision

To detect trip circuit and closing circuit failures, Sepam monitors:
- ■ shunt trip coil connection
- ■ closing coil connection
- ■ matching of breaking device open/closed position contacts
- ■ execution of breaking device open and close orders.

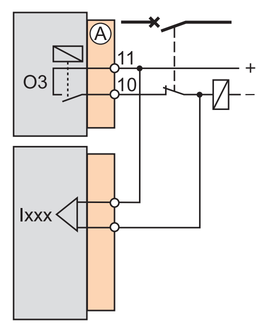
The trip and closing circuits are only supervised when connected as shown below.



Connection for shunt trip coil monitoring.



Connection for undervoltage trip coil monitoring.



Connection for closing circuit supervision

Cumulative breaking current monitoring

Six cumulative currents are proposed to assess breaking device pole condition:
- ■ total cumulative breaking current
- ■ cumulative breaking current between 0 and 2 In
- ■ cumulative breaking current between 2 In and 5 In
- ■ cumulative breaking current between 5 In and 10 In
- ■ cumulative breaking current between 10 In and 40 In
- ■ cumulative breaking current > 40 In.

Each time the breaking device opens, the breaking current is added to the cumulative total and to the appropriate range of cumulative breaking current.
Cumulative breaking current is given in $(kA)^2$.
An alarm can be generated when the total cumulative breaking current exceeds a set point.

Number of operations

Cumulative number of opening operations performed by the breaking device.

Circuit breaker operating time and charging time
Number of rackouts

Used to assess the condition of the breaking device operating mechanism.

Metering and diagnosis

Characteristics

Functions		Measurement range	Accuracy (1)	MSA141	Saving	Available data MSR/MST	
						Designation	Units
Metering							
Phase current		0,02 to 40 In	±0,5 %	■		I1, I2, I3	A
Residual current	Measured	0,005 to 20 In	±1 %	■		I0m	A
	Calculated	0,005 to 40 In	±1 %	■		I0c	A
Demand current		0,02 to 40 In	±0,5 %			I1moy, I2moy, I3moy	A
Peak demand current		0,02 to 40 In	±0,5 %		□	I1max, I2max, I3max	A
Voltage metering							
Phase-to-phase voltage		0,06 to 1,2 Unp	±0,5 %	■		U21, U32, U31	V
Phase-to-neutral voltage		0,06 to 1,2 Vnp	±0,5 %	■		V1, V2, V3	V
Residual voltage		0,04 to 3 Vnp	±1 %			V0	V
Neutral point voltage		0,04 to 3 Vntp	±1 %			Vnt	V
Positive sequence voltage		0,05 to 1,2 Vnp	±2 %			Vd	V
Negative sequence voltage		0,05 to 1,2 Vnp	±2 %			Vi	V
Frequency	Main channels (f)	25 to 65 Hz	±0,02 Hz	■		F	Hz
Power metering							
Active power (total or per phase)		0,015 Sn to 999 MW	±1 %	■		P	MW
Active power per phase						P1, P2, P3	MW
Peak demand active power		0,015 Sn to 999 MW	±1 %		□	Pmax	MW
Reactive power (total or per phase)		0,015 Sn to 999 Mvar	±1 %	■		Q	Mvar
Reactive power per phase						Q1, Q2, Q3	Mvar
Peak demand reactive power		0,015 Sn to 999 Mvar	±1 %		□	Qmax	Mvar
Apparent power (total or per phase)		0,015 Sn to 999 MVA	±1 %	■		S	MVA
Apparent power per phase						S1, S2, S3	MVA
Peak demand apparent power						Smax	MVA
Power factor (cos φ)		-1 to +1 (CAP/IND)	±0,01	■		cosPhi	MVA
Apparent power	Measured (+ and -)					Eam+, Eam-	MW.h
	Calculated (+ and -)	0 to $2,1.10^8$ MW.h	±1 % ±1 digit		□ □	Eac+, Eac-	MW.h
Reactive power	Measured (+ and -)					Erm+, Erm-	Mvar.h
	Calculated (+ and -)	0 to $2,1.10^8$ Mvar.h	±1 % ±1 digit		□ □	Erc+, Erc-	Mvar.h
Other metering							
Temperature		-30 to +200 °C or -22 to +392 °F	±1 °C de +20 to +140 °C ±1,8 °F de +68 to +284 °F	■		T1 to T16	°C / °F
Rotation speed		0 to 7200 tr/mn	±1 tr/mn			Rot104	tr / mn
Network diagnosis assistance							
Tripping context					□		
Tripping current		0,02 to 40 In	±5 %		□		
Number of trips		0 to 65535	-		□ □		
Negative sequence / unbalance		1 to 500 % Ib	±2 %			Ii / Ib	% Ib or % I'b
Total harmonic distortion, current		0 to 100 %	±1 %			Ithd	%
Total harmonic distortion, voltage		0 to 100 %	±1 %			Uthd	%
Phase displacement φ 0 (between V0 & I0)		0 to 359°	±2°			φ 0	°
Phase displacement φ 1, φ2, φ 3 (between V & I)		0 to 359°	±2°			φ 1, φ 2, φ 3	°
Thermal capacity used						Ech	%
Running hours counter						CH	hours
Disturbance recording					□		
Amplitude difference		0 to 1,2 Usync1	±1 %				
Frequency difference		0 to 10 Hz	±0,5 Hz				
Phase difference		0 to 359°	±2°				
Out-of-sync contex					□		

■ *available on MSA141 analog output module, according to setup*
□ *saved in the event of auxiliary supply outage, even without battery*
□ *saved by battery in the event of auxiliary supply outage*
(1) *Under reference conditions (IEC 60255-6), typical accuracy at In or Unp, cos φ > 0.8..*

3

Metering and diagnosis
Characteristics

Functions		Measurement range	Accuracy (1)	MSA141	Saving	Available data MSR/MST Description	Units
Machine operating assistance							
Phase-to-phase voltages U21, U22, U13		0,06 to 1,2 Unp	±0,5 %	■		U21 , U22 , U13	V
I1, I2, I3		0,02 to 40 In	±0,5 %	■		I1 , I2 , I3	A
Temperature		-30 to +200 °C or -22 to +392 °F	±1 °C de +20 to +140 °C ±1,8 °F de +68 to +284 °F			T1 à T16	°C / °F
Rotor speed of rotation caculated via 49RMS motor						Rot49	tr / mn
Rotor speed of rotation mesured via I104 input		0 to 7200 tr/mn	±1 tr/mn			Rot104	tr / mn
Motor thermal capacity used [2] 0 to 800 % (100 % for I phase = Ib)		±1 %	■	□ □		M	pu
Rotor thermal capacity used [2]						W	pu
Rotor resistance [2]						Rr+	Ω
Stator thermal capacity used [2]						E	pu
Stator resistance [3]						Rs	Ω
Positive-sequence current						Id	A
Negative-sequence current						Ii	A
Positive-sequence voltage		0,05 to 1,2 Vnp	±2 %			Vd	V
Negative-sequence voltage		0,05 to 1,2 Vnp	±2 %			Vi	V
Residual current	Measured	0,005 to 20 In	±1 %			I0	A
	Calculated	0,005 to 40 In	±1 %			I0_S	A
Measured residual voltage						V0	V
Motor torque [2]						C	pu
Slip (calculated via 49RMS motor)						g	pu
Frequency [4]						F	Hz
Remaining operating time before overload tripping		0 à 999 mn	±1 mn				
Waiting time after overload tripping		0 à 999 mn	±1 mn				
Running hours counter / operating time		0 à 65535 heures	±1 % ou ±0,5 h		□ □		
Starting current		1,2 Ib à 40 In	±5 %		□		
Starting time		0 à 300 s	±300 ms		□		
Number of starts before inhibition		0 à 60	-				
Start inhibit time		0 à 360 mn	±1 mn				
Phase displacement φ1, φ2, φ3 between I)		0 à 359°	±2°				
Apparent impedance Zd, Z21, Z32, Z13		0 à 200 kΩ	±5 %				
Capacitance		0 à 30 F	±5 %				
Switchgear diagnosis assistance							
Cumulative breaking current		0 à 65535 kA²	±10 %		□ □		
Number of operations		0 à 4.10⁹	-		□ □		
Operating time		20 à 100 ms	±1 ms		□ □		
Charging time		1 à 20 ms	±0,5 s		□ □		
Number of rackouts		0 à 65535	-		□ □		

■ *available on MSA141 analog output module, according to setup*
□ *saved in the event of auxiliary supply outage, even without battery*
□ *saved by battery in the event of auxiliary supply outage.*
(1) *Under reference conditions (IEC 60255-6), typical accuracy at In or Unp, cos φ > 0.8..*
(2) *The value used is that provided by the 49RMS motor thermal overload protection if this has been activated. The value is 0 if the 49RMS generic thermal overload protection has been activated.*
(3) *The value used is that for the active 49RMS protection: motor thermal overload or generic thermal overload.*
(4) *Only available for the main voltage channels.*

Protection
Description

Current protection functions

ANSI 50/51 - Phase overcurrent
Phase-to-phase short-circuit protection.
2 modes:
■ overcurrent protection sensitive to the highest phase current measured
■ machine differential protection sensitive to the highest differential phase currents obtained in self-balancing schemes.

Characteristics
■ 2 groups of settings
■ instantaneous or time-delayed tripping
■ definite time (DT), IDMT (choice of 16 standardized IDMT curves) or customized curve
■ with or without timer hold
■ tripping confirmed or unconfirmed, according to parameter setting:
□ unconfirmed tripping: standard
□ tripping confirmed by negative sequence overvoltage protection (ANSI 47, unit 1), as backup for distant 2-phase short-circuits
□ tripping confirmed by undervoltage protection (ANSI 27, unit 1), as backup for phase-to-phase short-circuits in networks with low short-circuit power.

ANSI 50N/51N or 50G/51G - Earth fault
Earth fault protection based on measured or calculated residual current values:
■ ANSI 50N/51N: residual current calculated or measured by 3 phase current sensors
■ ANSI 50G/51G: residual current measured directly by a specific sensor.

Characteristics
■ 2 groups of settings
■ definite time (DT), IDMT (choice of 17 standardized IDMT curves) or customized curve
■ with or without timer hold
■ second harmonic restraint to ensure stability during transformer energizing, activated by parameter setting.

ANSI 50BF - Breaker failure
If a breaker fails to be triggered by a tripping order, as detected by the non-extinction of the fault current, this backup protection sends a tripping order to the upstream or adjacent breakers.

ANSI 46 - Negative sequence / unbalance
Protection against phase unbalance, detected by the measurement of negative sequence current.
■ sensitive protection to detect 2-phase faults at the ends of long lines
■ protection of equipment against temperature build-up, caused by an unbalanced power supply, phase inversion or loss of phase, and against phase current unbalance.

Characteristi cs
■ 1 definite time (DT) curve
■ 9 IDMT curves: 4 IEC curves and 3 IEEE curves, 1 ANSI curve in RI^2 and 1 specific Schneider curve

ANSI 49RMS - Thermal overload
Protection against thermal damage caused by overloads on
■ machines (transformers, motors or generators)
■ cables
■ capacitors
The thermal capacity used is calculated according to a mathematical model which takes into account:
■ current RMS values
■ ambient temperature
■ negative sequence current, a cause of motor rotor temperature rise.
The thermal capacity used calculations may be used to calculate predictive data for process control assistance.
The protection may be inhibited by a logic input when required by process control conditions.

Thermal overload for machines - Characteristics
■ 2 groups of settings
■ 1 adjustable alarm set point
■ 1 adjustable tripping set point
■ adjustable initial thermal capacity used setting, to adapt protection characteristics to fit manufacturer's thermal withstand curves
■ equipment heating and cooling time constants.
The cooling time constant may be calculated automatically based on measurement of the equipment temperature by a sensor.

Thermal overload for cables - Characteristics
■ 1 group of settings
■ cable current carrying capacity, which determines alarm and trip set points
■ cable heating and cooling time constants.

Thermal overload for capacitors - Characteristics
■ 1 group of settings
■ alarm current, which determines the alarm set point
■ overload current, which determines the tripping set point
■ hot tripping time and current setting, which determine a point on the tripping curve.

Protection
Description

Recloser

ANSI 79
Automation device used to limit down time after tripping due to transient or semi-permanent faults on overhead lines. The recloser orders automatic reclosing of the breaking device after the time delay required to restore the insulation has elapsed. Recloser operation is easy to adapt for different operating modes by parameter setting.

Characteristics
■ 1 to 4 reclosing cycles, each cycle has an adjustable dead time
■ adjustable, independent reclaim time and safety time until recloser ready time delays
■ cycle activation linked to instantaneous or time-delayed short-circuit protection function (ANSI 50/51, 50N/51N, 67, 67N/67NC) outputs by parameter setting
■ inhibition/locking out of recloser by logic input.

Synchro-check

ANSI 25
This function checks the voltages upstream and downstream of a circuit breaker and allows closing when the differences in amplitude, frequency and phase are within authorized limits.

Characteristics
■ adjustable and independent set points for differences in voltage, frequency and phase
■ adjustable lead time to take into account the circuit-breaker closing time
■ 5 possible operating modes to take no-voltage conditions into account.

Directional current protection

ANSI 67 - Directional phase overcurrent

Phase-to-phase short-circuit protection, with selective tripping according to fault current direction.
It comprises a phase overcurrent function associated with direction detection, and picks up if the phase overcurrent function in the chosen direction (line or busbar) is activated for at least one of the 3 phases.

Characteristics
■ 2 groups of settings
■ instantaneous or time-delayed tripping
■ choice of tripping direction
■ definite time (DT), IDMT (choice of 16 standardized IDMT curves) or customized curve
■ with voltage memory to make the protection insensitive to loss of polarization voltage at the time of the fault
■ with or without timer hold.

ANSI 67N/67NC - Directional earth fault

Earth fault protection, with selective tripping according to fault current direction.
2 types of operation:
■ type 1, projection
■ type 2, according to the magnitude of the residual current phasor.

ANSI 67N/67NC type 1
Directional earth fault protection for impedant, isolated or compensated neutral systems, based on the projection of measured residual current.

Type 1 characteristics
■ 2 groups of settings
■ instantaneous or time-delayed tripping
■ definite time (DT) curve
■ choice of tripping direction
■ characteristic projection angle
■ no timer hold
■ with voltage memory to make the protection insensitive to recurrent faults in compensated neutral systems.

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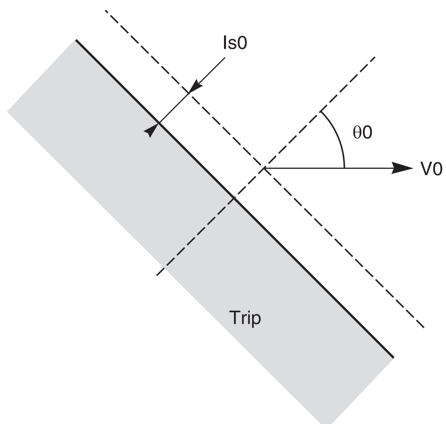

Tripping characteristic of ANSI 67N/67NC type 1 protection (characteristic angle θ0 ≠ 0°).

ANSI 67N/67NC type 2
Directional overcurrent protection for impedance and solidly earthed systems, based on measured or calculated residual current.
It comprises an earth fault function associated with direction detection, and picks up if the earth fault function in the chosen direction (line or busbar) is activated.

Type 2 characteristics
■ 2 groups of settings
■ instantaneous or time-delayed tripping
■ definite time (DT), IDMT (choice of 16 standardized IDMT curves) or customized curve
■ choice of tripping direction
■ with or without timer hold.

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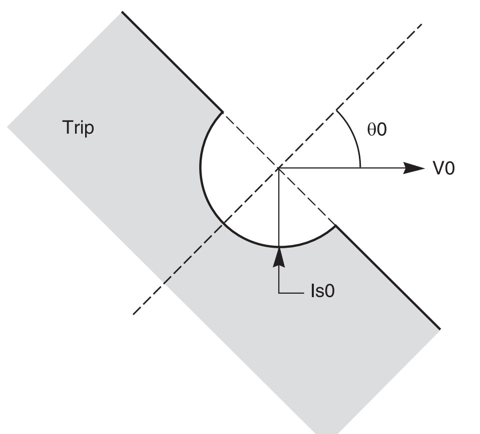

Tripping characteristic of ANSI 67N/67NC type 2 protection (characteristic angle θ0 ≠ 0°).

ANSI 67N/67NC type 3
Directional overcurrent protection for distribution networks in which the neutral earthing system varies according to the operating mode, based on measured residual current.
It comprises an earth fault function associated with direction detection (angular sector tripping zone defined by 2 adjustable angles), and picks up if the earth fault function in the chosen direction (line or busbar) is activated.
This protectionfunction complies with the CEI 0-16 Italian specification.

Type 3 characteristics
■ 2 groups of settings
■ instantaneous or time-delayed tripping
■ definite time (DT) curve
■ choice of tripping direction
■ no timer hold

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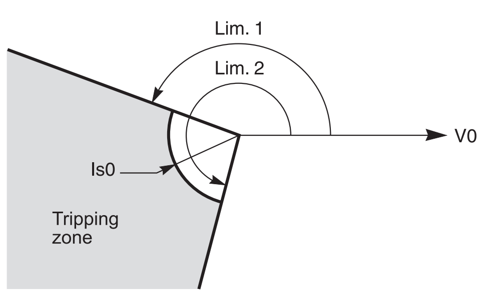

Tripping characteristic of ANSI 67N/67NC type 3 protection.

Directional power protection functions

ANSI 32P - Directional active overpower
Two-way protection based on calculated active power, for the following applications:
■ active overpower protection to detect overloads and allow load shedding
■ reverse active power protection:
□ against generators running like motors when the generators consume active power
□ against motors running like generators when the motors supply active power.

ANSI 32Q - Directional reactive overpower
Two-way protection based on calculated reactive power to detect field loss on synchronous machines:
■ reactive overpower protection for motors which consume more reactive power with field loss
■ reverse reactive overpower protection for generators which consume reactive power with field loss.

ANSI 37P - Directional active underpower
Two-way protection based on calculated active power
Checking of active power flows:
■ to adapt the number of parallel sources to fit the network load power demand
■ to create an isolated system in an installation with its own generating unit.

Machine protection functions

ANSI 37 - Phase undercurrent
Protection of pumps against the consequences of a loss of priming by the detection of motor no-load operation.
It is sensitive to a minimum of current in phase 1, remains stable during breaker tripping and may be inhibited by a logic input.

ANSI 48/51LR - Locked rotor / excessive starting time
Protection of motors against overheating caused by:
■ excessive motor starting time due to overloads (e.g. conveyor) or insufficient supply voltage.
The reacceleration of a motor that is not shut down, indicated by a logic input, may be considered as starting.
■ locked rotor due to motor load (e.g. crusher):
□ in normal operation, after a normal start
□ directly upon starting, before the detection of excessive starting time, with detection of locked rotor by a zero speed detector connected to a logic input, or by the underspeed function.

ANSI 66 - Starts per hour
Protection against motor overheating caused by:
■ too frequent starts: motor energizing is inhibited when the maximum allowable number of starts is reached, after counting of:
□ starts per hour (or adjustable period)
□ consecutive motor hot or cold starts (reacceleration of a motor that is not shut down, indicated by a logic input, may be counted as a start)
■ starts too close together in time: motor re-energizing after a shutdown is only allowed after an adjustable waiting time.

ANSI 40 - Field loss (underimpedance)
Protection of synchronous machines against field loss, based on the calculation of positive sequence impedance on the machine terminals or transformer terminals in the case of transformer-machine units.

Characteristics
■ 2 circular characteristics defined by reactances Xa, Xb and Xc

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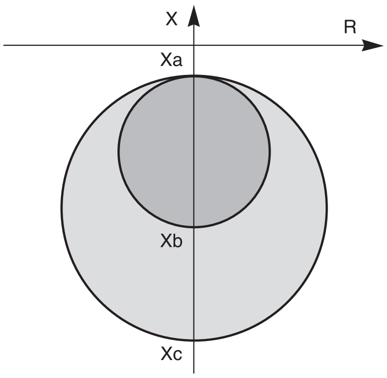

2 circular tripping characteristics of ANSI 40 protection.

■ tripping when the machine's positive sequence impedance enters one of the circular characteristics.
■ definite (DT) time delay for each circular characteristic
■ setting assistance function included in SFT2841 software to calculate the values of Xa, Xb and Xc according to the electrical characteristics of the machine (and transformer, when applicable).

Protection
Description

ANSI 12 - Overspeed
Detection of machine overspeed, based on the speed calculated by pulse-counting, to detect synchronous generator racing due to loss of synchronism, or for process monitoring, for example.

ANSI 14 - Underspeed
Machine speed monitoring based on the speed calculated by pulse-counting:
■ detection of machine underspeed after starting, for process monitoring, for example
■ zero speed data for detection of locked rotor upon starting.

ANSI 50V/51V - Voltage-restrained overcurrent
Phase-to-phase short-circuit protection, for generators. The current tripping set point is voltage-adjusted in order to be sensitive to faults close to the generator which cause voltage drops and lowers the short-circuit current.

Characteristics
■ instantaneous or time-delayed tripping
■ definite time (DT), IDMT (choice of 16 standardized IDMT curves) or customized curve
■ with or without timer hold.

ANSI 21B - Underimpedance
Phase-to-phase short-circuit protection, for generators, based on the calculation of apparent phase-to-phase impedance.

$$Z21 = \frac{U21}{I2 - I1}$$

apparent impedance between phases 1 and 2.
■ circular characteristic centered at origin defined by adjustable set point Zs

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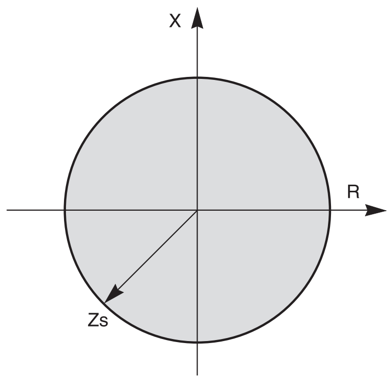

Circular tripping characteristic of ANSI 21B protection.

■ time-delayed definite time (DT) tripping when one of the three apparent impedances enters the circular tripping characteristic.

ANSI 26/63 - Thermostat/Buchholz
Protection of transformers against temperature rise and internal faults via logic inputs linked to devices integrated in the transformer.

ANSI 38/49T - Temperature monitoring
Protection that detects abnormal temperature build-up by measuring the temperature inside equipment fitted with sensors:
■ transformer: protection of primary and secondary windings
■ motor and generator: protection of stator windings and bearings.

Characteristics
■ 16 Pt100, NI100 or Ni120 type RTDs
■ 2 adjustable independent set points for each RTD (alarm and trip).

Protection
Description

Voltage protection functions

ANSI 27D - Positive sequence undervoltage
Protection of motors against faulty operation due to insufficient or unbalanced network voltage, and detection of reverse rotation direction.

ANSI 27R - Remanent undervoltage
Protection used to check that remanent voltage sustained by rotating machines has been cleared before allowing the busbar supplying the machines to be re-energized, to avoid electrical and mechanical transients.

ANSI 27 - Undervoltage
Protection of motors against voltage sags or detection of abnormally low network voltage to trigger automatic load shedding or source transfer.
Works with phase-to-phase or phase-to-neutral voltage, each voltage being monitored separately.

Characteristics
- definite time (DT) curve
- IDMT curve.

ANSI 59 - Overvoltage
Detection of abnormally high network voltage or checking for sufficient voltage to enable source transfer.
Works with phase-to-phase or phase-to-neutral voltage, each voltage being monitored separately.

ANSI 59N - Neutral voltage displacement
Detection of insulation faults by measuring residual voltage
- ANSI 59N: in isolated neutral systems
- ANSI 59N/64G1: in stator windings of generators with earthed neutral. Protects the 85 % to 90 % of the winding, terminal end, not protected by the ANSI 27TN/64G2 function, third harmonic undervoltage.

Characteristics
- definite time (DT) curve
- IDMT curve.

ANSI 47 - Negative sequence overvoltage
Protection against phase unbalance resulting from phase inversion, unbalanced supply or distant fault, detected by the measurement of negative sequence voltage.

FRT (fault ride through) Custom "Grid code" curve
Production installations must stay connected to the grid whenever the voltage is higher than that defined by the "Grid code" curve. The custom curve is defined point by point, with the disconnection time Tc in seconds on the X-axis and the voltage U/Un in pu on the Y-axis.

Frequency protection functions

ANSI 81H - Overfrequency
Detection of abnormally high frequency compared to the rated frequency, to monitor power supply quality.

ANSI 81L - Underfrequency
Detection of abnormally low frequency compared to the rated frequency, to monitor power supply quality.
The protection may be used for overall tripping or load shedding.
Protection stability is ensured in the event of the loss of the main source and presence of remanent voltage by a restraint in the event of a continuous decrease of the frequency, which is activated by parameter setting.

ANSI 81R - Rate of change of frequency
Protection function used for fast disconnection of a generator or load shedding control. Based on the calculation of the frequency variation, it is insensitive to transient voltage disturbances and therefore more stable than a phase-shift protection function.

Disconnection
In installations with autonomous production means connected to a utility, the "rate of change of frequency" protection function is used to detect loss of the main system in view of opening the incoming circuit breaker to:
- protect the generators from a reconnection without checking synchronization
- avoid supplying loads outside the installation.

Load shedding
The "rate of change of frequency" protection function is used for load shedding in combination with the underfrequency protection to:
- either accelerate shedding in the event of a large overload
- or inhibit shedding following a sudden drop in frequency due to a problem that should not be solved by shedding.

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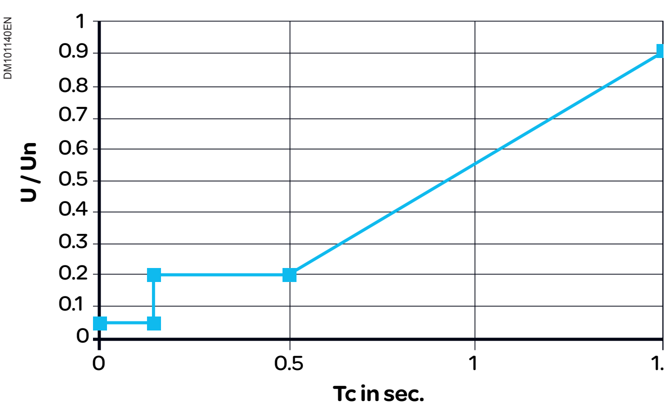

Custom "Grid code" curve

Protection
Tripping curves

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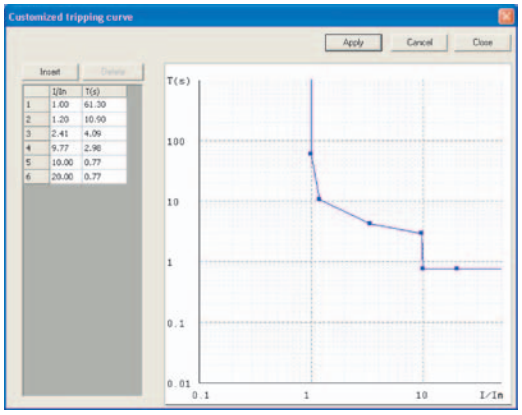

Customized tripping curve set using SFT2841 software.

Customized tripping curve

Defined point by point using the SFT2841 setting and operating software tool, this curve may be used to solve all special cases involving protection coordination or revamping.

IDMT tripping curves

Current IDM T tripping curves

Multiple IDMT tripping curves are offered, to cover most applications:
- IEC curves (SIT, VIT/LTI, EIT)
- IEEE curves (MI, VI, EI)
- usual curves (UIT, RI, IAC).

IEC curves

Equation:

$$td(I) = \frac{k}{\left(\frac{I}{Is}\right)^{\alpha} - 1} \times \frac{T}{\beta}$$

Curve type	Coefficient values		
	k	α	β
Standard inverse / A	0.14	0.02	2.97
Very inverse / B	13.5	1	1.50
Long time inverse / B	120	1	13.33
Extremely inverse / C	80	2	0.808
Ultra inverse	315.2	2.5	1

RI curve

Equation:

$$td(I) = \frac{1}{0{,}339 - 0{,}236\left(\frac{I}{Is}\right)^{-1}} \times \frac{T}{3{,}1706}$$

IEEE curves

Equation:

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

Curve type	Coefficient values			
	A	B	p	β
Moderately inverse	0.010	0.023	0.02	0.241
Very inverse	3.922	0.098	2	0.138
Extremely inverse	5.64	0.0243	2	0.081

IAC curves

Equation:

$$td(I) = \left(A + \frac{B}{\left(\frac{I}{Is} - C\right)} + \frac{D}{\left(\frac{I}{Is} - C\right)^{2}} + \frac{E}{\left(\frac{I}{Is} - C\right)^{3}}\right) \times \frac{T}{\beta}$$

Curve type	Coefficient values					
	A	B	C	D	E	β
Inverse	0.208	0.863	0.800	-0.418	0.195	0.297
Very inverse	0.090	0.795	0.100	-1.288	7.958	0.165
Extremely inverse	0.004	0.638	0.620	1.787	0.246	0.092

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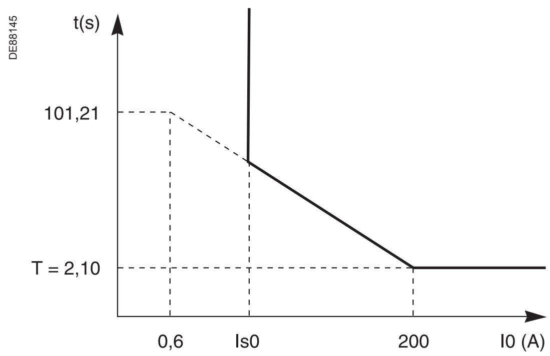
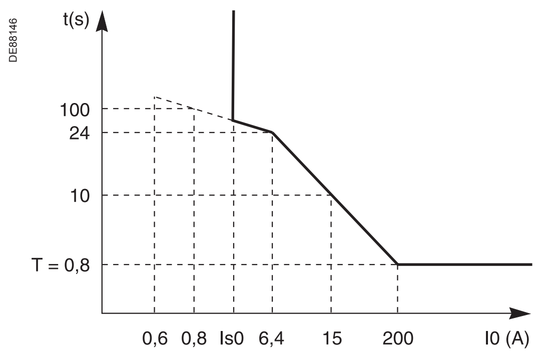
Protection
Tripping curves



EPATR-C Standard curve (logarithmic scale).



EPATR-B Standard curve (logarithmic scale).

Equation for EPATRB, EPATRC

EPATRB

For 0,6 A ⩽ I0 ⩽ 6,4 A

$$td(I0) = \frac{85{,}386}{I0^{0{,}975}} x \frac{T}{0{,}8}$$

For 6,4 A ⩽ Io ⩽ 200,0 A

$$td(I0) = \frac{140{,}213}{I0^{0{,}975}} x \frac{T}{0{,}8}$$

For I0 > 200,0 A
td (I0) = T

EPATRC

For 0,6 A ⩽ I0 ⩽ 200,0 A

$$td(I0) = 72 \times I0^{-2/3} x \frac{T}{2{,}10}$$

For I0 > 200,0 A
td (I0) = T

Voltage IDMT tripping curves

Equation for ANSI 27 - undervoltage

$$td(I) = \frac{T}{1 - \left(\frac{V}{Vs}\right)}$$

Equation for ANSI 59N - Neutral voltage displacement

$$td(I) = \frac{T}{\left(\frac{V}{Vs}\right) - 1}$$

Voltage/frequency ratio IDMT tripping curves

Equation for ANSI 27 - undervoltage

With G = V/f or U/f

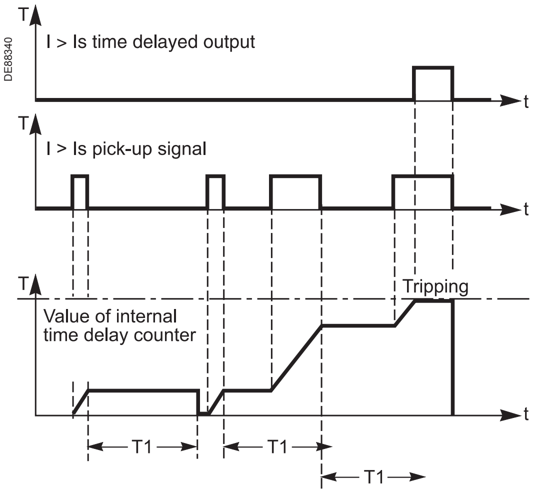
$$td(G) = \frac{1}{\left(\frac{G}{Gs} - 1\right)^{p}} x T$$

Curve type	P
A	0.5
B	1
C	2

Protection
Main characteristics

Setting of IDMT tripping curves,

Time delay T or TMS factor
The time delays of current IDMT tripping curves (except for customized and RI curves) may be set as follows:
■ time T, operating time at 10 x Is
■ TMS factor, factor shown as T/b in the equations on the left.



Detection of restriking faults with adjustable timer hold.

Timer hold
The adjustable timer hold T1 is used for:
■ detection of restriking faults (DT curve)
■ coordination with electromechanical relays (IDMT curve).
Timer hold may be inhibited if necessary.

2 groups of settings

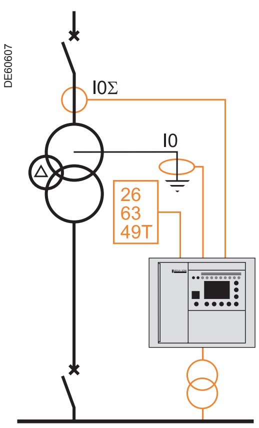
Phase-to-phase and phase-to-earth short-circuit protection
Each unit has 2 groups of settings, A and B, to adapt the settings to suit the network configuration.
The active group of settings (A or B) is set by a logic input or the communication link.

Example of use: normal / backup mode network
■ group A for network protection in normal mode, when the network is supplied by the utility
■ group B for network protection in backup mode, when the network is supplied by a backup generator.

Thermal overload for machines
Each unit has 2 groups of settings to protect equipment that has two operating modes.

Examples of use:
■ transformers: switching of groups of settings by logic input, according to transformer ventilation operating mode, natural or forced ventilation (ONAN or ONAF)
■ motors: switching of groups of settings according to current set point, to take into account the thermal withstand of motors with locked rotors.

3



Measurement origin: example.

Measurement origin
The measurement origin needs to be indicated for each unit of the protection functions that may use measurements of different origins.
The setting links a measurement to a protection unit and allows the protection units to be distributed optimally among the measurements available according to the sensors connected to the analog inputs.

Example: distribution of ANSI 50N/51N function units for transformer earth fault protection:
■ 2 units linked to measured I0 for transformer primary protection
■ 2 units linked to I0S for protection upstream of the transformer.

Summary table

Characteristics	Protection functions
2 groups of settings A et B	50/51, 50N/51N, 67, 67N/67NC
2 groups of settings, operating modes 1 and 2	49RMS Machine
IEC IDMT curves	50/51, 50N/51N, 50V/51V, 67, 67N/67NC type 2, 46
IEEE IDMT curves	50/51, 50N/51N, 50V/51V, 67, 67N/67NC type 2, 46
Usual IDMT curves	50/51, 50N/51N, 50V/51V, 67, 67N/67NC type 2
EPATR curves	50N/51N
Voltage IDMT curves	27, 59N
Customized curve	50/51, 50N/51N, 50V/51V, 67, 67N/67NC type 2
Timer hold	50/51, 50N/51N, 50V/51V, 67, 67N/67NC type 2

Protection
Setting ranges

Functions	Settings		Time delays
ANSI 12 - Overspeed			
	100 to 160 % of Wn		1 to 300 s
ANSI 14 - Underspeed			
	10 to 100 % of Wn		1 to 300 s
ANSI 21B - Underimpedance			
Impedance Zs	0.05 to 2.00 Vn/Ib		0.2 to 300 s
ANSI 25 - Synchro-check			
Measured voltages	Phase-to-phase	Phase-to-neutral	
Rated primary phase-to-phase voltage			
Unp sync1 (Vnp sync1 = Unp sync1/√3)	220 V to 250 kV	220 V to 250 kV	
Unp sync2 (Vnp sync2 = Unp sync2/√3)	220 V to 250 kV	220 V to 250 kV	
Rated secondary phase-to-phase voltage			
Uns sync1	90 V to 120 V	90 V to 230 V	
Uns sync2	90 V to 120 V	90 V to 230 V	
Synchro-check setpoints			
dUs set point	3 % to 30 % of Unp sync1	3 % to 30 % of Vnp sync1	
dfs set point	0.05 to 0.5 Hz	0,05 to 0,5 Hz	
dPhi set point	5 to 80°	5 to 80°	
Us high set point	70 % to 110 % Unp sync1	70 % to 110 % Vnp sync1	
Us low set point	10 % to 70 % Unp sync1	10 % to 70 % Vnp sync1	
Other settings			
Lead time	0 to 0.5 s	0 to 0.5 s	
Operating modes: no-voltage conditions for which coupling is allowed	Dead1 AND Live2	Dead1 AND Live2	
	Live1 AND Dead2	Live1 AND Dead2	
	Dead1 XOR Dead2	Dead1 XOR Dead2	
	Dead1 OR Dead2	Dead1 OR Dead2	
	Dead1 AND Dead2	Dead1 AND Dead2	
ANSI 27 - Undervoltage (L-L) or (L-N)			
Tripping curve	Definite time		
	IDMT		
Set point	5 to 100 % of Unp		0.05 to 300 s
ANSI 27D - Positive sequence undervoltage			
Set point and time delay	15 to 60 % of Unp		0.05 to 300 s
ANSI 27R - Remanent undervoltage			
Set point and time delay	5 to 100 % of Unp		0.05 to 300 s
ANSI 32P - Directional active overpower			
	1 to 120 % of Sn (1)		0.1 s to 300 s
ANSI 32Q - Directional reactive overpower			
	5 to 120 % of Sn (1)		0.1 s to 300 s
ANSI 37 - Phase undercurrent			
	0.05 to 1 Ib		0.05 to 300 s
ANSI 37P - Directional active underpower			
	5 to 100 % of Sn (1)		0.1 s to 300 s
ANSI 38/49T - Temperature monitoring			
Alarm set point TS1	0 °C to 180 °C or 32 °F to 356 °F		
Trip set point TS2	0 °C to 180 °C or 32 °F to 356 °F		
ANSI 40 - Field loss (underimpedance)			
Common point: Xa	0.02 Vn/Ib to 0.2 Vn/Ib + 187.5 kΩ		
Circle 1: Xb	0.2 Vn/Ib to 1.4 Vn/Ib + 187.5 kΩ		0.05 to 300 s
Circle 2: Xc	0.6 Vn/Ib to 3 Vn/Ib + 187.5 kΩ		0.1 s to 300 s
ANSI 46 - Negative sequence / unbalance			
Tripping curve	Definite time		
	Schneider Electric		
	EC: SIT/A, LTI/B, VIT/B, EIT/C		
	IEEE: MI (D), VI (E), EI (F)		
	RI² (setting constant from 1 to 100)		
Is set point	0.1 to 5 Ib	Definite time	0.1 to 300 s
	0.1 to 0.5 Ib (Schneider Electric)	IDMT	0.1 to 1s
	0.1 to 1 Ib (IEC, IEEE)		
	0.03 to 0.2 Ib (RI²)		

(1) Sn = √3.In.Unp.

Protection
Setting ranges

Functions	Settings		Time delays	
ANSI 47 - Negative sequence overvoltage				
Set point and time delay	1 to 50 % of Unp		0.05 to 300 s	
ANSI 48/51LR -Locked rotor / excessive starting time				
Is set point	0.5 Ib to 5 Ib	ST starting time	0.5 to 300 s	
		LT and LTS time delays	0.05 to 300 s	
ANSI 49RMS - Thermal overload for cables				
Admissible current	1 to 1.73 Ib			
Time constant T1	1 to 600 mn			
ANSI 49RMS - Thermal overload for capacitors				
Alarm current		1.05 Ib to 1.70 Ib		
Trip current		1.05 Ib to 1.70 Ib		
Positioning of the hot tripping curve	Current setting	1.02 x trip current to 2 Ib		
	Time setting	1 to 2000 minutes (variable range depending on the trip current and current setting)		
ANSI 49RMS - Thermal overload for machines			**Mode 1**	**Mode 2**
Accounting for negative sequence component		0 - 2.25 - 4.5 - 9		
Time constant	Heating		T1: 1 to 600 mn	T1: 1 to 600 mn
	Cooling		T2: 5 to 600 mn	T2: 5 to 600 mn
Alarm and tripping set points (Es1 and Es2)		0 to 300 % of rated thermal capacity		
Initial thermal capacity used (Es0)		0 to 100 %		
Switching of thermal settings condition		by logic input		
		by Is set point adjustable from 0.25 to 8 Ib		
Maximum equipement temperature		60 to 200 °C (140 °C to 392 °F)		
ANSI 49RMS - Motor thermal overload				
Measurement origin	I1, I2, I3			
Choice of thermal model	2 time constants/generic (see settings associated with generic thermal overload)			
Current set point - change of thermal settings		1 to 10 pu of Ib (± 0,1 pu of Ib)		
Characteristic times	Operating time accuracy	± 2 % or ±1 s		
Stator thermal settings				
Time constants	Motor thermal capacity used (τ long)	1 to 600 mn ± 1 mn		
	Stator thermal capacity used (τ short)	1 to 60 mn ± 0,1 mn		
	Cooling (τ cool)	5 to 600 mn ± 1 mn		
Tripping current set point (K)	50 to 173 % of Ib (± 1 % of Ib)			
Alarm current set point	50 to 173 % of Ib (± 1 % of Ib)			
Thermal exchange coefficient between the stator and the motor (α)	0 to 1 (± 0,01)			
Current characterizing hot state	0,5 to 1 pu of Ib (± 0,1 pu of Ib)			
Accounting for ambient temperature	yes / no			
Maximum equipment temperature (Tmax)	70 to 250 °C (± 1 °C) or 158 to 482 °F (± 1 °F)			
Rotor thermal settings				
Locked rotor amperes (IL)	1 to 10 pu of Ib (± 0,01 pu of Ib)			
Locked rotor torque (LRT)	0,2 to 2 pu of nominal torque (+/- 0.01 pu of nominal torque)			
Locked rotor cold limit time (Tc)	1 to 300 s (± 0.1 s)			
Locked rotor hot limit time (Th)	1 to 300 s (± 0.1 s)			
ANSI 49RMS - Transformer thermal overload				
Measurement origin	I1, I2, I3			
Choice of thermal model	Dry-type transformer			
	Immersed transformer			
	Generic			
Type of dry-type transformer	Natural ventilation (AN) / Forced ventilation (AF)			
Type of oil-filled transformere	Distribution ONAN / Power ONAN / ONAF / OF / OD			
Alarm set point (θ alarme)	Immersed transformer: 98 to 160 °C (± 1 °C) or 208 to 320 °F (± 1 °F)			
	Dry-type transformer: 95 to 245 °C (± 1 °C) or 203 to 473 °F (± 1 °F)			
Tripping set point (θ trip)	Immersed transformer: 98 to 160 °C (± 1 °C) or 208 to 320 °F (± 1 °F)			
	Dry-type transformer: 95 to 245 °C (± 1 °C) or 203 to 473 °F (± 1 °F)			
Time constant for dry-type transfo (τ)	1 to 600 mn ± 1 mn			
Time constant for oil-filled transfo	winding (τ wdg)	1 to 600 mn ± 1 mn		
	oil (τ oil)	5 to 600 mn ± 1 mn		

Protection
Setting ranges

Functions	Settings		Time delays
ANSI 50BF - Breaker failure			
Presence of current	0.2 to 2 In		
Operating time	0.05 s to 3 s		
ANSI 50/51 - Phase overcurrent			
	Tripping time delay	**Timer hold**	
Tripping curve	Definite time	DT	
	SIT, LTI, VIT, EIT, UIT (1)	DT	
	RI	DT	
	IEC: SIT/A, LTI/B, VIT/B, EIT/C	DT or IDMT	
	IEEE: MI (D), VI (E), EI (F)	DT or IDMT	
	IA : I, VI, EI	DT or IDMT	
	Customized	DT	
Is set point	0.05 to 24 In	Definite time	Inst; 0.05 s to 300 s
	0.05 to 2.4 In	IDMT	0.1 s to 12.5 s at 10 Is
Timer hold	Definite time (DT; timer hold)		Inst; 0.05 s to 300 s
	IDMT (IDMT; reset time)		0.5 s to 20 s
Confirmation	None		
	By negative sequence overvoltage		
	By phase-to-phase undervoltage		
ANSI 50N/51N or 50G/51G - Earth faultt			
	Tripping time delay	**Timer hold**	
Tripping curve	Definite time	DT	
	SIT, LTI, VIT, EIT, UIT (1)	DT	
	RI	DT	
	IEC : SIT/A, LTI/B, VIT/B, EIT/C	DT or IDMT	
	IEEE : MI (D), VI (E), EI (F)	DT or IDMT	
	IAC : I, VI, EI	DT or IDMT	
	EPATR-B, EPATR-C	DT	0.5 to 1 s
	Customized	DT	0.1 to 3s
Is set point	0.5 to 24 In	Definite time	Inst; 0.05 s to 300 s
	0.5 to 2.4 In	IDMT	0.1 s to 12.5 s at 10 Is0
Timer hold	Definite time (DT; timer hold)		Inst; 0.05 s to 300 s
	IDMT (IDMT; reset time)		0.5 s to 20 s
ANSI 50V/51V or 50G/51G - Voltage-restrained overcurrent			
	Tripping time delay	**Timer hold**	
Tripping curve	Definite time	DT	
	SIT, LTI, VIT, EIT, UIT (1)	DT	
	RI	DT	
	IEC : SIT/A, LTI/B, VIT/B, EIT/C	DT or IDMT	
	IEEE : MI (D), VI (E), EI (F)	DT or IDMT	
	IAC : I, VI, EI	DT or IDMT	
	Customized	DT	
Is set point	0.5 to 24 In	Definite time	Inst; 0.05 s to 300 s
	0.5 to 2.4 In	IDMT	0.1 s to 12.5 s at 10 Is0
Timer hold	Definite time (DT; timer hold)		Inst; 0.05 s to 300 s
	IDMT (IDMT; reset time)		0.5 s to 20 s
ANSI 59 - Overvoltage (L-L) or (L-N)			
Set point and time delay	50 to 150 % of Unp or Vnp		0.05 to 300 s
ANSI 59N - Neutral voltage displacement			
Tripping curve	Definite time		
	IDMT		
Set point	2 to 80 % of Unp	Definite time	0.05 to 300 s
	2 to 10 % of Unp	IDMT	0.1 to 100 s
ANSI 64REF - Restricted earth fault differential			
Is0 set point	0.05 to 0.8 In (In ⩾ 20 A)		
	0.1 to 0.8 In (In < 20 A)		
Measurement origin	Channels (I, I0)		
ANSI 66 - Starts per hour			
Total number of starts	1 to 60	Period	1 to 6 h
Number of consecutive starts	1 to 60	T time delay stop/start	0 to 90 mn

***(1)** Tripping as of 1.2 Is.*

Protection

Setting ranges

Functions		Settings		Time
ANSI 67 - Directional phase overcurrent				
Characteristic angle		**30°, 45°, 60°**		
		Tripping time delay	**Timer hold delay**	
Tripping curve		Definite time	DT	
		SIT, LTI, VIT, EIT, UIT (1)	DT	
		RI	DT	
		IEC: SIT/A, LTI/B, VIT/B, EIT/C	DT or IDMT	
		IEEE: MI (D), VI (E), EI (F)	DT or IDMT	
		IAC: I, VI, EI	DT or IDMT	
		Customized	DT	
Is set point		0.1 to 24 In	Definite time	Inst; 0.05 s to 300 s
		0.1 to 2.4 In	IDMT	0.1 s to 12.5 s at 10 Is0
Timer hold		Definite time (DT; timer hold)		Inst; 0.05 s to 300 s
		IDMT (IDMT; reset time)		0.5 s to 20 s
ANSI 67N/67NC - Directional earth fault, projection (type 1)				
Characteristic angle		-45°, 0°, 15°, 30°, 45°, 60°, 90°		
Is0 set point		0.01 to 15 In0 (mini. 0,1 A)	Definite time	Inst; 0.05 s to 300 s
Vs0 set point		2 to 80 % of Unp		
Memory time		T0mem time	0; 0.05 s to 300 s	
		V0mem validity set point	0; 2 to 80 % of Unp	
Measurment origin		I0 input or sum of phase currents I0S		
ANSI 67N/67NC - Directional earth fault, according to I0 vector magnitude (type 2)				
Characteristic angle		-45°, 0°, 15°, 30°, 45°, 60°, 90°		
		Tripping time delay	**Timer hold delay**	
Tripping curve		Definite time	DT	
		SIT, LTI, VIT, EIT, UIT (1)	DT	
		RI	DT	
		IEC: SIT/A,LTI/B, VIT/B, EIT/C	DT or IDMT	
		IEEE: MI (D), VI (E), EI (F)	DT or IDMT	
		IAC: I, VI, EI	DT or IDMT	
		Customized	DT	
Is0 set point		0.1 to 15 In0 (min. 0.1 A)	Definite time	Inst; 0.05 s to 300 s
		0.01 to 1 In0 (min. 0.1 A)	IDMT	0.1 s to 12.5 s at 10 Is0
Vs0 set point		2 to 80 % of Unp		
Timer hold		Definite time (DT; timer hold)		Inst; 0.05 s to 300 s
		IDMT (IDMT; reset time)		0.5 s to 20 s
Measurment origin		I0 input		
ANSI 67N/67NC type 3 - Directional earth fault, according to I0 vector magnitude directionalized on a tripping sector				
Tripping sector start angle		0° to 359°		
Tripping sector end angle		0° to 359°		
Is0 set point	CSH core balance CT (2 A rating)	0.1 A to 30 A	Definite time	Inst; 0.05 s to 300 s
	1 A CT	0.005 to 15 In0 (min. 0.1 A)		
	Core balance CT + ACE990 (range 1)	0.01 to 15 In0 (min. 0.1 A)		
Vs0 set point		Calculated V0 (sum of 3 voltages)	2 to 80 % of Unp	
		Measured V0 (external VT)	0.6 to 80 % of Unp	
Time between 2 power swings		1 to 300 s		
Measurment origin		I0 input		
ANSI 81H - Overfrequency				
Set point and time delay		50 to 55 Hz or 60 to 65 Hz		0.1 to 300 s
Setting range		Main channels (U)		
ANSI 81L - Underfrequency				
Set point and time delay		40 to 50 Hz or 50 to 60 Hz		0.1 to 300 s
Setting range		Main channels (U)		
ANSI 81R - Rate of change of frequency				
		0.1 to 10 Hz/s		0.15 to 300 s

Control and monitoring
Description

Sepam performs all the control and monitoring functions required for electrical network operation:
■ the main control and monitoring functions are predefined and fit the most frequent cases of use. They are ready to use and are implemented by simple parameter setting after the necessary logic inputs / outputs are assigned.
■ the predefined control and monitoring functions can be adapted for particular needs using the SFT2841 software, which offers the following customization options:
□ logic equation editor, to adapt and complete the predefined control and monitoring functions
□ creation of personalized messages for local annunciation
□ creation of personalized mimic diagrams corresponding to the controlled devices
□ customization of the control matrix by changing the assignment of output relays, LEDs and annunciation messages.

Operating principle
The processing of each control and monitoring function may be broken down into 3 phases:
■ acquisition of input data:
□ results of protection function processing
□ external logic data, connected to the logic inputs of an optional MES120 input / output module
□ local control orders transmitted by the mimic-based UMI
□ remote control orders (TC) received via the Modbus communication link
■ actual processing of the control and monitoring function
■ utilization of the processing results:
□ activation of outputs to control a device
□ information sent to the facility manager:
- by message and/or LED on the Sepam display and SFT2841 software
- by remote indication (TS) via the Modbus communication link
- by real-time indications on device status on the animated mimic diagram.

Logic inputs and outputs
The number of Sepam inputs / outputs must be adapted to fit the control and monitoring functions used.
The 4 outputs included in the Sepam series 60 base unit may be extended by adding 1 or 2 MES120 modules with 14 logic inputs and 6 output relays.
After the number of MES120 modules required for the needs of an application is set, the logic inputs are assigned to functions. The functions are chosen from a list which covers the whole range of possible uses. The functions are adapted to meet needs within the limits of the logic inputs available. The inputs may also be inverted for undervoltage type operation.
A default input / output assignment is proposed for the most frequent uses.

PE60303

Maximum Sepam series 60 configuration with 2 MES120 modules: 28 inputs and 16 outputs.

Logic inputs and outputs GOOSE
GOOSE logic inputs are used with the IEC61850 communication protocol.
The GOOSE inputs are divided between the 2 GSE virtual modules with 16 logic inputs.

Control and monitoring
Description of predefined functions

Each Sepam contains the appropriate predefined control and monitoring functions for the chosen application.

ANSI 94/69 - Circuit breaker/contactor control
Control of breaking devices equipped with different types of closing and tripping coils:
- circuit breakers with shunt or undervoltage trip coils
- latching contactors with shunt trip coils
- contactors with latched orders.

The function processes all breaking device closing and tripping conditions, based on:
- protection functions
- breaking device status data
- remote control orders
- specific control functions for each application (e.g. recloser, synchro-check).

The function also inhibits breaking device closing, according to the operating conditions.

Automatic transfer (AT)
This function transfers busbar supply from one source to another. It concerns substations with two incomers, with or without coupling.

The function carries out:
- automatic transfer with a break if there is a loss of voltage or a fault
- manual transfer and return to normal operation without a break, with or without synchro-check
- control of the coupling circuit breaker (optional)
- selection of the normal operating mode
- the necessary logic to ensure that at the end of the sequence, only 1 circuit breaker out of 2 or 2 out of 3 are closed.

The function is distributed between the two Sepam units protecting the two incomers. The synchro-check function (ANSI 25) is carried out by the optional MCS025 module, in conjunction with one of the two Sepam units.

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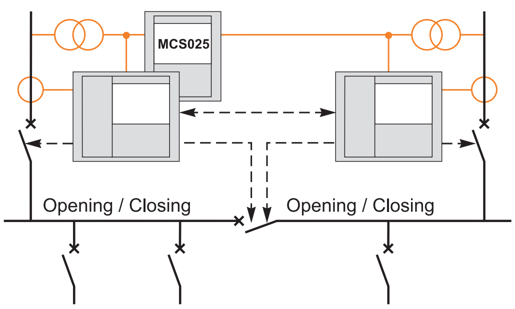

Automatic transfer with synchro-check controlled by Sepam series 60.

Load shedding - Automatic restart
Automatic load regulation on electrical networks by load shedding followed by automatic restarting of motors connected to the network

Load shedding
The breaking device opens to stop motors in case of:
- detection of a network voltage sag by the positive sequence undervoltage
- protection function ANSI 27D
- receipt of a load shedding order on a logic input.

Automatic restart
The motors disconnected as a result of the network voltage sag are automatically restarted:
- after the return of network voltage is detected by the positive sequence undervoltage protection function ANSI 27D
- and a time delay has run out, so as to stagger motor restarts.

De-excitation
Interruption of a synchronous generator's excitation supply and tripping of the generator breaking device in case of:
- detection of an internal generator fault
- detection of an excitation system fault
- receipt of a de-excitation order on a logic input or via the communication link.

Control and monitoring

Description of predefined functions

Genset shutdown

Shutdown of the driving machine, tripping of the breaking device and interruption of the generator excitation supply in case of:
- detection of an internal generator fault
- receipt of a genset shutdown order on a logic input or via the communication link.

ANSI 68 - Logic discrimination

This function provides:
- perfect tripping discrimination with phase-to-phase and phase-to-earth short-circuits, on all types of network
- faster tripping of the breakers closest to the source (solving the drawback of conventional time discrimination).

Each Sepam is capable of:
- sending a blocking input when a fault is detected by the phase overcurrent and earth fault protection functions, which may or may not be directional (ANSI 50/51, 50N/51N, 67 or 67N/67NC)
- and receiving blocking inputs which inhibit protection tripping. A saving mechanism ensures continued operation of the protection in the event of a blocking link failure.

ANSI 86 - Latching / acknowledgement

The tripping outputs for all the protection functions and all the logic inputs Ix can be latched individually. The latched information is saved in the event of an auxiliary power failure.
(The logic outputs cannot be latched.)

All the latched data may be acknowledged:
- locally, with the key reset
- remotely via a logic input
- or via the communication link.

The Latching/acknowledgement function, when combined with the circuit breaker/ contactor control function, can be used to create the ANSI 86 "Lockout relay" function.

Output relay testing

Each output relay is activated for 5 seconds, to make it simpler to check output connections and connected switchgear operation.

Control and monitoring
Description of predefined functions

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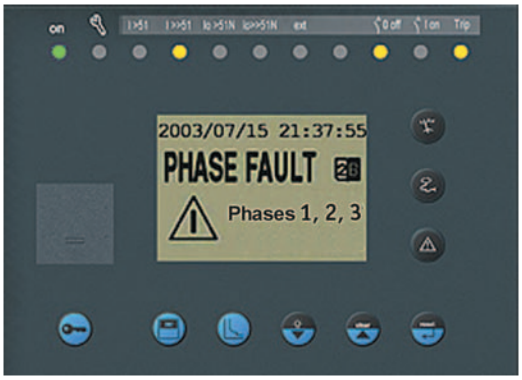

Local indications on the Sepam front panel.

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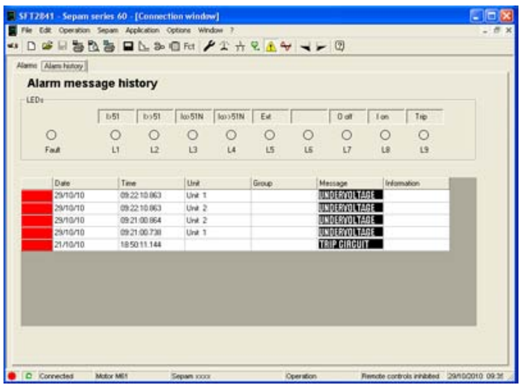


SFT2841: alarm history.

ANSI 30 - Local annunciation

LED indication

■ 2 LEDs, on the front and back of Sepam, indicate the unit operating status, and are visible when a Sepam without a UMI is mounted inside the LV compartment, with access to connectors:
□ green LED ON: Sepam on
□ red "key" LED: Sepam unavailable (initialization phase or detection of an internal failure)
■ 9 yellow LEDs on the Sepam front panel:
□ pre-assigned and identified by standard removable labels
□ the SFT2841 software tool may be used to assign LEDs and personalize labels.

Local annunciation on Sepam display

Events and alarms may be indicated locally on Sepam's advanced UMI or on the mimic-based UMI by:
■ messages on the display unit, available in 2 languages:
□ English, factory-set messages, not modifiable
□ local language, according to the version delivered (the language version is chosen when Sepam is set up)
■ the lighting up of one of the 9 LEDs, according to the LED assignment, which is set using SFT2841.

Alarm processing

■ when an alarm appears, the related message replaces the current display and the related LED goes on.
The number and type of messages depend on the type of Sepam. The messages are linked to Sepam functions and may be viewed on the front-panel display and in the SFT2841 "Alarms" screen.
■ to clear the message from the display, press the key
■ after the fault has disappeared, press the key : the light goes off and Sepam is reset

■ the list of alarm messages remains accessible (key) and may be cleared by pressing the key from 'Alarm" screen, but can not be cleared from "Alarm history" screen.

PE88038

Local control using the mimic-based UMI.

Local control using the mimic-based UMI

Sepam control mode

A key-switch on the mimic-based UMI is used to select the Sepam control mode.
Three modes are available : Remote, Local or Test.
In Remote mode:

- remote control orders are taken into account
- local control orders are disabled, with the exception of the circuit-breaker open order.

In Local mode:

- remote control orders are disabled, with the exception of the circuit-breaker open order
- local control orders are enabled.

Test mode should be selected for tests on equipment, e.g. during preventive-maintenance operations:

- all functions enabled in Local mode are available in Test mode
- no remote indications (TS) are sent via the communication link.

View device status on the animated mimic diagram

For safe local control of devices, all information required by operators can be displayed simultaneously on the mimic-based UMI:

- single-line diagram of the equipment controlled by Sepam, with an animated, graphic indication of device status in real time
- the desired current, voltage and power measurements.

The local-control mimic diagram can be customized by adapting one of the supplied, predefined diagrams or by creating a diagram from scratch.

Local control of devices

All the devices for which opening and closing are controlled by Sepam can be controlled locally using the mimic-based UMI.
The most common interlock conditions can be defined be logic equations.

The sure and simple operating procedure is the following:

- select the device to be controlled by moving the selection window using the keys or . Sepam checks whether local control of the selected device is authorized and informs the operator (selection window with a solid line)
- selection confirmation for the device to be controlled by pressing the key (the selection window flashes)
- device control by pressing:
  - key O: open order
  - or key I: close order.

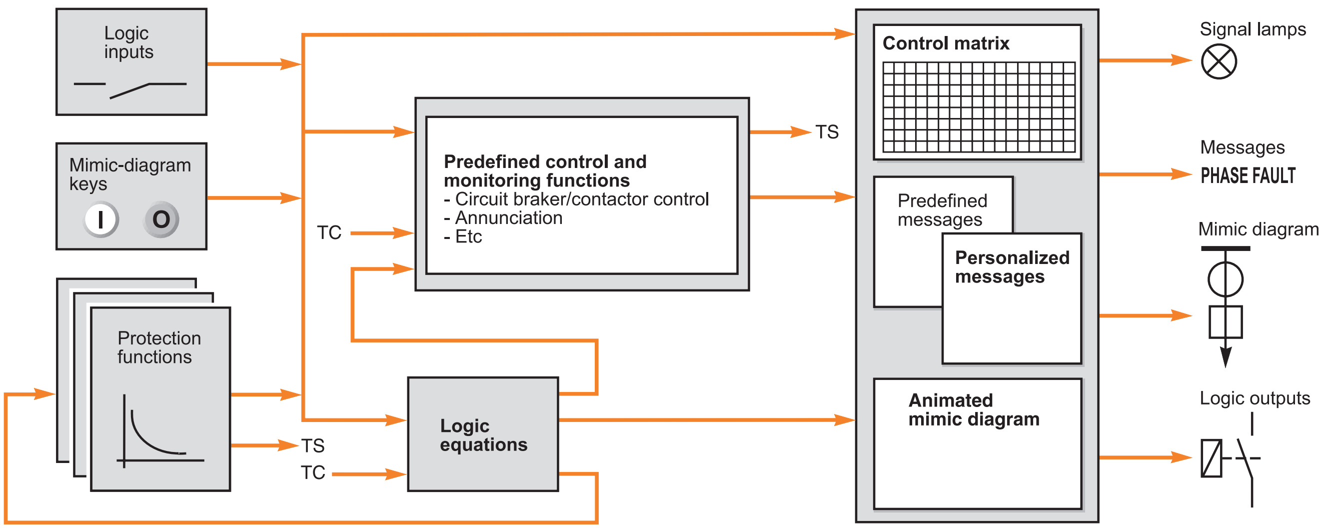
Control and monitoring

Adaptation of predefined functions using the SFT2841 software

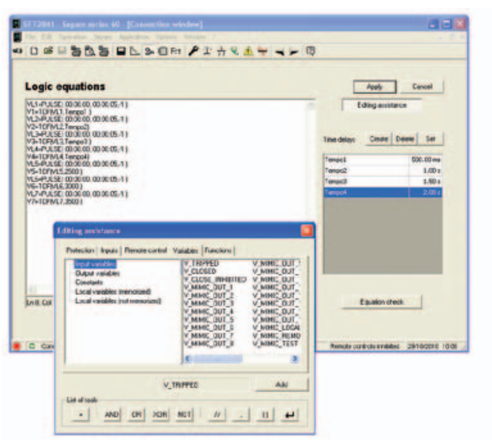
The predefined control and monitoring functions can be adapted for particular needs using the SFT2841 software, which offers the following customization options:
■ logic equation editor, to adapt and complete the predefined control and monitoring functions
■ creation of personalized messages for local annunciation
■ creation of custom mimic diagrams corresponding to the controlled devices
■ customization of the control matrix by changing the assignment of output relays, LEDs and annunciation messages.

Operating principle

DE60671



PE88111_SE



SFT2841: logic equation editor.

Logic equation editor

The logic equation editor included in the SFT2841 software can be used to:
■ complete protection function processing:
□ additional interlocking
□ conditional inhibition/validation of functions
□ etc.
■ adapt predefined control functions: particular circuit breaker or recloser control sequences, etc.

A logic equation is created by grouping logic input data received from:
■ protection functions
■ logic inputs
■ local control orders transmitted by the mimic-based UMI
■ remote control orders
using the Boolean operators AND, OR, XOR, NOT, and automation functions such as time delays, bistables and time programmer.
Equation input is assisted and syntax checking is done systematically.

The result of an equation may then be:
■ assigned to a logic output, LED or message via the control matrix
■ transmitted by the communication link, as a new remote indication
■ utilized by the circuit breaker/contactor control function to trip, close or inhibit breaking device closing
■ used to inhibit or reset a protection function.

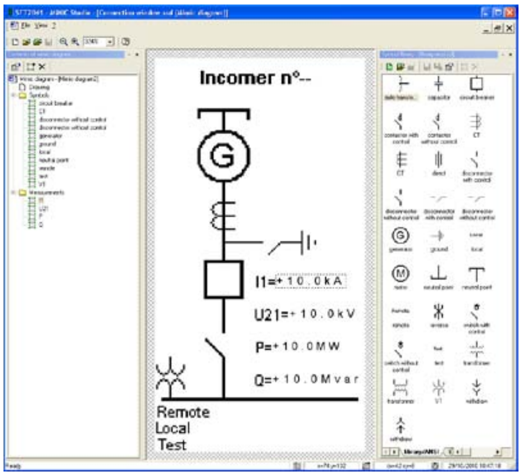
Control and monitoring

Adaptation of predefined functions using the SFT2841 software

Personalized alarm and operating messages

The alarm and operating messages may be personalized using the SFT2841 software tool.
The new messages are added to the list of existing messages and may be assigned via the control matrix for display:
■ on the Sepam display
■ in the SFT2841 "Alarms" and "Alarm History" screens.

PE88109_SE



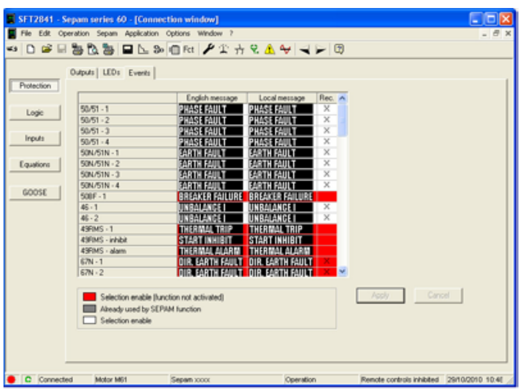
SFT2841: mimic-diagram editor.

Local-control mimic diagram

The mimic-diagram editor in the SFT2841 software can be used to create a single-line diagram corresponding exactly to the equipment controlled by Sepam.
Two procedures are available:
■ rework a diagram taken from the library of standard diagrams in the SFT2841 software
■ creation of an original diagram : graphic creation of the single-line diagram, positioning of symbols for the animated devices, insertion of measurements, text, etc.

Creation of a customized mimic diagram is made easy:
■ library of predefined symbols: circuit breakers, earthing switch, etc.
■ creation of personalized symbols.

PE88110_SE



SFT2841: control matrix.

Control matrix

The control matrix is a simple way to assign data from:
■ protection functions
■ control and monitoring functions
■ logic inputs
■ logic equations
to the following output data:
■ output relays
■ 9 LEDs on the front panel of Sepam
■ messages for local annunciation
■ triggering of disturbance recording.

Base unit
Presentation

Base units are defined according to the following characteristics:
- type of User-Machine Interface (UMI)
- working language
- type of base unit connector
- type of current sensor connector
- type of voltage sensor connector.

User-Machine Interface

Two types of User-Machine Interfaces (UMI) are available for Sepam series 60 base units:
- mimic-based UMI
- advanced UMI.

The advanced UMI can be integrated in the base unit or installed remotely on the cubicle. Integrated and remote advanced UMIs offer the same functions.

A Sepam series 60 with a remote advanced UMI is made up of:
- a bare base unit without any UMI, for mounting inside the LV compartment
- a remote advanced UMI (DSM303)
  - for flush mounting on the front panel of the cubicle in the location most suitable for the facility manager
  - for connection to the Sepam base unit using a prefabricated CCA77x cord.

The characteristics of the remote advanced UMI module (DSM303) are presented on page 218.

PE60304

Sepam series 60 base unit with integrated advanced UMI.

Comprehensive data for facility managers

All the data required for local equipment operation may be displayed on demand:
- display of all measurement and diagnosis data in numerical format with units and/or in bar graphs
- display of operating and alarm messages, with alarm acknowledgment and Sepam resetting
- display of the list of activated protection functions and the main settings of major protection functions
- adaptation of activated protection function set points or time delays in response to new operating constraints
- display of Sepam and remote module versions
- output testing and logic input status display
- entry of 2 passwords to protect parameter and protection settings.

PE60305

Sepam series 60 base unit with mimic-based UMI.

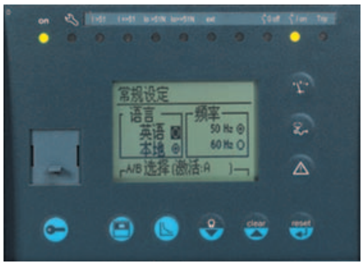
Local control of devices using the mimic-based UMI

The mimic-based UMI provides the same functions as the advanced UMI as well as local control of devices:
- selection of the Sepam control mode
- view device status on the animated mimic diagram
- local opening and closing of all the devices controlled by Sepam.

Ergonomic data presentation

- keypad keys identified by pictograms for intuitive navigation
- menu-guided access to data
- graphical LCD screen to display any character or symbol
- excellent display quality under all lighting conditions: automatic contrast adjusted and backlit screen (user activated).

PE88042



Customized Chinese advanced UMI.

Working language

All the texts and messages displayed on the advanced UMI or on the mimic-based UMI are available in 2 languages:
- English, the default working language
- and a second language, which may be
  - French
  - Spanish
  - another "local" language.

Please contact us regarding local language customization.

Connection of Sepam to the parameter setting tool

The SFT2841 parameter setting tool is required for Sepam protection and parameter setting.
A PC containing the SFT2841 software is connected to the RS 232 communication port on the front of the unit or trough the communication network.

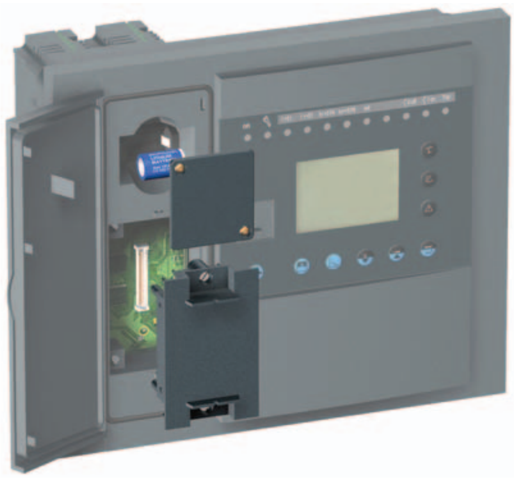
Base unit
Presentation

Selection guide

Base unit	With remote advanced UMI	With integrated advanced UMI	With mimic-based UMI
	PE60306 	PE60307 	PE60308 
Functions			
Local indication			
Metering and diagnosis data	■	■	■
Alarms and operating messages	■	■	■
List of activated protection functions	■	■	■
Main protection settings	■	■	■
Version of Sepam and remote modules	■	■	■
Status of logic inputs	■	■	■
Switchgear status on the animated mimic diagram			■
Phasor diagram of currents or voltages			■
Local control			
Alarm acknowledgement	■	■	■
Sepam reset	■	■	■
Output testing	■	■	■
Selection of Sepam control mode			■
Device open/close order			■
Characteristics			
Screen			
Size	128 x 64 pixels	128 x 64 pixels	128 x 240 pixels
Automatic contrast setting	■	■	■
Backlit screen	■	■	■
Keypad			
Number of keys	9	9	14
Control-mode switch			Remote / Local / Test
LEDs			
Sepam operating status	■ base unit: 2 LEDs visible on back ■ remote advanced UMI: 2 LEDs visible on front	2 LEDs, visible from front and back	2 LEDs, visible from front and back
Indication LEDs	9 LEDs on remote advanced UMI	9 LEDs on front	9 LEDs on front
Mounting			
	■ bare base unit, mounted at the back of the compartment using the AMT880 mounting plate ■ DSM303 remote advanced UMI module , flush mounted on the front of the cubicle and connected to the base unit with the CCA77x prefabricated cord	Flush mounted on front of cubicle	Flush mounted on front of cubicle

Base unit
Presentation

PE60309



Sepam series 60 memory cartridge and backup battery.

Hardware characteristics

Removable memory cartridge
The cartridge contains all the Sepam characteristics:
- ■ all Sepam protection and parameter settings
- ■ all the metering and protection functions required for the application
- ■ predefined control functions
- ■ functions customized by control matrix or logic equations
- ■ personalized local-control mimic diagram
- ■ accumulated energies and switchgear diagnosis values
- ■ working languages, customized and otherwise.

It may be made tamper-proof by lead sealing.
It is removable and easy to access on the front panel of Sepam to reduce maintenance time.
If a base unit fails, simply:
- ■ switch off Sepam and unplug connectors
- ■ retrieve original cartridge
- ■ replace the faulty base unit by a spare base unit (without cartridge)
- ■ load the original cartridge into the new base unit
- ■ plug in the connectors and switch Sepam on again:

Sepam is operational, with all its standard and customized functions, without requiring any reloading of protection and parameter settings.

Backup battery
Standard lithium battery, 1/2 AA format, 3.6 Volts.
It allows the following data to be stored in the event of an auxiliary power outage:
- ■ time-tagged event tables
- ■ disturbance recording data
- ■ peak demands, tripping context, etc
- ■ date and time.

The battery presence and charge are monitored by Sepam.
The main data (e.g. protection and parameter settings) are saved in the event of an auxiliary power outage, regardless of the state of the battery.

Auxiliary power supply
DC power supply voltage from 24 to 250 V DC.

Four relay outputs
The 4 relay outputs O1, O2, O3 and O5 on the base unit must be connected to connector A. Each output can be assigned to a predetermined function using the SFT2841 software.
O1 to O3 are 3 control outputs with one NO contact, used by default for the switchgear control function:
- ■ O1: switchgear tripping
- ■ O2: switchgear closing inhibition
- ■ O3: switchgear closing

O5 is an indication output used by default for the watchdog function and has two contacts, one NC and one NO.

3

Base unit
Presentation

PE60310

Main connector and voltage and residual current input connector
A choice of 2 types of removable, screw-lockable 20-pin connectors:
■ CCA620 screw-type connectors
■ or CCA622 ring lug connectors.
The presence of the connector is monitored.

Phase current input connectors
Current sensors connected to removable, screw-lockable connectors according to type of sensors used:
■ CCA630 or CCA634 connector for 1 A or 5 A current transformers
■ or CCA671 connector for LPCT sensors.
The presence of these connectors is monitored.

Mounting accessories

Spring clips
8 spring clips are supplied with the base unit to flush-mount Sepam in mounting plates 1.5 to 6 mm thick.
Simple, tool-free installation.

AMT880 mounting plate
It is used to mount a Sepam without UMI inside the compartment with access to connectors on the rear panel.
Mounting used with remote advanced UMI module (DSM303).

AMT820 blanking plate
It fills in the space left when a standard model Sepam 2000 is replaced by a Sepam series 60.

Spare base units
The following spares are available to replace faulty base units:
■ base units with or without UMI, without cartridge or connectors
■ all types of standard cartridges.

AMT852 lead sealing accessory
The AMT852 lead sealing accessory can be used to prevent unauthorized modification of the settings of Sepam series 60 units with integrated advanced UMIs.
The accessory includes:
■ a lead-sealable cover plate
■ the screws required to secure the cover plate to the integrated advanced UMI of the Sepam unit.

***Note: the** AMT852 lead sealing accessory can secured only to the integrated advanced UMIs of Sepam series 60 units.*

Base unit
Description

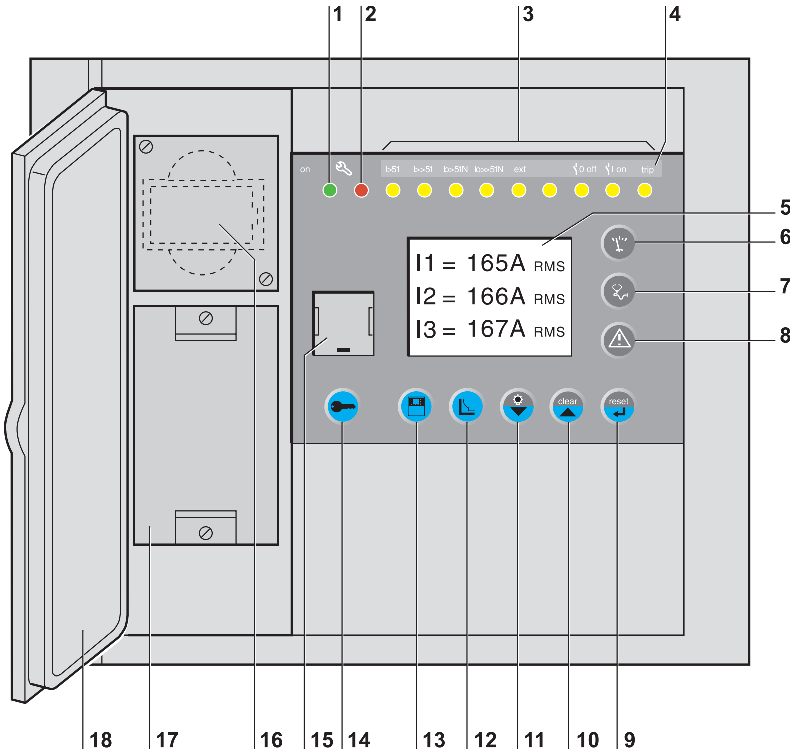
Front panel with advanced UMI

1 Green LED: Sepam on.
2 Red LED: Sepam unavailable.
3 9 yellow indication LEDs.
4 Label identifying the indication LEDs.

5 Graphical LCD screen.
6 Display of measurements.
7 Display of switchgear, network and machine diagnosis data.
8 Display of alarm messages.
9 Sepam reset (or confirm data entry).
10 Acknowledgement and clearing of alarms (or move cursor up).
11 LED test (or move cursor down).
12 Display and adaptation of activated protection settings.
13 Display of Sepam.
14 Entry of 2 passwords.
15 RS 232 PC connection port.

16 Backup battery.
17 Memory cartridge.
18 Door.

DE88156



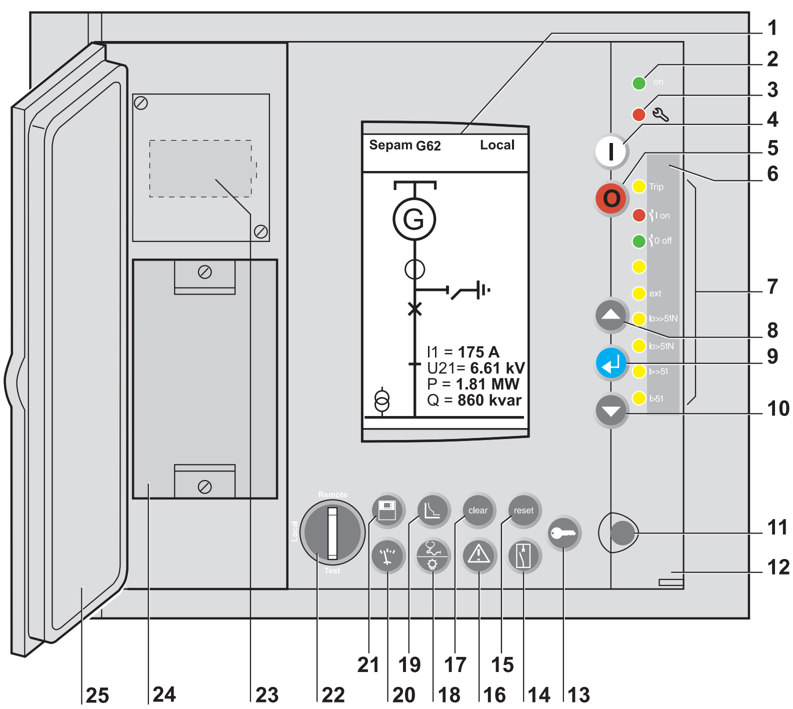
Front panel with mimic-based UMI

1 Graphical LCD screen.
2 Green LED: Sepam on.
3 Red LED: Sepam unavailable.
4 Local close order.
5 Local open order.
6 Label identifying the indication LEDs.
7 7 yellow indication LEDs, 1 red LED (I), 1 green LED (o).
8 Move cursor up.
9 Confirm data entry.
10 Move cursor down.
11 RS 232 PC connection port.
12 Transparent door.

13 Entry of 2 passwords.
14 Mimic-based UMI display.
15 Sepam reset.
16 Display of alarm messages.
17 Acknowledgement and clearing of alarms.
18 Display of switchgear and network diagnosis data (or LED test).
19 Display and adaptation of activated protection settings.
20 Display of measurements.
21 Display of Sepam.
22 Three-position key switch to select Sepam control mode.

23 Backup battery.
24 Memory cartridge.
25 Door.

DE60677



Base unit
Description

Rear panel

1 Base unit.
2 8 fixing points for 4 spring clips.
3 Red LED: Sepam unavailable.
4 Green LED: Sepam on.
5 Gasket.

(A) 20-pin connector for:
- 24 V DC to 250 V DC auxiliary supply
- 4 relay outputs.

(B1) Connector for 3 phase current I1, I2, I3 inputs.

(C1) Modbus communication port.

(D1) Remote module connection port.

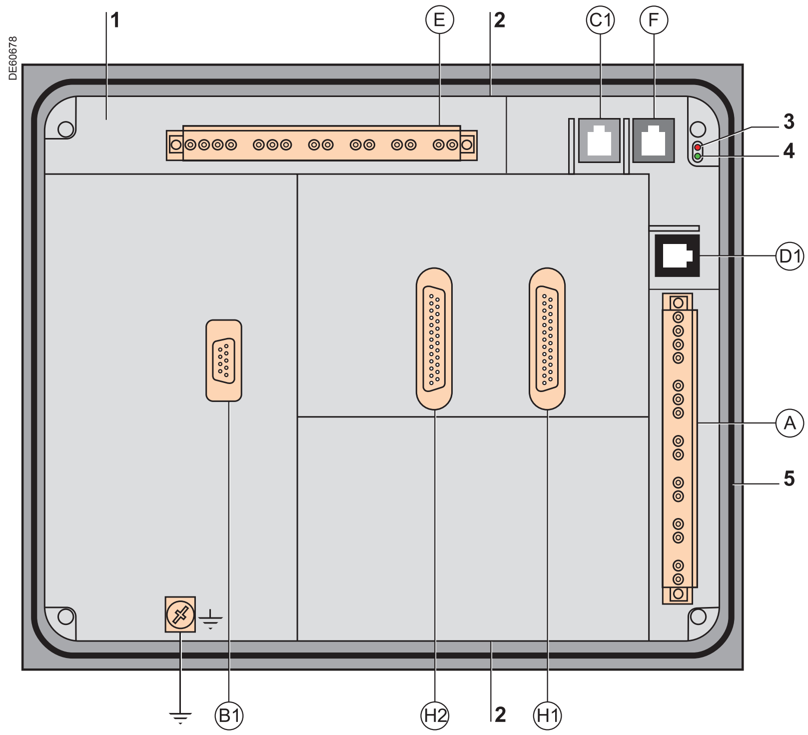
(E) 20-pin connector for:
- 3 phase voltage V1, V2, V3/V0 inputs
- 1 residual current I0 input.

(F) Communication port 2 for ACE850 modules only.

(H1) Connector for 1st MES120 input/output module.

(H2) Connector for 2nd MES120 input/output module.

⏚ Functional earth.



Base unit
Technical characteristics

Weight

	Base unit with advanced UMI	Base unit with mimic-based UMI
Minimum weight (base unit without MES120)	2.4 kg (5.29 lb)	3.0 kg (6.61 lb)
Maximum weight (base unit with 2 MES120)	3.4 kg (7.5 lb)	4.0 kg (8.82 lb)

Sensor inputs

Phase current inputs	1 A or 5 A CT
Input impedance	< 0.02 Ω
Consumption	< 0.02 VA (1 A CT) < 0.5 VA (5 A CT)
Continuous thermal withstand	4 In
1 second overload	100 In

Voltage inputs	Phase	Residual
Input impedance	> 100 k Ω	> 100 k Ω
Consommation	< 0.015 VA (100 V VT)	< 0.015 VA (100 V VT)
Continuous thermal withstand	240 V	240 V
1-second overload	480 V	480 V
Isolation of inputs in relation to other isolated groups	Enhanced	Enhanced

Relay outputs

Control relay outputs (O1, O2, O3; and O101, O102)

Voltage	DC	24/48 V DC	127 V DC	220 V DC	
	AC (47.5 to 63 Hz)				100 to 240 V AC
Continuous current		8 A	8 A	8 A	8 A
Breaking capacity	Resistive load	8 A / 4 A	0.7 A	0.3 A	
	Load L/R < 20 ms	6 A / 2 A	0.5 A	0.2 A	
	Load L/R < 40 ms	4 A / 1 A	0.2 A	0.1 A	
	Resistive load				8 A
	Load p.f. > 0.3				5 A
Making capacity		< 15 A for 200 ms			
Isolation of outputs in relation to other isolated groups		Enhanced			

Annunciation relay output (O5, O102 to O106, O202 to O206)

Voltage	DC	24/48 V DC	127 V DC	220 V DC	
	AC (47.5 to 63 Hz)				100 to 240 V AC
Continuous current		2 A	2 A	2 A	2 A
Breaking capacity	Load L/R < 20 ms	2 A / 1 A	0.5 A	0.15 A	
	Load p.f. > 0.3				1 A
Isolation of outputs in relation to other isolated groups		Enhanced			

Power supply

Voltage	24 to 250 V DC	-20 % / +10 %
Maximum consumption	< 16 W	
Inrush current	< 10 A 10 ms	
Acceptable ripple content	12 %	
Acceptable momentary outages	20 ms	

Battery

Format	1/2 AA lithium 3.6 V
Service life	10 years Sepam energized
	3 years minimum, typically 6 years Sepam not energized

(1) Relay outputs complying with clause 6.7 of standard C 97.90 (30 A, 200 ms, 2000 operations)

Base unit
Environmental characteristics

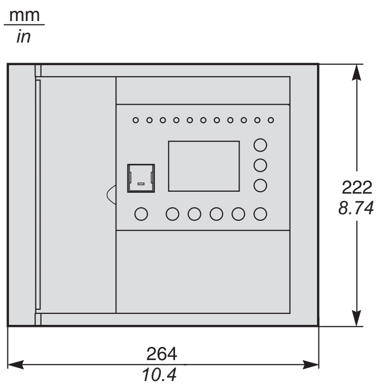
Electromagnetic compatibility	Standard	Level / Class	Value
Emission tests			
Disturbing field emission	IEC 60255-25		
	EN 55022	A	
Conducted disturbance emission	IEC 60255-25		
	EN 55022	A	
Immunity tests – Radiated disturbances			
Immunity to radiated fields	IEC 60255-22-3		10 V/m; 80 MHz - 1 GHz
	IEC 61000-4-3	III	10 V/m; 80 MHz - 2 GHz
	ANSI C37.90.2 (2004)		20 V/m; 80 MHz - 1 GHz
Electrostatic discharge	IEC 60255-22-2		8 kV air; 6 kV contact
	ANSI C37.90.3		8 kV air; 4 kV contact
Immunity to magnetic fields at network frequency	IEC 61000-4-8	4	30 A/m (continuous) - 300 A/m (1-3 s) (4)
Immunity tests – Conducted disturbances			
Immunity to conducted RF disturbances	IEC 60255-22-6	III	10 V
Electrical fast transients/burst	IEC 60255-22-4	A and B	4 kV; 2.5 kHz / 2 kV; 5 kHz
	IEC 61000-4-4	IV	4 kV; 2.5 kHz
	ANSI C37.90.1		4 kV; 2.5 kHz
1 MHz damped oscillating wave	IEC 60255-22-1		2.5 kV CM; 1 kV DM
	ANSI C37.90.1		2.5 kV CM; 2.5 kV DM
100 kHz damped sine wave	IEC 61000-4-12	III	2 kV CM
Slow damped oscillating wave (100 kHz to 1 MHz)	IEC 61000-4-18	III	2 kV CM
Fast damped oscillating wave (3 MHz, 10 MHz, 30 MHz)	IEC 61000-4-18	III	
Impulse wave	IEC 61000-4-5	III	2 kV CM; 1 kV DM
Immunity to conducted disturbances in common mode from 0 Hz to 150 kHz	IEC 61000-4-16	III	
Voltage interruptions	IEC 60255-11		100 % during 20 ms
Mechanical robustness	**Standard**	**Level / Class**	**Value**
In operation			
Vibrations	IEC 60255-21-1	2	1 Gn; 10 Hz - 150 Hz
	IEC 60068-2-6	Fc	3 Hz - 13.2 Hz; a = ±1 mm
	IEC 60068-2-64	2M1	
Shocks	IEC 60255-21-2	2	10 Gn / 11 ms
Earthquakes	IEC 60255-21-3	2	2 Gn (horizontal axes) 1 Gn (vertical axes)
De-energized			
Vibrations	IEC 60255-21-1	2	2 Gn; 10 Hz - 150 Hz
Shocks	IEC 60255-21-2	2	27 Gn / 11 ms
Jolts	IEC 60255-21-2	2	20 Gn / 16 ms
Climatic withstand	**Standard**	**Level / Class**	**Value**
In operation			
Exposure to cold	IEC 60068-2-1	Ad	-25 °C
Exposure to dry heat	IEC 60068-2-2	Bd	+70 °C
Continuous exposure to damp heat	IEC 60068-2-78	Cab	10 days; 93 % RH ; 40 °C
Salt mist	IEC 60068-2-52	Kb/2	6 days
Influence of corrosion/Gas test 2	IEC 60068-2-60	C	21 Days, 75% RH, 25°C, 500.10-9 vol/vol H_2S; 1000.10-9 vol/vol SO²
Influence of corrosion/Gas test 4	IEC 60068-2-60	Method 3	21 Days, 75% RH, 25°C, 10+/-5 H²S; 200+/-20 SO² ; 200+/-20 NO², 10+/-5 Cl² (10-9 vol/vol)
	EIA 364-65A	IIIA	42 days, 75% RH, 30°C, 100+/-20 H²S; 200+/-50 SO² ; 200+/-50 NO², 20+/-5 Cl² (10-9 vol/vol)
In storage (3)			
Temperature variation with specified variation rate	IEC 60068-2-14	Nb	-25 °C at +70 °C; 5 °C/min
Exposure to cold	IEC 60068-2-1	Ab	-25 °C
Exposure to dry heat	IEC 60068-2-2	Bb	+70 °C
Continuous exposure to damp heat	IEC 60068-2-78	Cab	56 days; 93 % RH; 40 °C
	IEC 60068-2-30	Db	6 days; 95 % RH; 55 °C
Safety	**Standard**	**Level / Class**	**Value**
Enclosure safety tests			
Front panel tightness	IEC 60529	IP52	Other panels IP20
	NEMA	Type 12	
Fire withstand	IEC 60695-2-11		650 °C with glow wire
Electrical safety tests			
1.2/50 µs impulse wave	IEC 60255-5		5 kV (1)
Power frequency dielectric withstand	IEC 60255-5		2 kV 1mn (2)
	ANSI C37.90		1 kV 1 mn (indication output) 1.5 kV 1 mn (control output)
Certification			
CE	EN 50263 harmonized standard	■ European Electromagnetic Compatibility Directive (EMCD) 2004 / 108 / EC of 15 December 2004 ■ European Low Voltage Directive (LVD) 2006/95/CE of 12 December 2006	
UL cULus	UL508 - CSA C22.2 n° 14-95		File E212533
CSA	CSA C22.2 n° 14-95 / n° 94-M91 / n° 0.17-00		File 210625

(1) Except for communication: 3 kV in common mode and 1 kV in differential mode.
(2) Except for communication: 1 kVrms.
(3) Sepam must be stored in its original packing.
(4) Iso > 0.1 Ino for the 50n/51n and 67n protection functions, with I0 calculated as the sum of the phase currents.

Base unit
Dimensions

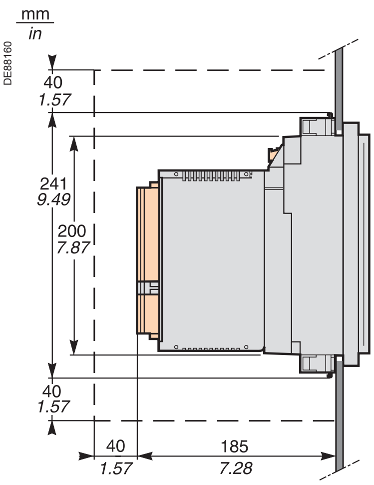
Dimensions

DE88159



Front view of Sepam.

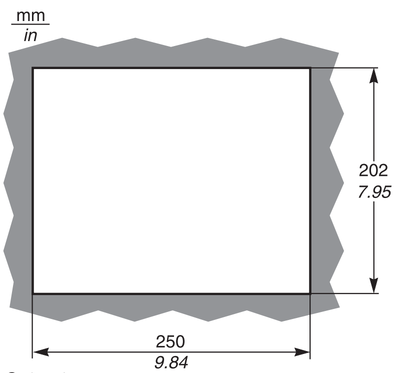
DE88160



Side view of Sepam with MES120, flush-mounted in front panel with spring clips.
Front panel: 1.5 mm (0.05 In) to 6 mm (0.23 In) thick.

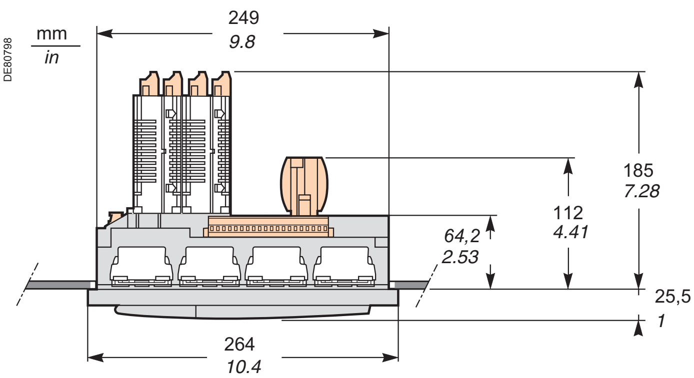
Clearance for Sepam assembly and wiring.

DE88161



Cut-out.

DE80798



Top view of Sepam with MES120, flush-mounted in front panel with spring clips.
Front panel: 1.5 mm (0.05 In) to 6 mm (0.23 In) thick.

⚠ CAUTION

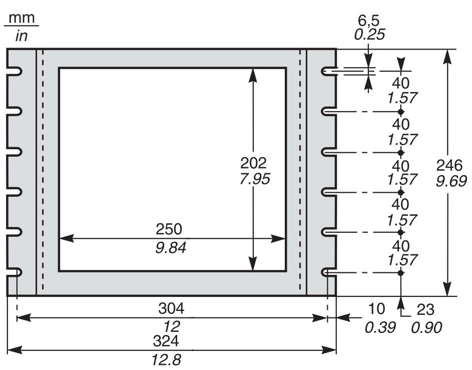
HAZARD OF CUTS

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

Failure to follow this instruction can cause serious injury.

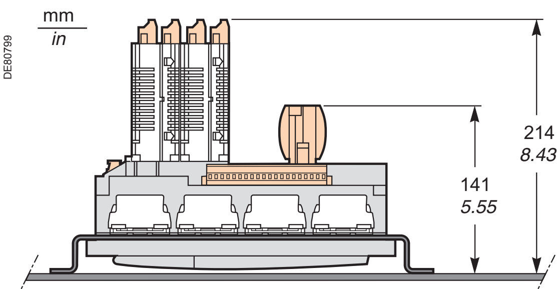
Assembly with AMT880 mounting plate

DE88163



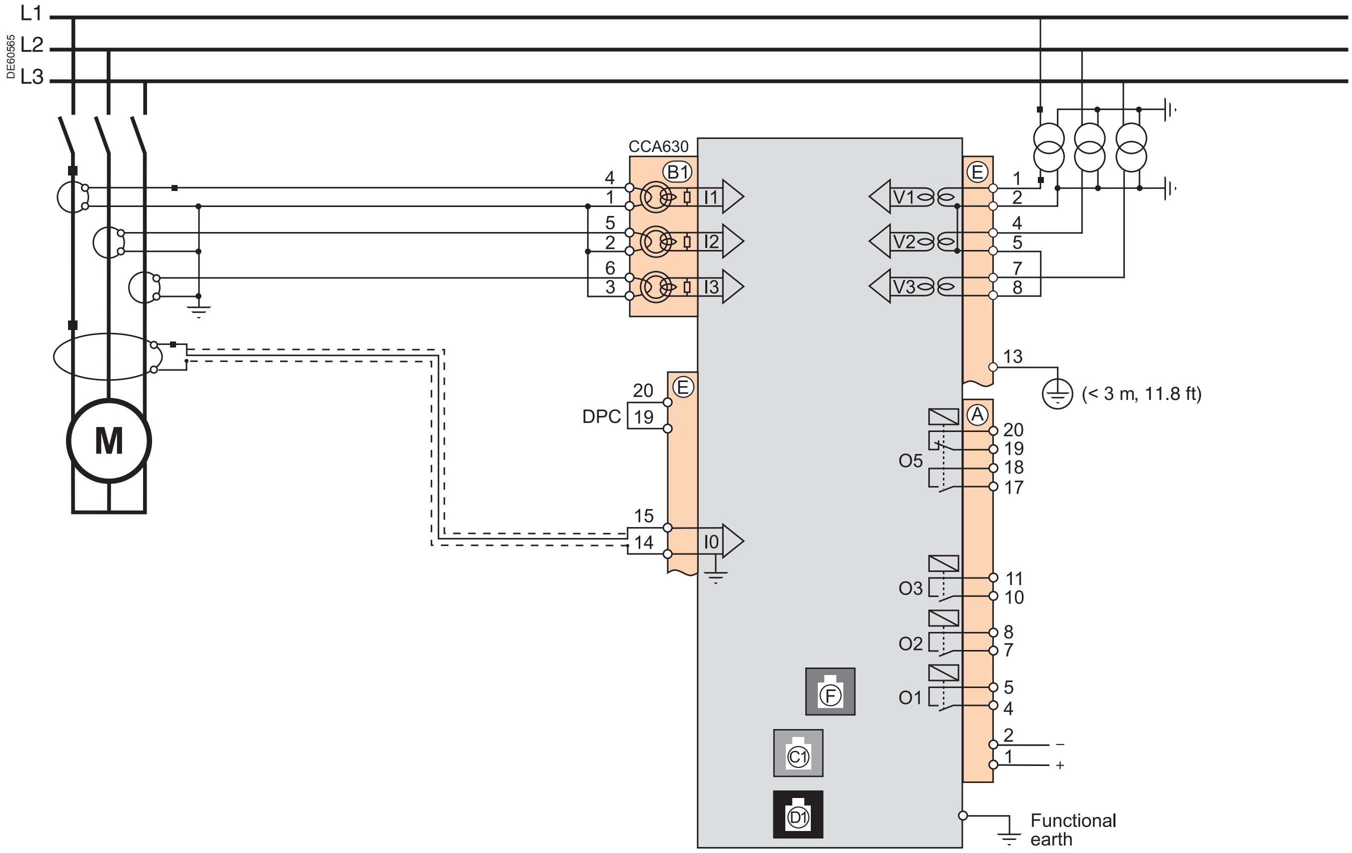
AMT880 mounting plate.

DE80799



Top view of Sepam with MES120, mounted with AMT880 and spring clips.
Mounting plate: 3 mm (0.11 In) thick.

Base unit
Sepam series 60



Base unit
Connection

Connection characteristics

Connector	Type	Reference	Wiring
(A), (E)	Screw type	CCA620	■ wiring with no fittings : □ 1 wire with max. cross-section 0.2 to 2.5 mm² (≥ AWG 24-12) or 2 wires with max. cross-section 0.2 to 1 mm² (≥ AWG 24-16) □ stripped length: 8 to 10 mm ■ wiring with fittings: □ recommended wiring with Telemecanique fittings: - DZ5CE015D for 1 x 1.5 mm² wire (AWG 16) - DZ5CE025D for 1 x 2.5 mm² wire (AWG 12) - AZ5DE010D for 2 x 1 mm² wires (AWG 18) □ tube length: 8.2 mm (0.32 in) □ stripped length: 8 mm (0.31 in)
	6.35 mm ring lugs	CCA622	■ 6.35 mm ring or spade lugs (1/4”) ■ maximum wire cross-section of 0.2 to 2.5 mm² (≥ AWG 24-12) ■ stripped length: 6 mm ■ use an appropriate tool to crimp the lugs on the wires ■ maximum of 2 ring or spade lugs per terminal ■ tightening torque: 1.2 (13.27 lb-in)
(C1)	White RJ45 plug		CCA612
(D1)	Black RJ45 plug		CCA770: L = 0.6 m (2 ft) CCA772: L = 2 m (6.6 ft) CCA774: L = 4 m (13.1 ft) CCA785 for MCS025 module: L = 2 m (6.6 ft)
(F)	Blue RJ45 plug		CCA614
DE88166 Functional earth	Ring lug		Earthing braid, to be connected to cubicle grounding: ■ flat copper braid with cross-section ≥ 9 mm² ■ maximum length: 300 mm (11.8 in)
(B1)	4 mm ring lugs	CCA630, CCA634 for connection of 1 A or 5 A CTs	■ wire cross-section 1.5 to 6 mm² (AWG 16-10) ■ tightening torque: 1.2 Nm (13.27 lb-in)
	RJ45 plug	CCA671, for connection of 3 LPCT sensors	Integrated with LPCT sensor

CAUTION

LOSS OF PROTECTION OR RISK OF NUISANCE TRIPPING

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

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

⚠ CAUTION

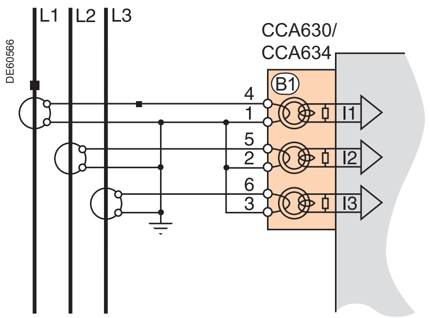
HAZARD OF ELECTRIC SHOCK, ELECTRIC ARC OR BURNS

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

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

Base unit
Phase current inputs

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



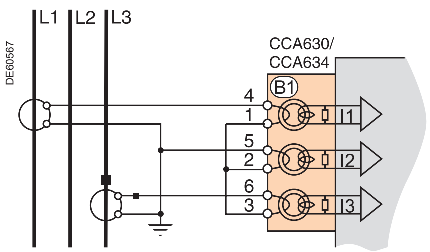
Connection of 3 x 1 A or 5 A sensors to the CCA630 connector.

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

Parameters

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

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



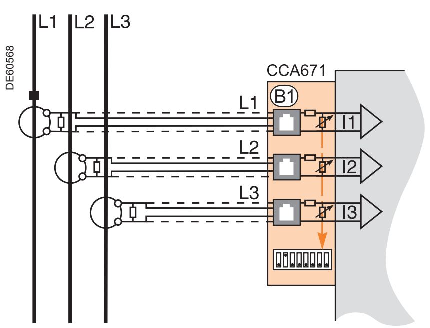
Connection of 2 x 1 A or 5 A sensors to the CCA630 connector.

Measurement of phase 1 and 3 currents is sufficient for all protection functions based on phase current.

Parameters

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

Variant 3: phase current measurement by 3 LPCT type sensors



Connection of 3 Low Power Current Transducer (LPCT) type sensors to the CCA671 connector. It is necessary to connect 3 sensors; if only one or two sensors are connected, Sepam goes into fail-safe position.

Measurement of the 3 phase currents allows the calculation of residual current.

The In parameter, primary rated current measured by an LPCT, is to be chosen from the following values, in Amps: 25, 50, 100, 125, 133, 200, 250, 320, 400, 500, 630, 666, 1000, 1600, 2000, 3150.
Parameter to be set using the SFT2841 software tool, to be completed by hardware setting of the microswitches on the CCA671 connector.

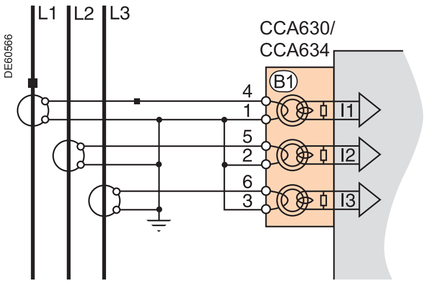
Parameters

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

Note: Parameter In must be set twice:
- Software parameter setting using the advanced UMI or the SFT2841 software tool
- Hardware parameter setting using microswitches on the CCA671 connector

Base unit
Residual current inputs

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

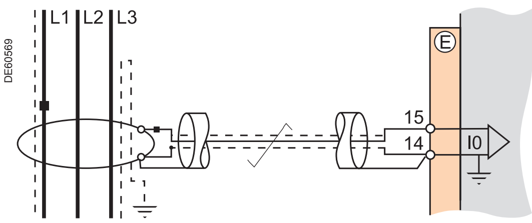


Description
Residual current is calculated by the vector sum of the 3 phase currents I1, I2 and I3, measured by 3 x 1 A or 5 A CTs or by 3 LPCT type sensors.
See current input connection diagrams.

Parameters

Residual current	rated residual current	Measuring range
Sum of 3 Is	In0 = In, CT primary current	0.01 to 40 In0 (minimum 0.1 A)

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

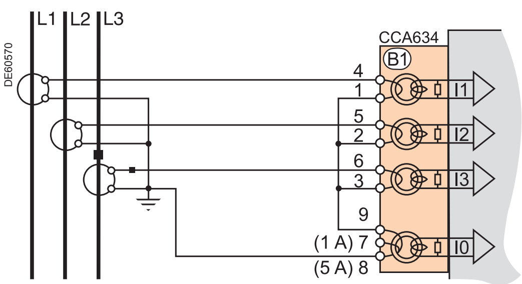


Description
Arrangement recommended for the protection of isolated or compensated neutral systems, in which very low fault currents need to be detected.

Parameters

Residual current	rated residual current	Measuring range
2 A rating CSH	In0 = 2 A	0.1 to 40 A
20 A rating CSH	In0 = 20 A	0.2 to 400 A

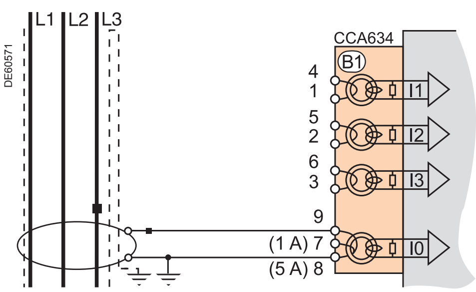
Variant 3: residual current measurement by 1 A or 5 A CTs and CCA634



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

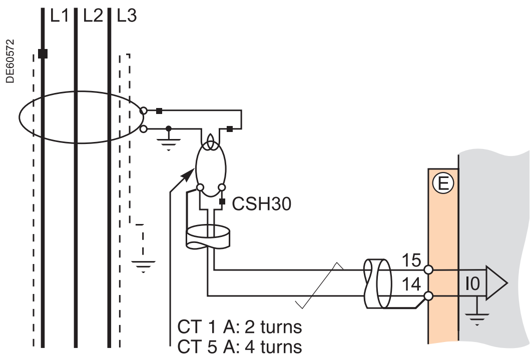
Parameters

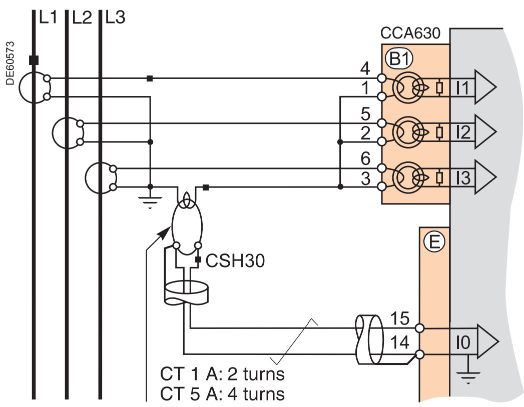
Residual current	rated residual current	Measuring range
1 A CT	In0 = In, CT primary current	0.01 to 20 In0 (minimum 0.1 A)
5 A CT	In0 = In, CT primary current	0.01 to 20 In0 (minimum 0.1 A)



Base unit
Residual current inputs

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





Description

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

■ CSH30 interposing ring CT connected to 1 A CT: make 2 turns through CSH primary

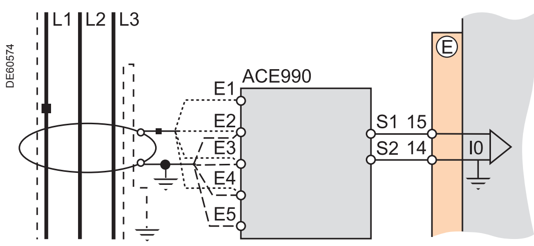
■ CSH30 interposing ring CT connected to 5 A CT: make 4 turns through CSH primary.

Parameters

Residual current	rated residual current	Measuring range
1 A CT	In0 = In, CT primary current	0.01 to 20 In0 (minimum 0.1 A)
5 A CT	In0 = In, CT primary current	0.01 to 20 In0 (minimum 0.1 A)

3

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



Description

The ACE990 is used as an interface between a MV core balance CT with a ratio of 1/n (50 ≤ n ≤ 1500) and the Sepam residual current input.

This arrangement allows the continued use of existing core balance CTs on the installation.

Parameters

Residual current	rated residual current	Measuring range
ACE990 - range 1 (0.00578 ≤ k ≤ 0.04)	In0 = Ik.n (1)	0.01 to 20 In0 (minimum 0.1 A)
ACE990 - range 2 (0.00578 ≤ k ≤ 0.26316)	In0 = Ik.n (1)	0.01 to 20 In0 (minimum 0.1 A)

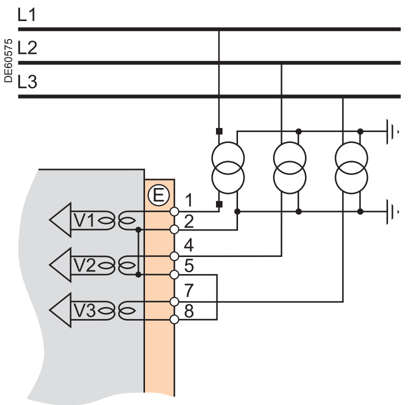
(1) n = number of core balance CT turns

k = factor to be determined according to ACE990 wiring and setting range used by Sepam

Phase voltage inputs
Residual voltage input
Main channels

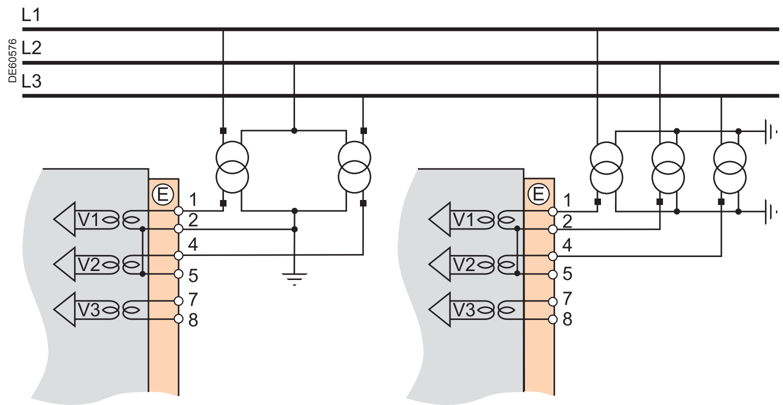
Phase voltage input connection variants

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



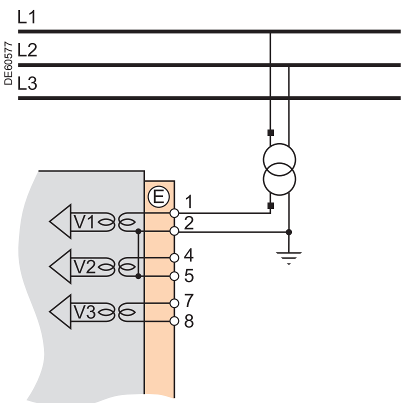
Measurement of the 3 phase-to-neutral voltages allows the calculation of residual voltage, V0Σ.

Variant 2: measurement of 2 phase-to-phase voltages (2 U)



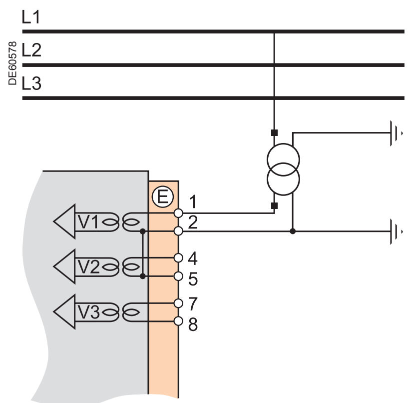
This variant does not allow the calculation of residual voltage, but V0 or Vnt measurment could be added as variant 5 or 6.

Variant 3: measurement of 1 phase-to-phase voltage (1 U)



This variant does not allow the calculation of residual voltage.

Variant 4: measurement of 1 phase-to-neutral voltage (1 V)

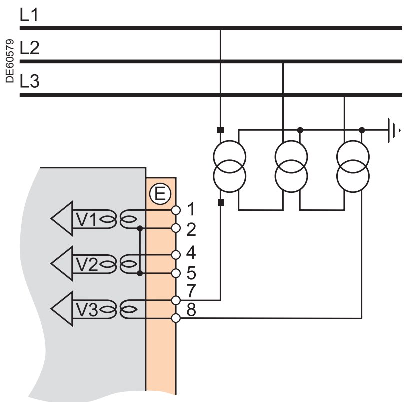


This variant does not allow the calculation of residual voltage.

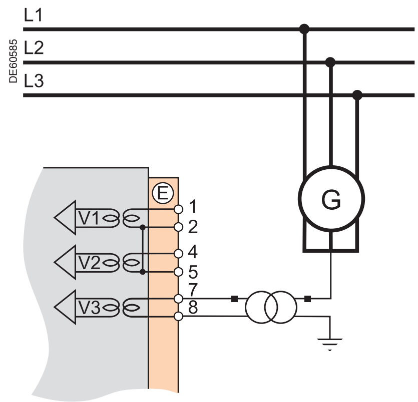
Phase voltage inputs
Residual voltage input
Main channels

Residual voltage input connection variants

Variant 5: measurement of residual voltage V0



Variant 6 : measurement of the residual voltage Vnt at the neutral point of a generator



Phase voltage inputs
Residual voltage input
Available functions

The availability of certain protection and metering functions depend on the phase and residual voltages measured by Sepam.

The table below gives the voltage input connection variants for which for each protection and metering function dependent on measured voltages is available.
Example:
The directional overcurrent protection function (ANSI 67N/67NC) uses residual voltage V0 as a polarization value.
It is therefore operational in the following cases:
- measurement of the 3 phase-to-neutral voltages or calculation of V0Σ
- measurement of residual voltage V0 (variant 3,5).

The protection and metering functions which do not appear in the table below are available regardless of the voltages measured.

Phase voltages measured (connection variant)		3 V (var. 1)		2 U (var. 2)			1 U (var. 3)			1 V (var. 4)		
Residual voltage measured (connection variant)		**–**	**V0 Sum**	**–**	**V0 (v. 5)**	**Vnt (v. 6)**	**–**	**V0 (v. 5)**	**Vnt (v. 6)**	**–**	**V0 (v. 5)**	**Vnt (v. 6)**
Protection functions dependent on voltages measured												
Directional phase overcurrent	67	■	■	■	■	■						
Directional earth fault	67N/67NC	■	■		■			■			■	
Directional active overpower	32P	■	■	■	■	■						
Directional reactive active overpower	32Q	■	■	■	■	■						
Directional active underpower	37P	■	■	■	■	■						
Field loss (underimpedance)	40	■	■	■	■	■						
Voltage-restrained overcurrent	50V/51V	■	■	■	■	■						
Underimpedance	21B	■	■	■	■	■						
Positive sequence undervoltage	27D	■	■	■	■	■						
Remanent undervoltage	27R	■	■	■	■	■	■	■	■	■	■	■
Undervoltage (L-L or L-N)	27	■	■	■	■	■	■	■	■	■	■	■
Overvoltage (L-L or L-N)	59	■	■	■	■	■	■	■	■	■	■	■
Neutral voltage displacement	59N	■	■		■	■		■	■		■	■
Negative sequence overvoltage	47	■	■	■	■	■					■	
Overfrequency	81H	■	■	■	■	■	■	■	■	■	■	■
Underfrequency	81L	■	■	■	■	■	■	■	■	■	■	■
Rate of change of frequency	81R	■	■	■	■	■						
Measurements dependent on voltages measured												
Phase-to-phase voltage U21, U32, U13		■	■	■	■	■	U21,	U21	U21			
Phase-to-neutral voltage V1, V2, V3		■	■		■					V1	V1	V1
Residual voltage V0		■	■		■			■			■	
Neutral point voltage Vnt						■			■			■
Positive sequence voltage Vd negative sequence voltage Vi		■	■	■	■	■						
Frequency		■	■	■	■	■	■	■	■	■	■	■
Active / reactive / apparent power: P, Q, S		■	■	■	■	■	■	■	■			
Peak demand power PM, QM		■	■	■	■	■	■	■	■			
Active / reactive / apparent power per phase : P1/P2/P3, Q1/Q2/Q3, S1/S2/S3		■ (1)	■ (1)		■ (1)					P1/ Q1/S1	P1/ Q1/S1	P1/ Q1/S1
Power factor		■	■	■	■	■	■	■	■			
Calculated active and reactive energy (±Wh, ±VARh)		■	■	■	■	■	■	■	■			
Total harmonic distortion, voltage Uthd		■	■	■	■	■	■	■	■			
Phase displacement φ0		■	■		■			■			■	
Phase displacement φ1, φ2, φ3		■	■	■	■	■						
Apparent positive sequence impedance Zd		■	■	■	■	■						
Apparent phase-to-phase impedances Z21, Z32, Z13		■	■	■	■	■						

■ *Function available on main voltage channels.*
(1) *If all three phase currents are measured.*