Sepam™ Series 40 Protective Relays

User's Manual

Instruction Bulletin

63230-216-219-B1

Retain for future use.

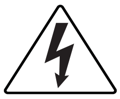
Merlin Gerin
Square D
Telemecanique

Schneider Electric

Safety symbols and messages

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

ANSI symbol



IEC symbol

Risk of electric shock

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

Safety alert

This is the safety alert symbol. It is used to alert you to potential personal injury hazards and prompt you to consult the manual. Obey all safety instructions that follow this symbol in the manual to avoid possible injury or death.

Safety messages

DANGER

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

WARNING

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

CAUTION

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

Important notes

Restricted liability

Electrical equipment should be serviced and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this manual. This document is not intended as an instruction manual for untrained persons.

Device operation

The user is responsible for checking that the rated characteristics of the device are suitable for its application. The user is responsible for reading and following the device’s operating and installation instructions before attempting to commission or maintain it. Failure to follow these instructions can affect device operation and constitute a hazard for people and property.

Protective grounding

The user is responsible for compliance with all the existing international and national electrical codes concerning protective grounding of any device.

FCC Notice

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. This Class A digital apparatus complies with Canadian ICES-003.

Contents

Contents

Overview

The Sepam™ range of protection relays is designed for all protection applications on medium-voltage public and industrial distribution networks.

It consists of three series of relays, with increasing levels of performance:

- *Sepam™ Series 20, for simple applications*
- *Sepam™ Series 40, for demanding applications*
- *Sepam™ Series 80, for custom applications*

All information relating to the Sepam™ range can be found in the following documents:

- *Sepam™ catalog, reference 63230-216-238*
- *Sepam™ Series 20 User's Manual, reference 63230-216-208*
- *Sepam™ Series 40 User's Manual, reference 63230-216-219*
- *Sepam™ Series 80 Reference Manual, reference 63230-216-230*
- *Sepam™ Series 80 Modbus Communication Manual, reference 63230-216-231*
- *Sepam™ Series 80 Installation Manual, reference 63230-216-229*
- *Sepam™ DNP3 Communication User's Manual, reference 63230-216-236*
- *Sepam™ IEC 60870-5-103 Communication User's Manual, reference 63230-216-237*

Sepam™ Series 20

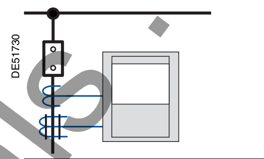
For usual applications

PE50465

Characteristics

- 10 logic inputs
- 8 relay outputs
- 1 communication port
- 8 temperature sensor inputs

DE51730



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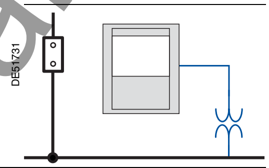


Sepam™ Series 40

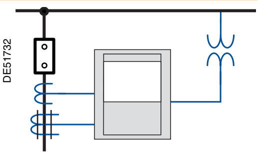
For demanding applications

PE50465

Characteristics

- 10 logic inputs
- 8 relay outputs
- Logic equation editor
- 1 communication port
- 16 temperature sensor inputs

DE51732



Sepam™ Series 80

For custom applications

PE50463

PE50464

Characteristics

- 42 logic inputs
- 23 relay outputs
- Logic equation editor
- 2 communication ports for multimaster or redundant architecture
- 16 temperature sensor inputs
- Removable memory cartridge with parameters and settings for quick return to service after replacement
- Battery for storing logs and recording data
- Mimic-based User Machine Interface for local control of the device in complete safety
- Optional Logipam programming software, for programming dedicated functions

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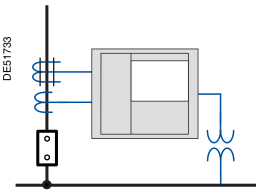

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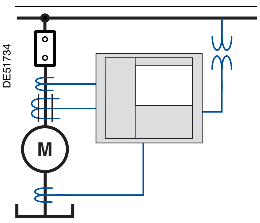

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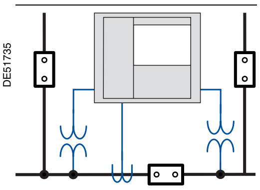

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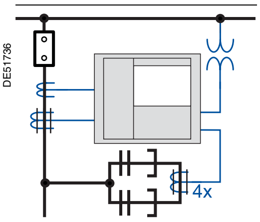
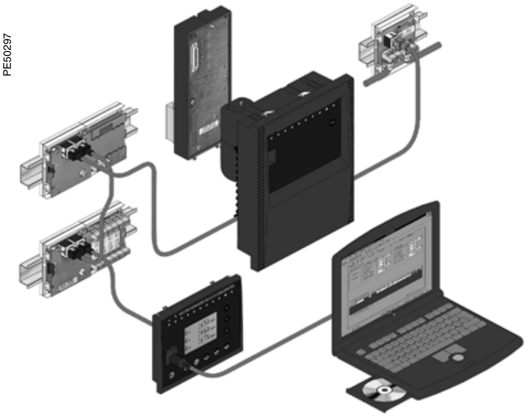


Overview

Protection		**Applications**					
Standard	**Specific**	**Substation**	**Bus**	**Transformer**	**Motor**	**Generator**	**Capacitor**
Current protection		**S20**		**T20**	**M20**		
	Breaker failure	**S23**		**T23**			
Voltage and frequency protection			**B21**				
	Rate of Change of Frequency (ROCOF)		**B22**				
Current, voltage and frequency protection		**S40**		**T40**		**G40**	
	Directional ground fault	**S41**			**M41**		
	Directional ground fault and phase overcurrent	**S42**		**T42**			
Current, voltage and frequency protection		**S80**	**B80**				
	Directional ground fault	**S81**		**T81**	**M81**		
	Directional ground fault and phase overcurrent	**S82**		**T82**		**G82**	
	Rate of Change of Frequency (ROCOF)	**S84**					
Current, voltage and frequency protection	Transformer or machine-transformer unit differential			**T87**	**M88**	**G88**	
	Machine differential				**M87**	**G87**	
Current, voltage and frequency protection	Voltage and frequency protection for two sets of buss		**B83**				
Current, voltage and frequency protection	Capacitor bank unbalance						**C86**

1

PE50297

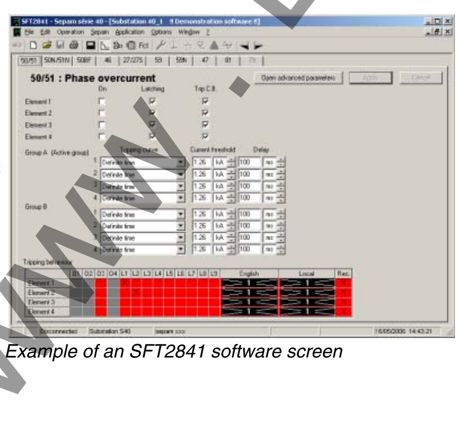


Sepam™ Series 40 a modular solution

PE50298

Sepam™ Series 40 with basic UMI and fixed advanced UMI

PE80147



Example of an SFT2841 software screen

The Sepam™ Series 40 family of protection and metering units is designed to operate machines and electrical distribution networks of industrial installations and utility substations for all levels of voltage. It consists of simple, high-performing solutions, suited to demanding applications that call for current and voltage metering.

Sepam™ Series 40 Selection Guide by Application			
Selection Criteria			
Measurements	I and V_{LL}	I and V_{LL}	I and V_{LL}
Specific protection functions		Directional ground fault	Directional ground fault and phase overcurrent
Applications			
Substation	S40	S41	S42
Transformer	T40		T42
Motor		M41	
Generator	G40		

Main Functions

Protection

- phase overcurrent protection and ground fault protection with adjustable reset time and switching of the active group of settings and zone selective interlocking
- ground fault protection insensitive to transformer switching
- RMS thermal overload protection that takes into account external operating temperature and ventilation operating rates
- directional ground fault protection suitable for all grounding systems, effectively ungrounded, compensated (neutral tuning reactor), or neutral to ground impedance (low resistance ground, high resistance ground or reactance grounded)
- directional phase overcurrent protection with voltage memory
- voltage and frequency protection functions (under/over, …)

Communication

Sepam™ can be connected to a supervision communication network (S-LAN) based on the following communication protocols:

- Modbus RTU
- DNP3
- IEC 60870-5-103

All data needed for centralized equipment management from a remote monitoring and control system is available via the communication port:

- reading: all measurements, alarms, protection settings
- writing: remote control commands

Two manuals describe DNP3 and IEC 60870-5-103 protocols for all Sepam™ units:

- DNP3 communication user manual, reference 63230-216-236
- IEC 60870-5-103 communication user manual, reference 63230-216-237

Diagnosis

Three types of diagnosis data for improved operation:

- network and machine diagnosis: tripping current, context of the last 5 trips, unbalance ratio, disturbance recording
- switchgear diagnosis: cumulative breaking current, trip circuit supervision, operating time
- diagnosis of the protection unit and additional modules: continuous self-testing, watchdog

Control and Monitoring

- circuit breaker program logic ready to use, requiring no auxiliary relays or additional wiring
- adaptation of control functions by a logic equation editor
- preprogrammed, customizable alarm messages on messages on UMI

User Machine Interface

Two levels of User Machine Interface (UMI) are available, as the user requires:

- **Basic UMI:** an economical solution for installations that do not require local operation (run via a remote monitoring and control system)
- **Fixed or Remote Advanced UMI:** a graphic LCD display and 9-key keypad are used to display the measurement and diagnosis values, alarm and operating messages and provide access to protection and parameter setting values, for installations that are operated locally

Selection Table

		Substation		Transformer		Motor		Generator
Protection	**ANSI Code**	**S40**	**S41**	**S42**	**T40**	**T42**	**M41**	**G40**
Phase overcurrent	50/51	4	4	4	4	4	4	4
Voltage-restrained overcurrent	50V/51V							1
Ground fault / Sensitive ground fault	50N/51N 50G/51G	4	4	4	4	4	4	4
Breaker failure	50BF	1	1	1	1	1	1	1
Negative sequence / current unbalance	46	2	2	2	2	2	2	2
Directional phase overcurrent	67			2		2		
Directional ground fault	67N/67NC		2	2		2	2	
Directional active overpower	32P		1	1			1	1
Directional reactive overpower	32Q/40						1	1
Thermal overload	49RMS				2	2	2	2
Phase undercurrent	37						1	
Excessive starting time, locked rotor	48/51LR/14						1	
Starts per hour	66						1	
Undervoltage	27D						2	
Remanent undervoltage	27R						1	
Undervoltage (3)	27/27S	2	2	2	2	2	2	2
Overvoltage (3)	59	2	2	2	2	2	2	2
Neutral overvoltage displacement	59N	2	2	2	2	2	2	2
Negative sequence overvoltage	47	1	1	1	1	1	1	1
Overfrequency	81H	2	2	2	2	2	2	2
Underfrequency	81L	4	4	4	4	4	4	4
Recloser (4 shots)	79	□	□	□				
Temperature monitoring (8 or 16 RTDs)	38/49T				□	□	□	□
Thermal / Pressure	26/63				□	□		
Metering								
Phase current Ia, Ib, Ic RMS, residual current Ir		■	■	■	■	■	■	■
Demand current Ia, Ib, Ic, peak demand current Iamax, Ibmax, Icmax		■	■	■	■	■	■	■
Voltage Vab, Vbc, Vac, Van, Vbn, Vcn, residual voltage Vr		■	■	■	■	■	■	■
Positive sequence voltage V1 / rotation direction Negative sequence voltage V2 / rotation direction		■	■	■	■	■	■	■
Frequency		■	■	■	■	■	■	■
Active, reactive and apparent power P, Q, S Peak demand power Pmax, Qmax, power factor (pf)		■	■	■	■	■	■	■
Calculated active and reactive energy (±W.h, ±VAR.h)		■	■	■	■	■	■	■
Active and reactive energy by pulse counting (±W.h, ±.VAR.h)		□	□	□	□	□	□	□
Temperature					□	□	□	□
Network and Machine Diagnosis								
Tripping context		■	■	■	■	■	■	■
Tripping current TripIa, TripIb, TripIc, TripIr		■	■	■	■	■	■	■
Unbalance ratio / negative sequence current I2		■	■	■	■	■	■	■
Phase displacement φr, φ'r,φrΣ,φa, φb, φc		■	■	■	■	■	■	■
Disturbance recording		■	■	■	■	■	■	■
Thermal capacity used					■	■	■	■
Remaining operating time before overload tripping					■	■	■	■
Waiting time after overload tripping					■	■	■	■
Running hours counter / operating time					■	■	■	■
Starting current and time							■	
Blocked start time, number of starts before blocking							■	
Switchgear Diagnosis								
Cumulative breaking current		■	■	■	■	■	■	■
Trip circuit supervision		□	□	□	□	□	□	□
Number of operations, operating time, charging time		□	□	□	□	□	□	□
CT / VT supervision	60FL	■	■	■	■	■	■	■
Control and Monitoring	**ANSI Code**							
Circuit breaker / contactor control (1)	94/69	■	■	■	■	■	■	■
Latching / acknowledgement	86	■	■	■	■	■	■	■
Zone selective interlocking	68	□	□	□	□	□	□	□
Switching of groups of settings		■	■	■	■	■	■	■
Annunciation	30	■	■	■	■	■	■	■
Logic equation editor		■	■	■	■	■	■	■
Additional Modules								
8 temperature sensor inputs - MET1482 module (2)					□	□	□	□
1 low level analog output - MSA141 module		□	□	□	□	□	□	□
Logic inputs/outputs - MES114/MES114E/MES114F (10I/4O) module		□	□	□	□	□	□	□
Communication interface - ACE9492, ACE959, ACE937, ACE969TP or ACE969FO		□	□	□	□	□	□	□

■ standard, □ according to parameter setting and MES114/MES114E/MES114F or MET1482 input/output module options.

***(1)** For NO or NC trip contacts*

***(2)** Two modules possible*

***(3)** Exclusive choice, phase-to-neutral voltage or phase-to-phase voltage for each of the two relays*

Weight

Minimum weight (base unit with basic UMI and without MES114)	3.09 lb (1.4 kg)
Maximum weight (base unit with advanced UMI and MES114)	4.19 lb (1.9 kg)

Analog Inputs

Current transformer	Input impedance	< 0.02 Ω
1 A or 5 A CT (with CCA630 or CA634)	Burden	< 0.02 VA at 1 A
1 A to 6250 A ratings		< 0.5 VA at 5 A
	Rated thermal withstand	4 In
	1-second overload	100 In
Voltage transformer	Input impedance	> 100 kΩ
220 V to 250 kV ratings	Input voltage	100 to 250 / √3 V
	Rated thermal withstand	240 V
	1-second overload	480 V

Temperature Sensor Input (MET1482 Module)

Type of sensor	Pt 100	Ni 100 / 120
Isolation from ground	None	None
Current injected in sensor	4 mA	4 mA
Maximum distance between sensor and module	0.62 mi (1 km)	

Logic Inputs

		MES114	MES114E		MES114F	
Voltage		24 to 250 V DC	110 to 125 V DC	110 V AC	220 to 250 V DC	220 to 240 V AC
Range		19.2 to 275 V DC	88 to 150 V DC	88 to 132 V AC	176 to 275 V DC	176 to 264 V AC
Frequency		-	-	47 to 63 Hz	-	47 to 63 Hz
Typical burden		3 mA	3 mA	3 mA	3 mA	3 mA
Typical switching threshold		14 V DC	82 V DC	58 V AC	154 V DC	120 V AC
Input limit voltage	At state 1	≥ 19 V DC	≥ 88 V DC	≥ 88 V AC	≥ 176 V DC	≥ 176 V AC
	At state 0	≤ 6 V DC	≤ 75 V DC	≤ 22 V AC	≤ 137 V DC	≤ 48 V AC
Isolation of inputs from other isolated groups		Enhanced	Enhanced	Enhanced	Enhanced	Enhanced

Relays Outputs

Control Relay Outputs (O1, O2, O11 contacts) (2)

Voltage	DC	24 / 48 V DC	125 V DC	250 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 / 4 A	0.7 A	0.3 A	
	L/R load < 20 ms	6 / 2 A	0.5 A	0.2 A	
	L/R load < 40 ms	4 / 1 A	0.2 A	0.1 A	
	Resistive load	-	-	-	8 A
	p.f. load > 0.3	-	-	-	5 A
Making capacity		< 15 A for 200 ms			
Isolation of outputs in relation to other isolated groups		Enhanced			

Annunciation Relay Output (O3, O4, O12, O13, O14 contacts)

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	L/R load < 20 ms	2 / 1 A	0.5 A	0.15 A	
	p.f. load > 0.3	-			1 A
Isolation of outputs in relation to other isolated groups		Enhanced			

Power Supply

Voltage	24 / 250 V DC	110 / 240 V AC
Range	-20% +10%	-20% +10% (47.5 to 63 Hz)
Deactivated burden (1)	< 6 W	< 6 VA
Maximum burden (1)	< 11 W	< 25 VA
Inrush current	< 10 A for 10 ms < 28 A for 100 µs	< 15 A for first half-cycle
Acceptable momentary outages	10 ms	10 ms

Analog Output (MSA141 Module)

Current	4 - 20 mA, 0 - 20 mA, 0 - 10 mA
Load impedance	< 600 Ω (wiring included)
Accuracy	0.50%

(1) According to configuration
(2) Relay outputs (O1, O2, O11 contact) comply with clause 6.7 of standard C37.90, (30 A, 200 ms, 2000 operations)

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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	B	
Immunity Tests – Radiated Disturbances			
Immunity to radiated fields	ANSI C37.90.2 (1995)		35 V/m ; 25 MHz - 1 GHz
	IEC 61000-4-3	III	10 V/m ; 80 MHz - 1 GHz
	IEC 61000-4-3		10 V/m, 80 MHz - 2 GHz
Electrostatic discharge	ANSI C37.90.3		8 kV air ; 4 kV contact
	IEC 60255-22-2		8kV air, 6kV contact
Immunity to magnetic fields at network frequency	IEC 61000-4-8	IV	30 A/m (continuous) - 300 A/m (13 s)
Immunity Tests – Conducted Disturbances			
Immunity to conducted RF disturbances	IEC 60255-22-6		10 V
Fast transient bursts	ANSI C37.90.1		4 kV ; 2.5 kHz
	IEC 61000-22-2	A or B	4 kV ; 2.5 kHz / 2 IV. 5kHz
	IEC 61000-4-4	IV	4kV, 2.5 kHz
1 MHz damped oscillating wave	ANSI C37.90.1		2.5 kV MC and MD
	IEC 60255-22-1	III	2.5 kV MC, 1kV MD
100 kHz damped oscillating wave	IEC 61000-4-12		2.5 kV MC ; 1 kV MD
Surges	IEC 61000-4-5	III	2 kV MC ; 1 kV MD
Voltage interruptions	IEC 60255-11		Series 20: 100%, 10 ms Series 40: 100%, 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	2 Hz - 13.2 Hz ; a = ±1 mm (±0.039 in)
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	30 Gn / 11 ms
Jolts	IEC 60255-21-2	2	20 Gn / 16 ms

Climate Conditions	Standard	Level / Class	Value
In operation			
Exposure to cold	IEC 60068-2-1	Series 20: Ab Series 40: Ad	-25 °C (-13 °F)
Exposure to dry heat	IEC 60068-2-2	Series 20: Bb Series 40: Bd	+70 °C (+158 °F)
Continuous exposure to damp heat	IEC 60068-2-3	Ca	10 days ; 93% RH ; 40 °C (104 °F)
Temperature variation with specified variation rate	IEC 60068-2-14	Nb	-13 °F to +158 °F (–25 °C to +70 °C) 5°C/min
Salt mist	IEC 60068-2-52	Kb/2	
Influence of corrosion	IEC 60068-2-60	C	21 days ; 75% RH ; 77 °F (25 °C) ; 0.5 ppm H_2S ; 1 ppm SO_2
Gaz test 4	IEC 60068-2-60		21 days ; 75% RH ; 77 °F (25 °C) 0.01 ppm H_2S ; 0.2 ppm SO_2 ; 0.02 ppm NO_2; ; 0.01 ppm Cl_2
In Storage [4]			
Exposure to cold	IEC 60068-2-1	Ab	-13 °F (-25 °C)
Exposure to dry heat	IEC 60068-2-2	Bb	+158 °F (+70 °C)
Continuous exposure to damp heat	IEC 60068-2-3	Ca	56 days ; 93% RH ; 104 °F (40 °C)

Safety	Standard	Level / Class	Value
Enclosure Safety Tests			
Front panel tightness	IEC 60529	IP52	Other panels closed, except for rear panel IP20
	NEMA	Type 12 with gasket supplied	
Fire withstand	IEC 60695-2-11		1200 °F (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 1 mn [2]

Certification			
CE	Harmonized standard: EN 50263	European directives: ■ 89/336/CEE Electromagnetic Comptability (EMC) Directive □ 92/31/CEE Amendment □ 93/68/CEE Amendment ■ 73/23/CEE Low Voltage Directive □ 93/68/CEE Amendment	
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 1kV in differential mode*
***(2)** Except for communication: 1 kVrms*
***(3)** Sepam™ must be stored in its original packing.*

Contents

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 tab.

General Settings		Selection	Setting Range
I_N	Rated phase current (sensor primary current)	2 or 3 CT 1 A / 5 A	1 A to 6250 A
		3 LPCTs	25 A to 3150 A (1)
I_B	Base current, according to rated power of equipment		0.4 to 1.3 I_N
I_{Nr}	Rated residual current(2)	Sum of three phase currents	See I_N rated phase current
		CSH120 or CSH200 zero sequence CT	2 A, 5 A or 20 A rating
		1 A/5 A CT	1 A to 6250 A (I_{Nr} = I_N)
		1 A/5 A CT Sensitivity x 10	0.1 A to 625 A (I_{Nr} = I_N/10)
		Zero sequence CT + ACE990 (the zero sequence CT ratio 1/n must be such that 50 ≤ n ≤ 1500)	According to current monitored and use of ACE990
$V_{LL}p$	Rated primary phase-to-phase voltage ($V_{Ln}p$: rated primary phase-to-neutral voltage $V_{LL}np = V_{LL}np/\sqrt{3}$)		220 V to 250 kV
$V_{LL}s$	Rated secondary phase-to-phase voltage	3 VTs: Van, Vbn, Vcn	100, 110, 115, 120, 200, 230 V
		2 VTs: Vab, Vbc	100, 110, 115, 120 V
		1 VT: Vab	100, 110, 115, 120 V
$V_{LL}sr$	Secondary zero sequence voltage for primary zero sequence voltage $V_{LL}np/\sqrt{3}$		$V_{LL}ns/3$ or $V_{LL}ns/\sqrt{3}$
	Rated frequency		50 Hz or 60 Hz
	Integration period (for demand current and peak demand current and power)		5, 10, 15, 30, 60 mn
	Pulse-type accumulated energy meter	Increments active energy	0.1 kW.h to 5 MWh
		Increments reactive energy	0.1 kVAR to 5 MVARh

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

(2) *I_{Nr} should be thought of as a relay input port for ground fault protection. This port can accept residually connected phase ct's and therefore measure positive, negative and zero sequence components. This port can also accept a zero sequence CT which measures only true zero sequence (no positive or negative sequence). So the port name "I_{Nr}" is just that – a port name. What kind of current (positive, negative or zero sequence) depends on the type of CTs used.*

Characteristics

Functions		Measurement Range	Accuracy (1)	MSA141	Saving
Metering					
Phase current		0.1 to 40 IN (3)	±0.5%	■	
Residual current(4)	Calculated	0.1 to 40 IN	±1%	■	
	Measured	0.1 to 20 INr	±1%	■	
Demand current		0.1 to 40 IN	±0.5%		
Peak demand current		0.1 to 40 IN	±0.5%		□
Phase-to-phase voltage		0.06 to 1.2 V_{LL}p	±0.5%	■	
Phase-to-neutral voltage		0.06 to 1.2 V_{Ln}p	±0.5%	■	
Residual voltage		0.04 to 3 V_{Ln}p	±1%		
Positive sequence voltage		0.05 to 1.2 V_{Ln}p	±2%		
Negative sequence voltage		0.05 to 1.2 V_{Ln}p	±2%		
Frequency		25 to 65 Hz	±0.02 Hz	■	
Active power		0.015 SN(2) to 999 MW	±1%	■	
Reactive power		0.015 SN(2) to 999 MVAR	±1%	■	
Apparent power		0.015 SN(2) to 999 MVA	±1%	■	
Peak demand active power		0.015 SN(2) to 999 MW	±1%		□
Peak demand reactive power		0.015 SN(2) to 999 MVAR	±1%		□
Power factor		-1 to +1 (CAP/IND)	±1%		
Calculated active energy		0 to 2.1.10^8 MW.h	±1% ±1 digit		□
Calculated reactive energy		0 to 2.1.10^8 MVAR.h	±1% ±1 digit		□
Temperature		-30 to +200 °C or -22 to +392 °F	±1 °C from +20 to +140 °C	■	
Network Diagnosis Assistance					
Tripping context					□
Phase tripping current		0.1 to 40 IN	±5%		□
Ground fault tripping current		0.1 to 20 INr	±5%		□
Negative sequence / unbalance		10 to 500% of IB	±2%		
Phase displacement φr (between Vr and Ir)		0 to 359°	±2°		
Phase displacement φa, φb, φc (between V and I)		0 to 359°	±2°		
Disturbance recording					
Machine Operating Assistance					
Thermal capacity used		0 to 800% (100% for I phase = IB)	±1%	■	□
Remaining operating time before overload tripping		0 to 999 mn	±1 mn		
Waiting time after overload tripping		0 to 999 mn	±1 mn		
Running hours counter / operating time		0 to 65535 hours	±1% or ±0.5 h		□
Starting current		1.2 IB to 24 IN	±5%		□
Starting time		0 to 300 s	±300 ms		□
Number of starts before blocking		0 to 60	1		
Blocked start time		0 to 360 mn	±1 mn		
Cooling time constant		5 to 600 mn	±5 mn		
Switchgear Diagnosis Assistance					
Cumulative breaking current		0 to 65535 kA²	±10%		□
Number of operations		0 to 4.10^9	1		□
Operating time		20 to 100 ms	±1 ms		□
Charging time		1 to 20 s	±0.5 s		□

■ *available on MSA141 analog output module, according to setup.*
□ *saved in the event of auxiliary supply outage.*
(1) *Typical accuracy, see details on subsequent pages.*
(2) *SN: apparent power, = √3.V_{LL}p.IN.*
(3) *Measurement up to 0.02 IN for information purpose.*
(4) *INr should be thought of as a relay input port for ground fault protection. This port can accept residually connected phase ct's and therefore measure positive, negative and zero sequence components. This port can also accept a zero sequence CT which measures only true zero sequence (no positive or negative sequence). So the port name "INr" is just that – a port name. What kind of current (positive, negative or zero sequence) depends on the type of CTs used.*

Phase Current

Operation

This function gives the RMS value of the phase currents:

- Ia: phase a current
- Ib: phase b current
- Ic: phase c current

It is based on RMS current measurement and considers up to 17th level harmonics.

Readout

The measurements may be accessed via:

- advanced UMI display unit by pressing the key
- a PC operating with SFT2841 software
- a communication link
- an analog converter with the MSA141 option

Characteristics

Measurement range	0.1 to 1.5 I_N (1)
Unit	A or kA
Accuracy	±0.5% typical (2) ±2% from 0.3 to 1.5 I_N ±5% if < 0.3 I_N
Display format (3)	3 significant digits
Resolution	0.1 A
Refresh interval	1 second (typical)

(1) *I_N rated current set in the general settings.*
(2) *At I_N, in reference conditions (IEC 60255-6).*
(3) *Display of values: 0.02 to 40 I_N*

Residual Current

Operation

This operation gives the RMS value of the residual current Ir and is based on measuring the fundamental component. I_{Nr} should be thought of as a relay input port for ground fault protection. This port can accept residually connected phase CTs and therefore measure positive, negative and zero sequence components. This port can also accept a zero sequence CT which measures only true zero sequence (no positive or negative sequence). So the port name "I_{Nr}" is just that – a port name. What kind of current (positive, negative or zero sequence) depends on the type of CTs used.

Readout

The residual current measured (Ir), and the residual current calculated by the sum of the phase currents (IrΣ) may be accessed via:

- the advanced UMI display unit by pressing the key
- a PC operating with SFT2841 software
- a communication link
- an analog converter with the MSA141 option

Characteristics

Measurement range		
Connection to 3 phase CTs:		0.1 to 1.5 I_{Nr} (1)
Connection to 1 CT		0.1 to 1.5 I_{Nr} (1) (3)
Connection to zero sequence CT with ACE990		0.1 to 1.5 I_{Nr} (1)
Connection to CSH residual current sensor	2 A rating	0.2 to 3 A (3)
	5 A rating	0.5 to 7.5 A (3)
	20 A rating	2 to 30 A (3)
Unit		A or kA
Accuracy (2)		±1% typical at I_{Nr} ±2% from 0.3 to 1.5 I_{Nr} ±5% if < 0.3 I_{Nr}
Display format		3 significant digits
Resolution		0.1 A
Refresh interval		1 second (typical)

(1) *I_{Nr} rated current set in the general settings.*
(2) *I_N reference conditions (IEC 60255-6), excluding sensor accuracy.*
(3) *I_{Nr} = I_{NCT} or I_{Nr} = I_{NCT}/10 according to setting.*

Average Current/ Peak Demand Current

Operation

This function provides two values:

- the average RMS current for each phase that has been obtained for each integration interval
- the greatest average RMS current value for each phase that has been obtained since the last reset

The values are refreshed after each "integration interval", an interval that may be set from 5 to 60 mn, and are saved in the event of a power outage.

Readout

The measurements may be accessed via:

- advanced UMI display unit by pressing the key
- a PC operating with SFT2841 software
- a communication link

Resetting to Zero:

1 press the clear key on the advanced UMI display unit when the peak demand current is displayed
2 via the clear command in the SFT2841 software
3 via the communication link (remote control command TC6).

Characteristics

Measurement range	0.1 to 1.5 IN (1)
Unit	A or kA
Accuracy	±0.5% typical (2) ±2% from 0.3 to 1.5 IN ±5% if < 0.3 IN
Display format (3)	3 significant digits
Resolution	0.1 A
Display format	5, 10, 15, 30, 60 minutes

***(1)** IN rated current set in the general settings.*
***(2)** At IN, in reference conditions (IEC 60255-6).*
***(3)** Display of values: 0.02 to 40 IN.*

Phase-to-Phase Voltage Phase-to-Neutral Voltage

Phase-to-Phase Voltage

Operation

This function gives the RMS value of the 50 or 60 Hz component of phase-to-phase voltages (according to voltage sensor connections):

- Vab: voltage between phases a and b
- Vbc: voltage between phases b and c
- Vca: voltage between phases c and a

It is based on measuring the fundamental component.

Readout

The measurements may be accessed via:

- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link
- an analog converter with the MSA141 option.

Characteristics

Measurement range	0.06 to 1.2 V_{LL}p (1)
Unit	V or kV
Accuracy	±0.5% typical (2) ±1% from 0.5 to 1.2 V_{LL}p ±2% from 0.06 to 0.5 V_{LL}p
Display format	3 significant digits
Resolution	1 V
Refresh interval	1 second (typical)

(1) *V_{LL} nominal rating set in the general settings.*
(2) *At V_{LL}p, in reference conditions (IEC 60255-6).*

Phase-to-Neutral Voltage

Operation

This function gives the RMS value of the 50 or 60 Hz component of phase-to-neutral voltages:

- Van: phase a phase-to-neutral voltage
- Vbn: phase b phase-to-neutral voltage
- Vcn: phase c phase-to-neutral voltage.

It is based on measuring the fundamental component.

Readout

The measurements may be accessed via:

- advanced UMI display unit by pressing the key
- a PC with the SFT2841 software
- a communication link
- an analog converter with the MSA141 option.

Characteristics

Measurement range	0.06 to 1.2 V_{Ln}p (1)
Unit	V or kV
Accuracy	±0.5% typical (2) ±1% from 0.5 to 1.2 V_{Ln}p ±2% from 0.06 to 0.5 V_{Ln}p
Display format	3 significant digits
Resolution	1 V
Refresh interval	1 second (typical)

(1) *V_{Ln}p: primary rated phase-to-neutral voltage ($V_{Ln}p = V_{LL}p/\sqrt{3}$).*
(2) *At V_{Ln}p in reference conditions (IEC 60255-6).*

Residual Voltage (Vr) Positive Sequence Voltage (V1)

Residual Voltage

Operation

This function gives the value of the residual voltage Vr = (Van + Vbn + Vcn).
Vr is measured:

- by taking the internal sum of the 3 phase voltages
- by an wye / open delta (sometimes referred to as a wye / broken delta) VT.

It is based on measuring the fundamental component.

Readout

The measurement may be accessed via:

- the advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link.

Characteristics

Measurement range	0.04 to 3 $V_{Ln}p$ (1)
Unit	V or kV
Accuracy	±1% from 0.5 to 3 $V_{Ln}p$ ±2% from 0.05 to 0.5 $V_{Ln}p$ ±5% from 0.04 to 0.05 $V_{Ln}p$
Display format	3 significant digits
Resolution	1 V
Refresh interval	1 second (typical)

(1) $V_{Ln}p$*: primary rated phase-to-neutral voltage (*$V_{Ln}p = V_{LL}p/\sqrt{3}$*).*

Positive Sequence Voltage

Operation

This function gives the calculated value of the positive sequence voltage V1.

Readout

The measurement may be accessed via:

- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link.

Characteristics

Measurement range	0.05 to 1.2 $V_{Ln}p$ (1)
Unit	V or kV
Accuracy	±2% at $V_{Ln}p$
Display format	3 significant digits
Resolution	1 V
Refresh interval	1 second (typical)

(1) $V_{Ln}p$*: primary rated phase-to-neutral voltage (*$V_{Ln}p = V_{LL}p/\sqrt{3}$*).*

Negative Sequence Voltage/ Frequency

Negative Sequence Voltage

Operation

This function gives the calculated value of the negative sequence voltage V2.

Readout

The measurement may be accessed via:

- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link.

Characteristics

Measurement range	0.05 to 1.2 $V_{Ln}p$ (1)
Unit	V or kV
Accuracy	±2% at $V_{Ln}p$
Display format	3 significant digits
Resolution	1 V
Refresh interval	1 second (typical)

(1) $V_{Ln}p$*: primary rated phase-to-neutral voltage (*$V_{Ln}p = V_{LL}p/\sqrt{3}$*).*

Frequency

Operation

This function gives the frequency value.
Frequency is measured via the following:

- based on Vab, if only one phase-to-phase voltage is connected to Sepam™
- based on positive sequence voltage V1, if the Sepam™ includes Vab and Vbc measurements.

Frequency is not measured if:

- the voltage Vab or positive sequence voltage V1 is less than 40% of V_{LL}
- the frequency is outside the measurement range.

Readout

The measurement may be accessed via:

- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link
- an analog converter with the MSA141 option.

Characteristics

Rated frequency		50 Hz, 60 Hz
Range		25 to 65 Hz
Accuracy (1)		±0.02 Hz
Display format		3 significant digits
Resolution	On SFT2841	0.01 Hz
	On Sepam™ display	0.1 Hz
Refresh interval		1 second (typical)

(1) *At* $V_{LL}p$ *in reference conditions (IEC 60255-6).*

Schneider Electric

Active, Reactive, & Apparent Power

Operation

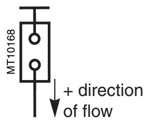
This function gives the power values:

- P active power = $\sqrt{3}.V_{LL}.I \cos \varphi$
- Q reactive power = $\sqrt{3}.V_{LL}.I.\sin \varphi$
- S apparent power = $\sqrt{3}.V_{LL}.I$.

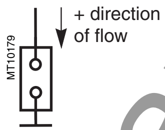
It measures the active and reactive power in 3-wire 3-phase arrangements by means of the two wattmeter method. The powers are obtained based on the phase-to-phase voltages Vab and Vbc and the phase currents Ia and Ic.
When only the voltage Vab is connected, P and Q are calculated (assuming balanced system voltage).

The following conditionis are assumed for standard practice:

- for the outgoing (for a feeder) circuit (1):
  - power exported by the bus is positive
  - power supplied to the bus is negative



- for the incoming (for a feeder) circuit (1):
  - power supplied to the bus is positive
  - power exported by the bus is negative.



Readout

The measurements may be accessed via:

- the advanced UMI display unit by pressing the key
- the display of a PC with the SFT2841 software
- the communication link
- an analog converter with the MSA141 option.

***(1)** Choice is made in the general settings.*

Characteristics

	Active Power P	Reactive Power Q
Measurement range	±(1.5% SN at 999 MW) (1)	±(1.5% SN at 999 MVAR (1)
Unit	kW, MW	kVAR, MVAR
Accuracy	±1% typical (2)	±1% typical (2)
Display format	3 significant digits	3 significant digits
Resolution	0.1 kW	0.1 kvar
Refresh interval	1 second (typical)	1 second (typical)

	Apparent power S
Measurement range	1.5% Sn at 999 MVA (1)
Unit	kVA, MVA
Accuracy	±1% typical (2)
Display format	3 significant digits
Resolution	0.1 kVA
Refresh interval	1 second (typical)

(1) $S_N = \sqrt{3} V_{LL}p.I_N$.
(2) At I_N, $V_{LL}p$, $\cos \varphi > 0.8$ in reference conditions (IEC 60255-6).

Peak Demand Active & Reactive Power/Power Factor (cos φ)

Peak Demand Active and Reactive Power

Operation

This function gives the greatest average active or reactive power value since the last reset. The values are refreshed after each "integration interval", an interval that is be set from 5 to 60 mn (common interval with peak demand phase currents). The values are saved in the event of a power outage.

Readout

The measurements may be accessed via:

- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link.

Resetting to Zero

- press the clear key on the advanced UMI display unit when a peak demand is displayed
- by using the **"clear"** command in the SFT2841 software
- by using the communication link (remote control command TC6).

Characteristics

	Active Power P	Reactive Power Q
Measurement range	±(1.5% Sn at 999 MW) (1)	±(1.5% Sn at 999 MVAR (1)
Unit	kW, MW	kVAR, MVAR
Accuracy	±1% typical (2)	±1% typical (2)
Display format	3 significant digits	3 significant digits
Resolution	0.1 kW	0.1 kvar
Integration interval	5, 10, 15, 30, 60 mn	5, 10, 15, 30, 60 mn

(1) *$S_N = \sqrt{3} V_{LL}p.I_N$.*
(2) *At I_N, $V_{LL}p$, cos φ > 0.8 in reference conditions (IEC 60255-6).*

Power Factor (cos φ)

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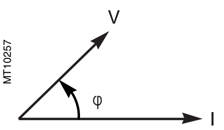


Operation

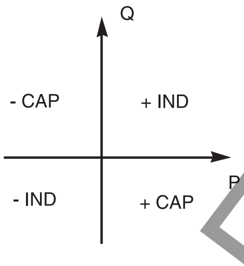
Power factor is defined by the following equation:

$$\cos\varphi = P / \sqrt{P^2 + Q^2}$$

It expresses the phase displacement between the phase currents and phase-to-neutral voltages.

The + and - signs and **IND** (inductive) and **CAP** (capacitive) indications give the direction of power flow and the type of load.

MT10258



Readout

The measurement may be accessed via:

- advanced UMI display unit by pressing the key
- a PC with the SFT2841 software
- a communication link.

Characteristics

Measurement range	-1 to 1 IND/CAP
Accuracy (1)	±0.01 typical
Display format	3 significant digits
Resolution	0.01
Refresh interval	1 second (typical)

(1) *At I_N, $V_{LL}p$, cos φ > 0.8 in reference conditions (IEC 60255-6).*

Accumulated Active and Reactive Energy

Operation

This function gives the following for the active and reactive energy values:

- accumulated energy conveyed in one direction
- accumulated energy conveyed in the other direction.

It is based on measurement of the fundamental component. The accumulated energy values are saved if power is lost.

Readout

The measurements may be accessed via:

- advanced UMI display unit by pressing the key
- PC with SFT2841 software
- a communication link.

Characteristics

	Active Energy	Reactive Energy
Metering capacity	0 to 2.1 10^8 MW.h	0 to 2.1 10^8 MVAR.h
Unit	MW.h	MVAR.h
Accuracy	±1% typical (1)	±1% typical (1)
Display format	10 significant digits	10 significant digits
Resolution	0.1 MW.h	0.1 MVAR.h

***(1)** At IN, V_{LL}p, cos φ > 0.8 in reference conditions (IEC 60255-6).*

Accumulated Active and Reactive Energy by Pulse Metering

Operation

This function meters energy through logic inputs. Energy incrementing is associated with each input (one of the general parameters to be set). Each input pulse increments the meter. Four inputs and four accumulated energy metering options are available:

- positive and negative active energy
- positive and negative reactive energy.

The accumulated active and reactive energy values are saved if power is lost.

Readout

- a PC with SFT2841 software
- a communication link.

Characteristics

	Active Energy	Reactive Energy
Metering capacity	0 to 2.1 10^8 MW.h	0 to 2.1 10^8 MVAR.h
Unit	MW	MVAR
Display format	10 significant digits	10 significant digits
Resolution	0.1 MW.h	0.1 MVAR.h
Increment	0.1 kW.h to 5 MW.h	0.1 kVAR.h to 5 MVAR.h
Impulse	15 ms min.	15 ms min.

Temperature

Operation

This function gives the temperature value measured by resistance temperature detectors (RTDs):

- platinum Pt100 (100 Ω at 0 °C or 32 °F) in accordance with the IEC 60751 and DIN 43760 standards
- nickel 100 Ω or 120 Ω (at 0 °C or 32 °F).

Each RTD channel gives one measurement:

tx = RTD x temperature.

The function also indicates RTD faults:

- RTD disconnected (tx > 205 °C or t > 401 °F)
- RTD shorted (tx < -35 °C or t < -31 °F).

The value is blocked if a fault display occurs. The associated monitoring function generates a maintenance alarm.

Readout

The measurement may be accessed via:

- advanced UMI display unit by pressing the key, in °C or in °F
- a PC with SFT2841 software
- a communication link
- an analog converter with the MSA141 option.

Characteristics

Range	-22 °F to +392 °F	-30 °C to +200 °C
Resolution	1 °F	1 °C
Accuracy (1)	±1.8 °F from +68 °F to +284 °F	±1 °C from +20 to +140 °C
	±3.6 °F from -22 °F to +68 °F	±2 °C from -30 to +20 °C
	±3.6 °F from +284 °F to +392 °F	±2 °C from +140 to +200 °C
Refresh interval		5 seconds (typical)

Accuracy derating according to wiring: see "Installation of MET1482 module"

Tripping Context

Operation

This function gives the values of physical units at the time of tripping to enable fault isolation analysis.
Values available on the advanced UMI are as follows:

- tripping currents
- residual currents (based on sum of phase currents and measured on Ir input)
- phase-to-phase voltages
- residual voltage
- frequency
- active power
- reactive power.

The SFT2841 software may be used to obtain the following in addition to the values available on the advanced UMI:

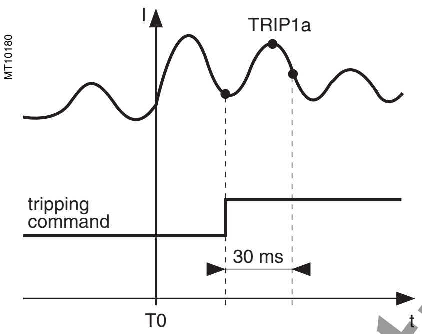
- phase-to-neutral voltages
- negative sequence voltage
- positive sequence voltage.

The values for the last five trips are stored with the date and time of tripping. They are saved in the event of a power outage.

Readout

The measurements may be accessed via:

- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link.



Tripping current (TRIPIa) acquisition

Tripping Current

Operation

This function gives the RMS value of currents at the prospective time of the last trip:

- TRIPIa: phase a current
- TRIPIb: phase b current
- TRIPIc: phase c current.

It is based on measuring the fundamental component.
Tripping current is the maximum RMS value measured during a 30 ms interval after the tripping contact activates on output O1.

Readout

The measurements may be accessed via:

- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link.

Characteristics

Measurement range	0.1 to 40 I_N (1)
Unit	A or kA
Accuracy	±5% ±1 digit
Display format	3 significant digits
Resolution	0.1 A

***(1)** I_N rated current set in the general settings.*

Network Diagnosis Functions
Negative Sequence/Current Unbalance

Operation
This function gives the negative sequence component: **T = I2/IB**
The negative sequence current is determined based on the phase currents:
- 3 phases

$$\vec{I}_2 = \frac{1}{3} \times (\vec{I}_a + a^2\vec{I}_b + a\vec{I}_c)$$

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

- 2 phases

$$\vec{I}_2 = \frac{1}{\sqrt{3}} \times (\vec{I}_a - a^2\vec{I}_c)$$

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

These two formulas are equal when there is no ground fault.

Readout
The measurements may be accessed via:
- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- the communication link.

Characteristics

Measurement range	10 to 500%
Unit	% IB
Accuracy	±2%
Display format	3 significant digits
Resolution	1%
Refresh interval	1 second (typical)

Network Diagnosis Functions
Phase Displacement φr
Phase Displacement φa, φb, φc

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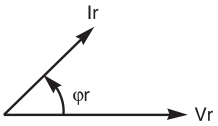

Phase displacement φr.

Phase Displacement φr

Operation

This function gives the phase displacement measured between the residual voltage and residual current in the trigonometric sense (see diagram). The measurement is used during commissioning to verify the correct directional ground fault protection unit connection.

Two values are available:
- φr, angle with measured Ir
- φrΣ, angle with Ir calculated by sum of phase currents.

Readout

The measurements may be accessed via:
- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link.

Characteristics

Measurement range	0 to 359°
Resolution	1°
Accuracy	±2°
Refresh interval	2 seconds (typical)

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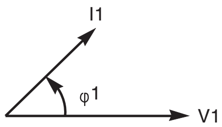


Phase displacement φ1.

Phase Displacement φa, φb, φc

Operation

This function gives the trigonometric phase displacement between the Van, Vbn, Vcn voltages and Ia, Ib, Ic currents respectively (see diagram). The measurements are used when Sepam™ is commissioned. They ensure that the voltage and current inputs are wired correctly. It does not operate when only Vab voltage is connected to Sepam™.

Readout

The measurements may be accessed via:
- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link.

Characteristics

Measurement range	0 to 359°
Resolution	1°
Accuracy	±2°
Refresh interval	2 seconds (typical)

2

Network Diagnosis Functions
Disturbance Recording

Operation
This function records analog signals and logic states . When a triggering event occurs, record storage activates according to the parameters set in SFT2841 (see the section on "Control and monitoring functions - Disturbance recording triggering"). The stored event begins before the triggering event and continues afterwards.
The record is made up of the following information:
- values sampled from the different signals
- the event date
- characteristics of the recorded channels.

The duration and number of records is also set using the SFT2841 software tool.

The files are recorded in First In First Out (FIFO) type shift storage. When the maximum number of records is reached, the oldest record is erased when a new record is entered.

The disturbance records are lost when the device is switched on and when the logic equations or alarm messages are changed.

Transfer
Files may be transferred in one of two ways:
- **locally**, by using a PC equipped with SFT2841 software. The PC is connected to the front panel connector
- **remotely**, using a software tool specific to the remote monitoring and control system.

Recovery
The signals are recovered from a record by means of the SFT2826 software tool.

Principle
MT10181

Characteristics
Record content	Set-up file: date, channel characteristics, measuring chain transformer ratio Sample file: 12 values per cycle/recorded signal
Analog signals (2) recorded	4 current channels (Ia, Ib, Ic, Ir) 3 voltage channels (Van, Vbn, Vcn or Vab, Vbc, Vr)
Logical states recorded	10 logic inputs, logic outputs O1 to O4, pick-up, 1 data item configurable by the logic equation editor
Number of records stored	1 to 19
Total duration of a record	1 s to 10 s The total records plus one should not exceed 20 s at 50 Hz and 16 s at 60 Hz. Examples (at 50 Hz) : 1 x 10 s record 3 x 5 s records 19 x 1 s records
Periods before triggering event (1)	0 to 99 cycles
File format	COMTRADE 97

***(1)** According to parameter setting with the SFT2841 software and factory-set to 36 cycles.*
***(2)** According to the type of sensors.*

Machine Operation Assistance Functions
Thermal Capacity Used/Cooling Time Constant

Thermal Capacity Used

Operation
The thermal capacity used is calculated by the thermal protection algorithm. The thermal capacity used measurement is given as a percentage of the rated thermal capacity..

Saving Thermal Capacity Used Value
When the protection unit trips, the current thermal capacity used is increased by 10% (The 10% increase is used to take into account the average temperature buildup of motors when starting) and saved. The saved value is reset to zero when the thermal capacity used has decreased sufficiently for the block start time delay to be zero. The saved value is used again making it possible to restart, taking into account the temperature that caused the trip. This value is stored in nonvolatile memory.

Readout
The measurements may be accessed via:
- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link
- an analog converter with the MSA141 option.

Characteristics
Measurement range	0 to 800 %
Unit	%
Display format	3 significant digits
Resolution	1%
Refresh interval	1 second (typical)

Cooling Time Constant

Operation
The cooling time constant T2 of the equipment being monitored (transformer, motor or generator) is estimated by the thermal overload protection function. It is calculated each time the equipment operates for a sufficiently long period, followed by a shutdown ($I < 0.1\ I_B$) and temperature stabilization phase.

The calculation is based on the temperature measured by RTDs 1, 2 and 3 (stator sensors for motors and generators) or by RTDs 1, 3 and 5 (primary winding sensors for transformers). For greater accuracy, ambient temperature should be measured by RTD 8.

If "other applications" is chosen in the RTD assignment table, T2 is not estimated.

Two measurements are available, one for each thermal operating rate of the monitored equipment.

Readout
The measurements may be accessed via:
- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link.

Characteristics
Measurement range	5 to 600 mn
Unit	mn
Resolution	1 mn
Accuracy	±5%
Display format	3 significant digits

Machine Operation Assistance Functions
Operating Time Before Tripping/ Waiting Time After Tripping

Remaining Operating Time Before Overload Tripping

Operation
The time is calculated by the thermal protection function. It depends on the thermal capacity used.

Readout
The measurements may be accessed via:
- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link.

Characteristics

Measurement range	0 to 999 mn
Unit	mn
Display format	3 significant digits
Resolution	1 mn
Refresh interval	1 second (typical)

Waiting Time After Overload Tripping

Operation
The time is calculated by the thermal protection function. It depends on the thermal capacity used.

Readout
The measurements may be accessed via:
- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link.

Characteristics

Measurement range	0 to 999 mn
Unit	mn
Display format	3 significant digits
Resolution	1 mn
Refresh period	1 second (typical)

Machine Operation Assistance Functions
Hours Counter, Starting Current & Starting/Overload Time

Running Hours Counter and Operating Time

The counter gives the total run time that the protected device (motor, generator or transformer) has been operating ($I > 0.1\ I_B$). The initial counter value may be modified using the SFT2841 software.
This value is saved in the event of an auxiliary power outage.

Readout

The measurements may be accessed via:

- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link.

Characteristics

Range	0 to 65535
Unit	hours

Starting Current and Starting/Overload Time

Operation

Starting/overload time is the time between the moment at which one of the 3 phase currents exceeds $1.2\ I_B$ and the moment at which the three currents drop back below $1.2\ I_B$.

The maximum phase current obtained during this period is the starting/overload current.

The two values are saved in case of auxiliary power outage.

Readout

The measurements may be accessed via:

- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link.

Characteristics

Starting/Overload Time	
Measurement range	0 to 300 s
Unit	s or ms
Display format	3 significant digits
Resolution	10 ms or 1 digit
Refresh interval	1 second (typical)
Starting/Overload Current	
Measurement range	$1.2\ I_B$ to $24\ I_N$ (1)
Unit	A or kA
Display format	3 significant digits
Resolution	0.1 A or 1 digit
Refresh interval	1 second (typical)

(1) *Or 65.5 kA.*

Machine Operation Assistance Functions
Number of Starts Before Blocking/ Start Block Time Delay

Number of Starts before Blocking

Operation
The number of starts allowed before inhbition is calculated by the number of starts protection function. The number of starts depends on the thermal state of the motor.

Readout
The measurements can be accessed via:
- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link.

Resetting to Zero
The number of starts counters can be reset to zero (after entering a password) as follows:
- on the advanced UMI display unit by pressing the clear key
- on a PC with SFT2841 software.

Characteristics

Measurement range	0 to 60
Unit	none
Display format	3 significant digits
Resolution	1
Refresh interval	1 second (typical)

Block Start Time Delay

Operation
The time delay is calculated by the number of starts protection function.
If the number of starts protection function indicates that starting is blocked, the time given represents the waiting time before starting is allowed.

Readout
The number of starts and waiting time can be accessed via:

- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link.

Characteristics

Measurement range	0 to 360 mn
Unit	mn
Display format	3 significant digits
Resolution	1 mn
Refresh interval	1 second (typical)

 Schneider Electric

Switchgear Diagnosis Functions
Cumulative Breaking Current &
Number of Operations

Cumulative Breaking Current

Operation
This function gives the cumulative breaking current in $(kA)^2$ for five current ranges.
It is based on measurement of the fundamental component.
The current ranges displayed are:
- $0 < I < 2 I_N$
- $2 I_N < I < 5 I_N$
- $5 I_N < I < 10 I_N$
- $10 I_N < I < 40 I_N$
- $I > 40 I_N$

This function gives the cumulative breaking current in $(kA)^2$ for five current ranges.
Each value is saved in case auxiliary power is lost.

Refer to switchgear documentation for use of this information.

Number of Operations
The function also gives the total number of breaking device operations.
It is activated by tripping commands (O1 relay). The number of operations is saved in case auxiliary power is lost.

Readout
The measurements may be accessed via:
- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link

The initial values can be introduced using the SFT2841 software tool to factor the real state of a used breaking device.

Characteristics

Cumulative Breaking Current $(kA)^2$	
Range	0 to 65535 $(kA)^2$
Unit	primary $(kA)^2$
Resolution	$1(kA)^2$
Accuracy (1)	±10% ±1 digit
Number of Operations	
Range	0 to 65535

(1) *At I_N, in reference conditions (IEC 60255-6).*

Switchgear Diagnosis Functions
Operating Time Charging Time

Operating Time

Operation
This function gives the value of the opening operating time of a breaking device [1] and change of status of the device open position contact connected to the I11 input [2]
The function is blocked when the input is set for AC voltage [3]. The value is saved in case auxiliary power is lost.

Readout
The measurement may be accessed via:
- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link

(1) Refer to switchgear documentation for use of this information.
(2) Optional MES module.
(3) Optional MES114E or MES114F modules.

Characteristics

Measurement range	20 to 100
Unit	ms
Accuracy	±1 ms typical
Display format	3 significant digits
Resolution	1 ms

Charging time

Operation
This function gives the value of the breaking device [1] operating mechanism charging time, determined according to the device closed position status change contact and the end of charging contact connected to the Sepam™ logic inputs [2].

The value is saved in the event of an auxiliary power outage.

Readout
The measurement may be accessed via:
- advanced UMI display unit by pressing the key
- a PC with SFT2841 software
- a communication link

(1) Refer to switchgear documentation for use of this information.
(2) Optional MES114 or MES114E or MES114F modules.

Characteristics

Measurement range	1 to 20
Unit	s
Accuracy	±0.5 sec
Display format	3 significant digits
Resolution	1s

Switchgear Diagnosis Functions
VT Supervision
ANSI Code 60FL

Operation

The VT (Voltage Transformer) supervision function is used to supervise the complete phase and residual voltage measurement chain:

- voltage transformers
- VT connection to Sepam™
- Sepam™ voltage analog inputs.

The function processes the following events:

- partial loss of phase voltages, detected by:
  - presence of negative sequence voltage
  - and absence of negative sequence current
- loss of all phase voltages, detected by:
  - presence of current on one of the three phases
  - and absence of all measured voltages
- tripping of the phase VT (and/or residual VT) protection relay, detected by the acquisition on a logic input of the fuse melting contact or auxiliary contact of the circuit breaker protecting the VTs
- other types of events may be processed using the logic equation editor.

The "Phase voltage fault" and "Residual voltage fault" information disappears automatically when:

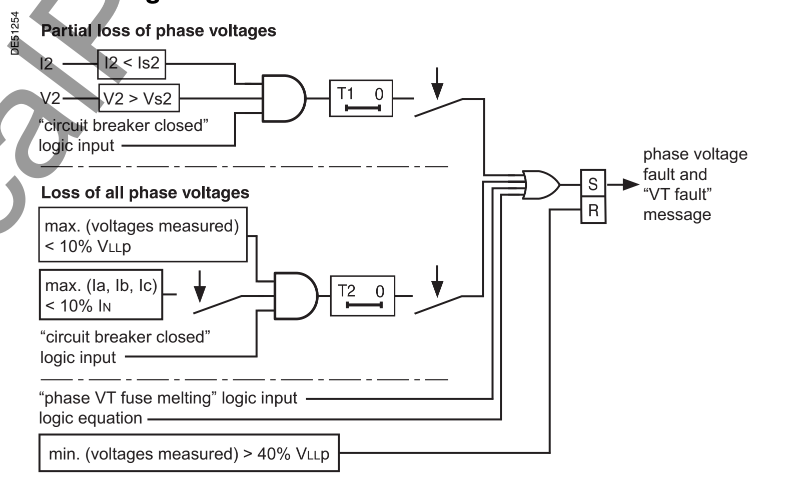
- the cause of the fault has disappeared; and,
- all measured voltages are present.

Use of "Circuit Breaker Closed" Information

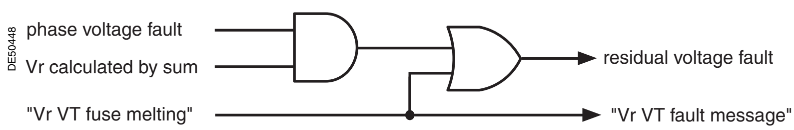
This information is used to detect the loss of one, two, or three voltages if it is connected to a logic input.

If the "circuit breaker closed" information is not connected to a logic input, the detection of VT faults due to the loss of one or more voltages is not determined by the position of the circuit breaker.

Block Diagram



Detection of phase voltage fault.



Detection of residual voltage fault.

Switchgear Diagnosis Functions
VT Supervision
ANSI Code 60V

Consequences of a VT Fault on Protection Functions

A "Phase voltage fault" affects the following protection functions:
- 27, 27S, 32P, 32Q/40, 47, 51V
- 59, only in cases where the protection function is set up for phase-to-neutral overvoltage, when the voltages are measured by two phase VTs + Vr VT
- 67

A "residual voltage fault" affects the following protection functions:
- 59N
- 67N/67NC.

The behavior of the protection functions in the event of a "Phase voltage fault" or "Residual voltage fault" is to be set up and the following choices are proposed:
- for protection functions 27/27S, 32P, 32Q/40, 47, 51V, 59 and 59N: block or no block
- for protection function 67: blocking or non-directional operation (50/51)
- for protection function 67N/67NC: block or non-directional operation (50N/51N).

Setting Advice

The partial loss of voltages is based on the detection of the presence of negative sequence voltage and the absence of negative sequence current.
By default:
- the presence of negative sequence voltage is detected when: V2 > 10% V_{Ln}p (Vs2)
- the absence of negative sequence current is detected when: I2 < 5% IN (Is2)
- time delay T1 is 1 s.

These default settings ensure the stability of the VT supervision function in the event of short-circuits or transient phenomena on the network.
The Isi set point may be raised for highly unbalanced networks.

Time delay T2 for the detection of the loss of all voltages must be longer than the time it takes for a short-circuit to be cleared by the protection function 50/51 or 67, to avoid the detection of a VT loss of voltage fault triggered by a 3-phase short-circuit.

The time delay for the 51V protection function must be longer than the T1 and T2 time delays used for the detection of voltage losses.

Characteristics

Validating the Detection of Partial Loss of Phase Voltages	
Setting	Yes / No
Vs2 Set Point	
Setting	2% to 100% of Vnp
Accuracy	±2% for V2 ≥ 10% V_{Ln}p ±5% for V2 < 10% V_{Ln}p
Resolution	1%
Pick-up / drop-out ratio	(95 ±2.5)% for V2 ≥ 10% V_{Ln}p
Is2 Set Point	
Setting	5% to 100% of IN
Accuracy	±5%
Resolution	1%
Pick-up / drop-out ratio	(105 ±2.5)%
Time Delay T1 (Partial Loss of Phase Voltages)	
Setting	0.1 s to 300 s
Accuracy	±2% or ±25 ms
Resolution	10 ms
Validating the Detection of Losing all Phase Voltages	
Setting	Yes / No
Detecting the Loss of all Voltages and Verifying the Presence of Current	
Setting	Yes / No
Time Delay T2 (All Voltages Lost)	
Setting	0.1 s to 300 s
Accuracy	±2% or ±25 ms
Resolution	10 ms
Voltage and Power Protection Behavior	
Setting	No action / block
Protection 67 Behavior	
Setting	Non-directional / block
Protection 67N/67NC Behavior	
Setting	Non-directional / block

Switchgear Diagnosis Functions
CT Supervision
ANSI Code 60C

Operation

The Current Transformer (CT) supervision function is used to supervise the complete phase current measurement chain:

- phase current sensors (1 A/5 A CTs or LPCTs)
- phase current sensor connection to Sepam™
- Sepam™ phase current analog inputs.

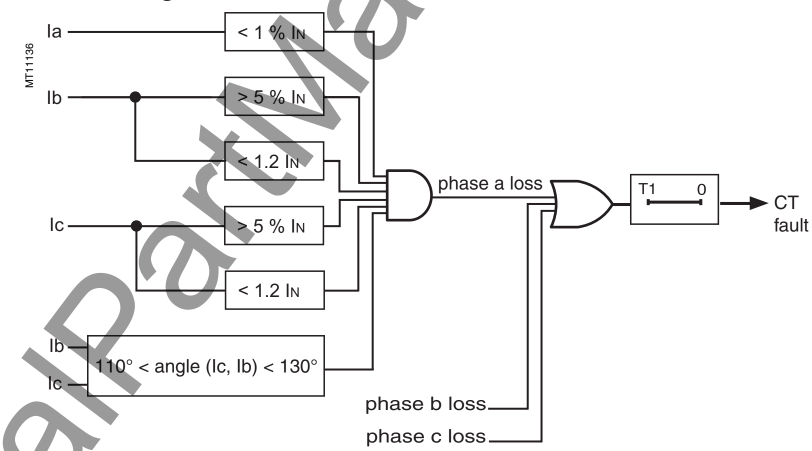
The function detects the loss of a phase current, when the three phase currents are measured. The function is inactive if only two phase current sensors are connected.

The "CT fault" information disappears automatically when the situation returns to normal, i.e. as soon as the three phase currents are measured and have values greater than 10% of IN.

In the event of the loss of a phase current, the following protection functions may be blocked to avoid nuisance tripping:

- 46, 32P and 32Q/40
- 51N and 67N, if Ir is calculated by the sum of the phase currents.

Block Diagram



Characteristics

Time Delay	
Setting	0.15 s to 300 s
Accuracy	±2% or ±25 ms
Resolution	10 ms
Blocking Protection Functions 46, 32P, 32Q/40, 51N, 67N	
Setting	No action / block

Contents

Setting Ranges

Functions	Settings			Time Delays
ANSI 27 - Phase-to-Phase Undervoltage				
	5 to 100% of $V_{LL}p$			0.05 s to 300 s
ANSI 27D/47 - Positive Sequence Undervoltage				
	15 to 60% of $V_{LL}p$			0.05 s to 300 s
ANSI 27R - Remanent Undervoltage				
	5 to 100% of $V_{LL}p$			0.05 s to 300 s
ANSI 27S - Phase-to-Neutral Undervoltage				
	5 to 100% of $V_{LL}p$			0.05 s to 300 s
ANSI 32P - Directional Active Overpower				
	1 to 120% of S_N (1)			0.1 s to 300 s
ANSI 32Q/40 - Directional Reactive Overpower				
	5 to 120% of S_N (1)			0.1 s to 300 s
ANSI 37 - Phase Undercurrent				
	0.15 to 1 I_B			0.05 s to 300 s
ANSI 38/49T - Temperature Monitoring (8 or 16 RTDs)				
Alarm and trip set points	32 to 356° F (0 to 180 °C)			
ANSI 46 - Negative Sequence / Unbalance				
Definite time	0.1 to 5 I_B			0.1 s to 300 s
Inverse Definite Minimum Time (IDMT)	0.1 to 0.5 I_B (Schneider Electric) 0.1 to 1 I_B (CEI, IEEE)			0.1 s to 1 s
Tripping curve	Schneider Electric			
	CEI: SIT/A, LTI/B, VIT/B, EIT/C			
	IEEE: MI (D), VI (E), EI (F)			
ANSI 47 - Negative Sequence Overvoltage				
	1 to 50% of $V_{LL}p$			0.05 s to 300 s
ANSI 48/51LR/14 - Excessive Starting Time, Locked Rotor				
	0.5 to 5 I_B	ST starting time		0.5 s to 300 s
		LT and LTS time delays		0.05 s to 300 s
ANSI 49RMS - Thermal Overload			**Rate 1**	**Rate 2**
Accounting for negative sequence component		0 - 2.25 - 4.5 - 9		
Time constant	Heating		T1: 5 to 120 mn	T1: 5 to 120 mn
	Cooling		T2: 5 to 600 mn	T2: 5 to 600 mn
Alarm and tripping set points		50 to 300% of rated thermal capacity		
Cold curve modification factor		0 to 100%		
Switching of thermal settings conditions		By logic input		
		By Is set point adjustable from 0.25 to 8 I_B		
Maximum equipment temperature		140 to 392 °F (60 to 200 °C)		

(1) $S_N = \sqrt{3} . I_N . V_{LL}p$

3

Functions	Settings		Time delays
ANSI 50/51 - Phase Overcurrent			
	Tripping Time Delay	**Timer Hold**	
Tripping curve	Definite time	DT	
	SIT, LTI, VIT, EIT, UIT (1)	DT	
	RI	DT	
	CEI: 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	
Is set point	0.1 to 24 IN	Definite time	
	0.1 to 2.4 IN	IDMT	
Timer hold	Definite time (DT ; timer hold)		
	IDMT (IDMT ; reset time)		
Confirmation	None		
	By negative sequence overvoltage		
	By phase-to-phase undervoltage		
ANSI 50BF - Breaker Failure			
Presence of current	0.2 to 2 IN		
Operating time	0.05 s to 300 s		
ANSI 50N/51N or 50G/51G - Ground Fault / Sensitive Ground Fault			
	Tripping Time Delay	**Timer Hold**	
Tripping curve	Definite time	DT	
	SIT, LTI, VIT, EIT, UIT (1)	DT	
	RI	DT	
	CEI: 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	
Isr set point	0.1 to 15 INr	Definite time	Inst ; 0.05 s to 300 s
	0.1 to 1 INr	IDMT	0.1 s to 12.5 s at 10 Isr
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 - Voltage-Restrained Overcurrent			
	Tripping Time Delay	**Timer Hold**	
Tripping curve	Definite time	DT	
	SIT, LTI, VIT, EIT, UIT (1)	DT	
	RI	DT	
	CEI: 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	
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 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
ANSI 59 - Overvoltage	**Phase-to-Phase**	**Phase-to-Neutral**	
	50 to 150% of V_{LL}p	50 to 150% of V_{Ln}p	0.05 s to 300 s
ANSI 59N - Neutral Voltage Displacement			
	2 to 80% of V_{LL}p		0.05 s to 300 s
ANSI 66 - Starts per Hour			
Starts per period	1 to 60	Period	1 to 6 hr
Consecutive starts	1 to 60	Time between starts	0 to 90 mn

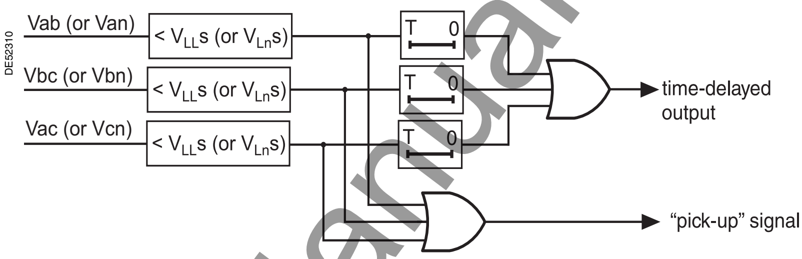
***(1)** Tripping at 1.2 Is.*

Functions		Settings		Time Delays
ANSI 67 - Directional Phase Overcurrent				
		Tripping Time Delay	**Timer Hold**	
Tripping curve		Definite time	DT	
		SIT, LTI, VIT, EIT, UIT (1)	DT	
		RI	DT	
		CEI: 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	
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 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
Characteristic angle		30°, 45°, 60°		
ANSI 67N/67NC Type 1 - Directional Ground Fault, According to Ir Projection				
Characteristic angle		-45°, 0°, 15°, 30°, 45°, 60°, 90°		
Isr set point		0.1 to 15 Inr	Definite time	Inst ; 0.05 s to 300 s
Vsr set point		2 to 80% of V_{LL}		
Memory time		Trmem time	0 ; 0.05 s to 300 s	
		Vrmem validity set point	0 ; 2 to 80% of $V_{LL}p$	
ANSI 67N/67NC Type 2 - Directional Ground Fault, According to Ir Magnitude with Half-Plan Tripping Zone				
Characteristic angle		-45°, 0°, 15°, 30°, 45°, 60°, 90°		
		Tripping Time delay	**Timer Hold**	
Tripping curve		Definite time	DT	
		SIT, LTI, VIT, EIT, UIT (1)	DT	
		RI	DT	
		CEI: 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	
Is0 set point		0.5 to 15 Inr	Definite time	Inst ; 0.05 s to 300 s
		0.5 to 1 Inr	IDMT	0.1 s to 12.5 s at 10 Isr
Vs0 set point		2 to 80% of $V_{LL}p$		
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 Type 3 - Directional Ground Fault, According to Ir Magnitude with Angular Sector Tripping Zone				
Angle at start of tripping zone		0° to 359°		
Angle at end of tripping zone		0° to 359°		
Isr set point	CSH zero sequence CT (2A rating)	0.1 A to 30 A	Definite time	Inst ; 0.05 to 300 s
	1 A CT (sensitive, Inr = 0.1 CT In)	0.05 to 15 Inr (min. 0.1 A)		
	Zero sequence CT + ACE990 (range 1)	0.05 to 15 Inr (min. 0.1 A)		
Vsr set point		Calculated Vr (sum of 3 voltages)	2 to 80% of $V_{LL}p$	
		Measured Vr (external VT)	0.6 to 80% of $V_{LL}p$	
ANSI 81H - Overfrequency				
		50 to 55 Hz or 60 to 65 Hz		0.1 s to 300 s
ANSI 81L - Underfrequency				
		40 to 50 Hz or 50 to 60 Hz		0.1 s to 300 s

***(1)** Tripping at1.2 Is.*

Undervoltage
ANSI Code 27/27S

Operation
The protection function is three-phase and operates according to parameter setting with phase-to-neutral or phase-to-phase voltage.
- It picks up if one of the three phase-to-neutral or phase-to-phase voltages drops below the $V_{LL}s$ (or $V_{Ln}s$) set point
- It includes a definite time delay, T.
- With phase-to-neutral operation, it indicates the faulty phase in the alarm associated with the fault.

Block Diagram


Characteristics
$V_{LL}s$ (or $V_{Ln}s$) Set Point	
Setting	5% $V_{LL}p$ (or $V_{Ln}p$) to 100% $V_{LL}p$ (or $V_{Ln}p$)
Accuracy (1)	±2% or ±0.002 $V_{LL}p$
Resolution	1%
Drop out/pick up ratio	103% ±2.5%
Time Delay T	
Setting	50 ms to 300 s
Accuracy (1)	±2%, or ±25 ms
Resolution	10 ms or 1 digit
Characteristic Times	
Operation time	pick-up < 35 ms (typically 25 ms)
Overshoot time	< 35 ms
Reset time	< 40 ms

(1) IN reference conditions (IEC 60255-6).

Connection Conditions					
Type of connection	Van, Vbn, Vcn	Vab	Vab, Vbc	Vab + Vr	Vab, Vbc + Vr
Phase-to-neutral operation	Yes	No	No	No	Yes
Phase-to-phase operation	Yes	on Vab only	Yes	on Vab only	Yes

Positive Sequence Undervoltage/ Phase Rotation Direction Check
ANSI Code 27D/47

3

Operation

Positive Sequence Undervoltage
The protection picks up when the positive sequence component V1 of a three-phase voltage system drops below the Vs1 set point with:

$$\vec{V}1 = (1/3)[\vec{V}an + a\vec{V}bn + a^2\vec{V}cn]$$

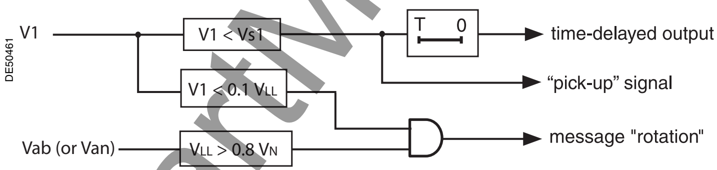
$$\vec{V}a = (1/3)[\vec{V}ab - a^2\vec{V}bc]$$

with $V = \frac{V_{LL}}{\sqrt{3}}$ and $a = e^{j\frac{2\pi}{3}}$

- it includes a definite time delay T
- it allows drops in motor electrical torque to be detected.

Phase Rotation Direction
This protection also allows the phase rotation direction to be detected.
The protection considers that the phase rotation direction is inverse when the positive sequence voltage is less than 10% of $V_{LL}p$ and when the phase-to-phase voltage is greater than 80% of $V_{LL}p$.

Block Diagram



Characteristics

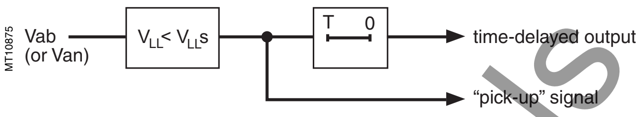
Vsd Set Point	
Setting	15% to 60% $V_{LL}p$
Accuracy (1)	±2%
Pick-up/drop-out ratio	103% ±2.5%
Resolution	1%
Time Delay	
Setting	50 ms to 300 s
Accuracy (1)	±2%, or from -25 ms to +35 ms
Resolution	10 ms or 1 digit
Characteristic Times	
Operating time	pick up < 55 ms
Overshoot time	< 35 ms
Reset time	< 35 ms

(1) IN reference conditions (IEC 60255-6).

Remanent Undervoltage
ANSI Code 27R

Operation
This protection is single-phase. It enables when Vab phase-to-phase voltage is less than the $V_{LL}s$ set point. The protection includes a definite time delay.

Block Diagram

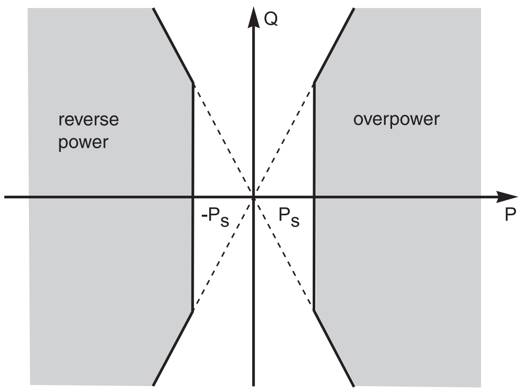


Characteristics

$V_{LL}s$ set point	
Setting	5% to 100% $V_{LL}p$
Accuracy (1)	±5% or ±0.005 $V_{LL}p$
Resolution	1%
Drop out/pick up ratio	104% ±3%
Time Delay T	
Setting	50 ms to 300 s
Accuracy (1)	±2%, or ±25 ms
Resolution	10 ms or 1 digit
Characteristic Times	
Operation time	< 40 ms
Overshoot time	< 20 ms
Reset time	< 30 ms

(1) In reference conditions (IEC 60255-6).

Directional Active Overpower
ANSI Code 32P



Operating zone.

Operation

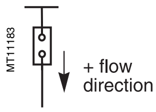
This function may be used as "active overpower" protection for energy management (load shedding) or "reverse active power" protection against motors running like generators and generators running like motors.

It enables if the active power flowing in one direction or the other (supplied or absorbed) is greater than the Ps set point. The function includes a definite time delay, T, and is based on the two-wattmeter method.

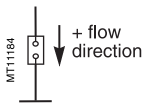
The function is enabled if the condition **P** $\geq$ **3.1% Q** is met. This condition provides a high level of sensitivity and high stability in the event of short-circuits.

The power sign is determined by one of the following parameters:

- for the feeder circuit:
  - power exported by the bus is positive
  - power supplied to the bus is negative.

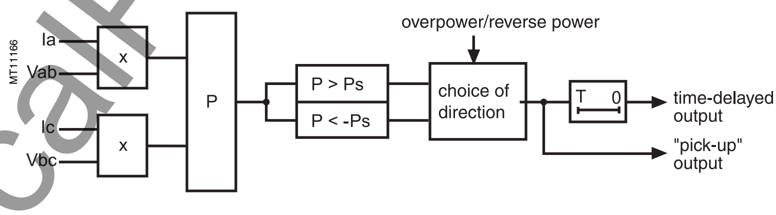


- for the main circuit:
  - power supplied to the bus is positive
  - power exported by the bus is negative



This protection function operates for VanVbnVcn, Vab/Vbc and Vab/Vbc + Vr connections.

Block Diagram

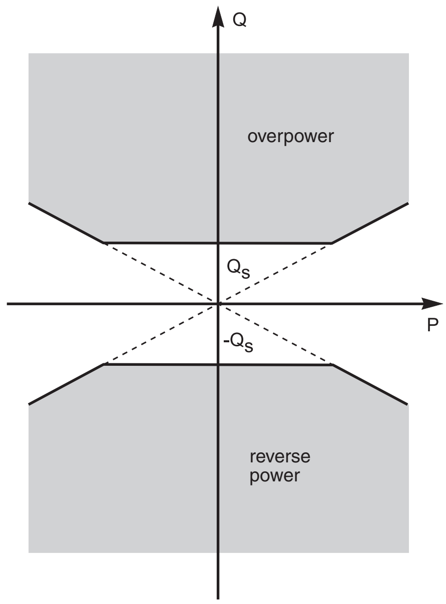


Characteristics

Tripping Direction	
Setting	overpower/reverse power
Ps Set Point	
Setting	1% to 120% SN (1)
Resolution	0.1 kW
Accuracy (2)	±0.3% SN for Ps between 1% and 5% SN
	±5% for Ps between 5% and 40% SN
	±3% for Ps between 40% and 120% SN
Drop out/pick up ratio	(93.5 ±5) %
Min. return variance	0.004 SN
Time Delay T	
Setting	100 ms to 300 s
Resolution	10 ms or 1 digit
Accuracy (2)	±2%, or from -10 ms to +35 ms
Characteristic Times	
Operation time	< 80 ms
Overshoot time	< 90 ms
Reset time	< 80 ms

(1) $S_N = \sqrt{3}.V_{LL}p.I_N$.
(2) *IN reference conditions (IEC 60255-6).*

Directional Reactive Overpower
ANSI Code 32Q/40



Operating zone

Operation

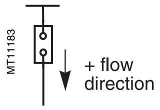
This protection function detects field loss on synchronous machines (generators or motors) connected to the network. The machine undergoes additional temperature build-up which may damage it. The directional reactive overpower function enables if the reactive power flowing in one direction or the other (supplied or absorbed) is greater than the Qs set point.

It includes a definite time delay, T, and is based on the two-wattmeter method.

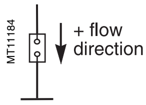
The function enables if the condition **Q** ≥ **3.1% P** is met: This condition provides a high level of sensitivity and high stability in the event of short-circuits.

The power sign is determined by one of the following parameters:

- for the feeder circuit:
  - power exported by the bus is positive
  - power supplied to the bus is negative



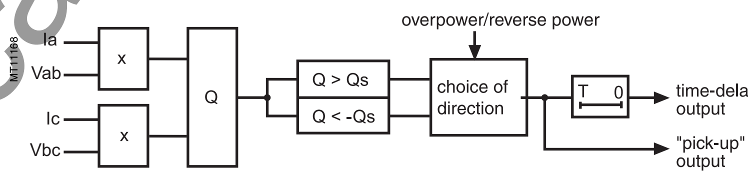
- for the main circuit:
  - power supplied to the bus is positive
  - power exported by the bus is negative.



This protection function operates for VanVbnVcn, Vab/Vbc, and Vab/Vbc + Vr connections.

To operate with certain synchronous motors, it may be necessary to block the protection function during motor starting. This is done using the "Starting in progress" output of the 48/51LR function in the equation editor.

Block Diagram



Characteristics

Tripping Direction	
Setting	overpower/reverse power
Qs Set Point	
Setting	5% to 120% SN (1)
Resolution	0.1 var
Accuracy (2)	±5% for Qs between 5% and 40% SN
	±3% for Qs between 40% and 120% SN
Drop out/pick up ratio	(93.5 ±5)%
Time Delay T	
Setting	100 ms to 300 s
Resolution	10 ms or 1 digit
Accuracy (2)	±2%, or from -10 ms to +35 ms
Characteristic Times	
Operation time	< 80 ms
Overshoot time	< 90 ms
Reset time	< 80 ms

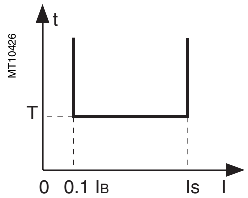
(1) $S_N = \sqrt{3}.V_{LL}p.I_N$.
(2) *IN reference conditions (IEC 60255-6).*

Phase Undercurrent
ANSI Code 37

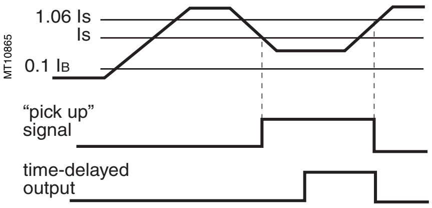
Operation
This is single phase protection: It enables when phase a current drops below the Is set point and is inactive when the current is less than 10% of IB

It is insensitive to current drops (breaking) due to circuit breaker tripping and includes a definite time delay, T.

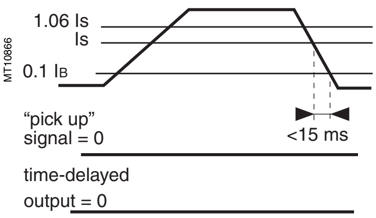
Undercurrent protection tripping can be blocked by the logic input "Block undercurrent".



Operating Principle

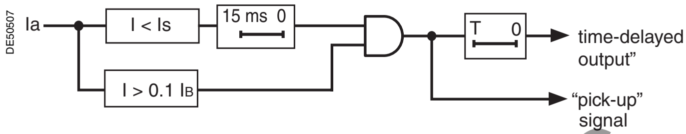


Case of current sag.



Case of circuit breaker tripping.

Block Diagram



Characteristics

Is Set Point	
Setting	15% IB ≤ Is ≤ 100% IB by steps of 1%
Accuracy [(1)]	±5%
Pick-up/drop-out ratio	106% ±5% for Is > 0.1 IN
T Time Delay	
Setting	50 ms ≤ T ≤ 300 s
Accuracy [(1)]	±2% or ±25 ms
Resolution	10 ms or 1 digit
Characteristic Times	
Operation time	< 60 ms
Overshoot time	< 35 ms
Reset time	< 40 ms

***(1)** IN reference conditions (IEC 60255-6).*

Temperature Monitoring
ANSI Code 38/49T

Operation

This protection is associated with a Resistance Temperature Detector (RTD) of the Pt100 platinum (100 Ω at 0 °C or 32 °F), Ni100 nickel (100 Ω), or Ni120 nickel (120 Ω) type detectors in accordance with IEC 60751 and DIN 43760 standards.

It enables when monitored temperature exceeds the Ts set point. It has two independent set points, one for alarm and one for tripping.

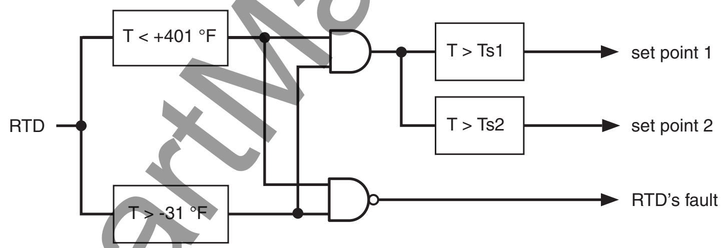
When the protection activates, it determines whether the RTD is shorted or disconnected:

- **RTD shorting** is detected if the measured temperature is less than -31 °F or -35 °C (measurement displayed "****")
- **RTD disconnect** is detected if the measured temperature is greater than +482 °F or +205 °C (measurement displayed "-****").

If an RTD fault is detected, the set point output relays are blocked and the protection outputs are set to zero. The "RTD fault" item is also made available in the control matrix and an alarm message is generated specifying the faulty RTD module.

Block Diagram

MT10878



Characteristics

Ts1 and Ts2 Set Points	°F	°C
Setting	32 °F to 356 °F	0 °C to 180 °C
Accuracy (1)	±2.7 °F	±1,5 °C
Resolution	1 °F	1 °C
Pick-up/drop-out difference		3 °C ±0,5 °
Characteristic Times		
Tripping time	< 5 seconds	

***(1)** See **"Connection of MET1482 Module"** chapter for accuracy derating according to wiring cross-section.*

Standard RTD Assignments

The standard assignments described below can be selected when configuring the first MET1482 module on the SFT2841 hardware configuration screen. The user must choose an assignment in order to use the thermal overload "Cooling time constant calculation" function.

	Motor/Generator Choice (M41, G40)	Transformer Choice (T40, T42)
RTD 1	Stator 1	Phase 1-T1
RTD 2	Stator 2	Phase 1-T2
RTD 3	Stator 3	Phase 2-T1
RTD 4	Bearing 1	Phase 2-T2
RTD 5	Bearing 2	Phase 3-T1
RTD 6	Bearing 3	Phase 3-T2
RTD 7	Bearing 4	
RTD 8	Ambient temperature	Ambient temperature

Negative Sequence/ Current Unbalance
ANSI Code 46

Operation

The negative sequence / unbalance protection function activates if the negative sequence component of phase currents is greater than the operation set point.

The function is time-delayed. It can be a definite time or Inverse Definite Minimum Time (IDMT) according to a standardized curve or specially adapted Schneider curve.

The three phase currents determine the negative sequence current.

$$\vec{I}2 = \frac{1}{3} \times (\vec{I}a + a^2\vec{I}b + a\vec{I}c)$$

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

If Sepam is connected to two phase current sensors only, the negative sequence current is:

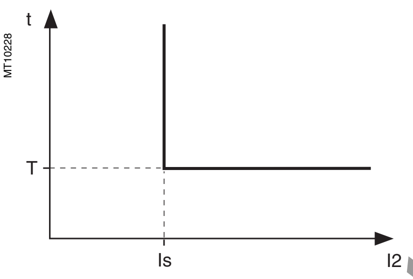
$$|\vec{I}2| = \frac{1}{\sqrt{3}} \times |\vec{I}a - a^2\vec{I}c|$$

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

Both formulas are equal when there is no zero sequence current (ground fault).

Definite Time Protection

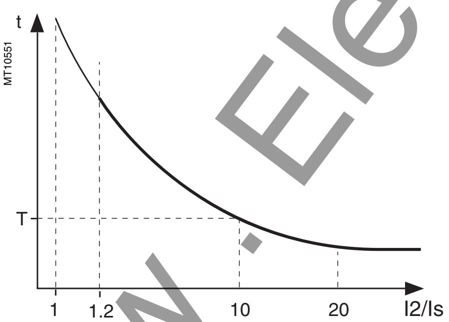
Is is the operation set point expressed in Amps, and **T** is the protection operation time delay.



Definite time protection principle.

Standardized IDMT Protection

IDMT protection operates in accordance with the IEC (60255-3), BS 142 and IEEE (C-37112) standards.



IDMT protection principle.

The Is setting is the vertical asymptote of the curve and T is the operation time delay for 10 Is.

For currents with a very large amplitude, the protection function has a definite time characteristic:

- if I2 > 20 Is, tripping time corresponds to 20 Is
- if I2 > 40 IN, tripping time corresponds to 40 IN.

The following standardized tripping curves are proposed:

- IEC standard inverse time SIT / A
- IEC very inverse time VIT or LTI / B
- IEC extremely inverse time EIT / C
- IEEE moderately inverse (IEC / D)
- IEEE very inverse (IEC / E)
- IEEE extremely inverse (IEC / F)

The curve equations are given in the chapter entitled "IDMT Protection Functions".

Inverse Definite Minimum Time (IDMT) Protection Schneider Curve

For I2 > Is, the time delay depends on the value of I2/IB. IB is the basis current of the protected equipment. It is defined when the general parameters are set.

T corresponds to the time delay for I2/IB = 5

The tripping curve is defined according to the following equations:

- for $Is/I_B \le I2/I_B \le 0.5$

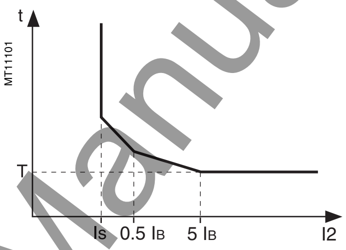
$$t = \frac{3.19}{(I2/I_B)^{1.5}} \cdot T$$

- for $0.5 \le I2/I_B \le 5$

$$t = \frac{4.64}{(I2/I_B)^{0.96}} \cdot T$$

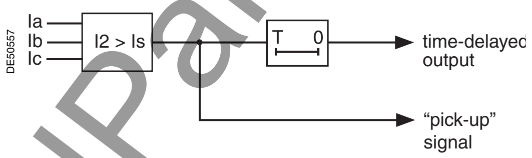
- for $I2/I_B > 5$

t = T



Schneider curve.

Block Diagram



Characteristics

Curve		
Setting	Definite, standardized IDMT (a choice of 6), Schneider IDMT	
Is Set Point		
Setting	Definite time	10% IB ≤ Is ≤ 500% IB
	Standardized IDMT (IEC, IEEE)	10% IB ≤ Is ≤ 100% IB
	Schneider IDMT	10% IB ≤ Is ≤ 50% IB
Resolution		1%
Accuracy (1)		±5%
Time Delay T		
Setting	Definite time	100 ms ≤ T ≤ 300 s
	IDMT	100 ms ≤ T ≤ 1 s
Resolution		10 ms or 1 digit
Accuracy (1)	Definite time	±2% or ±25 ms
	IDMT	±5% or ±35 ms
Characteristic Times		
Operation time		pick-up < 55 ms
Overshoot time		< 35 ms
Reset time		< 55 ms

(1) *IN reference conditions (IEC 60255-6).*

Negative Sequence/ Current Unbalance
ANSI Code 46

Determining the tripping time for different negative sequence current values for a given Schneider curve

Use the table to find the value of K that corresponds to the required negative sequence current. The tripping time is equal to KT.

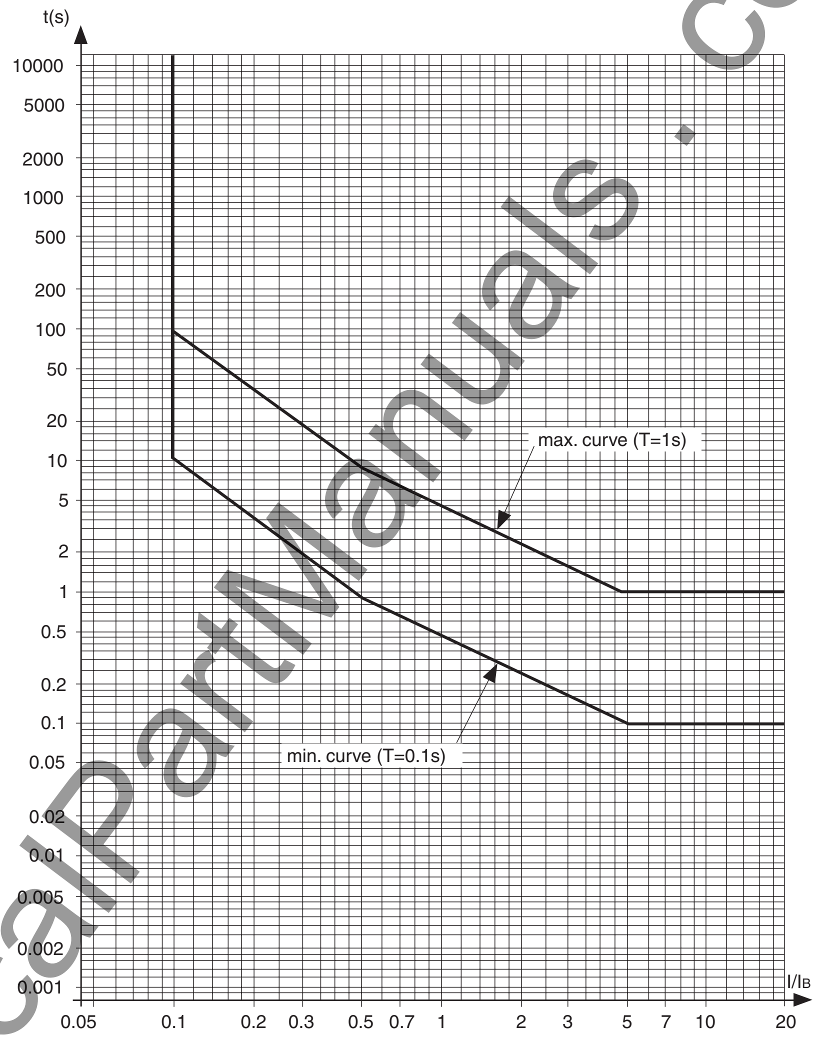
Example:
Given a tripping curve with the setting T = 0.5 s.

What is the tripping time at 0.6 IB?

Use the table to find the value of K that corresponds to 60% of IB.

The table reads K = 7.55. The tripping time is equal to: 0.5 x 7.55 = 3.755 s.

IDMT Tripping Schneider Curve



I2 (% IB)	10	15	20	25	30	33.33	35	40	45	50	55	57.7	60	65	70	75
K	99.95	54.50	35.44	25.38	19.32	16.51	15.34	12.56	10.53	9.00	8.21	7.84	7.55	7.00	6.52	6.11

I2 (% IB) cont'd	80	85	90	95	100	110	120	130	140	150	160	170	180	190	200	210
K cont'd	5.74	5.42	5.13	4.87	4.64	4.24	3.90	3.61	3.37	3.15	2.96	2.80	2.65	2.52	2.40	2.29

I2 (% IB) cont'd	22[illegible]	230	240	250	260	270	280	290	300	310	320	330	340	350	360	370
K cont'd	2.14	2.10	2.01	1.94	1.86	1.80	1.74	1.68	1.627	1.577	1.53	1.485	1.444	1.404	1.367	1.332

I2 (% IB) cont'd	380	390	400	410	420	430	440	450	460	470	480	490	≥ 500
K cont'd	1.298	1.267	1.236	1.18	1.167	1.154	1.13	1.105	1.082	1.06	1.04	1.02	1

Negative Sequence Overvoltage
ANSI Code 47

MT10546

Operation

The protection function is active if the negative sequence component (V2) of the voltages is above the set point (Vs2). It includes a definite time delay, T.

The the three phase voltages determine the negative sequence voltage:

$$\vec{V}2 = \frac{1}{3}(\vec{V}an + \mathbf{a}^2\vec{V}bn + \mathbf{a}\vec{V}cn)$$

or

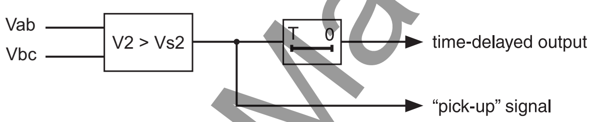
$$\vec{V}2 = \frac{1}{3}(\vec{V}ab - \mathbf{a}\vec{V}bc)$$

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

This protection funciton only operates with connections VanVbnVcn, Vab/Vbc + Vr, and Vab/Vbc.

Block Diagram

DE50510



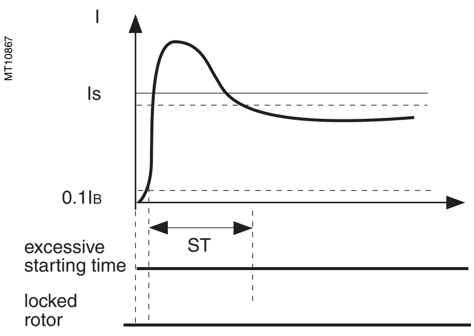
Characteristics

Vs2 Set Point	
Setting	1% to 50% $V_{LL}p$
Accuracy (1)	±2% for V2 ≥ 10% $V_{LL}p$
	±5% for V2 < 10% $V_{LL}p$
Resolution	1%
Drop out/pick up ratio	(97 ±2.5)% at V2 ≥ 10% $V_{LL}p$
Time Delay T	
Setting	50 ms to 300 s
Accuracy (1)	±2%, or ±25 ms
Resolution	10 ms or 1 digit
Characteristic Times	
Operation time	pick-up < 55 ms
Overshoot time	< 35 ms
Reset time	< 55 ms

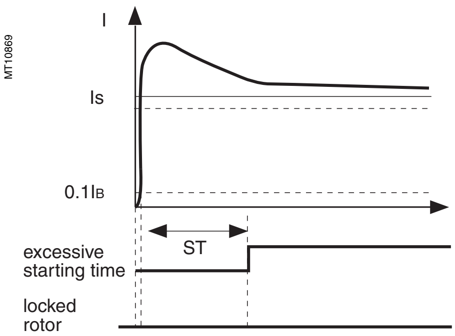
(1) In reference conditions (IEC 60255-6).

Schneider Electric

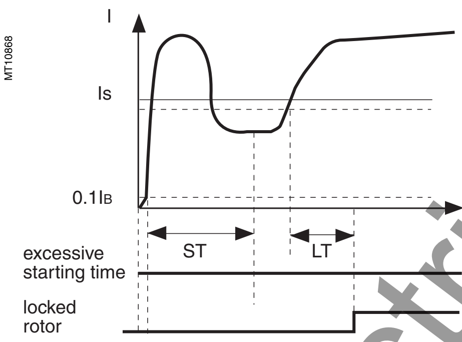
Excessive Starting Time, Locked Rotor
ANSI Code 48/51LR/14



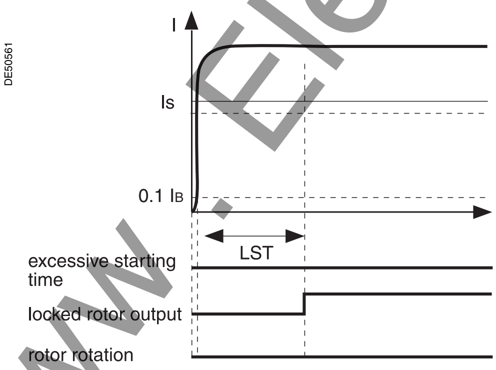
Case of normal starting.



Case of excessive starting time.



Case of locked rotor.



Case of starting locked rotor.

Operation

This function is three-phase:

1 **Excessive starting time (ST).** During start sequence, the protection enables when one of the three phase currents is greater than the set point **Is** for a period of time that is longer than the starting time delay, ST (normal starting time)
2 **Locked Rotor (LT)**: At the normal operating rate (after starting), the protection enables when one of the three phase currents is greater than the set point **Is** for a period of time that is longer than the LT time delay of the definite time type.
3 If the rotor is **locked on start (LTS)**. Large motors may have very long starting time (due to inertia) or a reduced voltage supply. This starting time is longer than the permissive rotor blocking time. To protect such a motor, the LTS timer initiates a trip if a start has been detected (I > Is) or if the motor speed is zero. For a normal start, the input I23 (zero-speed-switch) disables this protection.

Motor Acceleration

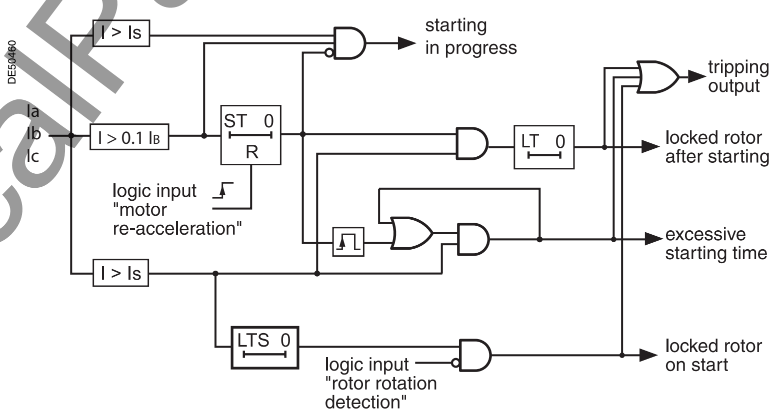
When a motor accelerates, it consumes a current in the vicinity of the starting current (> Is) without the current first passing through a value less than 10% of I_B. The ST time delay (which corresponds to the normal starting time) can be reinitialized by the logic input "motor re-acceleration."

This will reinitialize the **excessive starting time** protection and set the **locked rotor** protection LT time delay to a low value.

Starting is detected when the current consumed is 10% greater than the I_B curent. After start begins, an output is sent to the equation editor.

Is can be set at the motor current pickup for a mechanical JAM event.

Block Diagram



Characteristics

Is Set Point		
Setting		50% $I_B \le Is \le$ 500% I_B
Resolution		1%
Accuracy (1)		±5%
Drop out/pick up ratio		93.5% ±5%
Time Delay ST, LT, and LTS		
Setting	ST	500 ms ≤ T ≤ 300 s
	LT	50 ms ≤ T ≤ 300 s
	LTS	50 ms ≤ T ≤ 300 s
Resolution		10 ms or 1 digit
Accuracy (1)		±2% or from –25 ms to +40 ms

***(1)** In reference conditions (IEC 60255-6).*

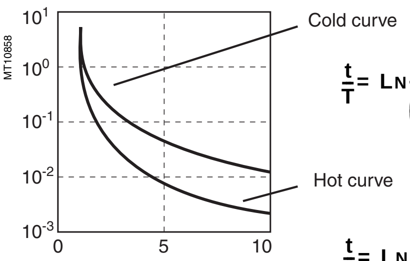
Description

The thermal overload function protects equipment (motors, transformers, generators, lines, capacitors) against overloads, based on current measurement.

Operation Curve

The protection gives a trip command when the heat rise is greater than the set point (E > Es). It is calculated according to an equivalent current measurement, **Ieq**.

The greatest permissible continuous current is
$I = I_B\sqrt{Es}$
The protection tripping time is set by time constant T:
- the calculated heat rise depends on the current consumed and the previous heat rise state
- the cold curve defines the protection tripping time based on zero heat rise
- the hot curve defines the protection tripping time based on 100% nominal heat rise.



Cold curve: $$\frac{t}{T} = L_N\frac{\left(\frac{Ieq}{I_B}\right)^2}{\left(\frac{Ieq}{I_B}\right)^2 - Es}$$

Hot curve: $$\frac{t}{T} = L_N\frac{\left(\frac{Ieq}{I_B}\right)^2 - 1}{\left(\frac{Ieq}{I_B}\right)^2 - Es}$$

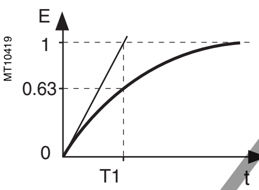
Alarm Set Point, Tripping Set Point

Two set points may be set for heat rise:
- Es1: alarm.
- Es2: tripping.

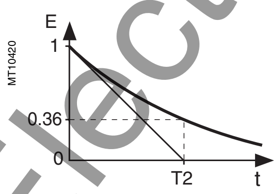
"Hot state" Set Point

When the function is used to protect a motor, this fixed set point is designed for detecting the hot state used by the number of starts function.
The value of the fixed set point is 50%.

Heat Rise and Cooling Time Constants



Heat rise time constant



Cooling time constant

For self-ventilated rotating machines, cooling is more effective when the machine is running than when it is stopped. The current value is used to determine running and stopping the equipment:
- **running** if $I > 0.1\ I_B$
- **stopped** if $I < 0.1\ I_B$.

Two time constants can be set:
- **T1**: heat rise time constant: concerns equipment that is running
- **T2**: cooling time constant: concerns equipment that is stopped.

Accounting for Harmonics

The current measured by the thermal protection is a 3-phase RMS current that considers 17th level harmonics.

Ambient Temperature Considerations

Most machines are designed to operate at a maximum ambient temperature of 104 °F (40 °C). The thermal overload function takes into account the ambient temperature (Sepam equipped with the temperature sensor module option, with sensor no. 8 assigned to measurement of ambient temperature) to increase the calculated heat rise value when the temperature measured exceeds 40 °C (104 °F).

Increase factor: $fa = \frac{Tmax - 40°C}{Tmax - Tambient}$

where: T max is the equipment's maximum temperature (according to insulation class).
T ambient is the measured temperature.

Adaptating the Protection to Motor Thermal Withstand

Motor thermal protection is often set based on the hot and cold curves supplied by the machine manufacturer. To fully comply with these experimental curves, additional parameters must be set:
- initial heat rise, Es0, is used to reduce the cold tripping time.

modified cold curve: $$\frac{t}{T} = L_N\frac{\left(\frac{Ieq}{I_B}\right)^2 - Es0}{\left(\frac{Ieq}{I_B}\right)^2 - Es}$$

- a second group of parameters (time constants and set points) is used to take into account thermal withstand of a locked rotor and when the current is greater than the adjustable set point Is.

Accounting for Negative Sequence Current

In the case of motors with wound rotors, the presence of a negative sequence component increases the heat rise in the motor. The negative sequence component of the current is taken into account in the protection by the equation

$Ieq = \sqrt{Iph^2 + K \cdot I2^2}$ where **Iph** is the greatest phase current
I2 is the negative sequence component of the current
K is an adjustable factor

K may have the following values: 0 - 2.25 - 4.5 - 9
For an induction motors, K is determined as follows:

$K = 2 \cdot \frac{Cd}{C_N} \cdot \frac{1}{g \cdot \left(\frac{Id}{I_B}\right)^2} - 1$ where: C_N, Cd: rated torque and starting torque
I_B, Id: basis current and starting current
g: rated slip.

Obtaining the Cooling Time Constant T2

The cooling time constant T2 can be obtained from the temperatures measured in the equipment by using temperature sensors connected to the MET1482 module.

T2 is calculated each time the equipment shuts down and cools ($I < 0.1\ I_B$) after it runs for a sufficient time. For motors and generators, T2 is calculated from the temperatures measured on the stator by Resistance Temperature Detectors (RTDs) 1, 2 and 3. For transformers, T2 is calculated according to the temperatures measured on the primary winding by RTDs 1, 3 and 5.

For better accuracy, ambient temperature should be measured with RTD 8.

If "Other applications" is selected in the RTD assignment table, T2 is not calculated.

Once the calculation has been made, the calculated value can be used to replace the T2 (1) parameter in one of two ways depending on the configuration:
- automatically, in which case each new calculated value updates the T2 constant used; or
- manually by entering the value in the T2 parameter.

***(1)** As a suggestion, use the calculated T2 if the equipment has carried out at least three starting cycles followed by cooling.*

Schneider Electric

Thermal Overload
ANSI Code 49 RMS

Blocked Start
The thermal overload protection can block the closing of the motor's control device until the heat rise drops back down below a value that allows restarting.
This value takes into account the heat rise produced by the motor when starting.

The block function is grouped together with the **starts per hour** protection and the indication BLOCKED START informs the user.

Saving Heat Rise Value
The current heat rise value is saved in case of auxiliary power outage.

Blocking Tripping
Tripping the thermal overload protection may be blocked by the logic input "Block thermal overload" when required by the process.

Using Two Operating Rates
The thermal overload protection function may be used to protect equipment with two operating rates, for example:
- transformers with two ventilation modes, with or without forced ventilation (ONAN / ONAF)
- two-speed motors.

The protection function has two groups of settings. Each group is suitable for equipment protection in one of the two operating rates.

The equipment's basis current, used to calculate heat rise, also depends on the operating rate:
- with rate 1, the basis current I_B (a general Sepam parameter) is used to calculate the heat rise in the equipment
- with rate 2, the basis current I_B-rate 2 (a specific thermal overload protection setting) is used to calculate the heat rise in the equipment.

Switching from one group of thermal settings to the other is done without losing the heat rise value. It is controlled by one of two means:
- a logic input, assigned to the "switching thermal settings" function
- when the phase current reaches an adjustable Is set point (to be used to process switching the thermal settings of a motor with locked rotor).

User information
The following information is available for the user:
- heat rise
- learnt cooling time constant T2
- time before restart enabled (in case of block start)
- time before tripping (with constant current).

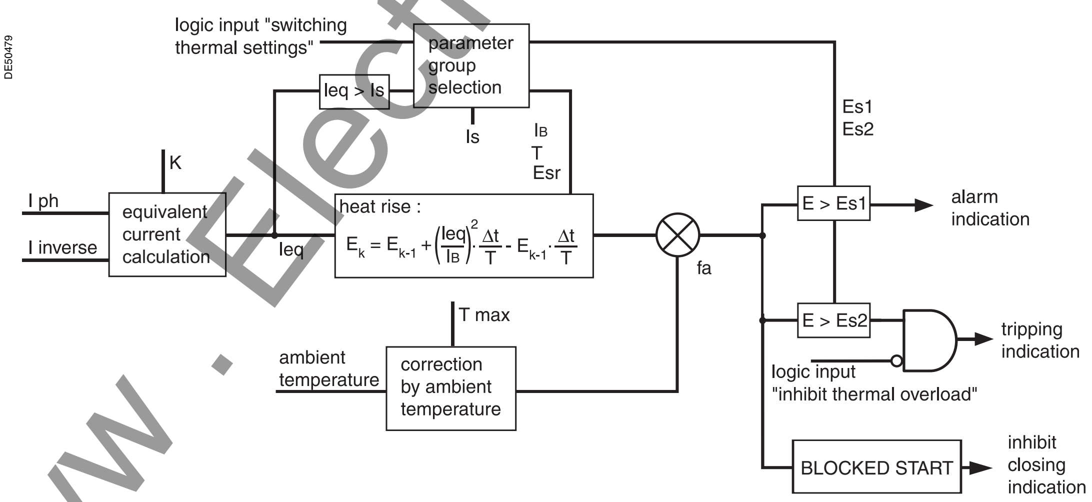
See chapter "Machine operation assistance functions".

Characteristics

Set Point		Rate 1	Rate 2
Setting	Es1 alarm set point	50% to 300%	50% to 300%
	Es2 tripping set point	50% to 300%	50% to 300%
	Es0 initial heat rise	0 to 100%	0 to 100%
Resolution		1%	1%
Time Constants			
Setting	T1 running (heat rise)	1 mn to 600 mn	1 mn to 600 mn
	T2 stopped (cooling)	5 mn to 600 mn	5 mn to 600 mn
Resolution		1 mn	1 mn
Accounting for Negative Sequence Component			
Setting	K	0 - 2.25 - 4.5 - 9	
Maximum Equipment Temperature (According to Insulation Class) (2)			
Setting		Tmax 60° à 200°	
Resolution		1°	
Tripping Time			
Accuracy (1)		±2% or 1 s	
RMS Current Measurement			
Accuracy		±5%	
Changing Operating Rate			
By current threshold Is	Setting	0.25 to 8 I_B	
By logic input "Switching of thermal settings"			
Basis Current for Thermal Operating Rate 2			
Setting		0.2 to 2.6 I_N	
Use of Learned Cooling Time Constant (T2)			
Setting		Yes / no	

(1) I_N reference conditions (IEC 60255-6).
(2) Equipment manufacturer data.

Block Diagram



Example 1

The following data are available:

- time constants for on operation T1 and off operation T2:
  - T1 = 25 min
  - T2 = 70 min
- maximum curve in steady state: Imax/IB = 1.05.

Setting Tripping Set Point Es2

Es2 = $(Imax/I_B)^2$ = 110%

Please note: if the motor absorbs a current of 1.05 IB in steady state, the heat rise calculated by the thermal overload protection will reach 110%.

Setting of alarm set point Es1

Es1 = 90% (I/IB = 0.95).

Knegative: 4.5 (usual value)

The other thermal overload parameters do not need to be set. They are not considered by default.

Example 2

The following data are available:

- motor thermal resistance in the form of hot and cold curves (see solid line curves in Figure 1)
- cooling time constant T2
- maximum steady state current: Imax/IB = 1.05.

Setting Tripping Set Point Es2

Es2 = $(Imax/I_B)^2$ = 110%

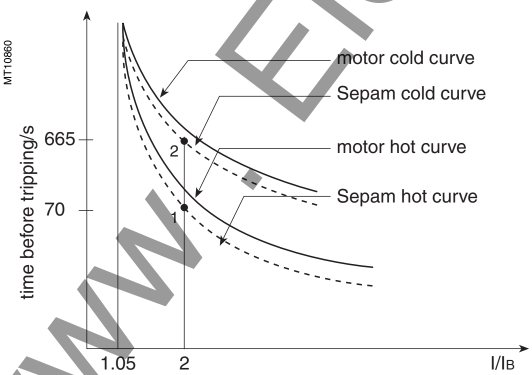
Setting Alarm Set Point Es1:

Es1 = 90% (I/IB = 0.95).

The manufacturer's hot/cold curves (1) can be used to determine the heating time constant T1.

The method consists of placing the Sepam hot/cold curves below those of the motor.

Figure 1: Motor thermal resistance and thermal overload tripping curves



For an overload of 2*IB, the value t/T1 = 0.0339 (2) is obtained.

For Sepam to trip at the point 1 (t = 70 s), T1 is equal to 2065 sec ≈ 34 min.

With a setting of T1 = 34 min, the tripping time is obtained based on a cold state (point 2). In this case, it is equal to t/T1 = 0.3216 ⇒ t ⇒ 665 sec, i.e. ≈ 11 min, which is compatible with the thermal resistance of the motor when cold.

The negative sequence factor is calculated using the equation defined on page 50.

The parameters of the second thermal overload relay do not need to be set.

They are not considered by default.

Example 3

The following data are available:

- motor thermal resistance in the form of hot and cold curves (see solid line curves in Figure 1),
- cooling time constant T2
- maximum steady state current: Imax/IB = 1.1.

The thermal overload parameters are determined in the same way as in the previous example.

Setting Tripping Set Point Es2

Es2 = $(Imax/I_B)^2$ = 120%

Setting Alarm Set Point Es1

Es1 = 90% (I/IB = 0.95).

The time constant T1 is calculated to trip the thermal overload protection after 100 s (point 1).

With t/T1 = 0.069 (I/IB = 2 and Es2 = 120%):

⇒ T1 = 100s / 0.069 = 1449 sec ≈ 24 min.

The tripping time starting from the cold state is equal to:

t/T1 = 0.3567 ⇒ t = 24 min*0.3567 = 513 s (point 2).

This tripping time is too long since the limit for this overload current is 400 s (point 2).

If the time constant T1 is lowered, the thermal overload protection will trip earlier, below point 2.

The risk that motor starting when hot will not be possible also exists in this case (see Figure 2 in which a lower Sepam hot curve would intersect the starting curve with V_{LL} = 0.9 V_{LL}).

The **Es0 parameter** is a setting that is used to solve these differences by lowering the Sepam cold curve without moving the hot curve.

In this example, the thermal overload protection should trip after 400 s starting from the cold state.

The following equation is used to obtain the Es0 value:

$$Es0 = \left[\frac{I_{processed}}{I_B}\right]^2 - e^{\frac{t_{necessary}}{T_1}} \cdot \left[\left[\frac{I_{processed}}{I_B}\right]^2 - Es2\right]$$

with:

$t_{necessary}$: tripping time necessary starting from a cold state.

$I_{processed}$: equipment current.

(1) When the machine manufacturer provides both a time constant T1 and the machine hot/cold curves, the use of the curves is recommended since they are more accurate.

*(2) The charts containing the numerical values of the Sepam **hot curve** may be used, or else the equation of the curve which is given on page 50.*

In numerical values, the following is obtained:

$$Es0 = 4 - e^{\frac{400\,sec}{24 x 60\,sec}} \cdot \left[4 - 1.2\right] = 0.3035 \approx 31\%$$

By setting Es0 = 31%, point 2 is moved downward to obtain a shorter tripping time that is compatible with the motor's thermal resistance when cold (see Figure 3).
Please note: A setting Es0 = 100% therefore means that the hot and cold curves are the same.

Figure 2: Hot/cold curves not compatible with the motor's thermal resistance

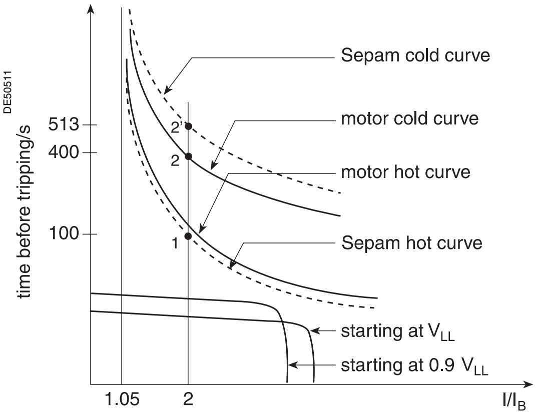
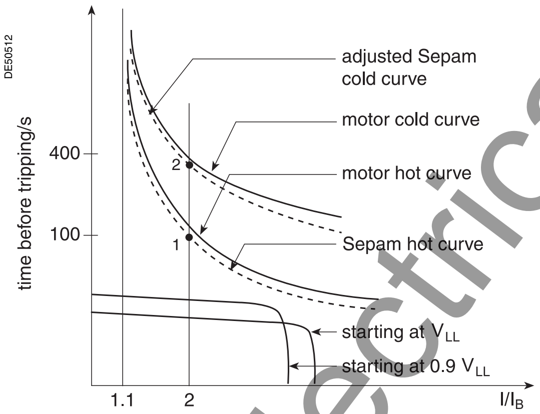


Figure 3: Hot/cold curves compatible with the motor's thermal resistance via the setting of an initial heat rise Es0

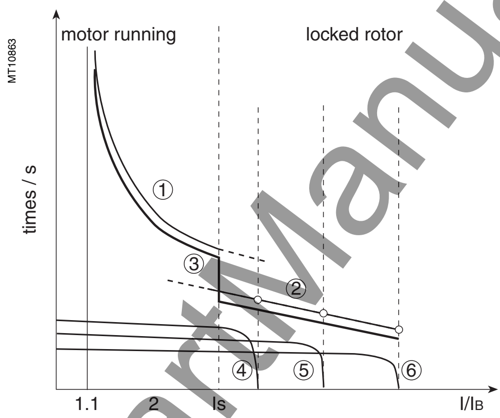


Using the Additional Setting Group
When a motor rotor is locked or turning very slowly, its thermal behavior differs from one with a rated load. In such conditions the motor is damaged by overheating the rotor or stator. For high power motors, rotor overheating is most often a limiting factor.

The thermal overload parameters chosen for operation with a low overload are no longer valid. "Excessive starting time" protection can be used to protect the motor in this case.

Motor manufacturers provide the thermal resistance curves (for different voltages at the time of starting) when the rotor is locked .

Figure 4: Locked rotor thermal resistance



①: thermal resistance, motor running
②: thermal resistance, motor stopped
③: Sepam tripping curve
④: starting at 65% V_{LL}
⑤: starting at 80% V_{LL}
⑥: starting at 100% V_{LL}

A second overload relay can be used to compensate for the information in these curves.

The time constant in this case is theoretically the shortest one: however, it should not be determined in the same way as that of the first relay.

The thermal overload protection switches between the first and second relay if the equivalent current **Ieq** exceeds the **Is** value (set point current), or **Ieq > Is**.

Example 4:

Transformer with two ventilation modes
The following data is given:
The rated current of a transformer with two ventilation modes is:

- I_B = 200 A without forced ventilation (ONAN mode), the transformer's main operating rate
- I_B = 240 A with forced ventilation (ONAF mode), a temporary operating rate, to have 20% more power available

The basis current setting for ventilation operating rate 1: I_B = 200 A (this is set in Sepam general parameters).

The basis current setting for ventilation operating rate 2: I_{B2} = 240 A (this is set in the specific thermal overload protection settings).

Switching thermal settings through the logic input is accomplished by the "switching thermal settings" function and is connected to the transformer ventilation control unit.

The settings related to each ventilation operating rate (Es set points, time constants) are determined according to the transformer characteristics provided by the manufacturer.

Cold Curves for Es0 = 0%

I/IB Es (%)	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50	1.55	1.60	1.65	1.70	1.75	1.80
50	0.6931	0.6042	0.5331	0.4749	0.4265	0.3857	0.3508	0.3207	0.2945	0.2716	0.2513	0.2333	0.2173	0.2029	0.1900	0.1782	0.1676
55	0.7985	0.6909	0.6061	0.5376	0.4812	0.4339	0.3937	0.3592	0.3294	0.3033	0.2803	0.2600	0.2419	0.2257	0.2111	0.1980	0.1860
60	0.9163	0.7857	0.6849	0.6046	0.5390	0.4845	0.4386	0.3993	0.3655	0.3360	0.3102	0.2873	0.2671	0.2490	0.2327	0.2181	0.2048
65	1.0498	0.8905	0.7704	0.6763	0.6004	0.5379	0.4855	0.4411	0.4029	0.3698	0.3409	0.3155	0.2929	0.2728	0.2548	0.2386	0.2239
70	1.2040	1.0076	0.8640	0.7535	0.6657	0.5942	0.5348	0.4847	0.4418	0.4049	0.3727	0.3444	0.3194	0.2972	0.2774	0.2595	0.2434
75	1.3863	1.1403	0.9671	0.8373	0.7357	0.6539	0.5866	0.5302	0.4823	0.4412	0.4055	0.3742	0.3467	0.3222	0.3005	0.2809	0.2633
80	1.6094	1.2933	1.0822	0.9287	0.8109	0.7174	0.6413	0.5780	0.5245	0.4788	0.4394	0.4049	0.3747	0.3479	0.3241	0.3028	0.2836
85	1.8971	1.4739	1.2123	1.0292	0.8923	0.7853	0.6991	0.6281	0.5686	0.5180	0.4745	0.4366	0.4035	0.3743	0.3483	0.3251	0.3043
90	2.3026	1.6946	1.3618	1.1411	0.9808	0.8580	0.7605	0.6809	0.6147	0.5587	0.5108	0.4694	0.4332	0.4013	0.3731	0.3480	0.3254
95		1.9782	1.5377	1.2670	1.0780	0.9365	0.8258	0.7366	0.6630	0.6012	0.5486	0.5032	0.4638	0.4292	0.3986	0.3714	0.3470
100		2.3755	1.7513	1.4112	1.1856	1.0217	0.8958	0.7956	0.7138	0.6455	0.5878	0.5383	0.4953	0.4578	0.4247	0.3953	0.3691
105		3.0445	2.0232	1.5796	1.3063	1.1147	0.9710	0.8583	0.7673	0.6920	0.6286	0.5746	0.5279	0.4872	0.4515	0.4199	0.3917
110			2.3979	1.7824	1.4435	1.2174	1.0524	0.9252	0.8238	0.7406	0.6712	0.6122	0.5616	0.5176	0.4790	0.4450	0.4148
115			3.0040	2.0369	1.6025	1.3318	1.1409	0.9970	0.8837	0.7918	0.7156	0.6514	0.5964	0.5489	0.5074	0.4708	0.4384
120				2.3792	1.7918	1.4610	1.2381	1.0742	0.9474	0.8457	0.7621	0.6921	0.6325	0.5812	0.5365	0.4973	0.4626
125				2.9037	2.0254	1.6094	1.3457	1.1580	1.0154	0.9027	0.8109	0.7346	0.6700	0.6146	0.5666	0.5245	0.4874
130					2.3308	1.7838	1.4663	1.2493	1.0885	0.9632	0.8622	0.7789	0.7089	0.6491	0.5975	0.5525	0.5129
135					2.7726	1.9951	1.6035	1.3499	1.1672	1.0275	0.9163	0.8253	0.7494	0.6849	0.6295	0.5813	0.5390
140						2.2634	1.7626	1.4618	1.2528	1.0962	0.9734	0.8740	0.7916	0.7220	0.6625	0.6109	0.5658
145						2.6311	1.9518	1.5877	1.3463	1.1701	1.0341	0.9252	0.8356	0.7606	0.6966	0.6414	0.5934
150						3.2189	2.1855	1.7319	1.4495	1.2498	1.0986	0.9791	0.8817	0.8007	0.7320	0.6729	0.6217
155							2.4908	1.9003	1.5645	1.3364	1.1676	1.0361	0.9301	0.8424	0.7686	0.7055	0.6508
160							2.9327	2.1030	1.6946	1.4313	1.2417	1.0965	0.9808	0.8860	0.8066	0.7391	0.6809
165								2.3576	1.8441	1.5361	1.3218	1.1609	1.0343	0.9316	0.8461	0.7739	0.7118
170								2.6999	2.0200	1.6532	1.4088	1.2296	1.0908	0.9793	0.8873	0.8099	0.7438
175								3.2244	2.2336	1.7858	1.5041	1.3035	1.1507	1.0294	0.9302	0.8473	0.7768
180									2.5055	1.9388	1.6094	1.3832	1.2144	1.0822	0.9751	0.8861	0.8109
185									2.8802	2.1195	1.7272	1.4698	1.2825	1.1379	1.0220	0.9265	0.8463
190									3.4864	2.3401	1.8608	1.5647	1.3555	1.1970	1.0713	0.9687	0.8829
195										2.6237	2.0149	1.6695	1.4343	1.2597	1.1231	1.0126	0.9209
200										3.0210	2.1972	1.7866	1.5198	1.3266	1.1778	1.0586	0.9605

Cold Curves for Es0 = 0%

I/IB Es (%)	1.85	1.90	1.95	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20	4.40	4.60
50	0.1579	0.1491	0.1410	0.1335	0.1090	0.0908	0.0768	0.0659	0.0572	0.0501	0.0442	0.0393	0.0352	0.0317	0.0288	0.0262	0.0239
55	0.1752	0.1653	0.1562	0.1479	0.1206	0.1004	0.0849	0.0727	0.0631	0.0552	0.0487	0.0434	0.0388	0.0350	0.0317	0.0288	0.0263
60	0.1927	0.1818	0.1717	0.1625	0.1324	0.1100	0.0929	0.0796	0.069	0.0604	0.0533	0.0474	0.0424	0.0382	0.0346	0.0315	0.0288
65	0.2106	0.1985	0.1875	0.1773	0.1442	0.1197	0.1011	0.0865	0.075	0.0656	0.0579	0.0515	0.0461	0.0415	0.0375	0.0342	0.0312
70	0.2288	0.2156	0.2035	0.1924	0.1562	0.1296	0.1093	0.0935	0.081	0.0708	0.0625	0.0555	0.0497	0.0447	0.0405	0.0368	0.0336
75	0.2474	0.2329	0.2197	0.2076	0.1684	0.1395	0.1176	0.1006	0.087	0.0761	0.0671	0.0596	0.0533	0.0480	0.0434	0.0395	0.0361
80	0.2662	0.2505	0.2362	0.2231	0.1807	0.1495	0.1260	0.1076	0.0931	0.0813	0.0717	0.0637	0.0570	0.0513	0.0464	0.0422	0.0385
85	0.2855	0.2685	0.2530	0.2389	0.1931	0.1597	0.1344	0.1148	0.0992	0.0867	0.0764	0.0678	0.0607	0.0546	0.0494	0.0449	0.0410
90	0.3051	0.2868	0.2701	0.2549	0.2057	0.1699	0.1429	0.1219	0.1054	0.092	0.0811	0.0720	0.0644	0.0579	0.0524	0.0476	0.0435
95	0.3251	0.3054	0.2875	0.2712	0.2185	0.1802	0.1514	0.1292	0.1116	0.0974	0.0858	0.0761	0.0681	0.0612	0.0554	0.0503	0.0459
100	0.3456	0.3244	0.3051	0.2877	0.2314	0.1907	0.1601	0.1365	0.1178	0.1028	0.0905	0.0803	0.0718	0.0645	0.0584	0.0530	0.0484
105	0.3664	0.3437	0.3231	0.3045	0.2445	0.2012	0.1688	0.1438	0.1241	0.1082	0.0952	0.0845	0.0755	0.0679	0.0614	0.0558	0.0509
110	0.3877	0.3634	0.3415	0.3216	0.2578	0.2119	0.1776	0.1512	0.1304	0.1136	0.1000	0.0887	0.0792	0.0712	0.0644	0.0585	0.0534
115	0.4095	0.3835	0.3602	0.3390	0.2713	0.2227	0.1865	0.1586	0.1367	0.1191	0.1048	0.0929	0.0830	0.0746	0.0674	0.0612	0.0559
120	0.4317	0.4041	0.3792	0.3567	0.2849	0.2336	0.1954	0.1661	0.1431	0.1246	0.1096	0.0972	0.0868	0.0780	0.0705	0.0640	0.0584
125	0.4545	0.4250	0.3986	0.3747	0.2988	0.2446	0.2045	0.1737	0.1495	0.1302	0.1144	0.1014	0.0905	0.0813	0.0735	0.0667	0.0609
130	0.4778	0.4465	0.4184	0.3930	0.3128	0.2558	0.2136	0.1813	0.156	0.1358	0.1193	0.1057	0.0943	0.0847	0.0766	0.0695	0.0634
135	0.5016	0.4683	0.4386	0.4117	0.3270	0.2671	0.2228	0.1890	0.1625	0.1414	0.1242	0.1100	0.0982	0.0881	0.0796	0.0723	0.0659
140	0.5260	0.4907	0.4591	0.4308	0.3414	0.2785	0.2321	0.1967	0.1691	0.147	0.1291	0.1143	0.1020	0.0916	0.0827	0.0751	0.0685
145	0.5511	0.5136	0.4802	0.4502	0.3561	0.2900	0.2414	0.2045	0.1757	0.1527	0.1340	0.1187	0.1058	0.0950	0.0858	0.0778	0.0710
150	0.5767	0.5370	0.5017	0.4700	0.3709	0.3017	0.2509	0.2124	0.1823	0.1584	0.1390	0.1230	0.1097	0.0984	0.0889	0.0806	0.0735
155	0.6031	0.5610	0.5236	0.4902	0.3860	0.3135	0.2604	0.2203	0.189	0.1641	0.1440	0.1274	0.1136	0.1019	0.0920	0.0834	0.0761
160	0.6302	0.5856	0.5461	0.5108	0.4013	0.3254	0.2701	0.2283	0.1957	0.1699	0.1490	0.1318	0.1174	0.1054	0.0951	0.0863	0.0786
165	0.6580	0.6108	0.5690	0.5319	0.4169	0.3375	0.2798	0.2363	0.2025	0.1757	0.1540	0.1362	0.1213	0.1088	0.0982	0.0891	0.0812
170	0.6866	0.6366	0.5925	0.5534	0.4327	0.3498	0.2897	0.2444	0.2094	0.1815	0.1591	0.1406	0.1253	0.1123	0.1013	0.0919	0.0838
175	0.7161	0.6631	0.6166	0.5754	0.4487	0.3621	0.2996	0.2526	0.2162	0.1874	0.1641	0.1451	0.1292	0.1158	0.1045	0.0947	0.0863
180	0.7464	0.6904	0.6413	0.5978	0.4651	0.3747	0.3096	0.2608	0.2231	0.1933	0.1693	0.1495	0.1331	0.1193	0.1076	0.0976	0.0889
185	0.7777	0.7184	0.6665	0.6208	0.4816	0.3874	0.3197	0.2691	0.2301	0.1993	0.1744	0.1540	0.1371	0.1229	0.1108	0.1004	0.0915
190	0.8100	0.7472	0.6925	0.6444	0.4985	0.4003	0.3300	0.2775	0.2371	0.2052	0.1796	0.1585	0.1411	0.1264	0.1140	0.1033	0.0941
195	0.8434	0.7769	0.7191	0.6685	0.5157	0.4133	0.3403	0.2860	0.2442	0.2113	0.1847	0.1631	0.1451	0.1300	0.1171	0.1062	0.0967
200	0.8780	0.8075	0.7465	0.6931	0.5331	0.4265	0.3508	0.2945	0.2513	0.2173	0.1900	0.1676	0.1491	0.1335	0.1203	0.1090	0.0993

3

Thermal Overload
ANSI Code 49 RMS
Setting Examples

Cold Curves for Es0 = 0%

I/IB Es (%)	4.80	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00	12.50	15.00	17.50	20.00
50	0.0219	0.0202	0.0167	0.0140	0.0119	0.0103	0.0089	0.0078	0.0069	0.0062	0.0056	0.0050	0.0032	0.0022	0.0016	0.0013
55	0.0242	0.0222	0.0183	0.0154	0.0131	0.0113	0.0098	0.0086	0.0076	0.0068	0.0061	0.0055	0.0035	0.0024	0.0018	0.0014
60	0.0264	0.0243	0.0200	0.0168	0.0143	0.0123	0.0107	0.0094	0.0083	0.0074	0.0067	0.0060	0.0038	0.0027	0.0020	0.0015
65	0.0286	0.0263	0.0217	0.0182	0.0155	0.0134	0.0116	0.0102	0.0090	0.0081	0.0072	0.0065	0.0042	0.0029	0.0021	0.0016
70	0.0309	0.0284	0.0234	0.0196	0.0167	0.0144	0.0125	0.0110	0.0097	0.0087	0.0078	0.0070	0.0045	0.0031	0.0023	0.0018
75	0.0331	0.0305	0.0251	0.0211	0.0179	0.0154	0.0134	0.0118	0.0104	0.0093	0.0083	0.0075	0.0048	0.0033	0.0025	0.0019
80	0.0353	0.0325	0.0268	0.0225	0.0191	0.0165	0.0143	0.0126	0.0111	0.0099	0.0089	0.0080	0.0051	0.0036	0.0026	0.0020
85	0.0376	0.0346	0.0285	0.0239	0.0203	0.0175	0.0152	0.0134	0.0118	0.0105	0.0095	0.0085	0.0055	0.0038	0.0028	0.0021
90	0.0398	0.0367	0.0302	0.0253	0.0215	0.0185	0.0161	0.0142	0.0125	0.0112	0.0100	0.0090	0.0058	0.0040	0.0029	0.0023
95	0.0421	0.0387	0.0319	0.0267	0.0227	0.0196	0.0170	0.0150	0.0132	0.0118	0.0106	0.0095	0.0061	0.0042	0.0031	0.0024
100	0.0444	0.0408	0.0336	0.0282	0.0240	0.0206	0.0179	0.0157	0.0139	0.0124	0.0111	0.0101	0.0064	0.0045	0.0033	0.0025
105	0.0466	0.0429	0.0353	0.0296	0.0252	0.0217	0.0188	0.0165	0.0146	0.0130	0.0117	0.0106	0.0067	0.0047	0.0034	0.0026
110	0.0489	0.0450	0.0370	0.0310	0.0264	0.0227	0.0197	0.0173	0.0153	0.0137	0.0123	0.0111	0.0071	0.0049	0.0036	0.0028
115	0.0512	0.0471	0.0388	0.0325	0.0276	0.0237	0.0207	0.0181	0.0160	0.0143	0.0128	0.0116	0.0074	0.0051	0.0038	0.0029
120	0.0535	0.0492	0.0405	0.0339	0.0288	0.0248	0.0216	0.0189	0.0167	0.0149	0.0134	0.0121	0.0077	0.0053	0.0039	0.0030
125	0.0558	0.0513	0.0422	0.0353	0.0300	0.0258	0.0225	0.0197	0.0175	0.0156	0.0139	0.0126	0.0080	0.0056	0.0041	0.0031
130	0.0581	0.0534	0.0439	0.0368	0.0313	0.0269	0.0234	0.0205	0.0182	0.0162	0.0145	0.0131	0.0084	0.0058	0.0043	0.0033
135	0.0604	0.0555	0.0457	0.0382	0.0325	0.0279	0.0243	0.0213	0.0189	0.0168	0.0151	0.0136	0.0087	0.0060	0.0044	0.0034
140	0.0627	0.0576	0.0474	0.0397	0.0337	0.0290	0.0252	0.0221	0.0196	0.0174	0.0156	0.0141	0.0090	0.0062	0.0046	0.0035
145	0.0650	0.0598	0.0491	0.0411	0.0349	0.0300	0.0261	0.0229	0.0203	0.0181	0.0162	0.0146	0.0093	0.0065	0.0047	0.0036
150	0.0673	0.0619	0.0509	0.0426	0.0361	0.0311	0.0270	0.0237	0.0210	0.0187	0.0168	0.0151	0.0096	0.0067	0.0049	0.0038
155	0.0696	0.0640	0.0526	0.0440	0.0374	0.0321	0.0279	0.0245	0.0217	0.0193	0.0173	0.0156	0.0100	0.0069	0.0051	0.0039
160	0.0720	0.0661	0.0543	0.0455	0.0386	0.0332	0.0289	0.0253	0.0224	0.0200	0.0179	0.0161	0.0103	0.0071	0.0052	0.0040
165	0.0743	0.0683	0.0561	0.0469	0.0398	0.0343	0.0298	0.0261	0.0231	0.0206	0.0185	0.0166	0.0106	0.0074	0.0054	0.0041
170	0.0766	0.0704	0.0578	0.0484	0.0411	0.0353	0.0307	0.0269	0.0238	0.0212	0.0190	0.0171	0.0109	0.0076	0.0056	0.0043
175	0.0790	0.0726	0.0596	0.0498	0.0423	0.0364	0.0316	0.0277	0.0245	0.0218	0.0196	0.0177	0.0113	0.0078	0.0057	0.0044
180	0.0813	0.0747	0.0613	0.0513	0.0435	0.0374	0.0325	0.0285	0.0252	0.0225	0.0201	0.0182	0.0116	0.0080	0.0059	0.0045
185	0.0837	0.0769	0.0631	0.0528	0.0448	0.0385	0.0334	0.0293	0.0259	0.0231	0.0207	0.0187	0.0119	0.0083	0.0061	0.0046
190	0.0861	0.0790	0.0649	0.0542	0.0460	0.0395	0.0344	0.0301	0.0266	0.0237	0.0213	0.0192	0.0122	0.0085	0.0062	0.0048
195	0.0884	0.0812	0.0666	0.0557	0.0473	0.0406	0.0353	0.0309	0.0274	0.0244	0.0218	0.0197	0.0126	0.0087	0.0064	0.0049
200	0.0908	0.0834	0.0684	0.0572	0.0485	0.0417	0.0362	0.0317	0.0281	0.0250	0.0224	0.0202	0.0129	0.0089	0.0066	0.0050

Hot Curves

I/IB Es (%)	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50	1.55	1.60	1.65	1.70	1.75	1.80
105		0.6690	0.2719	0.1685	0.1206	0.0931	0.0752	0.0627	0.0535	0.0464	0.0408	0.0363	0.0326	0.0295	0.0268	0.0245	0.0226
110		3.7136	0.6466	0.3712	0.2578	0.1957	0.1566	0.1296	0.1100	0.0951	0.0834	0.0740	0.0662	0.0598	0.0544	0.0497	0.0457
115			1.2528	0.6257	0.4169	0.3102	0.2451	0.2013	0.1699	0.1462	0.1278	0.1131	0.1011	0.0911	0.0827	0.0755	0.0693
120			3.0445	0.9680	0.6061	0.4394	0.3423	0.2786	0.2336	0.2002	0.1744	0.1539	0.1372	0.1234	0.1118	0.1020	0.0935
125				1.4925	0.8398	0.5878	0.4499	0.3623	0.3017	0.2572	0.2231	0.1963	0.1747	0.1568	0.1419	0.1292	0.1183
130				2.6626	1.1451	0.7621	0.5705	0.4537	0.3747	0.3176	0.2744	0.2407	0.2136	0.1914	0.1728	0.1572	0.1438
135					1.5870	0.9734	0.7077	0.5543	0.4535	0.3819	0.3285	0.2871	0.2541	0.2271	0.2048	0.1860	0.1699
140					2.3979	1.2417	0.8668	0.6662	0.5390	0.4507	0.3857	0.3358	0.2963	0.2643	0.2378	0.2156	0.1967
145						1.6094	1.0561	0.7921	0.6325	0.5245	0.4463	0.3869	0.3403	0.3028	0.2719	0.2461	0.2243
150						2.1972	1.2897	0.9362	0.7357	0.6042	0.5108	0.4408	0.3864	0.3429	0.3073	0.2776	0.2526
155						3.8067	1.5950	1.1047	0.8508	0.6909	0.5798	0.4978	0.4347	0.3846	0.3439	0.3102	0.2817
160							2.0369	1.3074	0.9808	0.7857	0.6539	0.5583	0.4855	0.4282	0.3819	0.3438	0.3118
165							2.8478	1.5620	1.1304	0.8905	0.7340	0.6226	0.5390	0.4738	0.4215	0.3786	0.3427
170								1.9042	1.3063	1.0076	0.8210	0.6914	0.5955	0.5215	0.4626	0.4146	0.3747
175								2.4288	1.5198	1.1403	0.9163	0.7652	0.6554	0.5717	0.5055	0.4520	0.4077
180								3.5988	1.7918	1.2933	1.0217	0.8449	0.7191	0.6244	0.5504	0.4908	0.4418
185									2.1665	1.4739	1.1394	0.9316	0.7872	0.6802	0.5974	0.5312	0.4772
190									2.7726	1.6946	1.2730	1.0264	0.8602	0.7392	0.6466	0.5733	0.5138
195									4.5643	1.9782	1.4271	1.1312	0.9390	0.8019	0.6985	0.6173	0.5518
200										2.3755	1.6094	1.2483	1.0245	0.8688	0.7531	0.6633	0.5914

I/IB Es (%)	1.85	1.90	1.95	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20	4.40	4.60
105	0.0209	0.0193	0.0180	0.0168	0.0131	0.0106	0.0087	0.0073	0.0063	0.0054	0.0047	0.0042	0.0037	0.0033	0.0030	0.0027	0.0025
110	0.0422	0.0391	0.0363	0.0339	0.0264	0.0212	0.0175	0.0147	0.0126	0.0109	0.0095	0.0084	0.0075	0.0067	0.0060	0.0055	0.0050
115	0.0639	0.0592	0.0550	0.0513	0.0398	0.0320	0.0264	0.0222	0.0189	0.0164	0.0143	0.0126	0.0112	0.0101	0.0091	0.0082	0.0075
120	0.0862	0.0797	0.0740	0.0690	0.0535	0.0429	0.0353	0.0297	0.0253	0.0219	0.0191	0.0169	0.0150	0.0134	0.0121	0.0110	0.0100
125	0.1089	0.1007	0.0934	0.0870	0.0673	0.0540	0.0444	0.0372	0.0317	0.0274	0.0240	0.0211	0.0188	0.0168	0.0151	0.0137	0.0125
130	0.1322	0.1221	0.1132	0.1054	0.0813	0.0651	0.0535	0.0449	0.0382	0.0330	0.0288	0.0254	0.0226	0.0202	0.0182	0.0165	0.0150
135	0.1560	0.1440	0.1334	0.1241	0.0956	0.0764	0.0627	0.0525	0.0447	0.0386	0.0337	0.0297	0.0264	0.0236	0.0213	0.0192	0.0175
140	0.1805	0.1664	0.1540	0.1431	0.1100	0.0878	0.0720	0.0603	0.0513	0.0443	0.0386	0.0340	0.0302	0.0270	0.0243	0.0220	0.0200
145	0.2055	0.1892	0.1750	0.1625	0.1246	0.0993	0.0813	0.0681	0.0579	0.0499	0.0435	0.0384	0.0341	0.0305	0.0274	0.0248	0.0226
150	0.2312	0.2127	0.1965	0.1823	0.1395	0.1110	0.0908	0.0759	0.0645	0.0556	0.0485	0.0427	0.0379	0.0339	0.0305	0.0276	0.0251
155	0.2575	0.2366	0.2185	0.2025	0.1546	0.1228	0.1004	0.0838	0.0712	0.0614	0.0535	0.0471	0.0418	0.0374	0.0336	0.0304	0.0277
160	0.2846	0.2612	0.2409	0.2231	0.1699	0.1347	0.1100	0.0918	0.0780	0.0671	0.0585	0.0515	0.0457	0.0408	0.0367	0.0332	0.0302
165	0.3124	0.2864	0.2639	0.2442	0.1855	0.1468	0.1197	0.0999	0.0847	0.0729	0.0635	0.0559	0.0496	0.0443	0.0398	0.0360	0.0328
170	0.3410	0.3122	0.2874	0.2657	0.2012	0.1591	0.1296	0.1080	0.0916	0.0788	0.0686	0.0603	0.0535	0.0478	0.0430	0.0389	0.0353
175	0.3705	0.3388	0.3115	0.2877	0.2173	0.1715	0.1395	0.1161	0.0984	0.0847	0.0737	0.0648	0.0574	0.0513	0.0461	0.0417	0.0379
180	0.4008	0.3660	0.3361	0.3102	0.2336	0.1840	0.1495	0.1244	0.1054	0.0906	0.0788	0.0692	0.0614	0.0548	0.0493	0.0446	0.0405
185	0.4321	0.3940	0.3614	0.3331	0.2502	0.1967	0.1597	0.1327	0.1123	0.0965	0.0839	0.0737	0.0653	0.0583	0.0524	0.0474	0.0431
190	0.4644	0.4229	0.3873	0.3567	0.2671	0.2096	0.1699	0.1411	0.1193	0.1025	0.0891	0.0782	0.0693	0.0619	0.0556	0.0503	0.0457
195	0.4978	0.4525	0.4140	0.3808	0.2842	0.2226	0.1802	0.1495	0.1264	0.1085	0.0943	0.0828	0.0733	0.0654	0.0588	0.0531	0.0483
200	0.5324	0.4831	0.4413	0.4055	0.3017	0.2358	0.1907	0.1581	0.1335	0.1145	0.0995	0.0873	0.0773	0.0690	0.0620	0.0560	0.0509

Hot Curves

I/IB Es (%)	4.80	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00	12.50	15.00	17.50	20.00
105	0.0023	0.0021	0.0017	0.0014	0.0012	0.0010	0.0009	0.0008	0.0007	0.0006	0.0006	0.0005	0.0003	0.0002	0.0002	0.0001
110	0.0045	0.0042	0.0034	0.0029	0.0024	0.0021	0.0018	0.0016	0.0014	0.0013	0.0011	0.0010	0.0006	0.0004	0.0003	0.0003
115	0.0068	0.0063	0.0051	0.0043	0.0036	0.0031	0.0027	0.0024	0.0021	0.0019	0.0017	0.0015	0.0010	0.0007	0.0005	0.0004
120	0.0091	0.0084	0.0069	0.0057	0.0049	0.0042	0.0036	0.0032	0.0028	0.0025	0.0022	0.0020	0.0013	0.0009	0.0007	0.0005
125	0.0114	0.0105	0.0086	0.0072	0.0061	0.0052	0.0045	0.0040	0.0035	0.0031	0.0028	0.0025	0.0016	0.0011	0.0008	0.0006
130	0.0137	0.0126	0.0103	0.0086	0.0073	0.0063	0.0054	0.0048	0.0042	0.0038	0.0034	0.0030	0.0019	0.0013	0.0010	0.0008
135	0.0160	0.0147	0.0120	0.0101	0.0085	0.0073	0.0064	0.0056	0.0049	0.0044	0.0039	0.0035	0.0023	0.0016	0.0011	0.0009
140	0.0183	0.0168	0.0138	0.0115	0.0097	0.0084	0.0073	0.0064	0.0056	0.0050	0.0045	0.0040	0.0026	0.0018	0.0013	0.0010
145	0.0206	0.0189	0.0155	0.0129	0.0110	0.0094	0.0082	0.0072	0.0063	0.0056	0.0051	0.0046	0.0029	0.0020	0.0015	0.0011
150	0.0229	0.0211	0.0172	0.0144	0.0122	0.0105	0.0091	0.0080	0.0070	0.0063	0.0056	0.0051	0.0032	0.0022	0.0016	0.0013
155	0.0253	0.0232	0.0190	0.0158	0.0134	0.0115	0.0100	0.0088	0.0077	0.0069	0.0062	0.0056	0.0035	0.0025	0.0018	0.0014
160	0.0276	0.0253	0.0207	0.0173	0.0147	0.0126	0.0109	0.0096	0.0085	0.0075	0.0067	0.0061	0.0039	0.0027	0.0020	0.0015
165	0.0299	0.0275	0.0225	0.0187	0.0159	0.0136	0.0118	0.0104	0.0092	0.0082	0.0073	0.0066	0.0042	0.0029	0.0021	0.0016
170	0.0323	0.0296	0.0242	0.0202	0.0171	0.0147	0.0128	0.0112	0.0099	0.0088	0.0079	0.0071	0.0045	0.0031	0.0023	0.0018
175	0.0346	0.0317	0.0260	0.0217	0.0183	0.0157	0.0137	0.0120	0.0106	0.0094	0.0084	0.0076	0.0048	0.0034	0.0025	0.0019
180	0.0370	0.0339	0.0277	0.0231	0.0196	0.0168	0.0146	0.0128	0.0113	0.0101	0.0090	0.0081	0.0052	0.0036	0.0026	0.0020
185	0.0393	0.0361	0.0295	0.0246	0.0208	0.0179	0.0155	0.0136	0.0120	0.0107	0.0096	0.0086	0.0055	0.0038	0.0028	0.0021
190	0.0417	0.0382	0.0313	0.0261	0.0221	0.0189	0.0164	0.0144	0.0127	0.0113	0.0101	0.0091	0.0058	0.0040	0.0030	0.0023
195	0.0441	0.0404	0.0330	0.0275	0.0233	0.0200	0.0173	0.0152	0.0134	0.0119	0.0107	0.0096	0.0061	0.0043	0.0031	0.0024
200	0.0464	0.0426	0.0348	0.0290	0.0245	0.0211	0.0183	0.0160	0.0141	0.0126	0.0113	0.0102	0.0065	0.0045	0.0033	0.0025

Description

The phase overcurrent function encompasses two groups of four units, Group A and Group B respectively.

The mode of switching from one group to the other is determined by parameter setting:
- by remote control (TC3, TC4)
- by logic input I13 (I13 = 0 group A, I13 = 1 group B)

or by forcing the use of the group.

Operation

The phase overcurrent protection function is three-pole. It picks up if one, two, or three of the phase currents reach the operation set point.

The alarm connected to protection function operation indicates the faulty phase or phases.

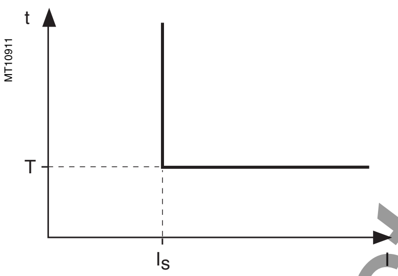
It is time-delayed. The time delay may be definite time (**DT**) or Inverse Definite Minimum Time (**IDMT)** according to the curves opposite.

Confirmation

The phase overcurrent protection function includes a selectable confirmation component.
The output is confirmed as follows:
- by phase-to-phase undervoltage protection unit 1
- by negative sequence overvoltage protection
- no confirmation.

Definite Time Protection

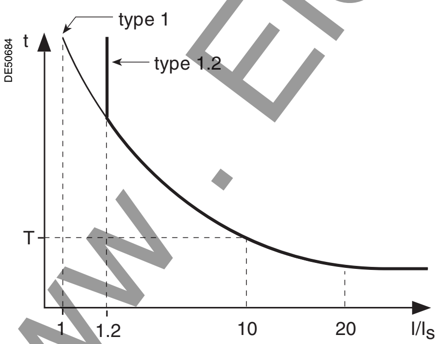
Is is the operation set point expressed in Amps, and **T** is the protection operation time delay.



Definite time protection principle.

IDMT protection

In addition to ANSI standards, IDMT protection operates in accordance with IEC (60255-3), BS 142, and IEEE (C-37112) standards.



IDMT protection principle.

The Is setting is the vertical asymptote of the curve, and T is the operation time delay for 10 Is.
The tripping time for I/Is values of less than 1.2 depends on the type of curve chosen.

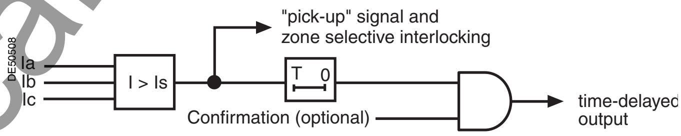
Name of Curve	Type
Standard inverse time (SIT)	1.2
Very inverse time (VIT or LTI)	1.2
Extremely inverse time (EIT)	1.2
Ultra inverse time (UIT)	1.2
RI curve	1
IEC standard inverse time SIT / A	1
IEC very inverse time VIT or LTI / B	1
IEC extremely inverse time EIT / C	1
IEEE moderately inverse (IEC / D)	1
IEEE very inverse (IEC / E)	1
IEEE extremely inverse (IEC / F)	1
IAC inverse	1
IAC very inverse	1
IAC extremely inverse	1

The curve equations are given in the chapter entitled "IDMT Protection Functions".

The function takes into account current variations during the time delay interval.
For currents with a very large amplitude, the protection function has a definite time characteristic:
- if I > 20 Is, tripping time is the time that corresponds to 20 Is
- if I > 40 IN, tripping time is the time that corresponds to 40 IN.

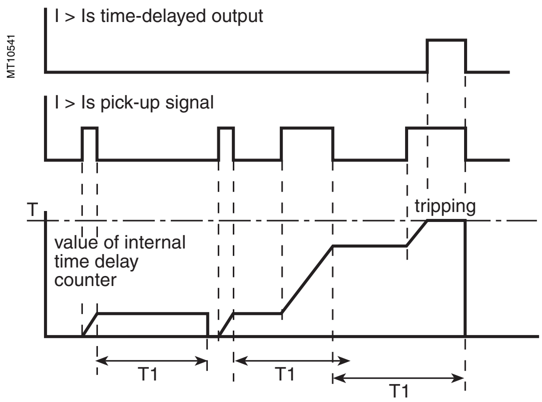
(In: current transformer rated current defined when the general settings are made).

Block Diagram



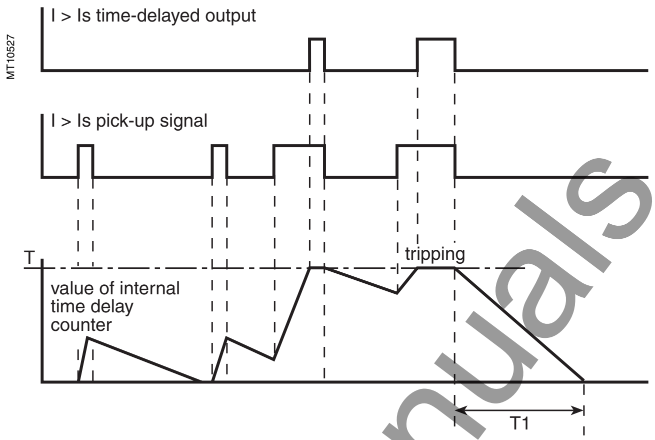
Timer Hold Delay

The function includes an adjustable timer hold delay T1:
- definite time (timer hold) for all the tripping curves.



Phase Overcurrent
ANSI Code 50/51

■ IDMT for IEC, IEEE, and IAC curves.



Characteristics

Tripping Curve		
Setting		Definite time, IDMT: chosen according to list on page 59
Confirmation		
Setting		by undervoltage (unit 1) by negative sequence overvoltage none
Is Set Point		
Setting	Definite time	0.1 I_N ≤ Is ≤ 24 I_N expressed in Amps
	IDMT	0.1 I_N ≤ Is ≤ 2.4 I_N expressed in Amps
Resolution		1 A or 1 digit
Accuracy (1)		±5% or ±0.01 I_N
Drop out/pick-up ratio		93.5% ±5% or > (1 - 0.015 I_N/Is) x 100%
Time Delay T (Operation Time at 10 Is)		
Setting	Definite time	inst., 50 ms ≤ T ≤ 300 s
	IDMT	100 ms ≤ T ≤ 12.5 s or TMS (2)
Resolution		10 ms or 1 digit
Accuracy (1)	Definite time	±2% or from –10 ms to +25 ms
	IDMT	Class 5 or from –10 ms to +25 ms
Timer Hold Delay T1		
Definite time (timer hold)		0; 0.05 to 300 s
IDMT (3)		0.5 to 20 s
Characteristic Times		
Operation time		Pick-up < 35 ms at 2 Is (typically 25 ms)
		Confirmed instantaneous: ■ inst. < 50 ms at 2 Is for Is ≥ 0.3 I_N (typically 35 ms) ■ inst. < 70 ms at 2 Is for Is < 0.3 I_N (typically 50 ms)
Overshoot time		< 35 ms
Reset time		< 50 ms (for T1 = 0)

(1) I_N reference conditions (IEC 60255-6).

(2) Setting ranges in TMS (Time Multiplier Setting) mode

Inverse (SIT) and IEC SIT/A:	*0.04 to 4.20*
Very inverse (VIT) and IEC VIT/B:	*0.07 to 8.33*
Very inverse (LTI) and IEC LTI/B:	*0.01 to 0.93*
Ext inverse (EIT) and IEC EIT/C:	*0.13 to 15.47*
IEEE moderately inverse:	*0.42 to 51.86*
IEEE very inverse:	*0.73 to 90.57*
IEEE extremely inverse:	*1.24 to 154.32*
IAC inverse:	*0.34 to 42.08*
IAC very inverse:	*0.61 to 75.75*
IAC extremely inverse:	*1.08 to 134.4*

(3) Only for standardized tripping curves of the IEC, IEEE and IAC types.

Operation

This function is designed to detect when a breaker does not open when a trip command is sent.

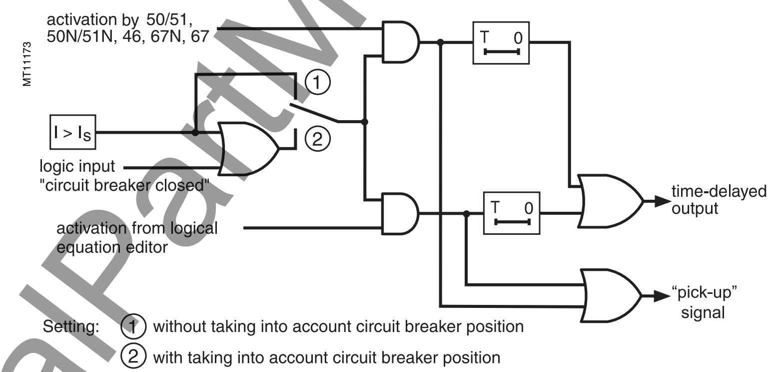
The "breaker failure" protection function is activated by an O1 output trip command received from the overcurrent protection functions (50/51, 50N/51N, 46, 67N, 67). It checks for the absence of current during the time interval specified by time delay **T**. It can also consider the position of the circuit breaker read on the logic inputs to determine the actual opening of the breaker.

Automatic activation of this protection function requires the use of the program logic circuit breaker control function. A specific input can also be used to activate the protection from the equation editor. That option is useful for adding special cases of activation (tripping by an external protection unit).

The time-delayed output of the protection unit should be assigned to a logic output via the control matrix.

Starting and stopping the time delay T counter are conditioned by the presence of a current above the set point (I > Is).

Block Diagram

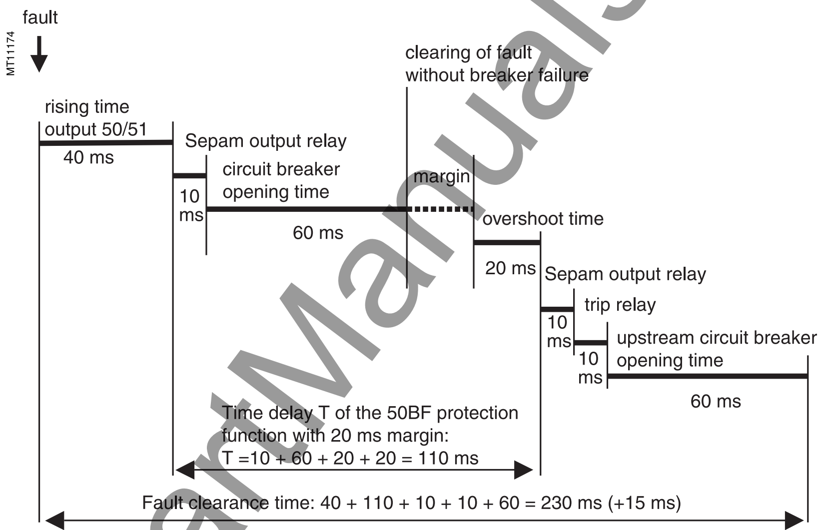


Example of Setting

The example below illustrates how to determine the time delay setting for the 50BF function

Overcurrent protection setting: T = inst.
Circuit breaker operating time: 60 ms.

Auxiliary relay operating time to open the upstream breaker or breakers: 10 ms.



The time delay for the 50BF function is the sum of the following times:

- Sepam O1 output relay pick-up time = 10 ms
- Circuit breaker opening time = 60 ms
- Overshoot time for the breaker failure function = 20 ms

To avoid unwanted tripping of the upstream breakers, choose a margin of approximately 20 ms. This provides a time delay T = 110 ms.

Characteristic

Is Set Point	
Setting	0.2 to 2 IN
Accuracy (1)	±5%
Resolution	0.1 A
Drop out/pick-up ratio	(87.5 ±10)%
Time Delay T	
Setting	0,05 s to 300 s
Accuracy (1)	±2%, or from 0 ms to 15 ms
Resolution	10 ms or 1 digit
Characteristic Time	
Overshoot time	< 20 ms
Considering the circuit breaker position	
Setting	With / without

Ground Fault
ANSI Code 50N/51N or 50G/51G

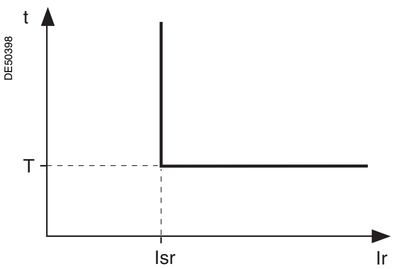
Description
The ground fault protection function comprises two groups of four units (Group A and Group B respectively). The mode of switching from one group to the other may be determined by parameter setting:
- by remote control (TC3, TC4)
- by logic input I13 (I13 = 0 group A, I13 = 1 group B)

or by forcing the use of the group.

Operation
The ground fault protection function is single-pole. It enables if ground fault current reaches operation set point.
It is time-delayed. The time delay may be definite time (**DT**) or IDMT according to the curves opposite.
The protection function includes second harmonic restraint which provides greater stability when transformers are energized. The restraint disables tripping, regardless of the fundamental current.

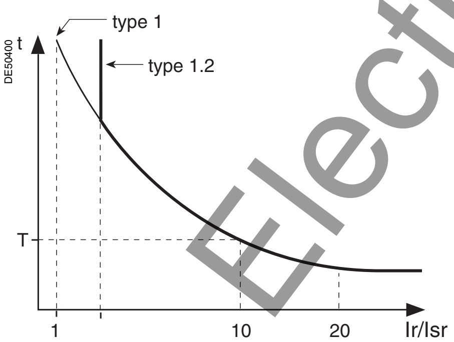
Parameter setting can block the restraint.

Definite Time Protection
Isr is the operation set point expressed in Amps, and T is the protection operation time delay.



Definite time protection principle.

IDMT Protection
IDMT protection operates in accordance with IEC (60255-3), BS 142 and IEEE (C-37112) standards.



IDMT protection principle.

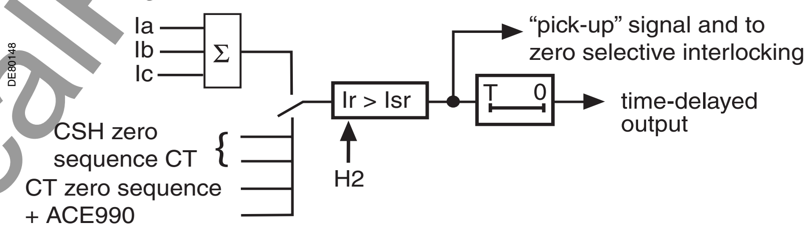
The Isr setting is the vertical asymptote of the curve, and T is the operation time delay for 1r Isr.
The tripping time for Ir/Isr values of less than 1.2 depends on the type of curve chosen.

Name of Curve	Type
Standard inverse time (SIT)	1.2
Very inverse time (VIT or LTI)	1.2
Extremely inverse time (EIT)	1.2
Ultra inverse time (UIT)	1.2
RI curve	1
IEC standard inverse time SIT / A	1
IEC very inverse time VIT or LTI / B	1
IEC extremely inverse time EIT / C	1
IEEE moderately inverse (IEC / D)	1
IEEE very inverse (IEC / E)	1
IEEE extremely inverse (IEC / F)	1
IAC inverse	1
IAC very inverse	1
IAC extremely inverse	1

The curve equations are given in the chapter entitled "IDMT Protection Functions".

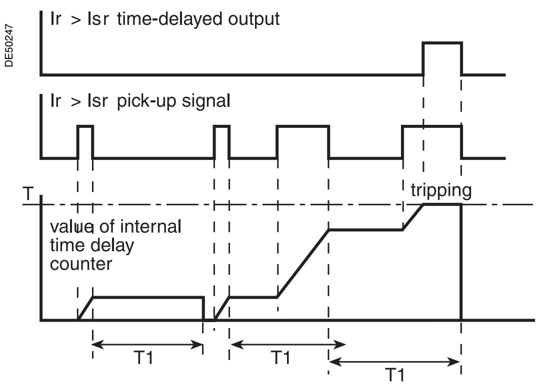
The function considers current variations during the time delay interval.
For large amplitude currents, the protection function has a definite time characteristic:
- if I > 20 Isr, tripping time is the time that corresponds to 20 Isr
- if I > 20 INr, tripping time is the time corresponding to 20 INr (operation based on Ir input)
- if Ir > 40 INr (1), tripping time is the time that corresponds to 40 INr (operation based on sum of phase currents).

Block Diagram



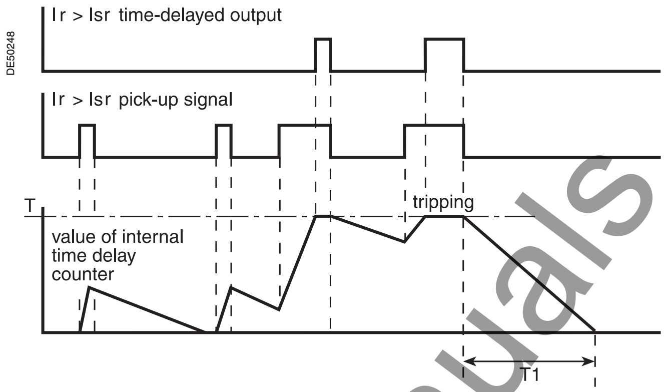
The choice between Ir (measured) and IrΣ (calculated by the sum of the phase currents) can be set for each unit, by default units 1 and 2 set to Ir and units 2 and 4 to IrΣ.
By mixing the two possibilities on the different units, it is possible to have:
- different dynamic set points
- different applications, e.g. zero sequence and tank ground leakage protection.

Timer Hold Delay
The function includes an adjustable timer hold delay T1:
- definite time (timer hold) for all the tripping curves



3

■ IDMT for IEC, IEEE and IAC curves.



Characteristics

Tripping Curve		
Setting		Definite time, IDMT: chosen according to list page 63
Isr Set Point		
Definite time setting		0.1 INr ≤ Isr ≤ 15 INr (1) expressed in Amps
	Sum of CTs (5)	0.1 INr ≤ Isr ≤ 15 INr
	With CSH sensor	
	2 A rating	0.2 A to 30 A
	5 A rating	0.5 A to 75 A
	20 A rating	2 A to 300 A
	CT	0.1 INr ≤ Isr ≤ 15 INr (min. 0.1 A)
	Zero sequence CT with ACE990	0.1 INr < Isr < 15 Inr
IDMT time setting		0.1 INr ≤ Isr ≤ INr (1) expressed in Amps
	Sum of CTs (5)	0.1 INr ≤ Isr ≤ INr
	With CSH sensor	
	2 A rating	0.2 A to 2 A
	5 A rating	0.5 A to 5 A
	20 A rating	2 A to 20 A
	CT	0.1 INr ≤ Isr ≤ INr (min. 0.1 A)
	Zero sequence CT with ACE990	0.1 INr < Isr < INr
Resolution		0.1 A or 1 digit
Accuracy (2)		±5% or ±0.01 INr
Drop out/pick-up ratio		93.5% ±5% (with CSH sensor, CT or zero sequence CT + ACE990)
		93.5% ±5% or > (1 - 0.015 INr/Isr) x 100% (sum of CTs)
Harmonic 2 Restraint		
Fixed threshold		17% ±5%
Time Delay T (Operation Time at 10 Isr)		
Setting	Definite time	inst. 50 ms ≤ T ≤ 300 s
	IDMT	100 ms ≤ T ≤ 12.5 s or TMS (3)
Resolution		10 ms or 1 digit
Accuracy (2)	Definite time	±2% or from -10 ms to +25 ms
	IDMT	class 5 or from -10 ms to +25 ms
Timer Hold Delay T1		
Definite time (timer hold)		0; 0.05 to 300 s
IDMT (4)		0.5 to 20 s
Characteristic Times		
Operation time		Pick-up < 35 ms at 2 Isr (typically 25 ms)
		Confirmed instantaneous: ■ inst. < 50 ms at 2 Isr for Isr ≥ 0.3 INr (typically 35 ms) ■ inst. < 70 ms at 2 Isr for Isr < 0.3 INr (typically 50 ms)
Overshoot time		< 35 ms
Reset time		< 40 ms (for T1 = 0)

***(1)** INr = IN if the sum of the three phase currents is used for the measurement.*
Isr = sensor rating if the measurement is taken by a CSH zero sequence CT.
INr = IN of the CT at In/10 according to parameter setting if the measurement is taken by a 1 A or 5 A current transformer.
***(2)** In reference conditions (IEC 60255-6)*
***(3)** Setting ranges in TMS (Time Multiplier Setting) mode*

Inverse (SIT) and IECIEC SIT/A:	*0.04 to 4.20*
Very inverse (VIT) and IEC VIT/B:	*0.07 to 8.33*
Very inverse (LTI) and IEC LTI/B:	*0.01 to 0.93*
Ext inverse (EIT) and IEC EIT/C:	*0.13 to 15.47*
IEEE moderately inverse:	*0.42 to 51.86*
IEEE very inverse:	*0.73 to 90.57*
IEEE extremely inverse:	*1.24 to 154.32*
IAC inverse:	*0.34 to 42.08*
IAC very inverse:	*0.61 to 75.75*
IAC extremely inverse:	*1.08 to 134.4*

***(4)** Only for standardized tripping curves of the IEC, IEEE and IAC types.*
***(5)** For Isr < 0.4 In0, the minimum time delay is 300 ms.*
If a shorter time delay is needed, use the CT + CSH30 or CT + CCA634 combination.

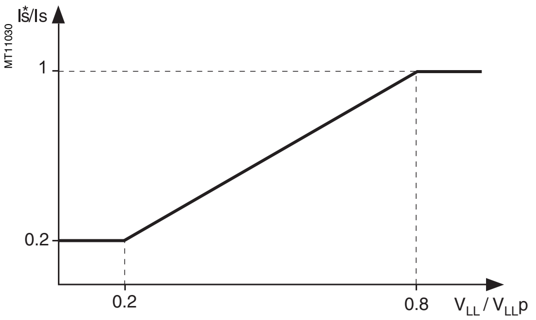
Voltage-Restrained Phase Overcurrent
ANSI Code 50V/51V

Operation
The voltage-restrained phase overcurrent protection function is used to protect generators. The operation set point is adjusted according to the voltage in order to consider causes of faults close to the generator that cause voltage dips and short-circuit current.

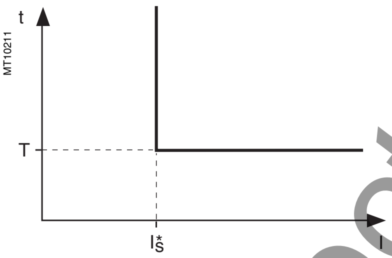
This protection function is three-pole. It enables if one, two, or three phase currents reach the voltage-adjusted operation set point Is*. The alarm linked to operation identifies the faulty phase or phases.
It is time-delayed. The delay may be definite time (DT) or IDMT according to the curves opposite.

The set point is adjusted according to the lowest of the phase-to-phase voltages measured. The adjusted set point Is* is defined by the following equation:

$$I_S^* = \frac{I_S}{3}\left(4\frac{V_{LL}}{V_{LL}p} - 0.2\right)$$

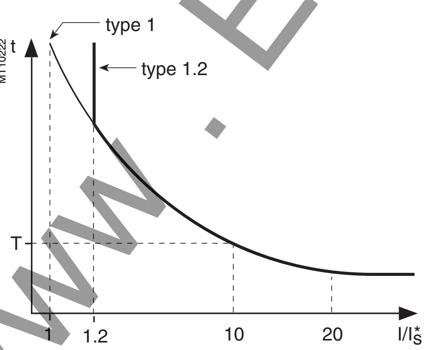


Definite Time Protection
Is is the operation set point expressed in Amps, and T is the protection operation time delay.



Definite time protection principle.

IDMT Protection
IDMT protection operates in accordance with the IEC (60255-3), BS 142 and IEEE (C-37112) standards.



IDMT protection principle.

The **Isr** setting is the vertical asymptote of the curve, and **T** is the operation time delay for 10 Isr.

The tripping time for **Ir/Isr** values less than 1.2 depends on the type of curve chosen.

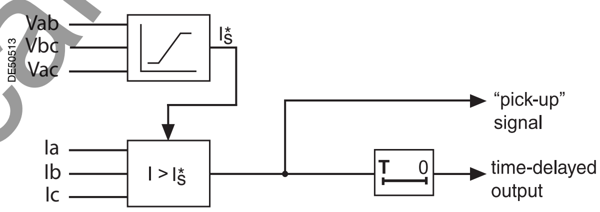
Name of Curve	Type
Standard inverse time (SIT)	1.2
Very inverse time (VIT or LTI)	1.2
Extremely inverse time (EIT)	1.2
Ultra inverse time (UIT)	1.2
RI curve	1
IEC standard inverse time SIT / A	1
IEC very inverse time VIT or LTI / B	1
IEC extremely inverse time EIT / C	1
IEEE moderately inverse (IEC / D)	1
IEEE very inverse (IEC / E)	1
IEEE extremely inverse (IEC / F)	1
IAC inverse	1
IAC very inverse	1
IAC extremely inverse	1

The curve equations are given in the chapter entitled "IDMT Protection Functions".

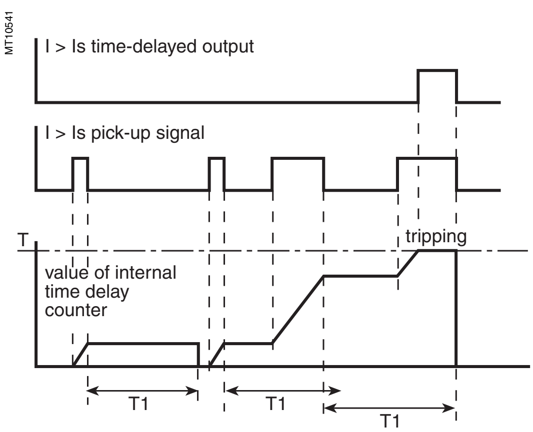
The function considers current variations during the time delay interval.
For currents with a very large amplitude, the protection function has a definite time characteristic:
- if I > 20 Is, tripping time is the time corresponding to 20 Is
- if I > 40 IN, tripping time is the time corresponding to 40 IN

(IN: current transformer rated current defined when the general settings are made).

Block Diagram



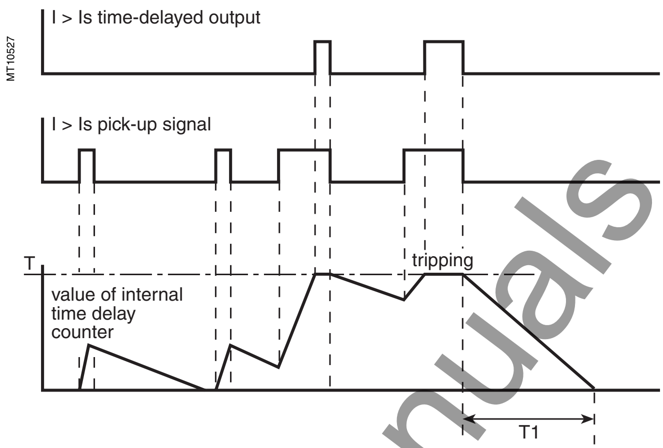
Timer Hold Delay
The function includes an adjustable timer hold delay T1:
- definite time (timer hold) for all the tripping curves



Voltage-Restrained Phase Overcurrent
ANSI Code 50V/51V

■ IDMT for IEC, IEEE and IAC curves.

MT10527



Characteristics

Tripping Curve		
Setting		Definite time, IDMT: chosen according to list
Is Set Point		
Setting	Definite time	0.5 IN ≤ Is ≤ 24 IN expressed in Amps
	IDMT	0.5 IN ≤ Is ≤ 2.4 IN expressed in Amps
Resolution		1 A or 1 digit
Accuracy (1)		±5% or ±0.01 IN
Drop out/pick-up ratio		93.5% ±5% or > (1 - 0.015 IN/Is*) x 100%
Time Delay T (Operation Time at 10 Isr)		
Setting	Definite time	inst. 50 ms ≤ T ≤ 300
	IDMT	100 ms ≤ T ≤ 12.5 s or TMS (2)
Resolution		10 ms or 1 digit
Accuracy (1)	Definite time	±2% or from –10 ms to +25 ms
	IDMT	class 5 or from –10 ms to +25 ms
Timer Hold Delay T1		
Definite time (timer hold)		0; 0.05 to 300 s
IDMT (3)		0.5 to 20 s
Characteristic Times		
Operation time		pick-up < 35 ms at 2 Is (typically 25 ms)
		Confirmed instantaneous: ■ inst. < 50 ms at 2 Is* for Is* > 0.3 IN (typically 35 ms) ■ inst. < 70 ms at 2 Is* for Is* ≤ 0.3 INr (typically 50 ms)
Overshoot time		< 35 ms
Reset time		< 50 ms (for T1 = 0)

(1) IN reference conditions (IEC 60255-6)
(2) Setting ranges in TMS (Time Multiplier Setting) mode
Inverse (SIT) and IECIEC SIT/A: 0.04 to 4.20
Very inverse (VIT) and IEC VIT/B: 0.07 to 8.33
Very inverse (LTI) and IEC LTI/B: 0.01 to 0.93
Ext inverse (EIT) and IEC EIT/C: 0.13 to 15.47
IEEE moderately inverse: 0.42 to 51.86
IEEE very inverse: 0.73 to 90.57
IEEE extremely inverse : 1,24 à 154,32
IAC inverse: 0.34 to 42.08
IAC very inverse: 0.61 to 75.75
IAC extremely inverse: 1.08 to 134.4
(3) Only for standardized tripping curves of IEC, IEEE and IAC types.

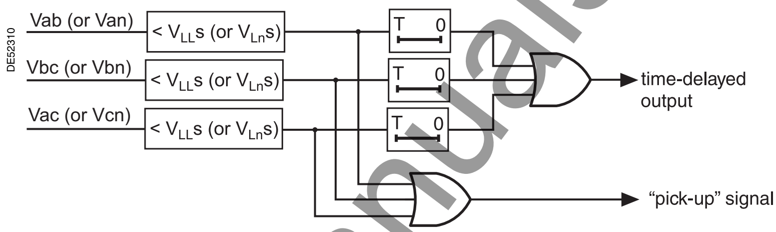
Overvoltage
ANSI Code 59

Operation

The protection function is single-phase and operates with phase-to-neutral or phase-to-phase voltage. It enables if one of the voltages concerned is above the $V_{LL}s$ (or $V_{Ln}s$) set point. It includes a definite time delay T

With phase-to-neutral operation, it indicates the faulty phase in the alarm associated with the fault.

Block Diagram



Characteristics

$V_{LL}s$ (or $V_{Ln}s$) Set Point	
Setting	50 % to 150% $V_{LL}p$ (or $V_{Ln}p$) (2)
Accuracy (1)	±2% or ±0.005 $V_{LL}p$
Resolution	1%
Drop out/pick up ratio	97% ±1%
Time Delay T	
Setting	50 ms to 300 s
Accuracy (1)	±2%, or ±25 ms
Resolution	10 ms or 1 digit
Characteristic Times	
Operation time	pick-up < 35 ms (typically 25 ms)
Overshoot time	< 35 ms
Reset time	< 40 ms

(1) IN reference conditions (IEC 60255-6).
(2) 135 % $V_{LL}p$ with VT 230 / $\sqrt{3}$.

Connnection Conditions					
Type of connection	Van, Vbn, Vcn	Vab	Vab, Vbc	Vab + Vr	Vab, Vbc + Vr
Phase-to-neutral operation	Yes	No	No	No	Yes
Phase-to-phase operation	Yes	on Vab only	Yes	on Vab only	Yes

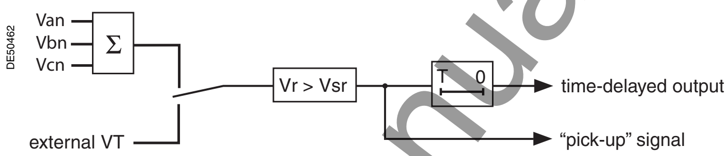
Neutral Voltage Displacement
ANSI Code 59N

Operation
The protection function enables if the residual voltage Vr is above a set point Vsr,

with $\vec{V}r = \vec{V}an + \vec{V}bn + \vec{V}cn$

It includes a definite time delay, T. The residual voltage is either calculated from the three phase voltages or measured by an external Voltage Transformer. ◆

The protection function operates for connections: VanVbnVcn, VabVbc + Vr and Vab + Vr.

Block Diagram


Characteristics

Vsr Set Point	
Setting	2% to 80% V_{LL}p if Vsr (2) = sum of 3Vs
	2% to 80% V_{LL}p if Vsr (2) = $V_{LL}s\sqrt{3}$
	5% to 80% V_{LL}p if Vsr (2) = $V_{LL}s\ \sqrt{3}$
Accuracy (1)	±2% or ±0.002 V_{LL}p
Resolution	1%
Drop out/pick up ratio	97% ±1% or > (1 - 0.001 V_{LL}p/Vsr) x 100%
Time Delay T	
Setting	50 ms to 300 s
Accuracy (1)	±2%, or ±25 ms
Resolution	10 ms or 1 digit
Characteristic Times	
Operation time	pick-up < 35 ms
Overshoot time	< 35 ms
Reset time	< 40 ms

(1) In reference conditions (IEC 60255-6).
(2) Vsr is one of the general settings.

Schneider Electric

Starts per Hour
ANSI Code 66

Operation
This is a three-phase function. It enables when the number of starts reaches the following limits:
- maximum number of starts (**Nt**) allowed per period of time (**P**)
- maximum allowed number of consecutive hot starts (**Nh**)
- maximum allowed number of consecutive cold starts (**Nc**).

Starting is detected when the current consumed becomes greater than 10% of the I_B current.

The number of consecutive starts is the number of starts counted during the last **P/Nt** minutes. **Nt** is the number of starts allowed per period.

The motor hot state corresponds to overshooting the fixed set point (50% heat rise) of the thermal overload function.

When the motor re-accelerates, it undergoes a stress similar to starting without the current first passing through a value less than 10% of I_B, The number of starts is not incremented in this instance.

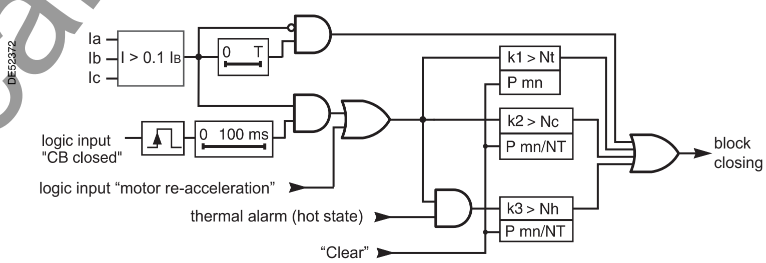
It is possible to increment the number of starts when a re-acceleration occurs by a logic data input (logic input "motor re-acceleration"). The "stop/start" time delay T may be used to block starting after a stop until the delay has elapsed.

Using "Circuit Breaker Closed" Data
In synchronous motor applications, it is advisable to connect the "circuit breaker closed" data to a logic input in order to enable more precise detection of starts. If the "circuit breaker closed" data is not connected to a logic input, the detection of a start is not conditioned by the position of the circuit breaker.

User Information
The following information is available for the user:
- the waiting time before a start is allowed
- the number of starts still allowed.

See the "Machine operation assistance functions" chapter.

Block Diagram



Characteristics

Period of Time (P)	
Setting	1 to 6 hours
Resolution	1
Nt total Number of Starts	
Setting	1 to 60
Resolution	1
Nh and Nc Number of Consecutive Starts	
Setting (1)	1 to Nt
Resolution	1
T time Delay Stop/Start	
Setting	0 mn $\le$ T $\le$ 90 mn
Resolution	1 mn or 1 digit

***(1)** With Nh $\le$ Nc.*

Description

The directional phase overcurrent function includes two groups of two units called respectively Group A and Group B.
The mode for switching from one group to the other can be determined by parameter setting:

- by remote control (TC3, TC4)
- by logic input I13 (I13 = 0 group A, I13 = 1 group B) or by using the group by force.

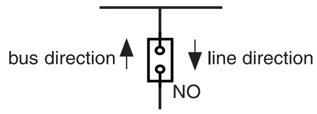
Operation

This protection function is three-phase. It includes a phase overcurrent function associated with direction detection. It enables if the phase overcurrent function in the chosen direction (line or bus) is activated for at least one of the three phases (or two out of three phases, according to parameter setting). The alarm linked to the protection operation indicates the faulty phase or phases.

It is time-delayed. The time delay may be definite time (**DT**) or IDMT according to the curves.

The direction of current is determined by measuring the phase in relation to a polarization value. It is qualified as bus direction or line direction, as shown below:

MT11175



The polarization value is the phase-to-phase value in quadrature with the current for cosφ= 1 (90° connection angle).

A phase current vector plane is divided into two half-planes corresponding to the line and bus zones. The characteristic angle θ is the angle of the perpendicular to the boundary line between the two zones and the polarization value.

Voltage Memory

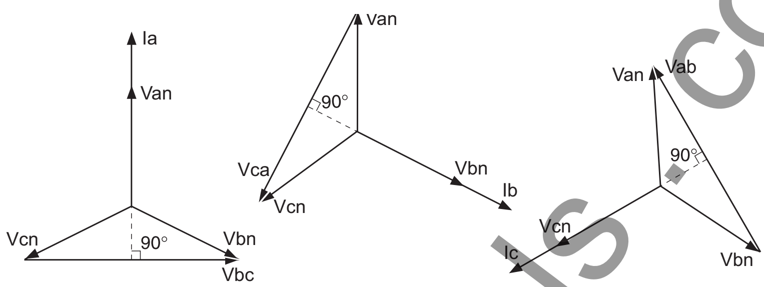
If all the voltages disappear during a 3-phase fault that is located near the bus, the voltage level may be insufficient to detect fault direction (< 1.5% V_{LL}p).

The protection function uses a voltage memory to reliably determine fault direction. The fault direction is saved as long as the voltage level is too low and the current is above the Is set point.

Closing After a Fault

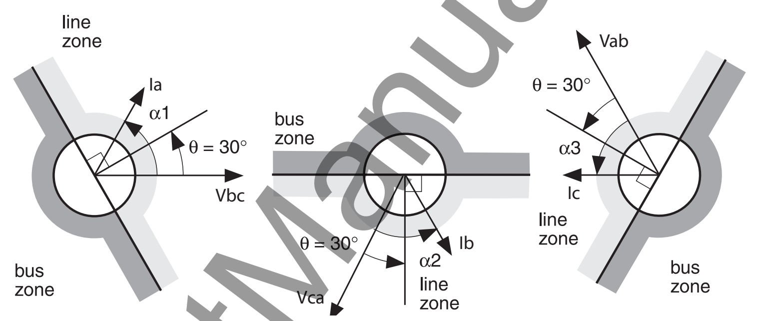
If the circuit breaker closes after a 3-phase fault on the bus, the voltage memory is blank. As a result, the direction cannot be determined and the protection does not trip. In such cases, a backup 50/51 protection function should be used.

MT11128



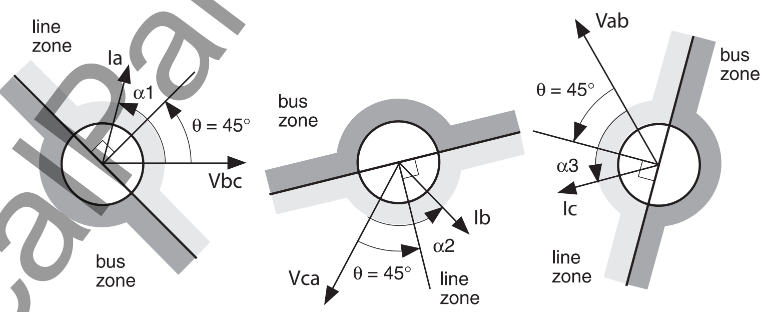
Three-phase function: polarization currents and voltages

DE50667



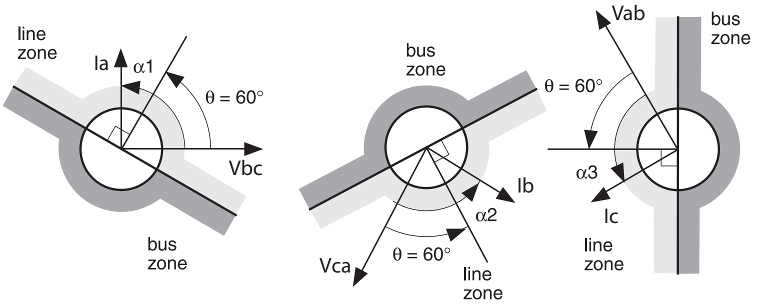
Fault tripping in line zone with θ = 30°

DE50668



Fault tripping in line zone with θ = 45°

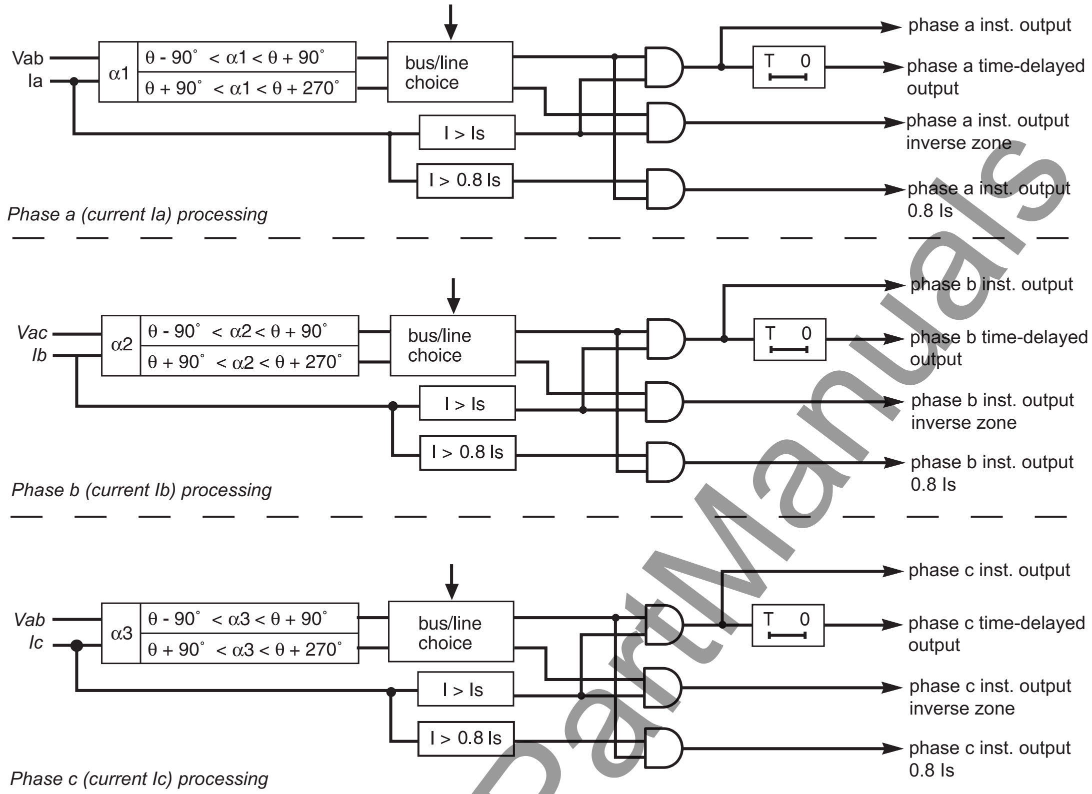
DE50669

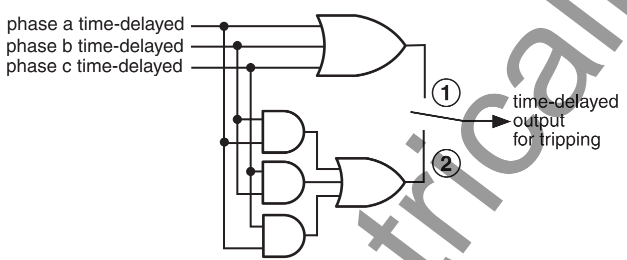


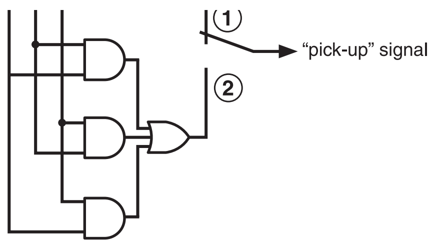
Fault tripping in line zone with θ = 60°

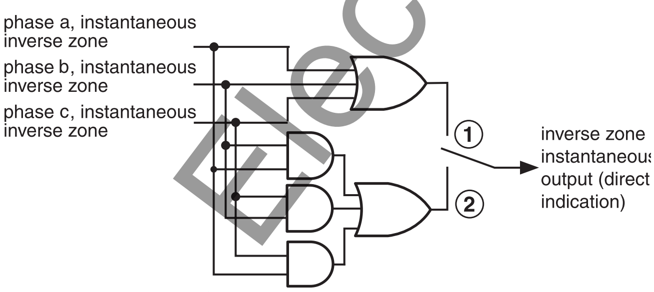
Directional Phase Overcurrent
ANSI Code 67

Block Diagrams

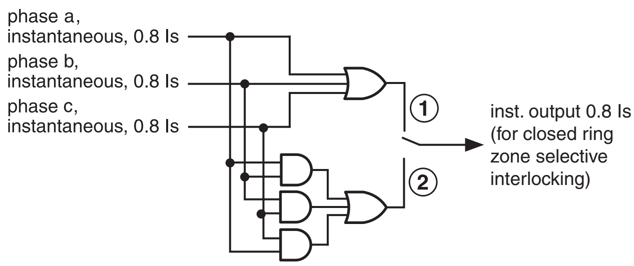








Grouping of output data



Setting tripping logic:
MT11182
(1) *one of three*
(2) *two of three*
Grouping output data

Tripping Logic

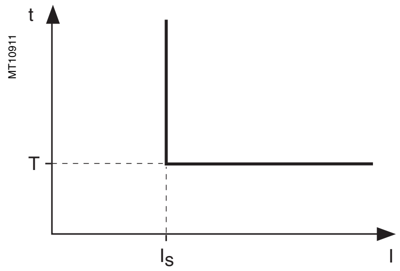
In certain cases, it is wise to choose a tripping logic of the two out of three phases type. Such cases can occur when two parallel transformers (Dy) are being protected. For a phase-to-phase fault on a transformer primary winding, there is a 2:1:1 ratio current distribution at the secondary end. The highest current is in the expected zone (operation zone for the faulty main, no operation zone for the fault-free main).

One of the lowest currents is at the limit of the zone. According to the line parameters, it may even be in the wrong zone. There is therefore a risk of tripping both mains.

Time Delay

Definite Time Protection

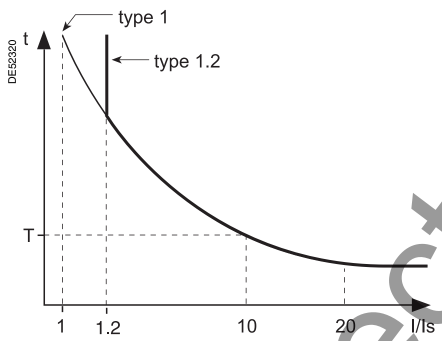
Is is the operation set point expressed in Amps, and **T** is the protection operation time delay.



Definite time protection principle.

IDMT Protection

IDMT protection operates in accordance with IEC (60255-3), BS 142 and IEEE (C-37112) standards.



IDMT protection principle.

The Is setting is the vertical asymptote of the curve, and T is the operation time delay for 10 Is.
The tripping time for I/Is values of less than 1.2 depends on the type of curve chosen.

Name of Curve	Type
Standard inverse time (SIT)	1.2
Very inverse time (VIT or LTI)	1.2
Extremely inverse time (EIT)	1.2
Ultra inverse time (UIT)	1.2
RI curve	1
IEC standard inverse time SIT / A	1
IEC very inverse time VIT or LTI / B	1
IEC extremely inverse time EIT / C	1
IEEE moderately inverse (IEC / D)	1
IEEE very inverse (IEC / E)	1
IEEE extremely inverse (IEC / F)	1
IAC inverse	1
IAC very inverse	1
IAC extremely inverse	1

The curve equations are given in the chapter entitled "IDMT Protection Functions".

The function considers current variations during the time delay interval.

For large amplitude currents, the protection function has a definite time characteristic:

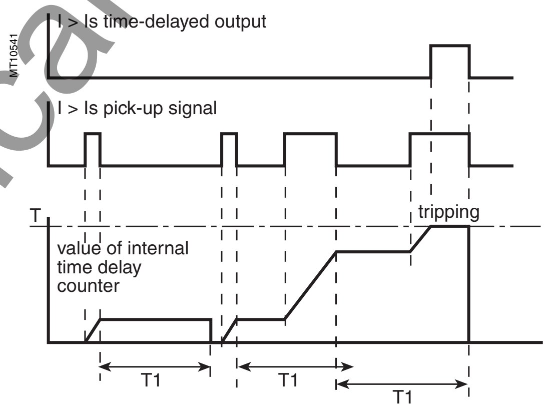
- if I > 20 Is, tripping time is the time corresponding to 20 Is
- if I > 40 IN, tripping time is the time corresponding to 40 IN.

(**IN**: current transformer rated current defined when the general settings are made).

Timer Hold Delay

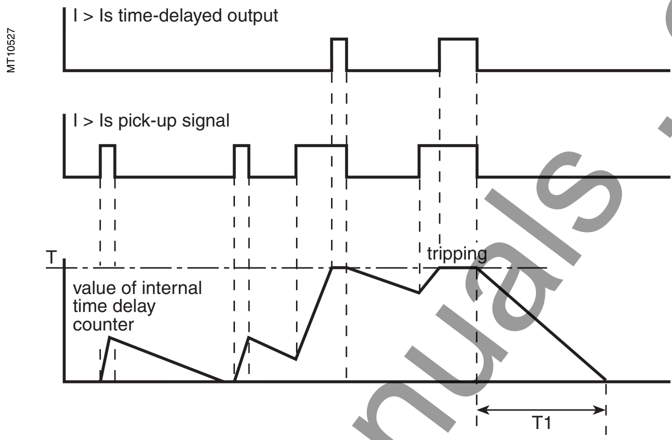
The function includes an adjustable timer hold delay T1:

- definite time (timer hold) for all the tripping curves.



Directional Phase Overcurrent
ANSI Code 67

■ IDMT for IEC, IEEE and IAC curves.



Characteristics

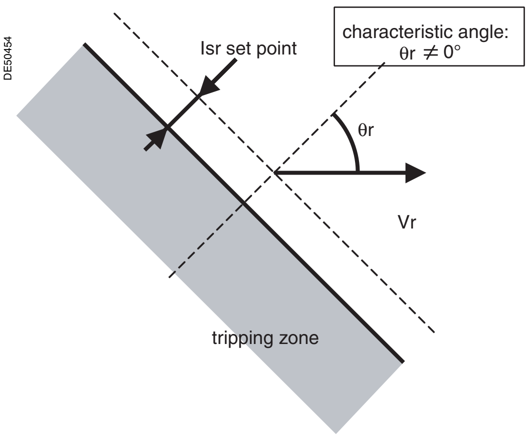
Characteristic Angle θ		
Setting		30°, 45°, 60°
Accuracy		±2°
Tripping Direction		
Setting		Bus / line
Tripping Logic		
Setting		One out of three / two out of three
Tripping Curve		
Setting		Definite time
		IDMT: chosen according to list page 72
Is Set Point		
Setting	Definite time	0.1 IN ≤ Is ≤ 24 IN expressed in Amps
	IDMT	0.1 IN ≤ Is ≤ 2.4 IN expressed in Amps
Resolution		1 A or 1 digit
Accuracy (1)		±5% or ±0.01 IN
Drop out/pick-up ratio		93.5% ±5% or > (1 - 0.015 IN/Is) x 100%
Time Delay T (Operation Time at 10 Is)		
Setting	Definite time	inst., 50 ms ≤ T ≤ 300 s
	IDMT	100 ms ≤ T ≤ 12.5 s or TMS (2)
Resolution		10 ms or 1 digit
Accuracy (1)	Definite time	t ≥ 100 ms ±2% or from –10 ms to +25 ms
	IDMT	Class 5 or from –10 ms to +25 ms
Timer Hold Delay T1		
Definite time (timer hold)		0 ; 0.05 to 300 s
IDMT (3)		0.5 to 20 s
Characteristic Times		
Operation time		pick-up < 75 ms to 2 Is (typically 65 ms)
		inst < 90 ms to 2 Is (confirmed instantaneous) (typically 75 ms)
Overshoot time		< 40 ms
Reset time		< 50 ms (for T1 = 0)

(1) IN reference conditions (IEC 60255-6).
(2) Setting ranges in TMS (Time Multiplier Setting) mode

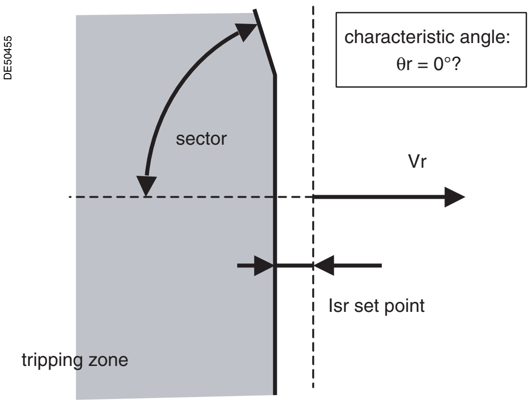
Inverse (SIT) and IEC SIT/A:	*0.04 to 4.20*
Very inverse (VIT) and IEC VIT/B:	*0.07 to 8.33*
Very inverse (LTI) and IEC LTI/B:	*0.01 to 0.93*
Ext inverse (EIT) and IEC EIT/C:	*0.13 to 15.47*
IEEE moderately inverse:	*0.42 to 51.86*
IEEE very inverse:	*0.73 to 90.57*
IEEE extremely inverse:	*1.24 to 154.32*
IAC inverse:	*0.34 to 42.08*
IAC very inverse:	*0.61 to 75.75*
IAC extremely inverse:	*1.08 to 134.4*

(3) Only for standardized tripping curves of the IEC, IEEE and IAC types.

Directional Ground Fault
ANSI Code 67N/67NC



Tripping characteristic of protection function 67N type 1 (θ0 ≠ 0°).



Protection function 67N type 1 (θ0 = 0°) tripping characteristics

Description

This function comprises two groups of settings, with two units for each group.
The mode of switching groups of settings may be determined by parameter setting:

- by input I13 (I13 = 0 group A, I13 = 1 group B)
- by remote control (TC3, TC4)
- operation with a single group (group A or group B).

To adapt to all cases of applications and all grounding systems, the protection function operates according to three different types of characteristics:

- **type 1**: the protection function uses Ir vector projection
- **type 2**: the protection function uses Ir vector magnitude
- **type 3**: the protection function uses Ir vector magnitude according to the Italian ENEL DK5600 specification.

Type 1 Operation

The function determines the projection of the residual current Ir on the characteristic line, the position of which is set by the setting of characteristic angle θr in relation to the residual voltage. The projection value is compared to the Isr set point. This projection method is suitable for radial feeders in resistive, effectively ungrounded, or compensated neutral systems that are designed to compensate for system capacitance by using a tuned inductor in the neutral (This is not a common practice in North America).

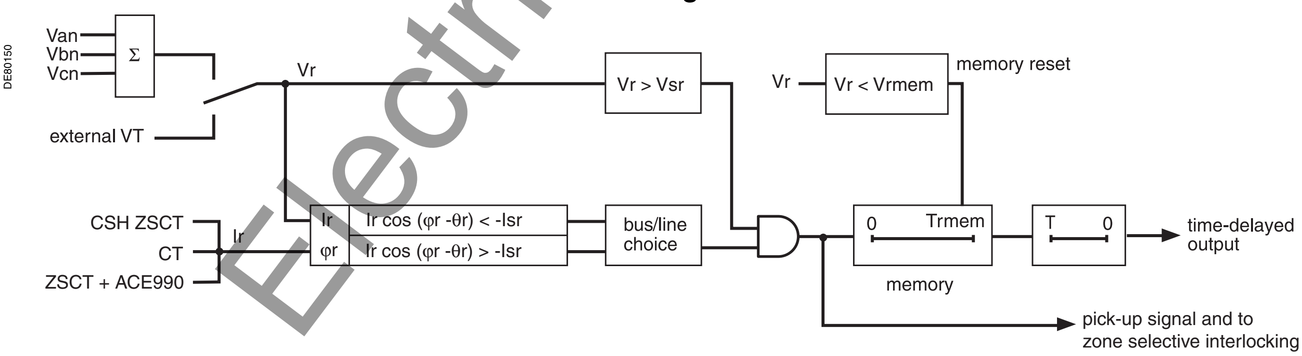
In compensated neutral systems, the ground fault function is characterized by its capacity to detect very brief, repetitive faults (recurrent faults). In the case of Petersen coils having no additional resistance, fault detection in steady state operating conditions is not possible due to the absence of active zero sequence current. The protection function uses the transient current at the beginning of the fault to ensure tripping.

The θr = 0° setting is suitable for compensated neutral systems. When this setting is selected, the parameter setting of the sector is used to reduce the protection tripping zone to ensure its stability on fault-free feeders.

The protection function operates with the residual current measured at the relay Ir input (operation with sum of three currents impossible). The protection function is blocked for residual voltages below the Vsr set point. The time delay is definite time.

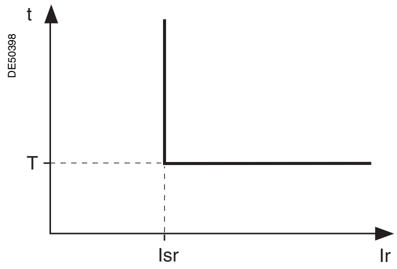
When a memory is added, recurrent faults can be detected. The memory is controlled by a time delay or by the residual voltage value. The tripping direction can be set at the bus end or line end.

Block Diagram



Definite Time Operation

Isr is the operation set point expressed in Amps, and **T** is the protection operation time delay.



Definite time protection principle.

Memory

The time delay Trmem controls the detection of recurrent faults. It also extends the transient pick-up information, thereby enabling the operation of the definite time delay, even with faults that rapidly extinguish (≈ 2 ms) and restrike periodically.

When a Petersen coil having no additional resistance is used, tripping is protected by fault detection during the transient fault appearance, with detection extended throughout the duration of the fault based on the $Vr \geq Vrmem$ criterion within the limit of Trmem. With this type of application, Trmem must be greater than T (definite time delay).

Standard Setting

The settings below are given for usual applications in the different grounding systems.
The shaded boxes represent default settings.

	Effectively Ungrounded	**Impedance Ground**	**Compensated Neutral**
Isr set point	Set according to coordination study	Set according to coordination study	Set according to coordination study
Characteristic angle θr	90°	0°	0°
Time delay T	Set according to coordination study	Set according to coordination study	Set according to coordination study
Direction	Line	Line	Line
Vsr setpoint	2% of V_{LL}s	2% of V_{LL}s	2% of V_{LL}s
Sector	N/A	86°	86°
Memory time T0mem	0	0	200 ms
Memory voltage Vrmem	0	0	0

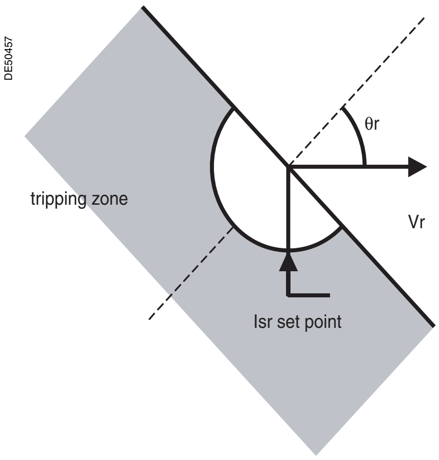
Directional Ground Fault
ANSI Code 67N/67NC

Characteristics - Type 1

Measurement Origin		
Setting range		Ir
Characteristic Angle θr		
Setting		-45°, 0°, 15°, 30°, 45°, 60°, 90°
Accuracy		±3°
Tripping Direction		
Setting		Bus / line
Isr Set Point		
Setting (1)		0.1 INr ≤ Isr ≤ 15 INr (1) expressed in Amps
	With CSH sensor	
	2 A rating	0.2 A ≤ Isr ≤ 30 A
	5 A rating	0.5 A ≤ Isr ≤ 75 A
	20 A rating	2 A ≤ Isr ≤ 300 A
	CT (1)	0.1 INr ≤ Isr ≤ 15 INr (min. 0.1 A)
	Zero sequence CT with ACE990	0.1 INr ≤ Isr ≤ 15 INr
Resolution		0.1 A or 1 digit
Accuracy at φr = 180° + θr		±5% or ±0.01 INr
Drop out/pick-up ratio		> 89% or > (1 - 0.015 INr/Isr) x 100%
Vsr Set Point		
Setting		2% to 80% $V_{LL}p$
Resolution		1%
Accuracy at φr = 180° + θr		±5%
Drop out/pick-up ratio		> 89%
Sector		
Setting		86°; 83°; 76°
Accuracy		±2°
Time Delay T		
Setting		inst., 0.05 s ≤ T ≤ 300 s
Resolution		10 ms or 1 digit
Accuracy		≤ 2% or -10 ms to +25 ms
Memory Time T0mem		
Setting		0,05 s ≤ T0mem ≤ 300 s
Resolution		10 ms or 1 digit
Memory Voltage Vrmem		
Setting		0; 2% $V_{LL}p$ ≤ Vrmem ≤ 80% $V_{LL}p$
Resolution		1%
Characteristic Times		
Operation time		Pick-up < 45 ms
		Confirmed instantaneous: ■ inst. < 50 ms at 2 Isr for Isr ≥ 0.3 INr (typically 35 ms) ■ inst. < 70 ms at 2 Isr for Isr < 0.3 INr (typically 50 ms)
Overshoot time		< 35 ms
Reset time		< 35 ms (at Trmem = 0)

(1) INr = sensor rating if the measurement is taken by a CSH120 or CSH200 zero sequence CT.
INr = IN of the CT if the measurement is taken by a 1 A or 5 A current transformer.
INr = IN of the CT /10 if the measurement is taken by a 1 A or 5 A current transformer with the sensitivity x 10 option.

Directional Ground Fault
ANSI Code 67N/67NC



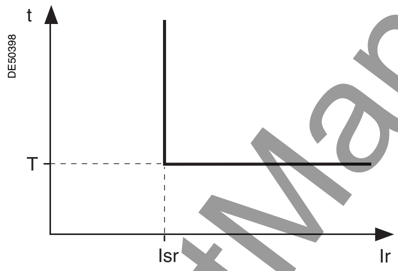
Tripping characteristic of protection 67N, type 2.

Type 2 Operation

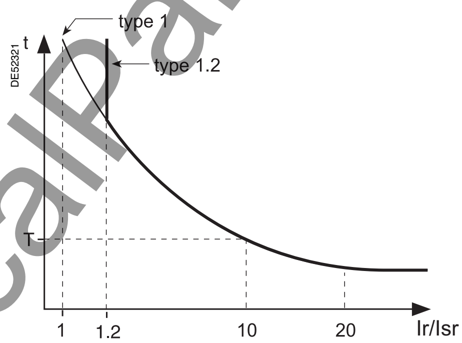
The protection function operates like a ground fault protection function with added direction criterion. It can be used in radial solidly grounded systems, and closed ring distribution networks that are solidly grounded. It has all the characteristics of a ground fault protection function (50N/51N) and can therefore be easily coordinated with that function.
The residual current is measured at the Sepam Ir input or calculated by using the sum of the phase currents in accordance with parameter settings.

The time delay may be definite time (DT) or IDMT according to the curves below. The protection function includes a timer hold delay T1 for the detection of restriking faults. The tripping direction may be set at the bus end or line end.

Definite Time Protection
Isr is the operation set point expressed in Amps, and **T** is the protection operation time delay.



IDMT Protection
The IDMT protection function operates in accordance with IEC 60255-3, BS 142, and IEEE C-37112 standards.



The **Is** setting is the vertical asymptote of the curve, and T is the operation time delay for 10 Isr.

The tripping time for Ir/Isr values of less than 1.2 depends on the type of curve chosen.

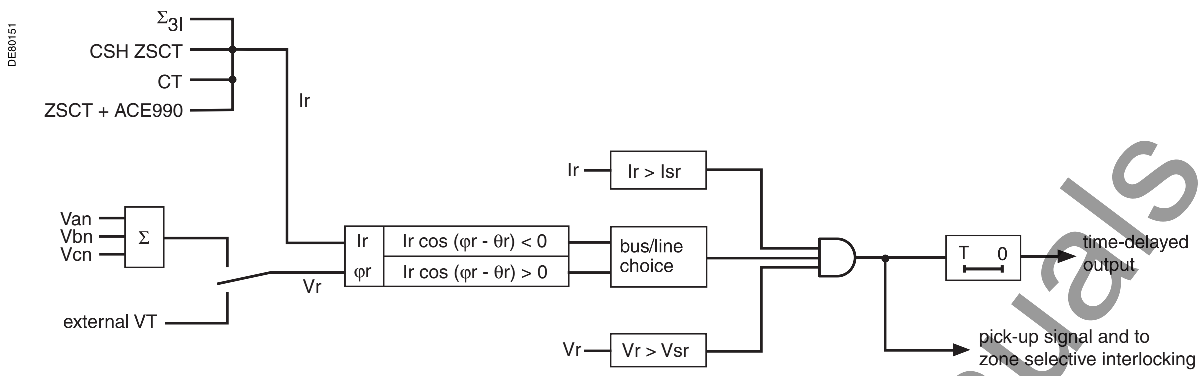
Name of Curve	Type
Standard inverse time (SIT)	1.2
Very inverse time (VIT or LTI)	1.2
Extremely inverse time (EIT)	1.2
Ultra inverse time (UIT)	1.2
RI curve	1
IEC temps inverse SIT / A	1
IEC very inverse time VIT or LTI / B	1
IEC extremely inverse time EIT / C	1
IEEE moderately inverse (IEC / D)	1
IEEE very inverse (IEC / E)	1
IEEE extremely inverse (IEC / F)	1
IAC inverse	1
IAC very inverse	1
IAC extremely inverse	1

The curve equations are given in the section titled "IDMT Protection Functions".

3

Directional Ground Fault
ANSI Code 67N/67NC

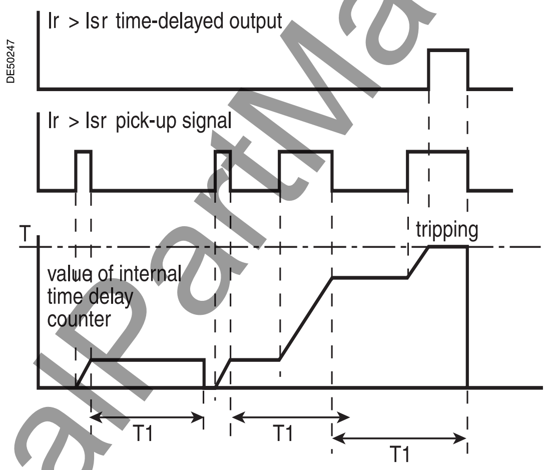
Block Diagram



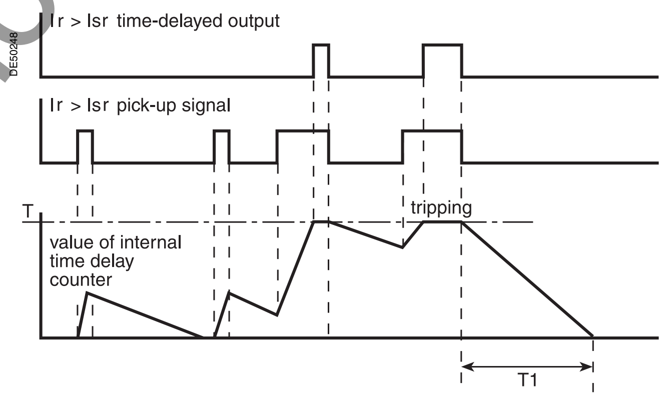
Timer Hold Delay

The function includes an adjustable timer hold delay T1:

- definite time (timer hold) for all the tripping curves.



- IDMT for IEC, IEEE and IAC curves.



Schneider Electric

Directional Ground Fault
ANSI Code 67N/67NC

Characteristics - Type 2

Measurement Origin		
Setting range		Ir
		IrΣ
Characteristic Angle θr		
Setting		–45°, 0°, 15°, 30°, 45°, 60°, 90°
Accuracy		±3°
Tripping Direction		
Setting		Bus / line
Isr Setting		
Definite time setting		0.1 INr ≤ Isr ≤ 15 INr [1] expressed in Amps
	Sum of CTs	0.1 INr ≤ Isr ≤ 15 INr
	With CSH sensor	
	2 A rating	0.2 A to 30 A
	5 A rating	0.5 A to 75 A
	20 A rating	2 A to 300 A
	CT	0.1 INr ≤ Isr ≤ 15 INr (min. 0.1 A)
	Zero sequence CT with ACE990	0.1 INr < Isr < 15 INr
Definite time setting		0.1 INr ≤ Isr ≤ INr [1] expessed in Amps
	Sum of CTs	0.1 INr ≤ Isr ≤ INr
	With CSH sensor	
	2 A rating	0.2 A to 2 A
	5 A rating	0.5 A to 5 A
	20 A rating	2 A to A
	CT	0.1 INr ≤ Isr ≤ 1 INr (min. 0.1 A)
	Zero sequence CT with ACE990	0.1 INr ≤ Isr ≤ INr
Resolution		0.1 A or 1 digit
Accuracy [2]		±5% or ±0.01 Inr
Drop out/pick-up ratio		93.5% ±5% (with CSH sensor, CT or zero sequence CT + ACE990)
		93.5% ±5% or > (1 - 0.015 INr/Isr) x 100% (sum of CTs)
Vsr Set Point		
Setting		2% V_{LL} to 80% V_{LL}
Resolution		1%
Accuracy		±5%
Drop out/pick-up ratio		93.5% ±5%
Time Delay T (Operation Time at 10 Isr)		
Setting	definite time	inst., 50 ms ≤ T ≤ 300 s
	IDMT	100 ms ≤ T ≤ 12.5 s or TMS [3]
Resolution		10 ms or 1 digit
Accuracy [2]	definite time	2% or -10 ms to +25 ms
	IDMT	Class 5 or from -10 to +25 ms
Timer Hold Delay T1		
Definite time (timer hold)		0; 50 ms ≤ T1 ≤ 300 s
IDMT [4]		0.5 s ≤ T1 ≤ 20 s
Characteristic Times		
Operation time		Pick-up < 40 ms at 2 Isr (typically 25 ms)
		Confirmed instantaneous: ■ inst. < 50 ms at 2 Isr for Isr ≥ 0.3 INr (typically 35 ms) ■ inst. < 70 ms at 2 Isr for Isr < 0.3 INr (typically 50 ms)
Overshoot time		< 35 ms
Reset time		< 40 ms (for T1 = 0)

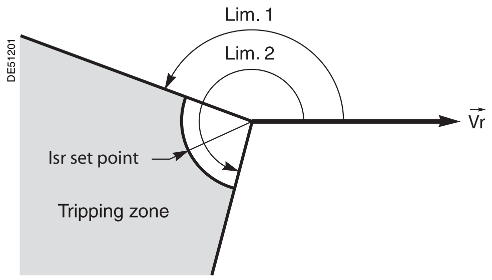
(1) INr = IN if the sum of the three phase currents is used for the measurement.
INr = sensor rating if the measurement is taken by a CSH120 or CSH200 zero sequence CT.
INr = IN of the CT if the measurement is taken by a 1 A or 5 A current transformer .
INr = IN of the CT /10 if the measurement is taken by a 1 A or 5 A current transformer with the sensitivity x 10 option.
(2) IN reference conditions (IEC 60255-6).
(3) Setting ranges in TMS (Time Multiplier Setting) mode

Inverse (SIT) and IEC SIT/A:	*0.04 to 4.20*
Very inverse (VIT) and IEC VIT/B:	*0.07 to 8.33*
Very inverse (LTI) and IEC LTI/B:	*0.01 to 0.93*
Ext inverse (EIT) and IEC EIT/C:	*0.13 to 15.47*
IEEE moderately inverse:	*0.42 to 51.86*
IEEE very inverse:	*0.73 to 90.57*
IEEE extremely inverse:	*1.24 to 154.32*
IAC inverse:	*0.34 to 42.08*
IAC very inverse:	*0.61 to 75.75*
IAC extremely inverse:	*1.08 to 134.4*

(4) Only for standardized tripping curves of the IEC, IEEE and IAC types.

3

Directional Ground Fault
ANSI Code 67N/67NC



Type 3 Operation

This protection function operates like a ground fault protection function with added angular direction criterion {*Lim.1*, *Lim.2*}. It is adapted for distribution networks in which the neutral grounding system varies according to the operating mode.

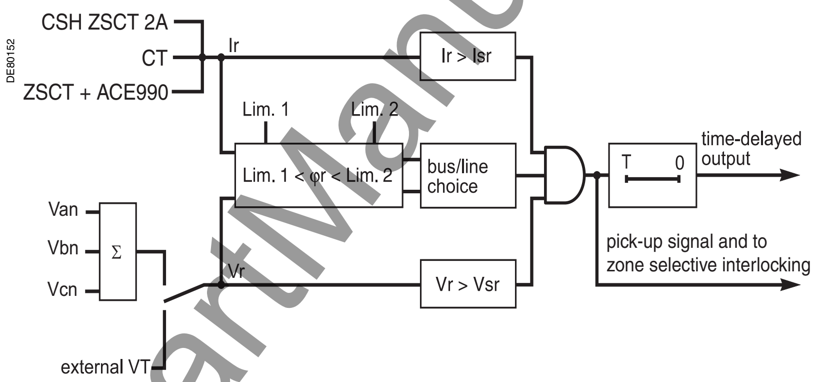
The tripping direction can be set at the bus end or line end.

The residual current is measured at the Sepam Ir input.

The time delay may be definite time (DT).

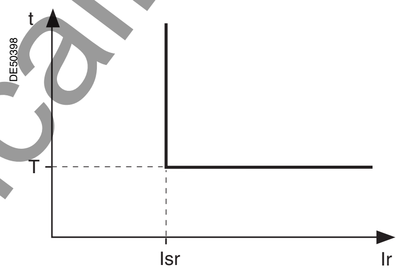
In choosing an **Isr** setting equal to zero, the protection is equivalent to the neutral voltage displacement protection (ANSI 59N).

Block Diagram



Definite Time Operation

Isr is the operation set point expressed in Amps, and **T** is the protection operation time delay



Definite time protection principle.

Schneider Electric

Directional Ground Fault
ANSI Code 67N/67NC

Characteristics - Type 3

Measurement Origin		
Setting range		Ir
Angle at Start of Tripping Zone *Lim.1*		
Setting		0° to 359°
Resolution		1°
Accuracy		±3°
Angle at End of Tripping Zone *Lim.2*		
Setting		0° to 359° (1)
Resolution		1°
Accuracy		±3°
Tripping Direction		
Setting		Bus / line
Isr Setting		
Setting (2)	With CSH zero sequence CT (2 A rating)	0.1 A to 30 A
	With 1 A CT	0.05 INr ≤ Isr ≤ 15 INr (min. 0.1 A)
	With zero sequence CT + ACE990 (range 1)	0.05 INr ≤ Isr ≤ 15 INr (min. 0.1 A) (3)
Resolution		0.1 A or 1 digit
Accuracy		±5%
Drop out/pick-up ratio		⩾ 90%
Vsr Set Point		
Setting	Calculated Vr (sum of 3 voltages)	2% V_{LL}p ≤ Vsr ≤ 80% V_{LL}p
	Measured Vr (external VT)	0.6% V_{LL}p ≤ Vsr ≤ 80% V_{LL}p
Resolution		0.1% for Vsr < 10% 1% for Vsr ≥ 10%
Accuracy		±5%
Drop out/pick-up ratio		⩾ 90%
Time Delay T		
Setting		Instantaneous, 50 ms ≤ T ≤ 300 s
Resolution		10 ms or 1 digit
Accuracy		⩽ 3% or ±20 ms at 2 Is0
Characteristics Times		
Operation time		Pick-up < 40 ms at 2 Isr
		Instantaneous < 50 ms at 2 Isr
Overshoot time		< 35 ms to 2 Isr
Reset time		< 50 ms to 2 Isr

(1) *The tripping zone Lim.2-Lim.1 must be greater than or equal to 10°.*
(2) *For Isr = 0, the protection is equivalent to the neutral voltage displacement protection (ANSI 59N).*
(3) *INr = k . n*
with n = number of zero sequence CT turns
and k = factor to be determined according to the wiring of the ACE990 (0.00578 ≤ k ≤ 0.04).

Standard Settings for Tripping Zone

The settings below are for usual applications in the different grounding systems.
The shaded boxes represent default settings.

	Effectively Grounded	Impedance Grounded	Solidly Grounded
Angle *Lim.1*	190°	100°	100°
Angle *Lim.2*	350°	280°	280°

3

Recloser
ANSI Code 79

Definition

Reclaim Time
The reclaim time delay is activated by a circuit breaker closing command given by the recloser. If no faults are detected before the end of the reclaim time delay, the initial fault is considered cleared. Otherwise a new reclosing cycle is initiated.

Safety Time until Recloser Ready
After the circuit breaker is manually closed, the recloser function is blocked during this time. If a fault occurs during this time, no reclosing shots are initiated and the circuit breaker remains permanently open.

Dead Time
The shot **"n"** dead time delay is activated by the circuit breaker tripping command given by the recloser in shot **n**.
The breaking device remains open throughout the time delay.

At the end of the cycle n dead time delay, the n+1 cycle begins, and the recloser commands the closing of the circuit breaker.

Operation

Initializating the Recloser
The recloser is ready to operate if all of the following conditions are met:
- "CB control" function activated and recloser in service
- circuit breaker closed
- safety time until 79 ready elapsed
- none of the recloser block conditions is true (see further on).

The "recloser ready" information can be viewed with the control matrix.

Recloser Shots
- **case of a cleared fault**: following a reclosing command, if the fault does not appear after the reclaim time has run out, the recloser reinitializes and a message appears on the display (see example 1).
- **case of a fault that is not cleared**: following instantaneous or time-delayed tripping by the protection unit, activation of the dead time associated with the first active cycle.

At the end of the dead time, a closing command is given, which activates the reclaim time. If the protection unit detects the fault before the end of the time delay, a tripping command is given and the following reclosing shot activates.
  - If the fault persists after all active shots have been run, a final trip command is given. A message appears on the display and closing is locked out until acknowledgment takes place, in accordance with the protection function parameter setting.
- **closing on a fault**. If the circuit breaker closes on a fault, or if the fault appears before the end of the safety time delay, the recloser is blocked.

Recloser Block Conditions
The recloser is blocked under the following conditions:
- voluntary open or close command
- recloser put out of service
- receipt of a block command from the logic input
- activation of the breaker failure function (50BF)
- appearance of a switchgear-related fault, such as trip circuit fault, control fault, SF6 pressure drop
- opening of the circuit breaker by a protection unit that does not run reclosing cycles (frequency protection) or by external tripping. In such cases, a final trip message appears.

Extension of the Dead Time
If, during a reclosing cycle, reclosing the circuit breaker is impossible because breaker recharging is not finished (following a drop in auxiliary voltage, recharging time is longer), the dead time can be extended to the time the circuit breaker is ready to carry out an "Open-Close-Open" cycle. The maximum time addded to the dead time is adjustable (Twait_max). If, at the end of the maximum waiting time, the circuit breaker is still not ready, the recloser is blocked (see example 4, 5).

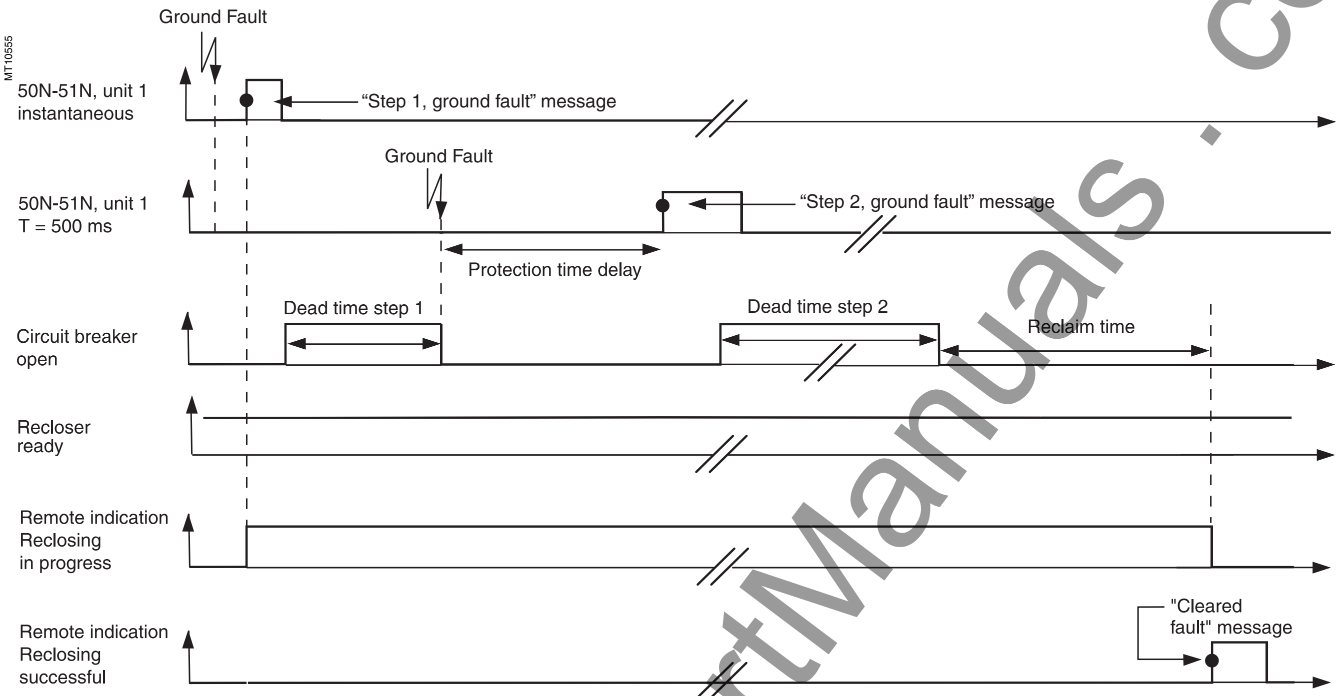
Characteristics

Reclosing Shots		Setting
Number of shots		1 to 4
Activation of shot 1 (1)	max I 1 to 4	inst. / delayed / no activation
	max Ir 1 to 4	inst. / delayed / no activation
	directional max I 1 to 2	inst. / delayed / no activation
	directional max Ir 1 to 2	inst. / delayed / no activation
	V_TRIPCB output (logic equation)	activation / no activation
Activation of shots 2, 3 and 4 (1)	max I 1 to 4	inst. / delayed / no activation
	max Ir 1 to 4	inst. / delayed / no activation
	directional max I 1 to 2	inst. / delayed / no activation
	directional max Ir 1 to 2	inst. / delayed / no activation
	V_TRIPCB output (logic equation)	activation / no activation
Time Delays		
Reclaim time		0.1 to 300 s
Dead time	shot 1	0.1 to 300 s
	shot 2	0.1 to 300 s
	shot 3	0.1 to 300 s
	shot 4	0.1 to 300 s
Safety time until 79 ready		0 to 60 s
Maximum additional dead time (Twait_max)		0.1 to 60 s
Accuracy	±2% or 25 ms	
Resolution	10 ms or 1 digit	

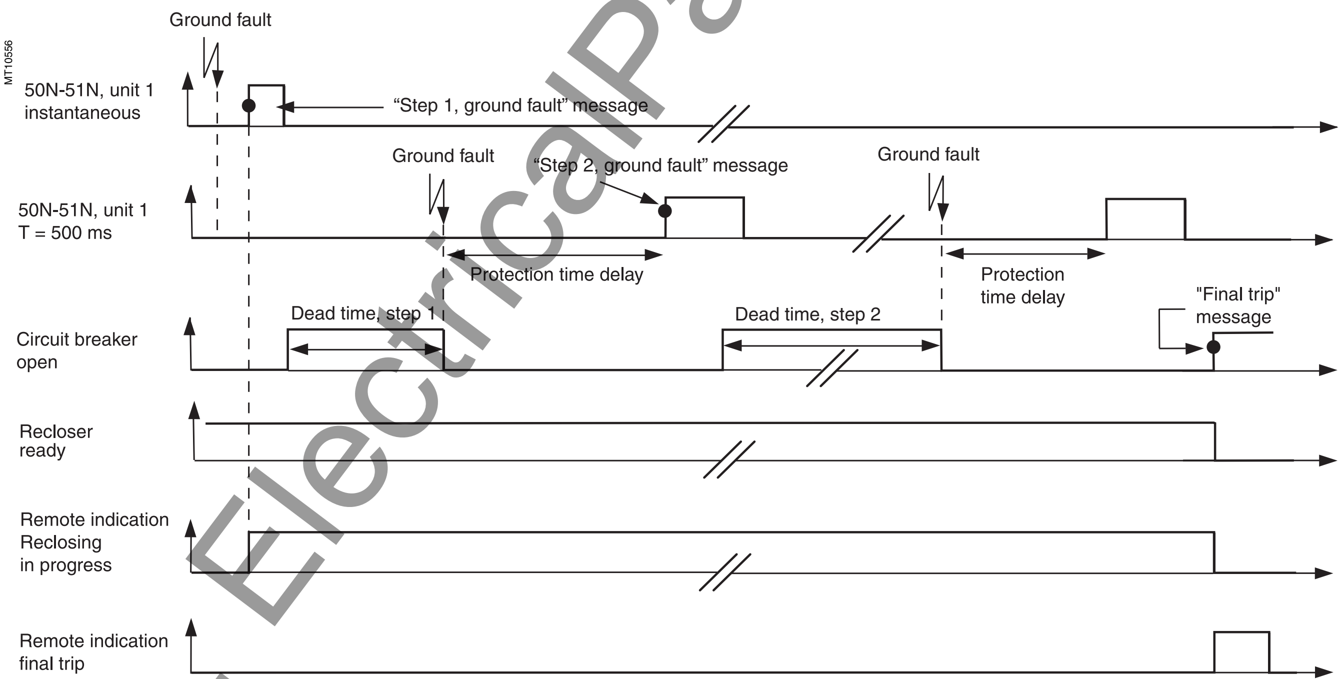
***(1)** If a protection function that does not activate reclosing shots leads to circuit breaker opening, the recloser is blocked.*

Recloser
ANSI Code 79

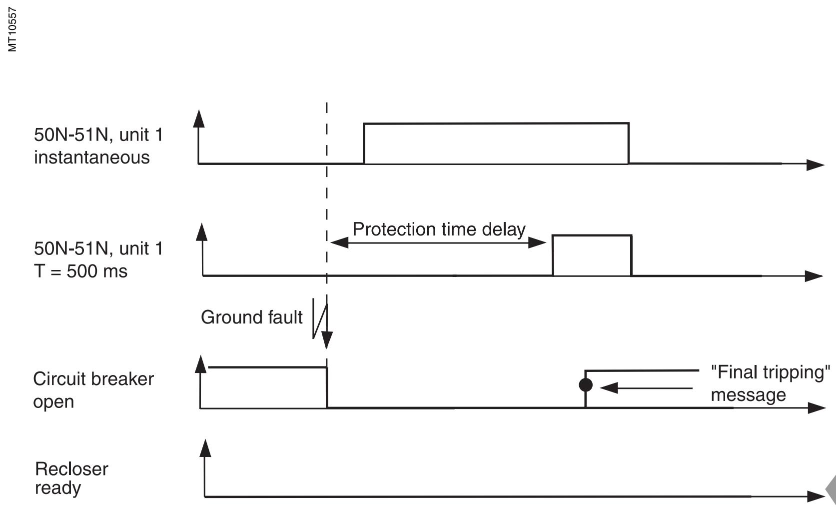
Example 1: Fault Cleared after the Second Shot



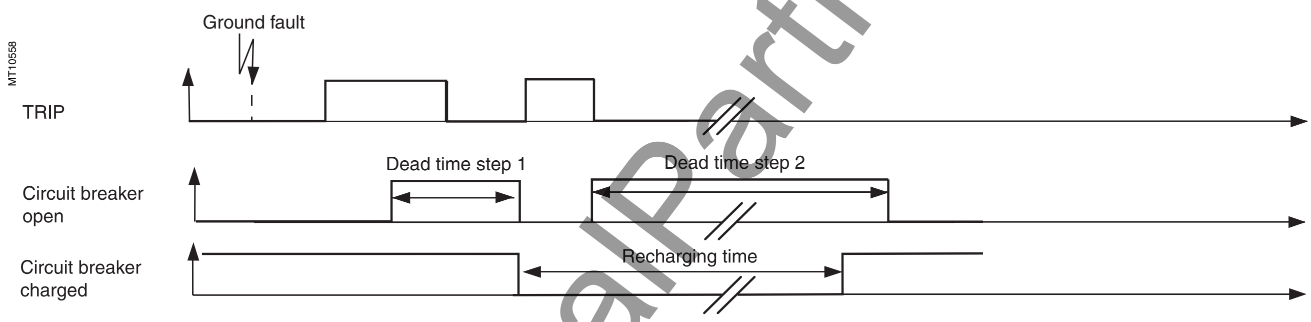
Example 2: Fault not Cleared



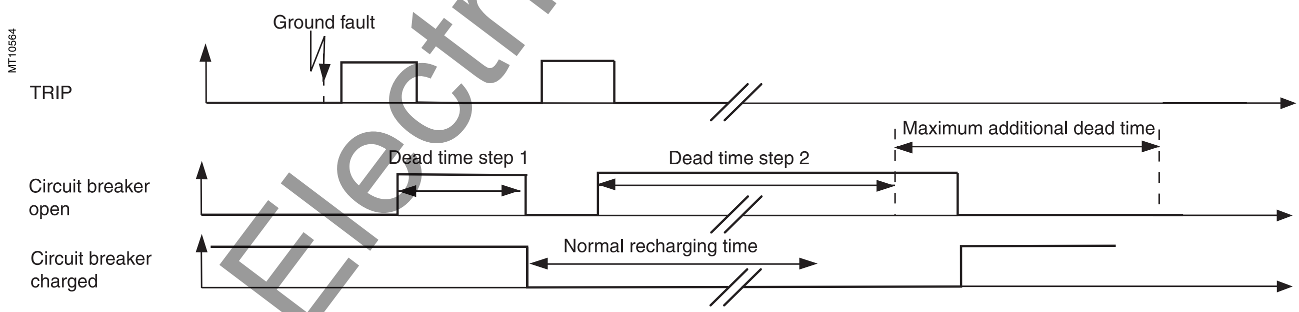
Example 3: Closing on a Fault



Example 4: No Extension of Dead Time

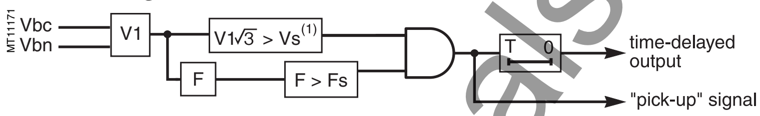


Example 5: Extension of Dead Time



Overfrequency
ANSI Code 81H

Operation
The protection function picks up when the positive sequence voltage frequency is above the Fs set point and the positive sequence voltage is above the Vs set point.
If a single VT is connected (Vab), the function picks up when the frequency is above the Fs set point and the Vab voltage is above the Vs set point.
It includes a definite time delay T.

Block Diagram


(1) Or Vab > Vs if only one VT.

Characteristics

Fs Set Point	
Setting	50 to 53 Hz or 60 to 63 Hz
Accuracy (1)	±0.02 Hz
Resolution	0.1 Hz
Pick up / drop out difference	0.25 Hz ±0.1 Hz
Vs Set point	
Setting	20% to 50% V_{LL}p
Accuracy (1)	±2%
Resolution	1%
Time Delay T	
Setting	100 ms to 300 s
Accuracy (1)	±2% or ±25 ms
Resolution	10 ms or 1 digit
Characteristic Times (1)	
Operation time	pick-up < 80 ms (typically 80 ms)
Overshoot time	< 40 ms
Reset time	< 50 ms

(1) IN reference conditions (IEC 60255-6).

3

Underfrequency
ANSI Code 81L

Operation

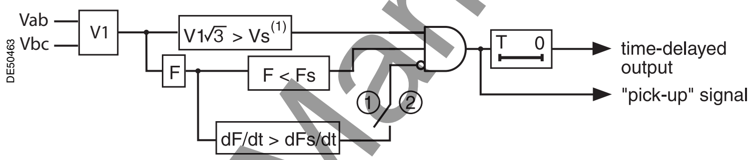
The function picks up when the positive sequence voltage frequency is below the Fs set point and if the negative sequence voltage is above the Vs set point.

If a single VT is connected (Vab), the function picks up when the frequency is below the Fs set point and the Vab voltage is above the Vs set point.
It includes a definite time delay T.

The protection function includes a restraint which may be configured according to the rate of change of frequency which blocks the protection in the event of a continuous decrease in frequency greater than the block set point.

This setting avoids the tripping of all the feeders when the bus is resupplied by remanent motor voltage following the loss of the main.

Block Diagram



setting: ① without restraint
② with restraint

***(1)** Or Vab > Vs if only one VT.*

Characteristics

Fs Set Point	
Setting	40 to 50 Hz or 50 to 60 Hz
Accuracy (1)	±0.02 Hz
Resolution	0.1 Hz
Pick-up / drop out difference	0.25 Hz ±0.1 Hz
Vs Set Point	
Setting	20% to 50% V_{LL}p
Accuracy (1)	2%
Resolution	1%
Restraint on Frequency Variation	
Setting	With / without
dFs/dt set point	1 Hz/s to 15 Hz/s
Accuracy (1)	1 Hz/s
Resolution	1 Hz/s
Time Delay T	
Setting	100 ms to 300 s
Accuracy (1)	±2% or ±25 ms
Resolution	10 ms or 1 digit
Characteristic Times (1)	
Operation time	pick-up < 80 ms
Overshoot time	< 40 ms
Reset time	< 50 ms

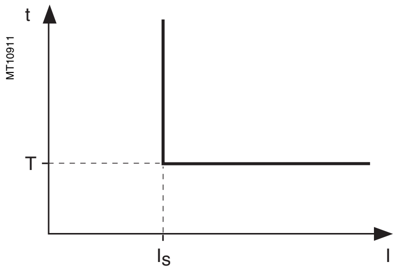
***(1)** In reference conditions (IEC 60255-6).*

General
Trip Curves

Presentation of tripping curve operation and settings for protection functions using:
- *definite time*
- *IDMT*
- *timer hold*

Definite Time Protection

The tripping time is constant. The time delay is started when the set point is overrun.



Definite time protection principle.

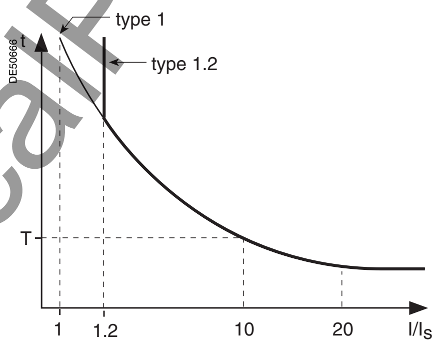
Inverse Definite Minimum Time (IDMT) protection

The operation time depends on the protected value (phase current, ground fault current, etc.) in accordance with standards IEC 60255-3, BS 142 and IEEE C-37112. Operation is represented by a characteristic curve, such as:
- t = f(I) curve for the **phase overcurrent** function
- t = f(Ir) curve for the **ground fault** function.

The rest of the document is based on t = f(I); the reasoning may be extended to other variables Ir, etc.

The curve is defined by:
- its type (standard inverse, very inverse, extremely inverse)
- current setting **Is,** which corresponds to the vertical asymptote of the curve
- time delay **T,** which corresponds to the operation time for I = 10 Is.

These three settings are made chronologically by type, Is current, time delay T. Changing the time delay T setting by x% changes all of the operation times in the curve by x%.



IDMT protection principle.

The tripping time for I/Is values less than 1.2 depends on the type of curve selected.

Name of Curve	Type
Standard inverse time (SIT)	1.2
Very inverse time (VIT or LTI)	1.2
Extremely inverse time (EIT)	1.2
Ultra inverse time (UIT)	1.2
RI curve	1
IEC inverse time SIT / A	1
IEC very inverse time VIT or LTI / B	1
IEC extremely inverse time EIT / C	1
IEEE moderately inverse (IEC / D)	1
IEEE very inverse (IEC / E)	1
IEEE extremely inverse (IEC / F)	1
IAC inverse	1
IAC very inverse	1
IAC extremely inverse	1

When the monitored value is more than 20 times the set point, the tripping time is limited to the value corresponding to 20 times the set point.

If the monitored value exceeds the measurement capacity of Sepam (40 In for the phase current channels, 20 INr for the residual current channels), the tripping time is limited to the value corresponding to the largest measurable value (40 IN or 20 INr).

Current IDMT Tripping Curves

Multiple IDMT tripping curves are offered to cover most applications:

- IEC curves (SIT, VIT/LTI, EIT)
- IEEE curves (MI, VI, EI)
- commonly used curves (UIT, RI, IAC).

IEC Curves

Equation

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

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:

$$t_d(I) = \frac{1}{0.339 - 0.236\left(\frac{I}{I_s}\right)^{-1}} \times \frac{T}{3.1706}$$

IEEE Curves

Equation

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

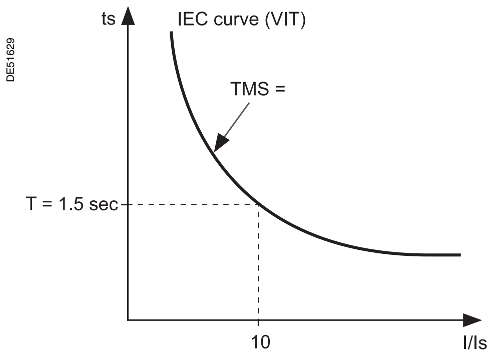
Curve Type	Coefficient Values			
	A	B	p	β
Moderately inverse	0.010	0.023	0.02	0.241
Very inverse	3.922	0.098	2	0.138
Extremely inverse	5.64	0.0243	2	0.081

IAC curves

Equation

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

$$t_d(I) = \left(A + \frac{B}{\left(\frac{I}{I_s} - C\right)} + \frac{D}{\left(\frac{I}{I_s} - C\right)^2} + \frac{E}{\left(\frac{I}{I_s} - C\right)^3}\right) \text{x} \frac{T}{\beta}$$



Example.

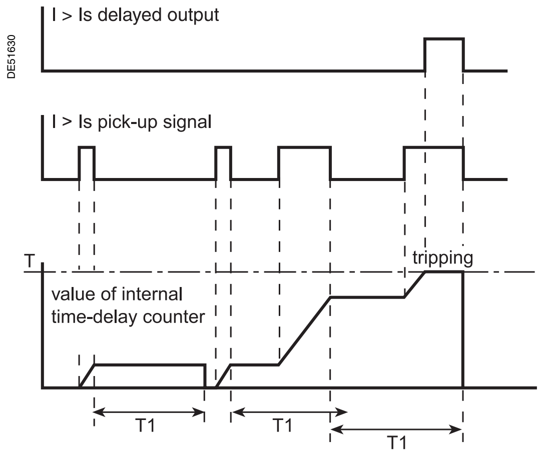
Setting IDMT Tripping Curves, Time Delay T, or TMS Factor

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/β in the equations on the left.

Example: $\mathbf{t(I)} = \dfrac{\mathbf{13.5}}{\dfrac{\mathbf{I}}{\mathbf{Is}} - \mathbf{1}} \times \mathbf{TMS}$ where $\mathbf{TMS} = \dfrac{\mathbf{T}}{\mathbf{1.5}}$.

The VIT type IEC curve is positioned so as to be the same with TMS = 1 or T = 1.5 s.



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 blocked if necessary.

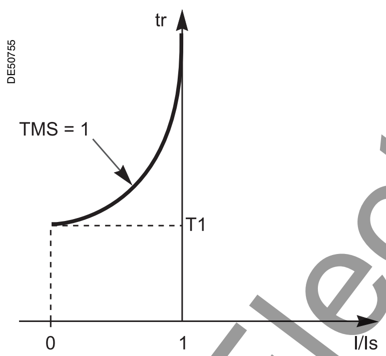
IDMT Timer Hold Curve Equation

Equation: $\mathbf{t_r(I)} = \dfrac{\mathbf{T1}}{\mathbf{1} - \left(\dfrac{\mathbf{I}}{\mathbf{Is}}\right)^2} \times \dfrac{\mathbf{T}}{\beta}$ where $\dfrac{\mathbf{T}}{\beta} = \mathbf{TMS}$.

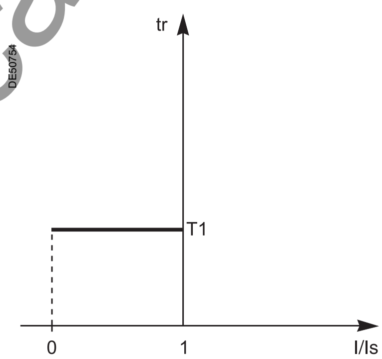
where:

T1 = timer hold setting (timer hold for I reset = 0 and TMS = 1)
T = tripping time delay setting (at 10 Is)

b = basic tripping curve value at $\dfrac{\mathbf{k}}{\mathbf{10}^{\alpha} - \mathbf{1}}$.



Timer hold dependent on current I.



Constant timer hold.

3

Implementing IDMT Curves: Examples of Problems to be Solved.

Problem 1.
Given the type of IDMT, determine the Is current and time delay T settings.

Theoretically, the Is current setting corresponds to the maximum continuous current. It is usually the rated current of the protected equipment (cable, transformer).

The time delay T corresponds to operation at 10 Is on the curve. This setting is determined by evaluating the constraints involved in discrimination with the upstream and downstream protection devices.

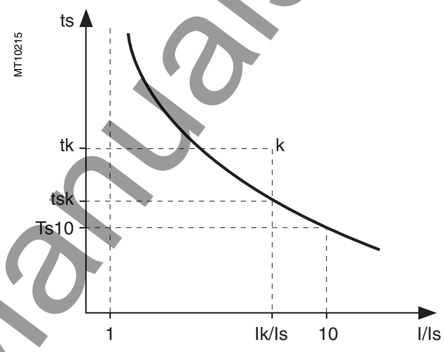
The discrimination constraint leads to the definition of point A on the operation curve (IA, tA), that is, the point corresponding to the maximum fault current for the downstream protection device.

Problem 2.
Given the type of IDMT, the Is current setting and a point k (Ik, tk) on the operation curve, determine the time delay setting T.

On the standard curve of the same type, read the operation time tsk that corresponds to the relative current **Ik/Is** and the operation time Ts10 that corresponds to the relative current **I/Is = 10.**

The time delay setting to be used so that the operation curve passes through the point k (Ik, tk) is:

$$T = Ts10 \times \frac{tk}{tsk}$$



Another practical method:
The table below gives the values of **K = ts/ts10** as a function of **I/Is.**

In the column that corresponds to the type of time delay, read the value **K = tsk/Ts10** on the line for **Ik/Is.**

The time delay setting to be used so that the operation curve passes through point k (Ik, tk) is: **T = tk/k.**

Example
Data:
- type of time delay: standard inverse time (**SIT**)
- set point: Is
- a point k on the operation curve: k (3.5 Is; 4 s)

Question: What is the time delay T setting (operation time at 10 Is)?
Reading the table: **SIT** column, line **I/Is** = **3.5** therefore **K = 1.858**

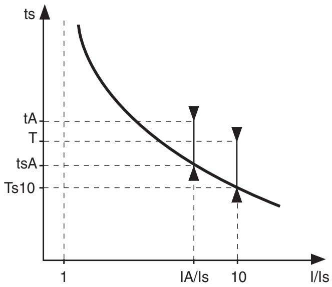
Answer: The time delay setting is **T = 4/1.858 = 2.15 s**

General
Trip Curves

Problem 3.
Given the Is current and time delay T settings for a type of time delay (standard inverse, very inverse, extremely inverse), find the operation time for a current value IA.

On the standard curve of the same type, read the operation time tsA that corresponds to the relative current IA/Is and the operation time Ts10 that corresponds to the relative current **I/Is = 10.**

The operation time tA for the current IA with the Is and T settings is **tA = tsA x T/Ts10.**



Another Practical Method:
The table below gives the values of **K = ts/Ts10** as a function of **I/Is.**
In the column corresponding to the type of time delay, read the value **K = tsA/Ts10** on the line for **IA/Is,** the operation time tA for the current IA with the Is and T settings is **tA = K . T.**

Example
Data:
- type of time delay: very inverse time (**VIT**)
- set point: Is
- time delay T = 0.8 s.

Question: What is the operation time for the current IA = 6 Is?
Reading the table: **VIT** column**,** line I/Is = 6, therefore k = 1.8

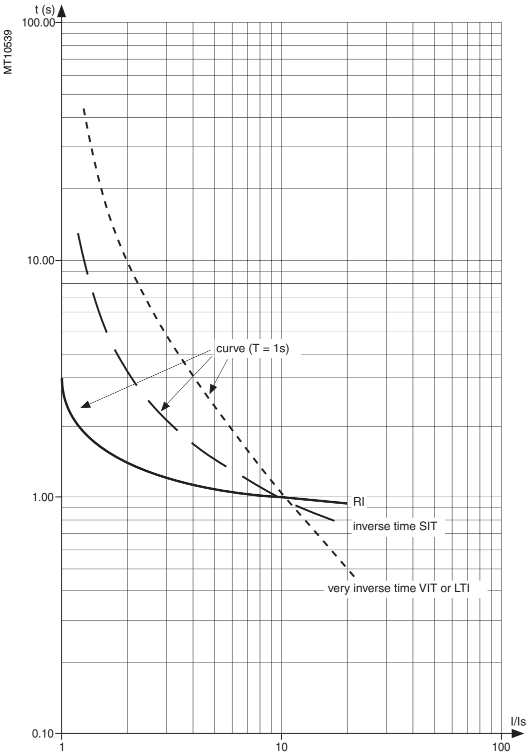
Answer: The operation time for the current IA is t = 1.80 x 0.8 = 1.44 s.

Table of K values

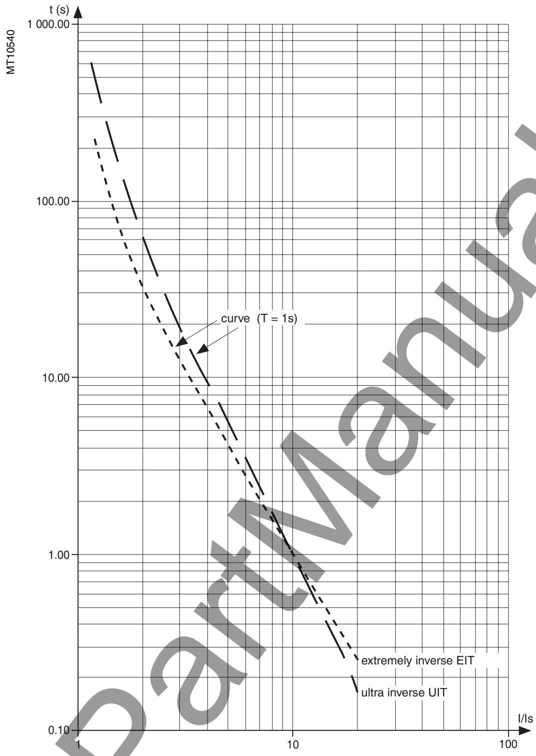
I/Is	SIT and IEC/A	VIT, LTI and IEC/B	EIT and IEC/C	UIT	RI	IEEE MI (IEC/D)	IEEE VI (IEC/E)	IEEE EI (IEC/F)	IAC I	IAC VI	IAC EI
1.0	—	—	—	—	3.062	—	—	—	62.005	62.272	200.226
1.1	24.700 (1)	90.000 (1)	471.429 (1)	—	2.534	22.461	136.228	330.606	19.033	45.678	122.172
1.2	12.901	45.000	225.000	545.905	2.216	11.777	65.390	157.946	9.413	34.628	82.899
1.5	5.788	18.000	79.200	179.548	1.736	5.336	23.479	55.791	3.891	17.539	36.687
2.0	3.376	9.000	33.000	67.691	1.427	3.152	10.199	23.421	2.524	7.932	16.178
2.5	2.548	6.000	18.857	35.490	1.290	2.402	6.133	13.512	2.056	4.676	9.566
3.0	2.121	4.500	12.375	21.608	1.212	2.016	4.270	8.970	1.792	3.249	6.541
3.5	1.858	3.600	8.800	14.382	1.161	1.777	3.242	6.465	1.617	2.509	4.872
4.0	1.676	3.000	6.600	10.169	1.126	1.613	2.610	4.924	1.491	2.076	3.839
4.5	1.543	2.571	5.143	7.513	1.101	1.492	2.191	3.903	1.396	1.800	3.146
5.0	1.441	2.250	4.125	5.742	1.081	1.399	1.898	3.190	1.321	1.610	2.653
5.5	1.359	2.000	3.385	4.507	1.065	1.325	1.686	2.671	1.261	1.473	2.288
6.0	1.292	1.800	2.829	3.616	1.053	1.264	1.526	2.281	1.211	1.370	2.007
6.5	1.236	1.636	2.400	2.954	1.042	1.213	1.402	1.981	1.170	1.289	1.786
7.0	1.188	1.500	2.063	2.450	1.033	1.170	1.305	1.744	1.135	1.224	1.607
7.5	1.146	1.385	1.792	2.060	1.026	1.132	1.228	1.555	1.105	1.171	1.460
8.0	1.110	1.286	1.571	1.751	1.019	1.099	1.164	1.400	1.078	1.126	1.337
8.5	1.078	1.200	1.390	1.504	1.013	1.070	1.112	1.273	1.055	1.087	1.233
9.0	1.049	1.125	1.238	1.303	1.008	1.044	1.068	1.166	1.035	1.054	1.144
9.5	1.023	1.059	1.109	1.137	1.004	1.021	1.031	1.077	1.016	1.026	1.067
10.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10.5	0.979	0.947	0.906	0.885	0.996	0.981	0.973	0.934	0.985	0.977	0.941
11.0	0.959	0.900	0.825	0.787	0.993	0.963	0.950	0.877	0.972	0.957	0.888
11.5	0.941	0.857	0.754	0.704	0.990	0.947	0.929	0.828	0.960	0.939	0.841
12.0	0.925	0.818	0.692	0.633	0.988	0.932	0.912	0.784	0.949	0.922	0.799
12.5	0.910	0.783	0.638	0.572	0.985	0.918	0.896	0.746	0.938	0.907	0.761
13.0	0.895	0.750	0.589	0.518	0.983	0.905	0.882	0.712	0.929	0.893	0.727
13.5	0.882	0.720	0.546	0.471	0.981	0.893	0.870	0.682	0.920	0.880	0.695
14.0	0.870	0.692	0.508	0.430	0.979	0.882	0.858	0.655	0.912	0.868	0.667
14.5	0.858	0.667	0.473	0.394	0.977	0.871	0.849	0.631	0.905	0.857	0.641
15.0	0.847	0.643	0.442	0.362	0.976	0.861	0.840	0.609	0.898	0.846	0.616
15.5	0.836	0.621	0.414	0.334	0.974	0.852	0.831	0.589	0.891	0.837	0.594
16.0	0.827	0.600	0.388	0.308	0.973	0.843	0.824	0.571	0.885	0.828	0.573
16.5	0.817	0.581	0.365	0.285	0.971	0.834	0.817	0.555	0.879	0.819	0.554
17.0	0.808	0.563	0.344	0.265	0.970	0.826	0.811	0.540	0.874	0.811	0.536
17.5	0.800	0.545	0.324	0.246	0.969	0.819	0.806	0.527	0.869	0.804	0.519
18.0	0.792	0.529	0.307	0.229	0.968	0.812	0.801	0.514	0.864	0.797	0.504
18.5	0.784	0.514	0.290	0.214	0.967	0.805	0.796	0.503	0.860	0.790	0.489
19.0	0.777	0.500	0.275	0.200	0.966	0.798	0.792	0.492	0.855	0.784	0.475
19.5	0.770	0.486	0.261	0.188	0.965	0.792	0.788	0.482	0.851	0.778	0.463
20.0	0.763	0.474	0.248	0.176	0.964	0.786	0.784	0.473	0.848	0.772	0.450

***(1)** Values only suitable for IEC A, B and C curves.*

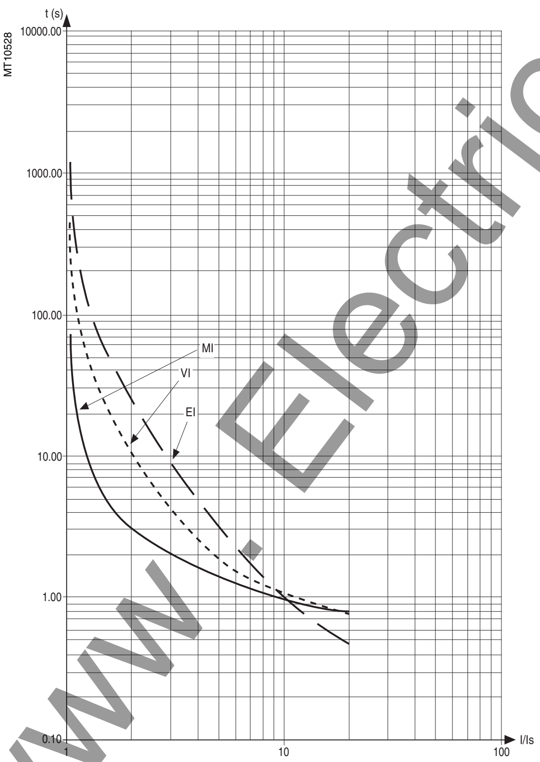
Standard Inverse Time (SIT) Curve
Very Inverse Time (VIT or LTI) Curve
RI Curve



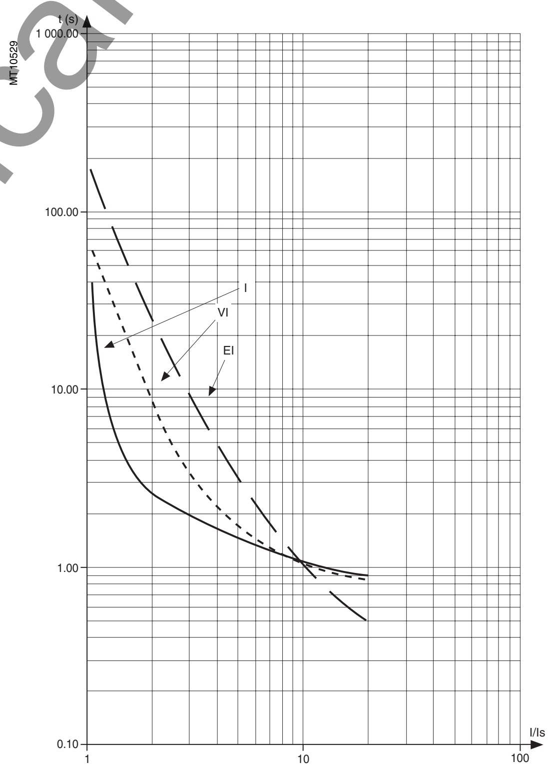
Extremely Inverse Time (EIT) Curve
Ultra Inverse Time (UIT) Curve



IEEE Curves



IAC Curves



Contents

Overview

Sepam™ performs control and monitoring functions required for electrical network operation. The main control and monitoring functions are predefined and fit the applications most frequently used. They are ready to use, and are implemented by simple parameter setting after the necessary logic inputs / outputs have been 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 predefined control and monitoring functions
- creation of user messages for local display
- customization of the control matrix by changing the assignment of output relays, LEDs and display messages

Operating Principle

Processing each control and monitoring function is broken down into three phases:

- input data acquisition:
  - results of protection function processing
  - external logic data, connected to the logic inputs of an optional MES120 input / output module
  - remote control commands (TC) received via the communication link
- control and monitoring function logic processing
- utilizating the processing results:
  - activating output relays to trigger an actuator
  - sending information to the facility manager:
    - by message and/or LED on the advanced UMI and SFT2841 software
    - by remote indication (TS) via the communication link.

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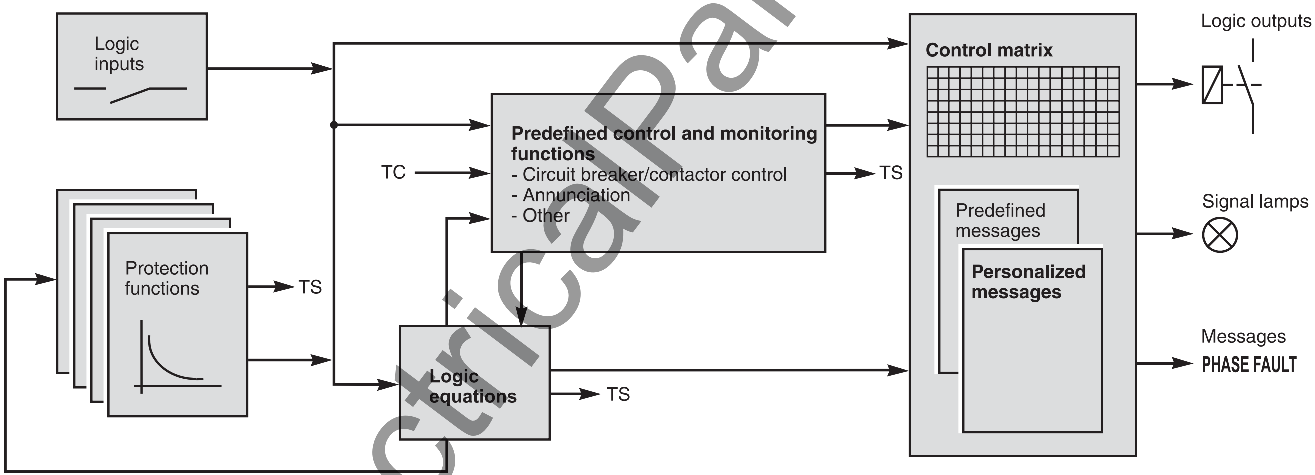


Logic Inputs and Outputs

The number of Sepam™ inputs / outputs is adapted to fit the control and monitoring functions used.

The four outputs included in the Sepam™ Series 40 base unit may be extended by adding one MES114 module with 10 logic inputs and 4 output relays.

After selecting the MES114 type required by an application, the logic inputs must be assigned to functions. The functions to which inputs are assigned are chosen from a list of available functions that covers the whole range of possible uses. The functions used can be adapted to meet needs within the limits of the logic inputs available. The inputs may also be inverted for undervoltage type operation.

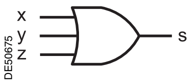
A default input / output assignment is proposed for the most frequent uses.

Definition of Symbols

This page gives the meaning of symbols used in the block diagrams that illustrate the different control and monitoring functions in this chapter.

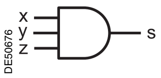
Logic functions

- "OR"



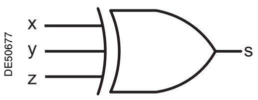
Equation: S = X + Y + Z.

- "AND"



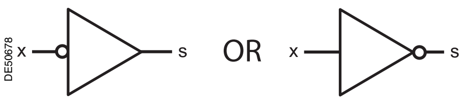
Equation: S = X x Y x Z.

- exclusive OR "XOR"



S = 1 if one and only one input is set to 1
(S = 1 if X + Y + Z = 1).

- Complement
  These functions may use the complement of one or more input values.

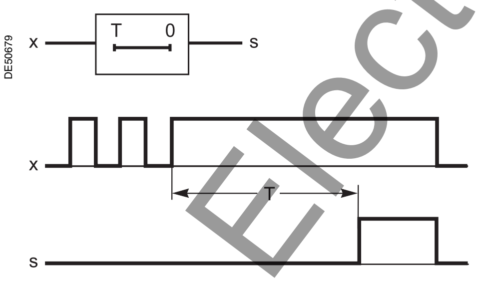


Equation: S = $\overline{X}$ (S = 1 if X = 0).

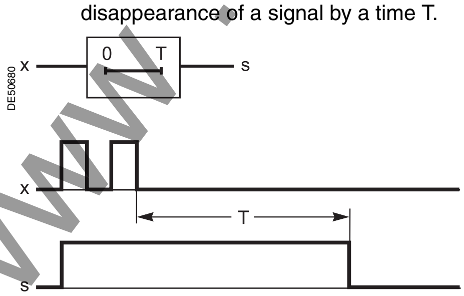
Delay Timers

Two types of delay timers:

- "on" delay timer: used to delay the appearance of a signal by a time T

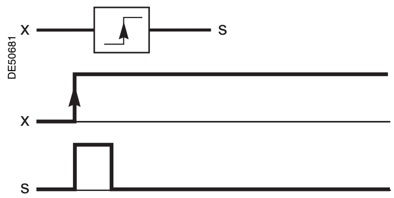


- "off" delay timer: used to delay the disappearance of a signal by a time T.

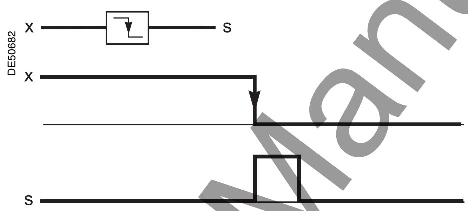


Pulse Mode Operation

- "on" pulse: used to create a short-duration pulse (1 cycle) each time a signal appears



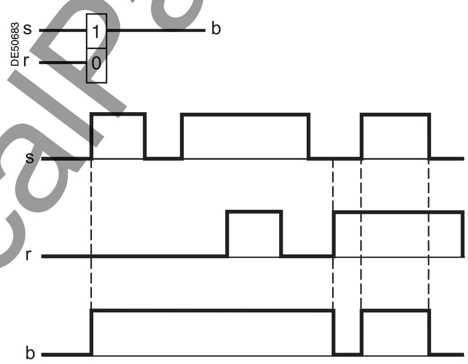
- "off" pulse: used to create a short-duration pulse (1 cycle) each time a signal disappears.



Note: *the disappearance of a signal may be caused by an auxiliary power outage.*

Bistable Functions

Bistable functions may be used to store values.



Equation: B = S + $\overline{R}$ x B.

Logic Input/Output Assignment

Inputs and outputs can be assigned to predefined control and monitoring functions by using the SFT2841 software according to the uses listed in the table below.

Regardless of assignment status, all logic inputs can be used for the SFT2841 customization functions according to specific application needs:

- in the control matrix, to link inputs to output relays, LED indications or display messages
- in the logic equation editor, as logic equation variables

The control logic of each input can be inverted for undervoltage type operation.

Functions	S40, S41	S42	T40, T42	M41	G40	Assignment
Logic Inputs						
Open position	■	■	■	■	■	I11
Closed position	■	■	■	■	■	I12
Zone selective interlocking, receive blocking input 1	■	■	■		■	Free
Zone selective interlocking, receive blocking input 2		■				Free
Switching of groups of settings A/B	■	■	■	■	■	I13
External reset	■	■	■	■	■	Free
External tripping a	■	■	■	■	■	Free
External tripping b	■	■	■	■	■	Free
External tripping c	■	■	■	■	■	Free
Buchholz/gas tripping			■			Free
Thermostat tripping			■			Free
Pressure tripping			■			Free
Thermistor tripping			■	■	■	Free
Buchholz/gas alarm			■			Free
Thermostat alarm			■			Free
Pressure alarm			■			Free
Thermistor alarm			■	■	■	Free
End of charging position	■	■	■	■	■	Free
Block remote control	■	■	■	■	■	Free
SF6	■	■	■	■	■	Free
Block recloser	■	■				Free
External synchronization	■	■	■	■	■	I21
Block thermal overload			■	■	■	Free
Switching of thermal settings			■	■	■	Free
Motor re-acceleration				■		Free
Rotor rotation detection				■		Free
Block undercurrent				■		Free
Block closing	■	■	■	■	■	Free
Open command	■	■	■	■	■	Free
Close command	■	■	■	■	■	Free
Phase voltage transformer fuse melting	■	■	■	■	■	Free
Residual voltage transformer fuse melting	■	■	■	■	■	Free
External positive active energy counter	■	■	■	■	■	Free
External negative active energy counter	■	■	■	■	■	Free
External positive reactive energy counter	■	■	■	■	■	Free
External negative reactive energy counter	■	■	■	■	■	Free
Logic Outputs						
Tripping	■	■	■	■	■	O1
Block close	■	■	■	■	■	O2
Watchdog	■	■	■	■	■	O4
Close command	■	■	■	■	■	O11

Note: *All logic inputs are available through a communication link and are accessible in the SFT2841 matrix for other non predefined applications.*

Standard Logic Input Assignment

The table below lists the logic input assignment obtained by choosing the "Standard assignment" button in the SFT2841 software.

Functions	S40, S41	S42	T40, T42	M41	G40	Assignment
Logic inputs						
Open position	■	■	■	■	■	I11
Closed position	■	■	■	■	■	I12
Zone selective interlocking, blocking reception 1	■	■	■		■	I13
Zone selective interlocking, blocking reception 2		■				I21
Switching of groups of settings A/B				■		I13
External reset	■	■	■	■	■	I14
External tripping a	■			■	■	I21
External tripping b	■	■		■	■	I22
External tripping c	■	■		■	■	I23
Buchholz/gas tripping			■			I21
Thermostat tripping			■			I22
Buchholz/gas alarm			■			I23
Thermostat alarm			■			I24
Block remote control	■	■	■	■	■	I25
SF6	■	■	■	■	■	I26

Description

Sepam™ is used to control breaking devices equipped with different types of closing and tripping contacts:

- circuit breakers with NO or NC trip contacts (parameter setting of O1 in the front of the advanced UMI or using SFT2841)
- latching contactors with NO trip contacts

Integrated Circuit Breaker / Contactor Control

This function controls the breaking device. It is coordinated with the recloser and zone selective interlocking functions and includes the anti-pumping function.

It performs the following operations according to the parameter setting:

- trip output O1 by:
  - protection unit (units configured to trip the circuit breaker)
  - zone selective interlocking
  - remote control via the communication link
  - external protection
  - open command by logic input
- close output O11 by:
  - recloser
  - remote control via the communication link (remote control may be blocked by the "block remote control" logic input)
  - closing control by logic input
- Block output O2 closing by:
  - trip circuit fault (TCS)
  - SF6 fault
  - block command by logic input.

Circuit Breaker / Contactor Control with Lockout Function (ANSI 86)

The ANSI 86 function traditionally performed by lockout relays may be carried out by Sepam™ using the predefined Circuit breaker / contactor control function, with latching of all tripping conditions (protection function outputs and logic inputs).

With this function, Sepam™ performs the following:

- grouping of all tripping conditions and breaking device control
- latching of the trip command with blocking a close until the cause of tripping disappears and is acknowledged by the user (see "Latching / acknowledgment")
- indication of the cause of tripping:
  - locally by signal lamps ("Trip" and others) and by messages on the display
  - remotely by remote indications.

Circuit Breaker/Contactor Control
ANSI Code 94/69

Block Diagram

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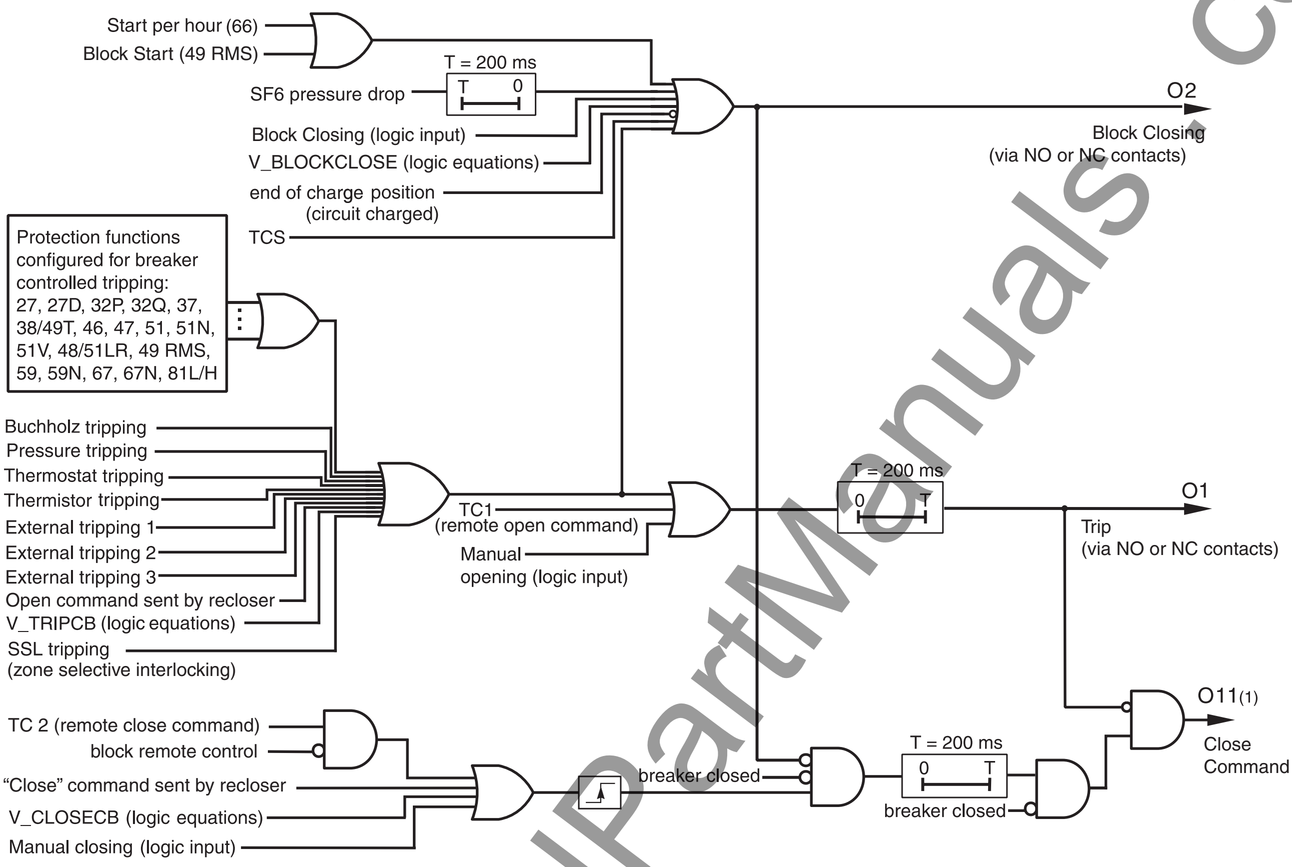
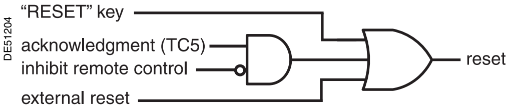


***(1)** The close command is only available when the MES114 option is included*

4

Circuit Breaker/Contactor Control
ANSI Code 94/69

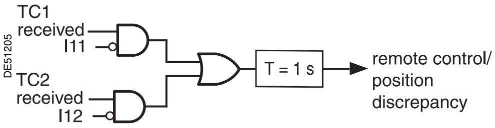


Latching / Acknowledgement
The tripping outputs of all protection functions and logic inputs can be latched individually.

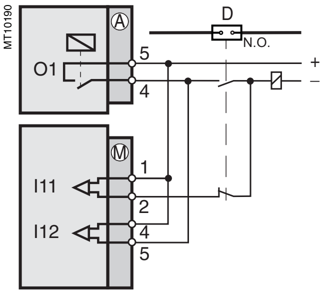
Logic outputs may not be latched. The logic outputs set up in pulse mode maintain pulse-type operation, even when linked to latched data.

Latched data are saved in the event of a power outage. All latched data may be acknowledged locally on the UMI, or remotely by means of a logic input or via the communication link. The remote indication TS104 remains present after latching operations until acknowledgment has taken place.

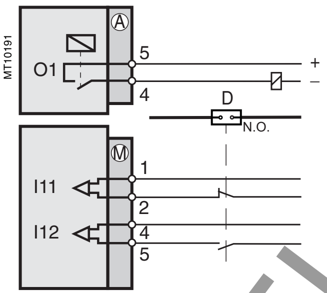
The "Latching / acknowledgment" function associated with the "Circuit breaker / contactor control" function can also perform the ANSI 86 "Lockout relay" function.



TC / Circuit Breaker Position Discrepancy
This function detects a discrepancy between the last remote control command received and the actual position of the circuit breaker.
The information is accessible via remote indication TS105.



Wiring for shunt trip unit



Wiring for undervoltage trip unit

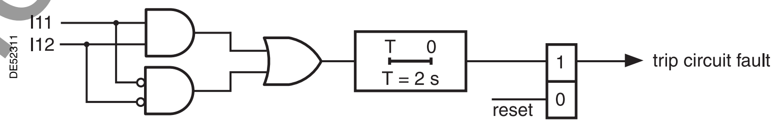
Trip Circuit Supervision and Open / Closed Matching
Description
This supervision is designed for trip circuits: With normally open trip contacts the function detects:
- circuit continuity
- loss of supply
- mismatching position contacts.

The function blocks breaking device closing.

With Normally Closed (NC) trip circuit, the function detects position contacts mismatching. Trip circuit supervision is unnecessary in this case.

The information is accessible in the matrix and via the remote indication TS106.

Block Diagram (1)

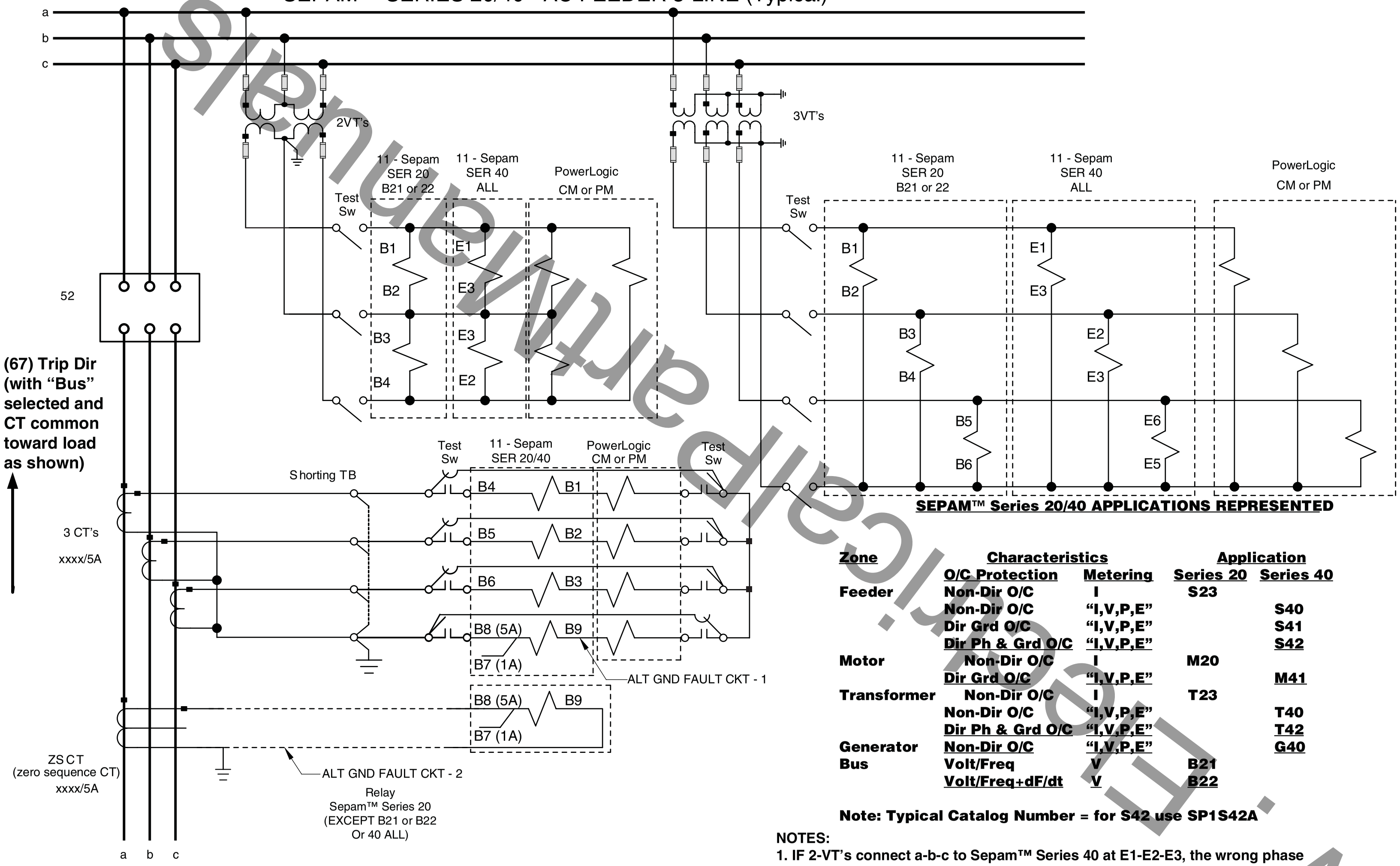


***(1)** With MES option.*
The function is activated if inputs I11 and I12 are set respectively as circuit breaker "open position" and circuit breaker "closed position".

Open and Close Command Supervision
Following a circuit breaker open or close command, a two-second time delay occurs. The system then determines whether the circuit breaker has actually changed status. If the circuit breaker status does not match the last command sent, a "Control fault" message and remote indication TS108 are generated.

Schneider Electric

SEPAM™ SERIES 20/40 - AC FEEDER 3-LINE (Typical)



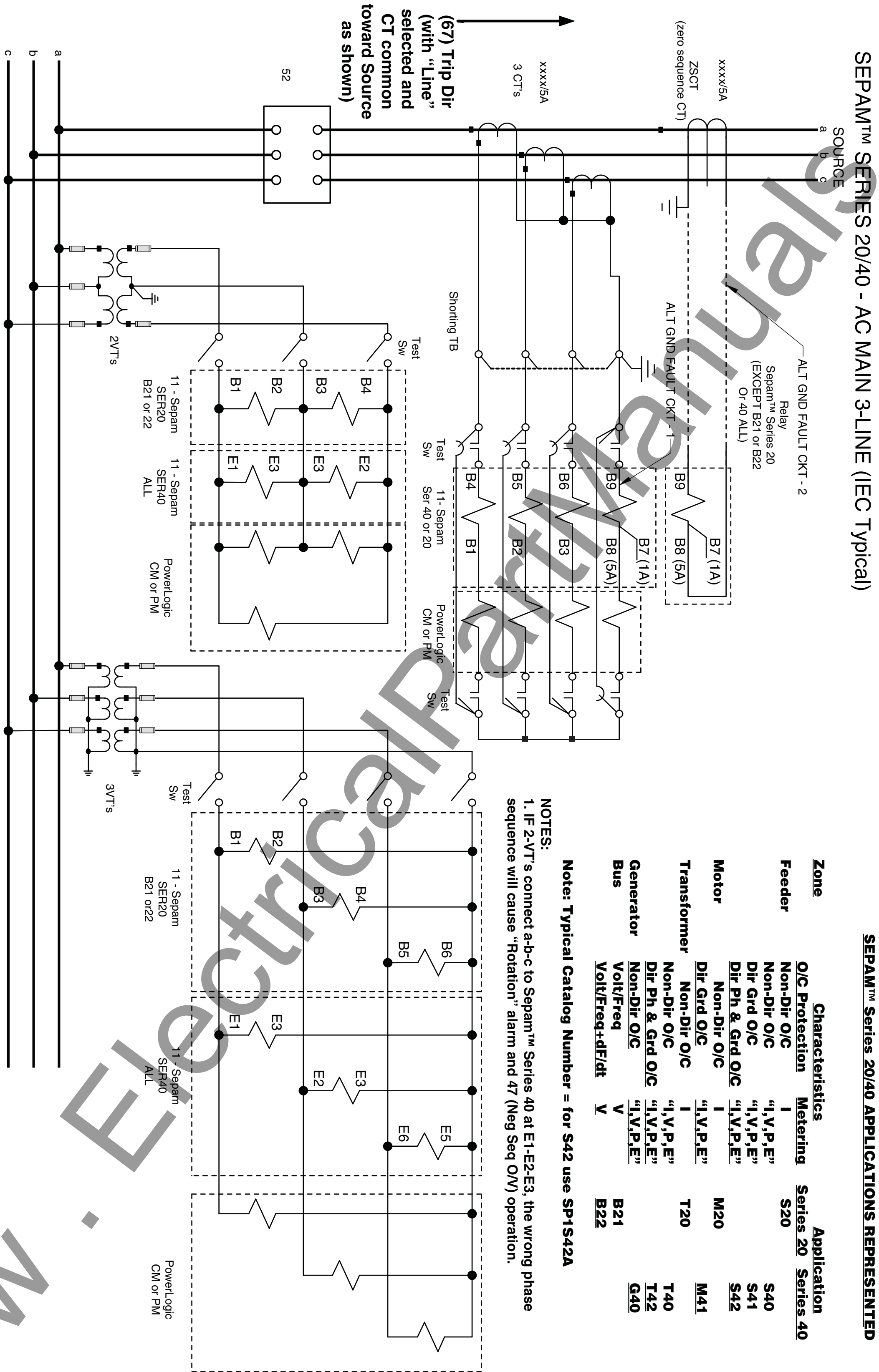
SEPAM™ Series 20/40 APPLICATIONS REPRESENTED

Zone	Characteristics: O/C Protection	Characteristics: Metering	Application: Series 20	Application: Series 40
Feeder	Non-Dir O/C	I	S23	
	Non-Dir O/C	"I,V,P,E"		S40
	Dir Grd O/C	"I,V,P,E"		S41
	Dir Ph & Grd O/C	"I,V,P,E"		S42
Motor	Non-Dir O/C	I	M20	
	Dir Grd O/C	"I,V,P,E"		M41
Transformer	Non-Dir O/C	I	T23	
	Non-Dir O/C	"I,V,P,E"		T40
	Dir Ph & Grd O/C	"I,V,P,E"		T42
Generator	Non-Dir O/C	"I,V,P,E"		G40
Bus	Volt/Freq	V	B21	
	Volt/Freq+dF/dt	V	B22	

Note: Typical Catalog Number = for S42 use SP1S42A

NOTES:
1. IF 2-VT's connect a-b-c to Sepam™ Series 40 at E1-E2-E3, the wrong phase sequence will cause "Rotation" alarm and 47 (Neg Seq O/V) operation.

Circuit Breaker/Contactor Control
AC Main 3-Line (IEC Typical)



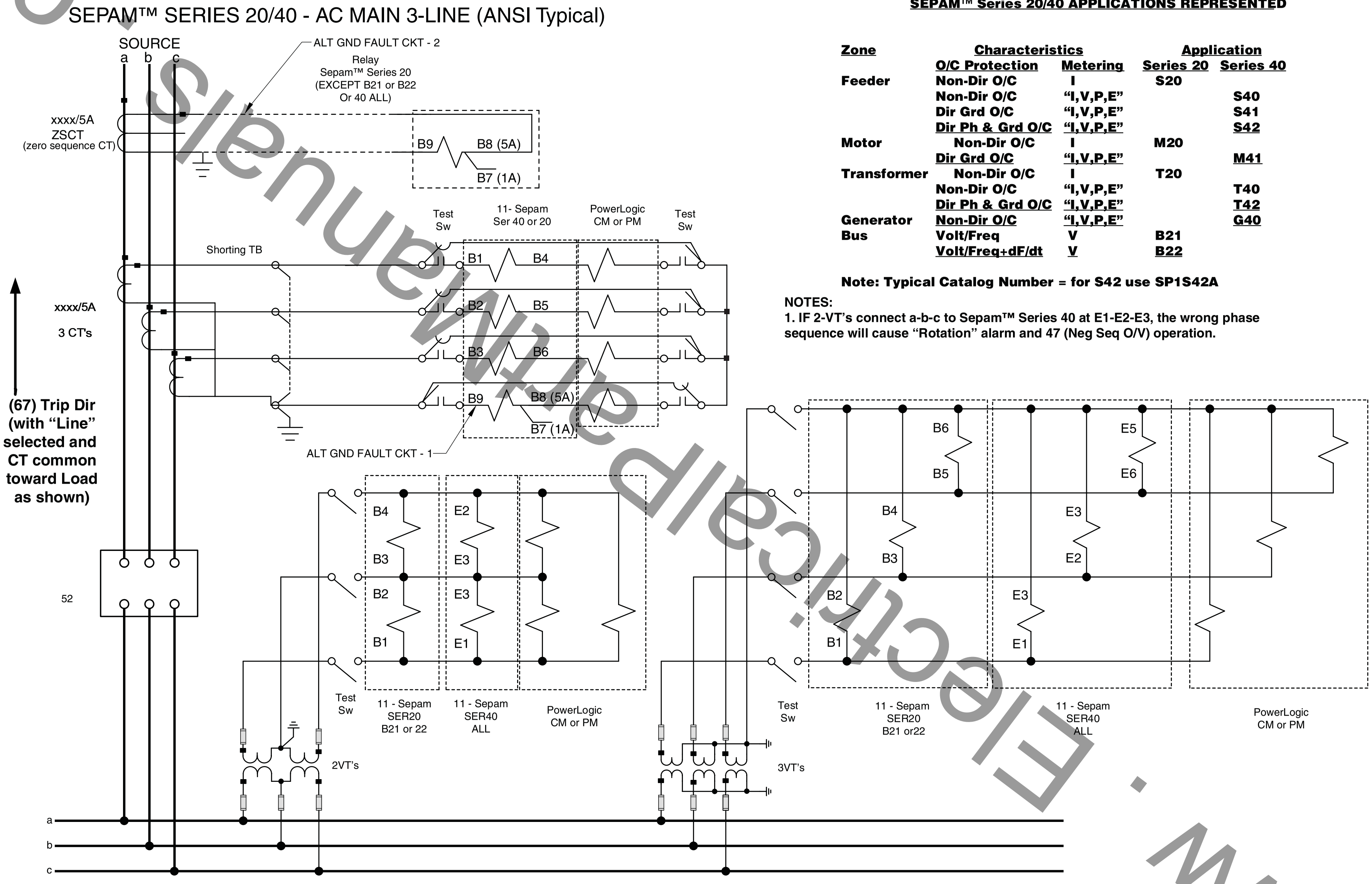
SEPAM™ Series 20/40 APPLICATIONS REPRESENTED

Zone	Characteristics O/C Protection	Metering	Application Series 20	Application Series 40
Feeder	Non-Dir O/C	I	S20	
	Non-Dir O/C	"I,V,P,E"		S40
	Dir Grd O/C	"I,V,P,E"		S41
	Dir Ph & Grd O/C	"I,V,P,E"		S42
Motor	Non-Dir O/C	I	M20	
	Dir Grd O/C	"I,V,P,E"		M41
Transformer	Non-Dir O/C	I	T20	
	Non-Dir O/C	"I,V,P,E"		T40
	Dir Ph & Grd O/C	"I,V,P,E"		T42
Generator	Non-Dir O/C	"I,V,P,E"		G40
Bus	Volt/Freq	V	B21	
	Volt/Freq+dF/dt	V	B22	

Note: Typical Catalog Number = for S42 use SP1S42A

NOTES:
1. IF 2-VT's connect a-b-c to Sepam™ Series 40 at E1-E2-E3, the wrong phase sequence will cause "Rotation" alarm and 47 (Neg Seq O/V) operation.

Circuit Breaker/Contactor Control
AC Main 3-Line (ANSI Typical)

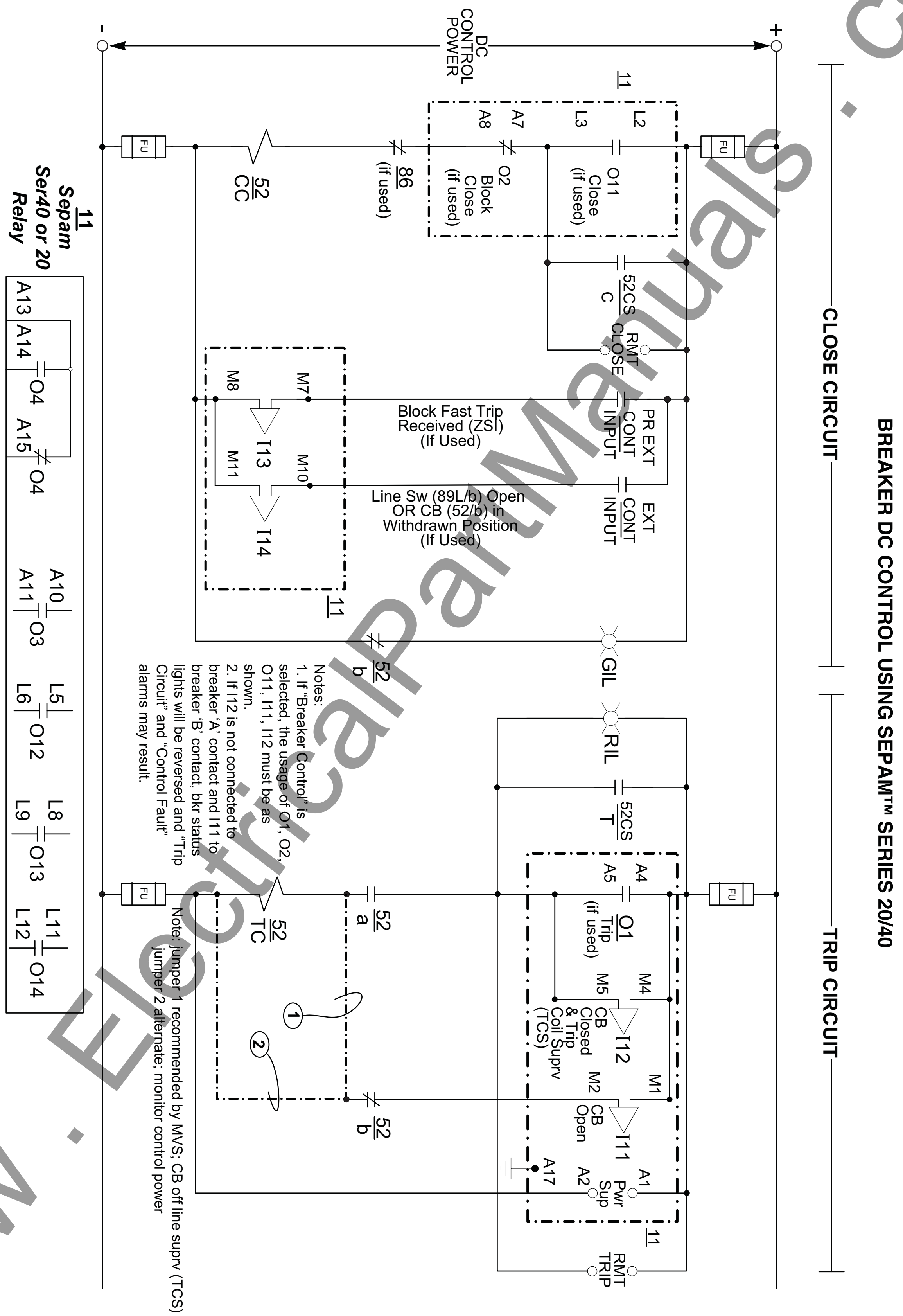


SEPAM™ Series 20/40 APPLICATIONS REPRESENTED

Zone	Characteristics: O/C Protection	Characteristics: Metering	Application: Series 20	Application: Series 40
Feeder	Non-Dir O/C	I	S20	
	Non-Dir O/C	"I,V,P,E"		S40
	Dir Grd O/C	"I,V,P,E"		S41
	Dir Ph & Grd O/C	"I,V,P,E"		S42
Motor	Non-Dir O/C	I	M20	
	Dir Grd O/C	"I,V,P,E"		M41
Transformer	Non-Dir O/C	I	T20	
	Non-Dir O/C	"I,V,P,E"		T40
	Dir Ph & Grd O/C	"I,V,P,E"		T42
Generator	Non-Dir O/C	"I,V,P,E"		G40
Bus	Volt/Freq	V	B21	
	Volt/Freq+dF/dt	V	B22	

Note: Typical Catalog Number = for S42 use SP1S42A

NOTES:
1. IF 2-VT's connect a-b-c to Sepam™ Series 40 at E1-E2-E3, the wrong phase sequence will cause "Rotation" alarm and 47 (Neg Seq O/V) operation.


BREAKER DC CONTROL USING SEPAM™ SERIES 20/40
CLOSE CIRCUIT
TRIP CIRCUIT
DC CONTROL POWER
-
+
FU
11
L2
L3
A7
A8
O11 Close (if used)
O2 Block Close (if used)
86 (if used)
52 CC
52CS C
RMT CLOSE
PR EXT CONT INPUT
EXT CONT INPUT
Block Fast Trip Received (ZSI) (If Used)
Line Sw (89L/b) Open OR CB (52/b) in Withdrawn Position (If Used)
M7
M8
I13
M10
M11
I14
52 b
GIL
RIL
52CS T
A4
A5
O1 Trip (if used)
M4
M5
CB Closed & Trip Coil Suprv (TCS)
I12
M1
M2
CB Open
I11
A1
A2
Pwr Sup
A17
RMT TRIP
52 a
52 TC
1
2
11 Sepam Ser40 or 20 Relay
A13
A14
O4
A15
Self-test Alarm Output (Watchdog)
A10
A11
O3
Block Upstream Fast Trip (Zone Seq Intlk) (If Used)
L5
L6
O12
L8
L9
O13
L11
L12
O14
Indication Outputs (If Used)
Notes:
1. If "Breaker Control" is selected, the usage of O1, O2, O11, I11, I12 must be as shown.
2. If I12 is not connected to breaker 'A' contact and I11 to breaker 'B' contact, bkr status lights will be reversed and "Trip Circuit" and "Control Fault" alarms may result.
Note: jumper 1 recommended by M/S; CB off line suprv (TCS) jumper 2 alternate; monitor control power

Zone Selective Interlocking
ANSI Code 68
Radial Network

Application

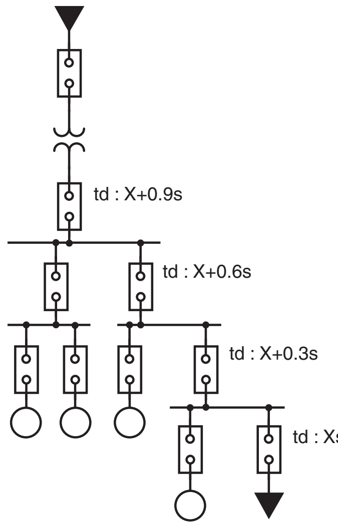
This function provides:

- full tripping discrimination
- a substantial reduction in the delayed tripping of circuit breakers nearest the source (drawback of the classical time-based discrimination process).

The system applies to the following phase overcurrent, ground fault, and directional protection functions:

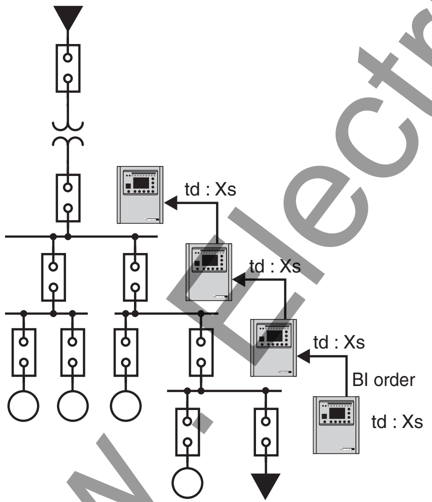
- definite time (DT)
- Inverse Definite Minimum Time (IDMT)
- Standard Inverse Time (SIT)
- Very Inverse Time (VIT)
- Extremely Inverse Time (EIT)
- Ultra Inverse Time (UIT)

MT10196



Example: radial distribution using time-based discrimination (td: tripping time definite time curves).

MT10197

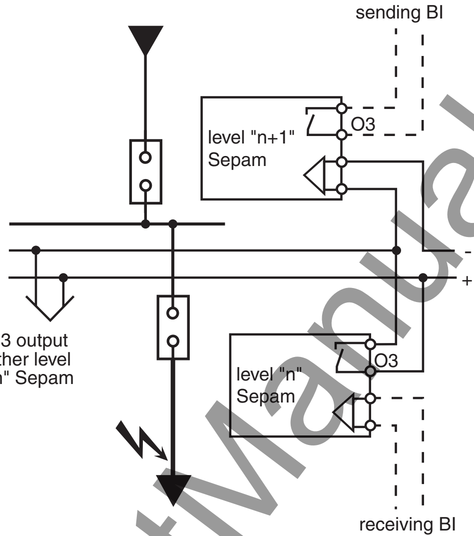


Example: radial distribution using the Sepam™ zone selective interlocking system.

With this type of system, time delays are set in accordance with the device to be protected without concern for the discrimination aspect.

Operating Principle

MT10195



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

- the protection units upstream from the fault are triggered
- the protection units downstream from the fault are not triggered
- only the first protection unit upstream from the fault should trip.

Each Sepam™ can send and receive blocking information[1].

When a fault current triggers Sepam™, it sends blocking information to output O3 **(2)** and trips the associated circuit breaker if it does not receive blocking information on the logic input assigned to "receipt of BI" **(3)**.

The blocking information is sent for as long as it takes to clear the fault. It is interrupted after a time delay that considers the breaking device operating time and protection unit reset time.

This system minimizes the duration of the fault (which minimizes arc flash energy) and optimizes discrimination in downgraded situations.

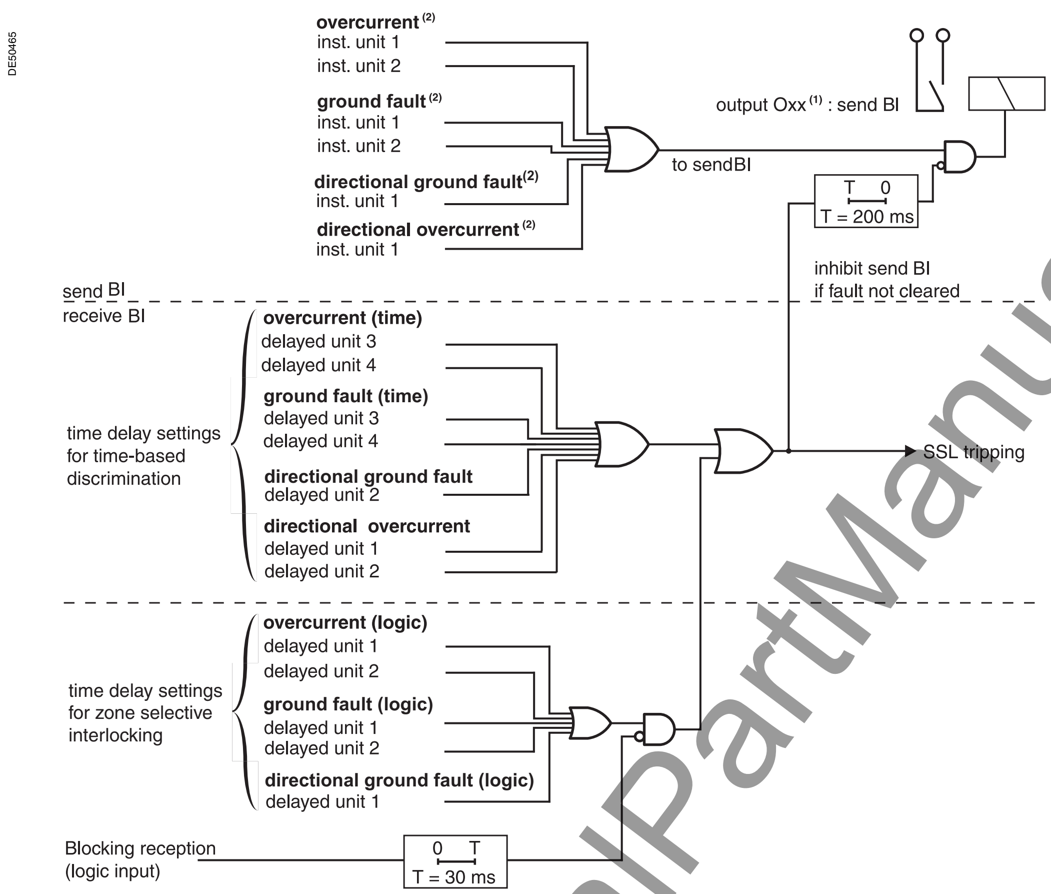
Pilot Wire Test

The pilot wire test may be performed using the output relay test function.

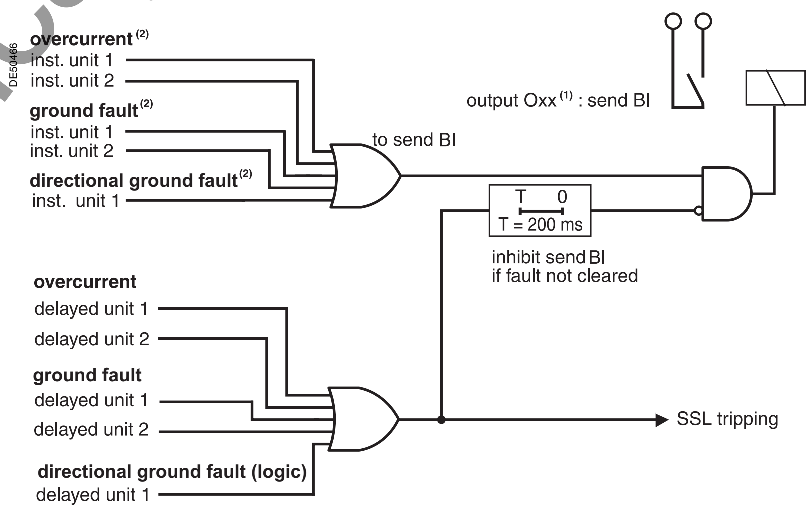
__(1)__ Motor Sepam™s can send only blocking information. They are not affected by the receipt of blocking information since they are designed for loads only.
__(2)__ Default parameter setting.
__(3)__ According to parameter setting and presence of an additional MES114 module.

Zone Selective Interlocking
ANSI Code 68
Radial Network

Block Diagram: Sepam™ S40, S41, T40, T42, G40



Block Diagram: Sepam™ M41



The protection units must be configured to trip the circuit breaker in order to be considered in zone selective interlocking.

(1) *According to parameter setting (O3 by default).*
(2) *Instantaneous action (inst) corresponds to protection "pick up" signal information.*

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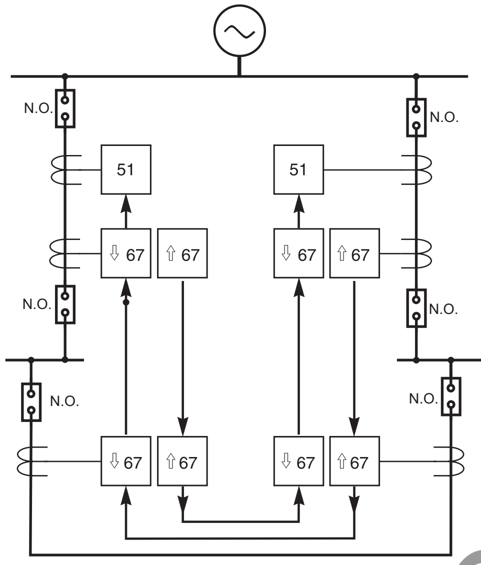
Zone Selective Interlocking
ANSI Code 68
Closed Ring Network

Application

Closed ring network protection may be provided using Sepam™ S42, which includes the following functions:

- Two units of directional phase (67) and ground fault (67N) protection functions:
  - a unit to detect faults located in the "line" direction
  - a unit to detect faults located in the "bus" direction
- double zone selective interlocking function, with:
  - sending of two blocking information, according to the detected fault direction
  - receipt of two blocking information to block the directional protection relays according to their detection direction.

MT11208



⇩, ⇧ : *direction of 67/67N protection functions*

↑ : *direction of blocking signals*

With the combination of the directional protection functions and the zone selective interlocking function, the faulty section may be isolated with minimum delay by the tripping of the circuit breakers on either side of the fault.

Protection functions 67 and 67N prepare the blocking information.

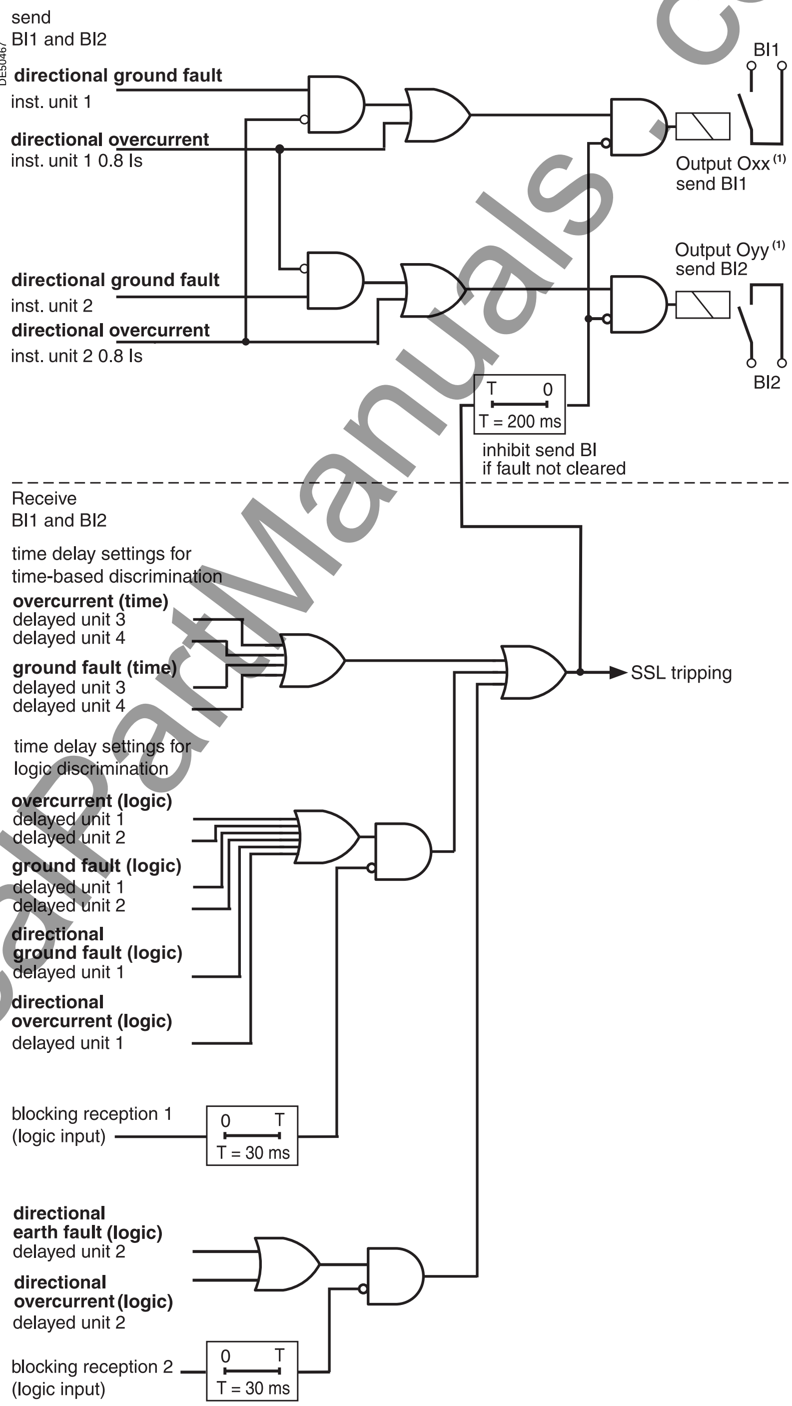
Priority is given to protection function 67: when protection functions 67 and 67N detect faults in opposite directions at the same time, the blocking information is determined by the direction of the fault detected by protection function 67.

The instantaneous output of protection function 67, activated at 80% of the Is set point, is used to send blocking information. This avoids uncertainly when the fault current is close to the Is set point.

Note : The NO references are to output contacts (program logic setting) not the state of the circuit breaker. The breaker status for all breakers on this page is CLOSED.

Block Diagram: Sepam™ S42

DE50467

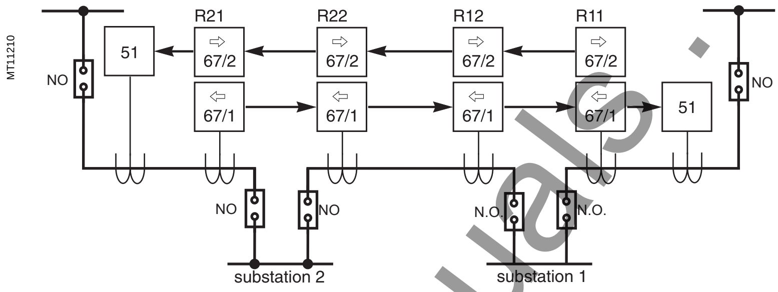


(1) Default parameter setting: O3 for send BI1 and O12 for send BI2

Zone Selective Interlocking
ANSI Code 68
Closed Ring Network

Example: Closed Ring Protection Function Setting:

Case of a closed ring with two substations, each of which comprises two Sepam™ S42 relays, marked R11, R12 and R21, R22.



⇨, ⇦ : *direction of 67/67N protection functions*

↑ : *direction of blocking signals*

Note : The NO references are to output contacts (program logic setting) not the state of the circuit breaker. The breaker status for all breakers above is CLOSED.

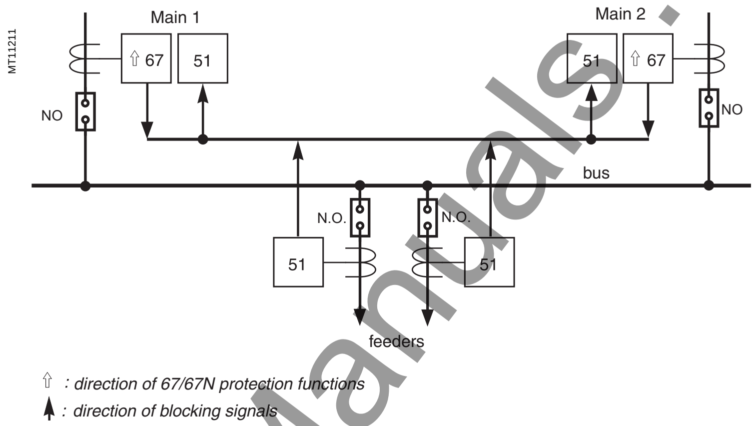
Starting at one end of the ring, the detection direction of units 1 and 2 of the directional protection functions should be alternated between line and bus.

Example of setting of the different Sepam™ with zone selective interlocking:

Substation 1	
Sepam™ S42 no. R11	**Sepam™ S42 no. R12**
■ Logic input/output assignment: I13: blocking reception 1 O3: send blocking information BI1 O12: send blocking information BI2 ■ 67, 67N, unit 1: tripping direction = bus ■ 67, 67N, unit 2: tripping direction = line	■ Logic input/output assignment: I13: blocking reception 1 I14: blocking reception 2 O3: send blocking information BI1 O12: send blocking information BI2 ■ 67, 67N, unit 1: tripping direction = line ■ 67, 67N, unit 2: tripping direction = bus
Substation 2	
Sepam™ S42 no. R22	**Sepam™ S42 no. R21**
■ Logic input/output assignment: I13: blocking reception 1 I14: blocking reception 2 O3: send blocking information BI1 O12: send blocking information BI2 ■ 67, 67N, unit 1: tripping direction = bus ■ 67, 67N, unit 2: tripping direction = line	■ Logic input/output assignment: I13: blocking reception 1 O3: send blocking information BI1 O12: send blocking information BI2 ■ 67, 67N, unit 1: tripping direction = line ■ 67, 67N, unit 2: tripping direction = bus

Zone Selective Interlocking
ANSI Code 68
Substation with Two Parallel Mains

Application
Substations supplied by two (or more) parallel mains may be protected using Sepam™ S42 or Sepam™ T42, by a combination of directional phase (67) and ground fault (67N) protection functions, with the zone selective interlocking function.



Note : The NO references are to output contacts (program logic setting) not the state of the circuit breaker. The breaker status for all breakers above is CLOSED.

To keep both mains from tripping when a fault ocurs upstream from one main, the main protection devices must operate as follows:

- protection 67 of the faulty main detects the fault current in the "line" direction, the protection tripping direction:
  - sends a blocking information to block the phase overcurrent protection functions (50/51) of both mains
  - and trips the main circuit breaker
- protection function 67 of the fault-free main is insensitive to fault current in the "bus" direction.

Examples: Parallel Main Protection Function Setting

Protection by Sepam™ S42

- logic input/output assignment:
  - I13: blocking reception 1 - **Do not assign any inputs to blocking reception 2**
  - O3: send blocking information BI1
- protection function 67 unit 1: tripping direction = line
  - instantaneous output: send blocking information BI1
  - time-delayed output: blocked by receipt of BI1 on I13
- protection function 67, unit 2: tripping direction = line
  - time-delayed output: tripping of circuit breaker triggered by fault upstream from main (not blocked since no input is assigned to blocking reception 2).

Protection by Sepam™ T42

- logic input/output assignment:
  - I13: blocking reception 1
  - O3: send blocking information BI1
- protection function 67 unit 1: tripping direction = line
  - instantaneous output: send blocking information BI1
  - time-delayed output: tripping of circuit breaker triggered by a fault upstream from the main (not blocked by the receipt of BI1 on I13)
- protection function 67, unit 2: if necessary.

Disturbance Recording Triggering

Description

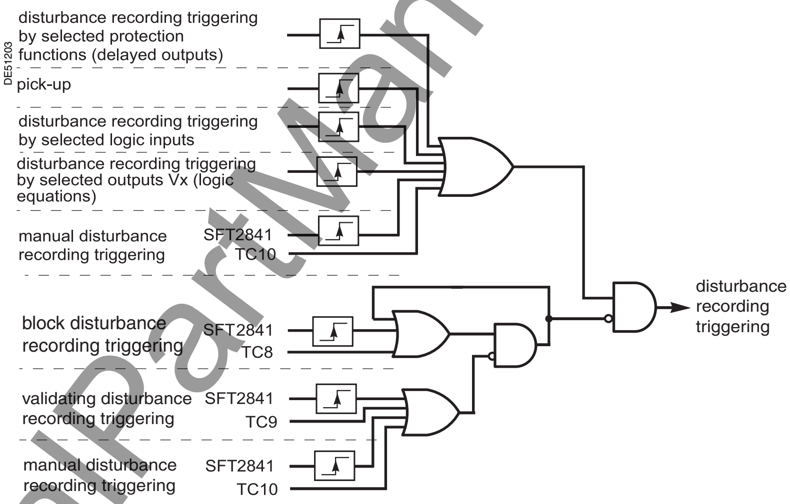
Recording analog and logic signals can be triggered by different events, either by control matrix parameter setting or by manual action:

- triggering by the grouping of all pick-up signals of the protection functions in service
- triggering by the delayed outputs of selected protection functions
- triggering by selected logic inputs
- triggering by selected outputs Vx (logic equations)
- manual triggering by a remote control command (TC10)
- manual triggering via the SFT2841 software tool.

Disturbance recording can be:

- blocked through the SFT2841 software or by remote control command (TC8)
- validated through the SFT2841 software or by remote control command (TC9).

Block Diagram



Switching Groups of Settings

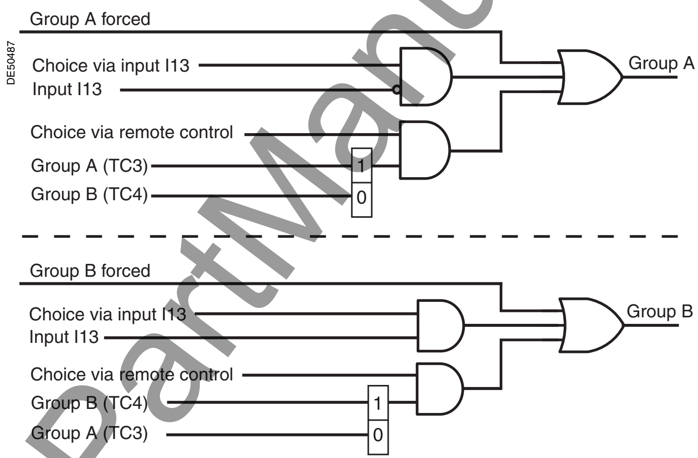
Description

There are two groups of settings (groups A and B) for phase overcurrent, ground fault, directional phase overcurrent, and directional ground fault protection functions. Switching from one group of settings to another makes it possible to adapt the protection characteristics to suit the electrical environment of the application (such as, change of grounding system, transition to local production). The switching of settings is global and applies to all the units of the protection functions mentioned above.

The setting switching mode is determined by parameter setting:

- switching according to the position of logic input I13 (0 = group A, 1 = group B)
- switching by remote control (TC3, TC4)
- forced group A or group B.

Block Diagram



Local Indication
ANSI Code 30

Events are displayed on the front panel of Sepam™ by:
- a message on the advanced UMI display
- lighting one of the 9 yellow signal lamps.

Message Type Indication

Predefined Messages
All the messages connected to the standard Sepam™ functions are predefined and available in two language versions:
- in English, factory messages, not modifiable
- in the local language, according to the version delivered.

The language version is chosen at the time of Sepam™ parameter setting.
The messages are visible on the Sepam™ display units equipped with advanced UMI and in the SFT2841 Alarms screen.
- the number and type of predefined messages depend on type of Sepam™. The table below gives the complete list of all predefined messages.

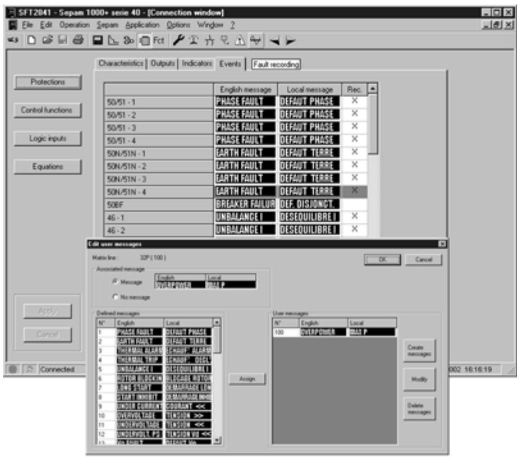
List of Messages

Functions	UK English	US English (US)
Phase overcurrent	PHASE FAULT (2)	PHASE FAULT (2)
Voltage-restrained phase overcurrent	O/C V REST(2)	O/C V REST (2)
Ground fault	EARTH FAULT	GROUND FAULT
Circuit breaker failure	BREAKER FAILURE	BREAKER FAILURE
Unbalance / negative sequence	UNBALANCE I	UNBALANCE I
Directional phase overcurrent	DIR. PHASE FAULT (2)	DIR. PHASE FAULT (2)
Directional ground fault	DIR. EARTH FAULT	DIR. GROUND FAULT
Active overpower	REVERSE P	REVERSE P
Reactive overpower	REVERSE Q	REVERSE Q
Thermal overload	THERMAL ALARM THERMAL TRIP	THERMAL ALARM THERMAL TRIP
Locked rotor / Locked rotor at startup	ROTOR BLOCKING ST^{RT} LOCKED ROT^{R}.	JAMMED/STALL LOCKED ROTOR
Excessive starting time	LONG START	LONG START
Number of starts	START INHIBIT	BLOCKED START
Phase undercurrent	UNDERCURRENT	UNDERCURRENT
Overvoltage	OVERVOLTAGE (3)	OVERVOLTAGE (3)
Undervoltage	UNDERVOLTAGE (3)	UNDERVOLTAGE (3)
Positive sequence undervoltage	UNDERVOLT. PS ROTATION -	UNDERVOLT. PS REV. ROTATION
Neutral voltage displacement	V0 FAULT	Vr FAULT
Overfrequency	OVER FREQ.	OVER FREQ.
Underfrequency	UNDER FREQ.	UNDER FREQ.
Negative sequence overvoltage	UNBALANCE U	UNBALANCE V
Temperature (RTDs) (1)	OVER TEMP. ALM OVER TEMP. TRIP RTD'S FAULT MET1 (1 to 2)	OVER TEMP. ALM OVER TEMP. TRIP RTD'S FAULT (1 to 2)
Thermostat	THERMOS^{T}. ALARM THERMOS^{T}. TRIP	THERMOS^{T}. ALARM THERMOS^{T}. TRIP
Buchholz	BUCHHOLZ ALARM BUCHH/GAS TRIP	BUCHHOLZ ALARM BUCHH/GAS TRIP
Pressure	PRESSURE ALM. PRESSURE TRIP	PRESSURE ALM. PRESSURE TRIP
Thermistor PTC/NTC	THERMIS^{T}. ALARM THERMIS^{T}. TRIP	THERMIS^{T}. ALARM THERMIS^{T}. TRIP
External tripping x (1 to 3)	EXT. TRIP x (1 to 3)	EXTERNAL TRIP x (1 to 3)
Trip circuit supervision	TRIP CIRCUIT	TRIP CKT FAULT
Circuit breaker control	CONTROL FAULT	CB CNTRL FAULT
Recloser	CYCLE x (1 to 4) (4)	SHOT x (1 to 4) (4)
Recloser	FINAL TRIP	FINAL TRIP
Recloser	CLEARED FAULT	CLEARED FAULT
SF6	SF6 LOW	SF6 LOW
Phase VT supervision	VT FAULT	VT FAULT
V0 VT supervision	VT FAULT V0	VT FAULT Vr
CT supervision	CT FAULT	CT FAULT

***(1)** RTD FAULT message: refer to the maintenance chapter.*
***(2)** With indication of the faulty phase.*
***(3)** With indication of the faulty phase, when used with phase-to-neutral voltage.*
***(4)** With indication of the protection unit that has initiated the cycle (phase fault, ground fault, ...).*

Local Indication
ANSI Code 30

MT11188



Personalized message editor.

Personalized User Messages

30 additional messages can be created using the SFT2841 software to link a message to a logic input or the result of a logic equation, for example, or to replace a predefined message by a personalized message.

Personalized User Message Editor in SFT2841

The personalized message editor is integrated in the SFT2841 software tool and can be accessed from the control matrix screen in either connected or unconnected mode:

- display on the screen the "Event" tab associated with "Protection": the predefined messages associated with the protection functions appear
- double-click on one of the messages displayed to activate the personalized message editor.

Personalized Message Editor Functions

- Creating and modifying personalized messages. This is accomplished in English and the local language by text input or importing of an existing bitmap file (*.bmp) or by point to point drawing
- Deleting personalized messages
- Assigning predefined or personalized messages to an event defined in the control matrix:
  - from the control matrix screen, "Events" tab, double-click on the event to be linked to a new message
  - select the new predefined or personalized message, from among the messages presented
  - and "Assign" it to the event.

The same message can be assigned to several events with no restriction.

SFT 2841 Message Display

Predefined messages are stored in Sepam™'s memory and appear:

- written out in text format in connected mode
- in code number format in unconnected mode

The personalized messages are saved with the other Sepam™ parameters and protection settings and are displayed written out in text format in connected and unconnected modes.

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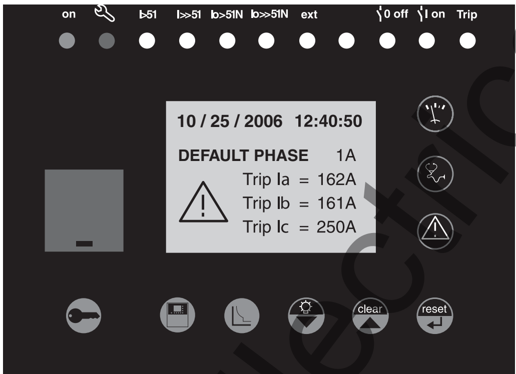


Alarm message on the advanced UMI.

Message Processing on the Advanced UMI Display

When an event occurs, the related message appears on the advanced UMI display.

The user presses the clear key to clear the message and be able to consult all the advanced UMI screens in the normal fashion.

The user must press the reset key to acknowledge latched events, such as protection outputs).

The list of messages remains accessible in the alarm history (key), in which the last 16 messages are stored. The last 250 messages may be consulted with the SFT2841 software.

To delete the messages stored in the alarm history:

- display the alarm history on the advanced UMI
- press the clear key.

Signal Lamp Type Indication

The nine yellow signal lamps on the front of Sepam™ are assigned by default to the following events:

Lamp	Event	Front Panel Label
LED 1	Tripping of protection 50/51 unit 1	I>51
LED 2	Tripping of protection 50/51 unit 2	I>>51
LED 3	Tripping of protection 50N/51N unit 1	Io>51N
LED 4	Tripping of protection 50N/51N unit 2	Io>>51N
LED 5		Ext
LED 6		
LED 7	Circuit breaker open (I11) (1)	0 off
LED 8	Circuit breaker closed (I12) (1)	I on
LED 9	Tripping by circuit breaker control	Trip

(1) Assignment by default with MES114.

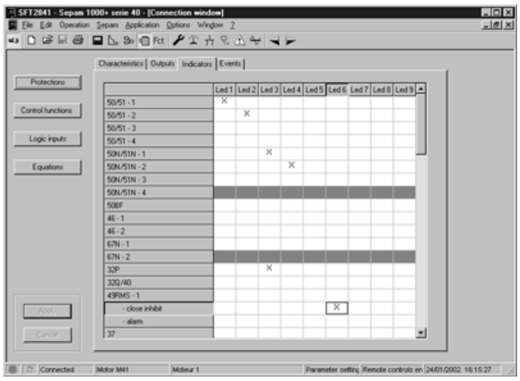
The default parameter setting may be personalized using the SFT2841 software:

- the assignment of signal lamps to events is to be defined in the control matrix screen, "LEDs" tab
- editing and printing personalized labels are proposed in the "Sepam™" menu.

4

Control Matrix

MT11186



SFT2841: control matrix.

The control matrix is used for simple assignment of the logic outputs and signal lamps to information produced by the protection units, program logic and logic inputs. Each column creates a logic OR between all the lines selected.

The matrix can also be used to display the alarms connected to the information. It guarantees the consistency of the parameter setting with the predefined functions. The following data are managed in the control matrix and may be set using the SFT2841 software tool.

Data	Meaning	Comments
"Protections" Button		
All application protection functions	Protection time-delayed output and additional outputs when applicable	Additional actions in "Characteristic" tab: In service / out of service Protection latching Participation of the protection unit in circuit breaker tripping
"Control Functions" Button		
Tripping	Tripping by the circuit breaker control function	Forced on O1
Block closing	Blocks closing by the circuit breaker control function	Forced on O2
Closing	Closing by the circuit breaker control function	Forced on O11 (requires an MES114)
Pick-up	Logical OR of the instantaneous output of all protection units	
Drop-out	A protection unit time delay counter has not yet gone back to 0.	
TCS fault	Trip circuit fault	
Remote control discrepancy / Circuit breaker position	Discrepancy between the last state send by the remote monitoring and control system and the circuit breaker position	
CB control fault	A circuit breaker open or close command has not been successfully executed	
Block Fault Recording	Disturbance recording blocked	
Sending of blocking information BI1	Sending of the blocking information to the following Sepam™ in zone selective interlocking chain 1	O3 by default
Sending of blocking information BI2	Sending of the blocking information to the next Sepam™ in zone selective interlocking chain 2	O12 by default On S42 only
Trip by zone selective interlocking	Trip command sent by the zone selective interlocking function	Only when the zone selective interlocking function is used without the circuit breaker control function
Cleared fault	The recloser function has operated sucessfully	Impulse type output
Final trip	The circuit breaker is definitively open after the reclosing shots	Impulse type output
Recloser ready	The recloser is ready to carry out the shots	
Recloser in service	The recloser is in service	
Recloser shot 1	Shot 1 in progress	
Recloser shot 2	Shot 2 in progress	
Recloser shot 3	Shot 3 in progress	
Recloser shot 4	Shot 4 in progress	
Reverse phase rotation	The voltages measured are rotating in reverse	
MET148-1 fault MET148-2 fault	Hardware problem on an MET module (module 1 or 2) or on an RTD	
Watchdog	Monitoring of Sepam™ operation	Always on O4 if used
"Logic Inputs" Button		
Logic inputs I11 to I14	According to configuration	If MES114 module is configured
Logic inputs I21 to I26	According to configuration	If MES114 is configured
"Equations" Button		
V1 to V10	Logical equation editor outputs	

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Logic Equations

Application

This function can be used to configure simple logic functions by combining data received from the protection functions or logic inputs.

By using logic operators (AND, OR, XOR, NOT) and time delays, new processing operations and indications can be added to the existing ones.

The logic functions produce outputs that can be used in:
- the matrix to control relay outputs, light up LEDs or display new messages
- the protection functions to create new blocking or reset conditions
- circuit breaker control to add cases of circuit breaker tripping, closing or blocking
- disturbance recording to record particular logic data

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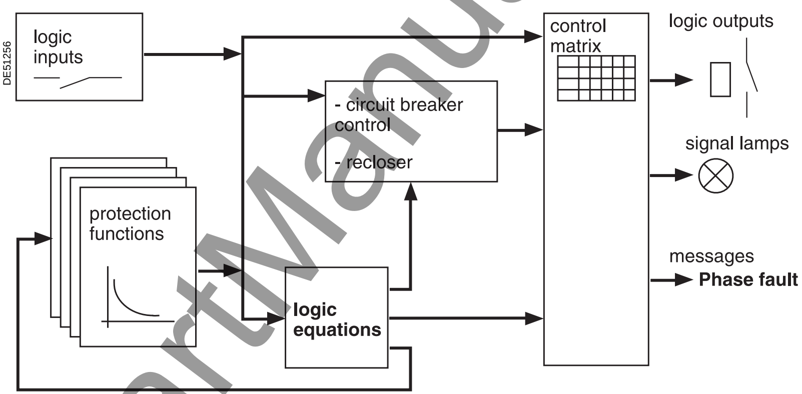
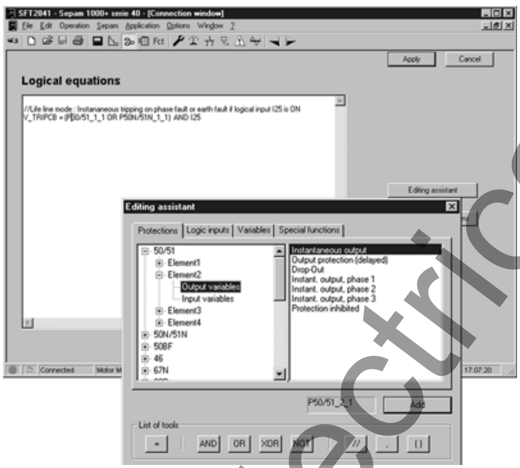


MT11189



Logical equation editor.

Logic Function Configuration

Logical functions are entered in text format in the SFT2841 editor. Each line includes a logic operation, the result of which is assigned to a variable.
Example:
V1 = P5051_2_3 OR I12
The lines are executed sequentially every 14 ms.

Description of Operations

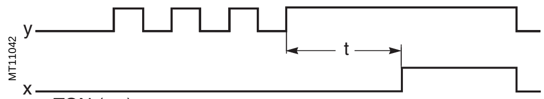
Operators
- **NOT**: logic inversion
- **OR**: logic OR
- **AND**: logic AND
- **XOR**: exclusive OR. **V1 XOR V2** is equivalent to **(V1 AND (NOT V2)) OR (V2 AND (NOT V1))**
- **=**: assignment of a result
- **//**: start of a comment, the characters on the right are not processed
- **(,)**: the operations may be grouped between brackets.

Functions
- x **= SR**(y, z): bistable with priority given to Set
  - x is set to 1 when y is equal to 1
  - x is set to 0 when z is equal to 1 (and y is equal to 0)
  - x is unchanged in the other cases.
- **LATCH**(x, y, ...): latching of variables x, y, ...

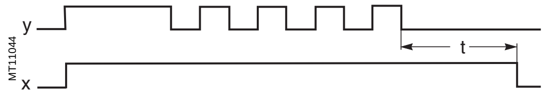
The variables are maintained constantly at 1 after having been set to 1 a first time. They are reset to 0 after Sepam™ is set (reset key, external input or remote control command).

The LATCH function accepts as many parameters as the number of variables that the user wishes to latch. It applies to the entire program, whatever the position in the program. For easier reading, it is advisable to put LATCH at the start of the program.

Logic Equations



x = TON (y, t)



x = TOF (y, t)

- **x = TON**(y, t): on delay timer

The **x** variable follows the switching to 1 of the y variable with a delay t (t in ms).

- x = **TOF**(y, t): off delay timer
  The x variable follows the switching to 0 of the y variable with a delay t (t in ms).

- x = **PULSE**(d, i, n): time-tagger
  Used to generate n periodic pulses, separated by a time interval i as of the starting time d
  - d is expressed as hour:minute:second
  - i is expressed as hour:minute:second
  - n is an integer (n = -1: repetition until the end of the day).

Example: V1 = PULSE (8:30:00, 1:0:0,4) will generate 4 pulses at one-hour intervals at 8 h 30, 9 h 30, 10 h 30, 11 h 30. This will be repeated every 24 hours.
The pulses last for a 14 ms cycle. V1 has the value of 1 during the cycle.
If necessary, V1 may be extended using the **TOF, SR** or **LATCH** functions.

Maximum Number of Functions:
- the total number of delay timers (TON and TOF) and time-taggers (PULSE) taken together cannot exceed 16
- there is no limit on the number of bistable (SR) and latching (LATCH) functions.

Input Variables
They come from protection functions or logic inputs. They may only appear on the right of the assignment sign:
- **I11** to **I14**, **I21** to **I26**: logic inputs
- **P**protection_unit_data: a protection output.
  Example: **P50/51_2_1**, overcurrent protection, unit 2, data 1: time-delayed output. The data numbers are detailed in the table which follows.

Output Variables
They are directed to the matrix, or to the protection functions, or to the program logic functions. They may only appear on the left of the assignment sign:

The output variables should only be used once; otherwise the last assignment is taken into account.
- outputs to the matrix: **V1** to **V10**
  The outputs are included in the matrix and may therefore control signal lamps, relay outputs or messages.
- outputs to a protection input: **P**protection_unit_data
  Example: **P59_1_113**, overvoltage protection, unit 1, data 113: protection blocking. The data numbers are detailed in the table which follows.
- outputs to program logic:
  - **V_TRIPCB**: circuit breaker tripping by the circuit breaker control function. Used to complete circuit breaker tripping conditions and activate the recloser.
  - **V_CLOSECB**: circuit breaker closing by the circuit breaker control function. Used to generate a circuit breaker close command based on a particular condition.
  - **V_BLOCKCLOSE**: block circuit breaker closing by the circuit breaker control function. Used to add circuit breaker closing block conditions.
  - **V_FLAGREC**: data saved in disturbance recording. Used to save a specific logical status in addition to those already present in disturbance recording.

Local Variables
Variables designed for intermediary calculations. They are not available outside the logic equation editor. They may appear on the left or right of the assignment sign. There are 31 variables, assigned as **VL1** to **VL31.**

Two constants are also predefined: **K_1** always equal to 1 and **K_0** always equal to 0.

Details of Protection Inputs/Outputs

The table below lists the input/output data available for each protection function. The SFT2841 software includes a data input assistance tool which may be used to quickly identify each data item:

- numbers less than 100 correspond to the protection outputs that may be used as equation input variables
- numbers between 100 and 199 correspond to the protection inputs that may be used as equation output variables
- numbers greater than 200 correspond to the recloser outputs that may be used as equation input variables.

Table of Protection Function Input and Output Variables

Designation	Bit	27/ 27S	27D	27R	32P	32Q	37	38/ 49T	46	47	48/ 51 LR	49 RMS	50/ 51	50 BF	50N 51N	51V	59	59N	66	67	67N	79	81H	81L	CT	VT
Outputs																										
Instantaneous output (Pick-up)	1	■	■	■	■	■	■		■	■			■	■	■	■	■	■		■	■		■	■		
Protection output (time-delayed)	3	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■
Drop-out	4												■		■	■				■	■					
Instantaneous output inverse zone	6																			■	■					
Phase a fault	7	■ (1)											■			■	■ (1)			■					■	
Phase b fault	8	■ (1)											■			■	■ (1)			■					■	
Phase c fault	9	■ (1)											■			■	■ (1)			■					■	
Alarm	10							■				■														
Block closing	11											■														
RTD fault	12							■																		
Locked rotor	13										■															
Excessive starting time	14										■															
Locked rotor at start-up	15										■															
Protection blocked	16	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■
Hot state	18											■														
Positive active power	19				■																					
Negative active power	20				■																					
Instantaneous output at 0.8 Is	21																			■						
Starting in progress	22										■									■						
Recloser in service	201																					■				
Recloser ready	202																					■				
Cleared fault	203																					■				
Final trip	204																					■				
Reclosing shot 1	211																					■				
Reclosing shot 2	212																					■				
Reclosing shot 3	213																					■				
Reclosing shot 4	214																					■				
Inputs																										
Reset	101	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
VT fault	103																									■
Start 50BF	107													■												
Block	113	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

(1) When the protection function is used for phase-to-neutral voltage.

4

Logic Equations

Processing After Losing Auxiliary Voltage
The **V1** to **V10, VL1** to **VL 31** and **V_TRIPCB, V_CLOSECB, V_INHIBCLOSE, V_FLAGREC** variables are saved if Sepam™ loses auxiliary power. The status is restored when the power returns, thereby allowing the statuses produced by **LATCH**, **SR** or **PULSE** type memory operators to be saved.

Special Cases
Brackets must be used in expressions which comprise different **OR, AND, XOR or NOT** operators, such as:

- **V1 = VL1 AND I12 OR P27/27S_1_1. //** incorrect expression
- **V1 = (VL1 AND I12) OR P27/27S_1_1. //** correct expression
- **V1 = VL1 OR I12 OR P27/27S_1_1. //** correct expression
  Only the **V1 to V10, VL1 to VL31 and V_TRIPCB, V_CLOSECB, V_BLOCKCLOSE, V_FLAGREC** variables are allowed in the **LATCH** function

Function parameters cannot be expressions:

- **VL3 = TON ((V1 AND V3), 300) //** incorrect expression
- VL4 = V1 AND V3
- **VL3 = TON (VL4, 300) //** correct.

Use Limit
The number of operators and functions (**OR, AND, XOR, NOT, =, TON, TOF, SR, PULSE**) is limited to 100.

Examples of Applications

1 **Latching the recloser final trip data.** By default, this data is of the impulse type at the recloser output. If required by operating conditions, it may be latched as follows:
LATCH (V1) // V1 may be latched
V1 = P79_1_204 // recloser "final trip" output.
V1 may then control a signal lamp or relay output in the matrix.

2 **Latching a signal lamp without latching the protection function.** Certain operating conditions call for the latching of indications on the front panel of Sepam™, without latching of the trip output O1.
LATCH (V1, V2)
V1 = P50/51_1_1 OR P50/51_3_1 // tripping, units 1 and 3 of protection 50/51
V2 = P50/51_2_1 OR P50/51_4_1 // tripping, units 2 and 4 of protection 50/51
V1 and V2 must be configured in the matrix to control 2 front panel signal lamps.

3 **Circuit breaker tripping** if input I13 is present for more than 300 ms.
V_TRIPCB = TON (I13, 300).

4 **Life Line Mode (example 1).** If work is underway with the power on (indicated by input I25), and the user wishes to change the relay behavior as follows:
- circuit breaker tripping by the instantaneous outputs of protection functions 50/51, unit 1 or 50N/51N, unit 1 AND if input I25 is present:
- Block Recloser: **P79_1_113 = I25**

5 **Life Line Mode (example 2)**. The user can block protection functions 50N/51N and 46 by an input I24:
P50N/51N_1_113 = I24
P46_1_113 = I24

6 **Validation of a 50N/51N protection function by logic input I21**. An 50N/51N protection function set with a very low set point must only trigger the tripping of the circuit breaker if it is validated by an input. The input comes from a relay which accurately measures the current in the neutral point:
V_TRIPCB = P50N/51N_1_3 AND I21

7 **Blocking circuit breaker closing if thermal alarm set points are overrun**. The temperature protection function 38/49T supplies 16 alarm bits. If one of the first three bits is activated the user wishes to block circuit breaker closing:
V_INHIBCLOSE = P38/49T_1_10 OR P38/49T_2_10 OR P38/49T_3_10.

Contents

General

Modbus communication allows Sepam™ to be connected to a supervisor or any other device with a master Modbus communication channel.
Sepam™ is always a slave station.

Sepam™ is connected to a Modbus communication network via a communication interface.

There is a choice of two types of communication interface:

- Communication interfaces to connect Sepam™ to a single network:
  - ACE9492, for connection to a 2-wire RS485 network
  - ACE959, for connection to a 4-wire RS485 network
  - ACE937, for connection to a fiber-optic star network.
- Communication interfaces to connect Sepam™ to two networks:
  - ACE969TP, for connection to:
    - one 2-wire RS485 Modbus S-LAN supervision communication network
    - one 2-wire RS485 E-LAN engineering communication network
  - ACE969FO, for connection to:
    - one fiber-optic Modbus S-LAN supervision communication network
    - one 2-wire RS485 E-LAN engineering communication network.

Data Available

The data available depend on the type of Sepam™.

Measurement Readout

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

Program Logic Data Readout

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

Remote Control Commands

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

Other Functions

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

Characterization of Exchanges

The Modbus protocol may be used to read or write one or more bits, one or more words, the contents of the event counters or the contents of the diagnosis counters.

Modbus Functions Supported

The Modbus protocol used by Sepam™ is a compatible sub-group of the RTU Modbus protocol.
The functions listed below are handled by Sepam™:

- basic functions (data access)
  - function 1: reading of n output or internal bits
  - function 2: reading of n input bits
  - function 3: reading of n output or internal words
  - function 4: reading of n input words
  - function 5: writing of 1 bit
  - function 6: writing of 1 word
  - function 7: high-speed reading of 8 bits
  - function 15: writing of n bits
  - function 16: writing of n words.
- communication-management functions:
  - function 8: Modbus diagnosis
  - function 11: reading of Modbus event counter
  - function 43: sub-function 14: reading of identification.

The following exception codes are supported:

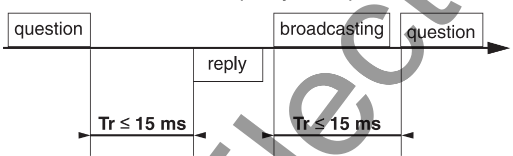
- 1: unknown function code
- 2: incorrect address
- 3: incorrect data
- 4: not ready (cannot process request)
- 7: not acknowledged (remote reading and setting).

Response Time

The communication **response time (Tr)** is less than 15 ms, including a 3-character silence (approximately 3 ms at 9600 bauds).
This time is given with the following parameters:

- 9600 bauds
- format: 8 bits, odd parity, 1 stop bit.

MT10524



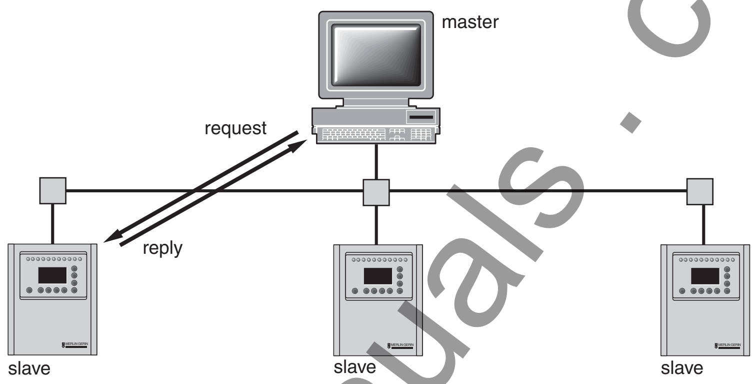
Synchronizing Exchanges

Any character that is received after a silence of more than three characters is treated like a new frame. A silence of at least three characters must be left on the line between two frames.

Example: at 9600 bauds, this time is equal to approximately 3 milliseconds.

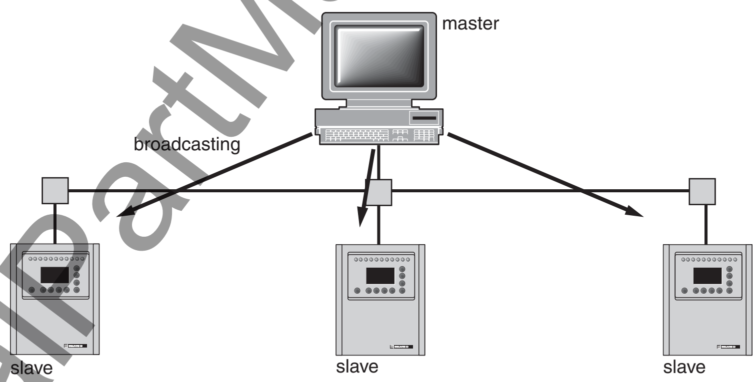
Protocol Principle

MT10203



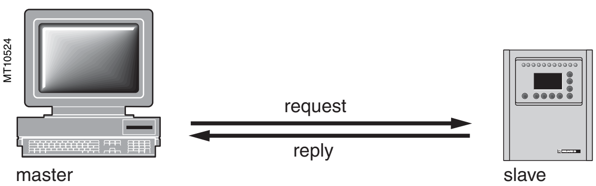
Exchanges are initiated by the master and include a request by the master and a reply by the slave (Sepam™). Requests by the master are either addressed to a given Sepam™ identified by its number in the first byte of the request frame, or addressed to all the Sepam™ (broadcasting).

MT10204



Broadcast commands are necessarily write commands.
No replies are transmitted by Sepam™.

MT10524



It is not necessary to have a detailed knowledge of the protocol unless the master is a central computer that requires corresponding programming. All Modbus exchanges include two messages: a request by the master and a reply by the Sepam™.
All the frames that are exchanged have the same structure. Each message or frame contains 4 types of data:

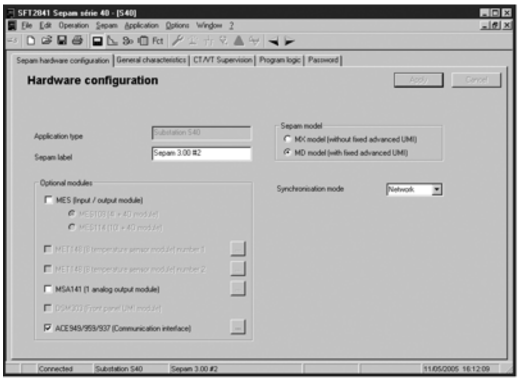
slave number	function code	data zones	CRC 16 check zone

- slave number (1 byte): this indicates the receiving Sepam™ (0 to FFh). If it is equal to zero, the request concerns all the slaves (broadcasting) and there is no reply message
- function code (1 byte): this is used to select a command (read, write, bit, word) and to check that the reply is correct
- data zones (n bytes): these zones contain the parameters relating to the function: bit, address, word address, bit value, word value, number of bits, number of words
- check zone (2 bytes): this zone is used to detect transmission errors.

5

Configuring the Communication Interfaces

PE50619



SFT2841: Sepam™ Configuration screen.

Access to Configuration Parameters

The Sepam™ communication interfaces are configured using SFT2841 software.
The configuration parameters can be accessed from the Communication configuration window in SFT2841.
To access this window:

- open the **Sepam™ configuration** window in SFT2841
- check the box for ACE9xx (communication interface)
- click [...]: the **Communication configuration** window appears
- select the type of interface used: ACE949/ACE959/ACE937, ACE969TP or ACE969FO
- select the Modbus communication protocol.

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

Parameters to Configure	ACE949 ACE959 ACE937	ACE969TP	ACE969FO
Physical layer parameters	■	■	■
Fiber-optic parameters			■
Modbus advanced parameters	■	■	■
E-LAN parameters		■	■

PE50620

SFT2841: communication configuration window for ACE949.

Configuring the Physical Layer of the Modbus Port

Asynchronous serial transmission is used with the following character format:

- 1 start bit
- 8 data bits
- 1 stop bit
- parity according to parameter setting.

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

The configuration parameters for the physical layer of the Modbus port are:

- slave number (Sepam™ address)
- transmission speed
- parity check type.

Parameters	Authorized Values	Default Value
Sepam™ address	1 to 247	1
Speed	4800, 9600, 19200 or 38400 baud	19200 baud
Parity	None, Even or Odd	Even

Configuring the ACE969FO Fiber-Optic Port

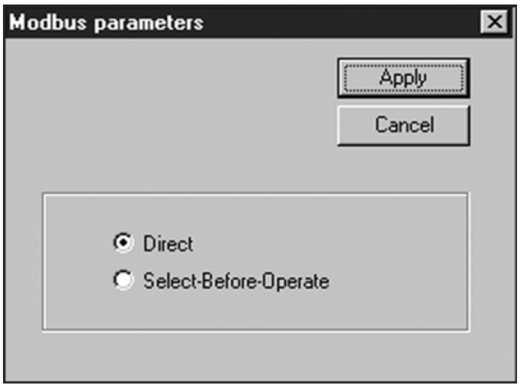
The configuration for the physical layer of the ACE969FO fiber-optic port is completed with the following two parameters:

- **Link idle state**: light-on or light-off
- **Echo mode**: with or without.

Fiber-Optic Parameters	Authorized Values	Default Value
Link idle state	Light Off or Light On	Light Off
Echo mode	Yes (fiber-optic ring) or No (fiber-optic star)	No

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

PE50621



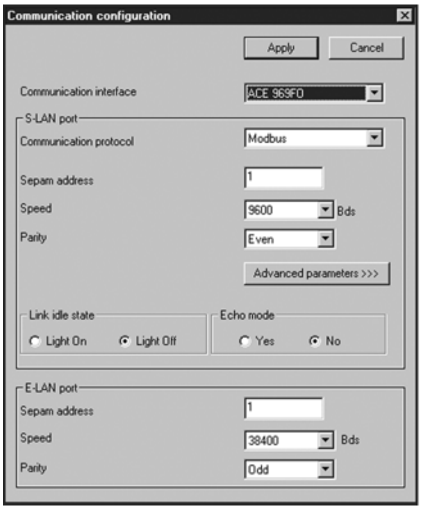
SFT2841: Modbus advanced parameters window

Configuring Modbus Advanced Parameters

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

Advanced Parameters	Authorized Values	Default Value
Remote control mode	Direct or SBO (Select Before Operate) mode	Direct

PE50622



SFT2841: communication configuration window for ACE969FO

Configuring the Physical Layer of the ACE969 E-LAN Port

The E-LAN port on the ACE969TP and ACE969FO communication interfaces is a 2-wire RS485 port.

The configuration parameters for the physical layer of the E-LAN port are:

- Sepam™ address
- transmission speed (parity check type).
  - The number of stop bits is always set at 1
  - If a configuration with parity is selected, each character will contain 11 bits:
    - 1 start bit + 8 data bits + 1 parity bit + 1 stop bit
    - If a no parity configuration is selected, each character will contain 10 bits: 1 start bit + 8 data bits + 1 stop bit

Parameters	Authorized Values	Default Value
Sepam™ address	1 to 247	1
Speed	4800, 9600, 19200 or 38400 baud	38400 baud
Parity	None, Even or Odd	Odd

Configuration Tips

- The Sepam™ address MUST be assigned before Sepam™ is connected to the communication network
- You are also strongly advised to set the other physical layer configuration parameters before making the connection to the communication network
- Modifying the configuration parameters during normal operation will not disturb Sepam™ but will reset the communication port

5

Installing the Communication Network

Preliminary Study

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

- the type of medium (electrical or fiber optic)
- the number of Sepam™ units per network
- the transmission speed
- the ACE interfaces configuration
- the Sepam™ parameter settings

Sepam™ User Manual

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

Preliminary Checks

The following preliminary checks must be made:

- check the CCA612 cord connection between the ACE interface and the Sepam™ base unit
- check the ACE Modbus communication port connection
- check the complete ACE configuration
- check the auxiliary power supply connection for the ACE969

Checking the ACE Interface Operation

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

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

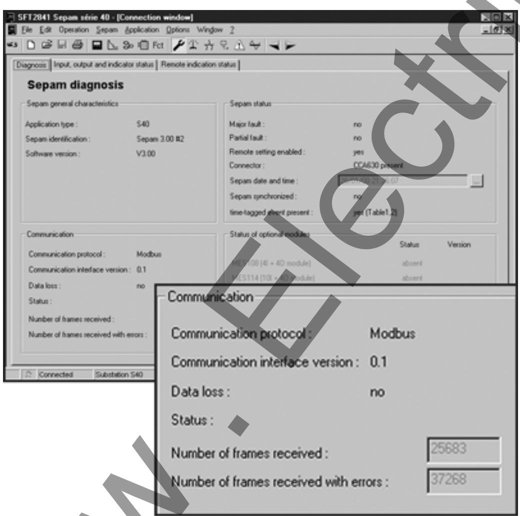
Link Activity LED for ACE9492, ACE959 and ACE937

The link activity LED for ACE9492, ACE959 and ACE937 interfaces flashes when Sepam™ transmission or reception is active.

Indicator LEDs on the ACE969

- green "on" LED: ACE969 energized
- red "key" LED: ACE969 interface status
  - LED off: ACE969 configured and communication operational
  - LED flashing: ACE969 configuration error or ACE969 not configured
  - LED on: ACE969 error
- link activity LED: S-LAN Tx flashing, Sepam™ transmission active
- link activity LED: S-LAN Rx flashing, Sepam™ reception active

PE50623



SFT2841: Sepam™ series 40 diagnosis screen

Diagnosis Using SFT2841 Software

Sepam™ Diagnosis Screen

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

Sepam™ Communication Diagnosis

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

- name of the protocol configured
- Modbus interface version number
- number of valid frames received (CPT9)
- number of invalid (error) frames received (CPT2)

5

Link Activity LED
The ACE interface link activity LEDs are activated by variations in the signal on the Modbus network. When the supervisor communicates with Sepam™ (during transmission or reception), these LEDs flash.

After wiring, check the information given by the link activity LEDs when the supervisor operates.

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

Functional Test
If questions arise about link operation:
- run read/write cycles in the test zone
- use Modbus diagnosis function 8 (sub-code 0, echo mode).

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

Test Zone	
Read	
Transmission	01 03 0C00 0002 C75B
Reception	01 03 04 0000 0000 FA33
Write	
Transmission	01 10 0C00 0001 02 1234 6727
Reception	01 10 0C00 0001 0299
Read	
Transmission	01 03 0C00 0001 875A
Reception	01 03 02 1234 B533
Function 8 - Modbus Diagnosis, Echo Mode	
Transmission	01 08 0000 1234 ED7C
Reception	01 08 0000 1234 ED7C

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

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

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

Using the Counters
Modbus diagnosis counters help to detect and resolve communication problems. They can be accessed by the dedicated read functions (Modbus protocol functions 8 and 11).
CPT2 and CPT9 counters can be displayed on SFT2841 ("Sepam™ Diagnosis" screen).

An incorrect speed (or parity) increments CPT2. Non-reception is signaled by the lack of change on CPT9.

Operating Anomalies
It is advisable to connect the Sepam™ units to the Modbus network one by one. Verify that the supervisor is sending frames to the relevant Sepam™ by checking the activity on the RS232 - RS485 converter (or the fiber-optic converter if there is one) and on the ACE module.

RS485 Network
- check the wiring on each ACE module
- check the tightness of the screw terminals on each ACE module
- check the connection of the CCA612 cord linking the ACE module to the Sepam™ base unit
- ensure that polarization is only at one point
- check for impedance matching at both ends of the RS485 network
- check the auxiliary power supply connection to the ACE969TP
- ensure that the ACE9092 or ACE919 converter being used is connected, powered and set up correctly

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

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

Presentation

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

	Hexadecimal Starting Address	Ending Address	Modbus Functions Enabled
Synchronization zone	0002	0005	3, 16
Identification zone	0006	000F	3
Event Table 1			
Exchange word	0040	0040	3, 6, 16
Events (1 to 4)	0041	0060	3
Event Table 2			
Exchange word	0070	0070	3, 6, 16
Events (1 to 4)	0071	0090	3
Data			
Remote control commands	00F0	00F0	3, 4, 6, 16 1, 2, 5, 15 (1)
Remote control confirmation	00F1	00F1	3, 4, 6, 16 1, 2, 5, 15 (1)
Status	0100	0112	3, 4 1, 2 (1)
Measurements	0113	0158	3, 4
Diagnosis	0159	0185	3, 4
Phase displacement	01A0	01A9	3, 4
Tripping context	0250	0275	3, 4
Switchgear diagnosis	0290	02A5	3, 4
Application	02CC	02FE	3
Test zone	0C00	0C0F	3, 4, 6, 16 1, 2, 5, 15
Protection Settings			
Read zone 1	1E00	1E7C	3
Read request zone 1	1E80	1E80	3, 6, 16
Remote settings zone 1	1F00	1F7C	3, 6
Read zone 2	2000	207C	3
Read request zone 2	2080	2080	3, 6, 16
Remote settings zone 2	2100	217C	3, 16
Disturbance Recording			
Choice of transfer function	2200	2203	3, 16
Identification zone	2204	2271	3
Disturb. rec. exchange word	2300	2300	3, 6, 16
Disturbance recording data	2301	237C	3

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

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

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Synchronization Zone

The synchronization zone is a table that contains the absolute date and time for the time-tagging function. Time messages should be written in a single block containing four words, using function 16: write word.

Messages can be read word by word or by groups of words using function 3.

Synchronization Zone	Word Address	Access	Modbus Function Enabled
Binary time (year)	0002	Read/write	3, 16
Binary time (months + days)	0003	Read	3
Binary time (hours + minutes)	0004	Read	3
Binary time (milliseconds)	0005	Read	3

See "Time-Tagging Events" chapter for data format.

Identification Zone

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

Some of the information in the identification zone is also found in the configuration zone at the address 02CCh.

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

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

Event 1 Zone

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

Events 1 Zone	Word Address	Access	Modbus Function Enabled
Exchange word	0040	Read/write	3, 6, 16
Event n°1	0041-0048	Read	3
Event n°2	0049-0050	Read	3
Event n°3	0051-0058	Read	3
Event n°4	0059-0060	Read	3

See "Time-Tagging Events" chapter for data format.

Event 2 Zone

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

Event 2 Zone	Word Address	Access	Modbus Function Enabled
Exchange word	0070	Read/write	3, 6, 16
Event n°1	0071-0078	Read	3
Event n°2	0079-0080	Read	3
Event n°3	0081-0088	Read	3
Event n°4	0089-0090	Read	3

See "Time-Tagging Events" chapter for data format.

Remote Control Zone

The remote control zone is a table containing the pre-assigned remote control bits (TC). The zone can be read or written using the word functions or bit functions. The use of remote control commands is discussed in detail on page 5/138.

Remote Control Commands	Word Address	Bit Address	Access	Function	Format
TC1-TC16	00F0	0F00	R/W	3/4/6/16 1/2/5/15	B
STC1-STC16	00F1	0F10	R/W	3/4/6/16 1/2/5/15	B

Status Zone

The **status zone** is a table containing the Sepam™ check-word, pre-assigned remote indication bits (TS), logic inputs, logic equation bits, logic outputs, LEDs, and analog output control word.

The TS assignments are discussed in detail on page 5/137.

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

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

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

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

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

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

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

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

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

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

LD : red LED indicating Sepam™ unavailable.

Measurement Zone x 1

Measurements x 1	Word Address	Access	Modbus Function Enabled	Format	Unit
Phase current Ia (x 1)	0113	R	3, 4	16NS	0.1 A
Phase current Ib (x 1)	0114	R	3, 4	16NS	0.1 A
Phase current Ic (x 1)	0115	R	3, 4	16NS	0.1 A
Residual current Ir Sum (x 1)	0116	R	3, 4	16NS	0.1 A
Residual current measured (x 1)	0117	R	3, 4	16NS	0.1 A
Average phase current Ima (x 1)	0118	R	3, 4	16NS	0.1 A
Average phase current Imb (x 1)	0119	R	3, 4	16NS	0.1 A
Average phase current Imc (x 1)	011A	R	3, 4	16NS	0.1 A
Peak demand phase current IMa (x 1)	011B	R	3, 4	16NS	0.1 A
Peak demand phase current IMb (x 1)	011C	R	3, 4	16NS	0.1 A
Peak demand phase current IMc (x 1)	011D	R	3, 4	16NS	0.1 A
Phase-to-phase voltage Vab (x 1)	011E	R	3, 4	16NS	1 V
Phase-to-phase voltage Vbc (x 1)	011F	R	3, 4	16NS	1 V
Phase-to-phase voltage Vca (x 1)	0120	R	3, 4	16NS	1 V
Phase-to-neutral voltage Van (x 1)	0121	R	3, 4	16NS	1 V
Phase-to-neutral voltage Vbn (x 1)	0122	R	3, 4	16NS	1 V
Phase-to-neutral voltage Vcn (x 1)	0123	R	3, 4	16NS	1 V
Residual voltage Vr (x 1)	0124	R	3, 4	16NS	1 V
Positive sequence voltage V1 (x 1)	0125	R	3, 4	16NS	1 V
Negative sequence voltage V2 (x 1)	0126	R	3, 4	16NS	1 V
Frequency	0127	R	3, 4	16NS	0.01 Hz
Active power P (x 1)	0128	R	3, 4	16S	1 kW
Reactive power Q (x 1)	0129	R	3, 4	16S	1 kvar
Apparent power S (x 1)	012A	R	3, 4	16S	1 kVA
Peak demand active power Pm (x 1)	012B	R	3, 4	16S	1 kW
Peak demand reactive power Qm (x 1)	012C	R	3, 4	16S	1 kvar
Power factor cos φ (x 100)	012D	R	3, 4	16S	0.01
Positive active energy Ea+ (x 1)	012E/012F	R	3, 4	2 x 16NS	100 kW.h
Negative active energy Ea- (x 1)	0130/0131	R	3, 4	2 x 16NS	100 kW.h
Positive reactive energy Er+ (x 1)	0132/0133	R	3, 4	2 x 16NS	100 kvar.h
Negative reactive energy Er- (x 1)	0134/0135	R	3, 4	2 x 16NS	100 kvar.h

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Measurement Zone x 10

Measurements x 10	Word Address	Access	Modbus Function Enabled	Format	Unit
Phase current Ia (x 10)	0136	R	3, 4	16NS	1 A
Phase current Ib (x 10)	0137	R	3, 4	16NS	1 A
Phase current Ic (x 10)	0138	R	3, 4	16NS	1 A
Residual current Ir Sum (x 10)	0139	R	3, 4	16NS	1 A
Residual current measured (x 10)	013A	R	3, 4	16NS	1 A
Average phase current Ima (x 10)	013B	R	3, 4	16NS	1 A
Average phase current Imb (x 10)	013C	R	3, 4	16NS	1 A
Average phase current Imc (x 10)	013D	R	3, 4	16NS	1 A
Peak demand phase current IMa (x 10)	013E	R	3, 4	16NS	1 A
Peak demand phase current IMb (x 10)	013F	R	3, 4	16NS	1 A
Peak demand phase current IMc (x 10)	0140	R	3, 4	16NS	1 A
Phase-to-phase voltage Vab (x 10)	0141	R	3, 4	16NS	10 V
Phase-to-phase voltage Vbc (x 10)	0142	R	3, 4	16NS	10 V
Phase-to-phase voltage Vca (x 10)	0143	R	3, 4	16NS	10 V
Phase-to-neutral voltage Van (x 10)	0144	R	3, 4	16NS	10 V
Phase-to-neutral voltage Vbn (x 10)	0145	R	3, 4	16NS	10 V
Phase-to-neutral voltage Vcn (x 10)	0146	R	3, 4	16NS	10 V
Residual voltage Vr (x 10)	0147	R	3, 4	16NS	10 V
Positive sequence voltage V1 (x 10)	0148	R	3, 4	16NS	10 V
Negative sequence voltage V2 (x 10)	0149	R	3, 4	16NS	10 V
Frequency	014A	R	3, 4	16NS	0.01 Hz
Active power P (x 100)	014B	R	3, 4	16S	100 kW
Reactive power Q (x 100)	014C	R	3, 4	16S	100 kvar
Apparent power S (x 100)	014D	R	3, 4	16S	100 kVA
Peak demand active power Pm (x 100)	014E	R	3, 4	16S	100 kW
Peak demand reactive power Qm (x 100)	014F	R	3, 4	16S	100 kvar
Power factor cos φ (x 100)	0150	R	3, 4	16S	0.01
Positive active energy Ea+ (x 1)	0151/0152	R	3, 4	2 x 16NS	100 kW.h
Energie active négative Ea- (x 1)	0153/0154	R	3, 4	2 x 16NS	100 kW.h
Positive reactive energy Er+ (x 1)	0155/0156	R	3, 4	2 x 16NS	100 kvar.h
Negative reactive energy Er- (x 1)	0157/0158	R	3, 4	2 x 16NS	100 kvar.h

Diagnosis

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

Phase Displacement Zone

Phase Displacement	Word Address	Access	Modbus Function Enabled	Format	Unit
Phase displacement φrΣ	01A0/01A1	L	3, 4	32NS	1°
Phase displacement φr	01A2/01A3	L	3, 4	32NS	1°
Phase displacement φa	01A4/01A5	L	3, 4	32NS	1°
Phase displacement φb	01A6/01A7	L	3, 4	32NS	1°
Phase displacement φc	01A8/01A9	L	3, 4	32NS	1°

Tripping Context Zone

Latest Tripping Context	Word Address Modbus	Access	Modbus Function Enabled	Format	Unit
Time-tagging of the context (see "Time-Tagging Events" chapter)	0250/0253	R	3	IEC	-
Tripping current Itripa	0254	R	3, 4	32NS	0.1 A
Tripping current Itripb	0256	R	3, 4	32NS	0.1 A
Tripping current Itripc	0258	R	3, 4	32NS	0.1 A
Residual current Ir Sum	025A	R	3, 4	32NS	0.1 A
Residual current Ir measured	025C	R	3, 4	32NS	0.1 A
Phase-to-phase voltage Vab	025E	R	3, 4	32NS	1 V
Phase-to-phase voltage Vbc	0260	R	3, 4	32NS	1 V
Phase-to-phase voltage Vca	0262	R	3, 4	32NS	1 V
Phase-to-neutral voltage Van	0264	R	3, 4	32NS	1 V
Phase-to-neutral voltage Vbn	0266	R	3, 4	32NS	1 V
Phase-to-neutral voltage Vcn	0268	R	3, 4	32NS	1 V
Residual voltage Vr	026A	R	3, 4	32NS	1 V
Positive sequence voltage V1	026C	R	3, 4	32NS	1 V
Negative sequence voltage V2	026E	R	3, 4	32NS	1 V
Frequency	0270	R	3, 4	32NS	0.01 Hz
Active power P	0272	R	3, 4	32S	1 kW
Reactive power Q	0274	R	3, 4	32S	1 kvar

Switchgear Diagnosis Zone

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

Configuration and Application Zone

Configuration and Application	Word Address	Access	Modbus Function Enabled	Format	Unit
Type of application (1)	02CC	R	3	-	-
Name of application (S40, S41, T42…)	02CD/02D2	R	3	ASCII 12c	-
Sepam™ marking	02D3/02DC	R	3	ASCII 20c	-
Sepam™ application version	02DD/02DF	R	3	ASCII 6c	-
Modbus address (slave number) for Level 2	02E0	R	3	-	-
Modbus address (slave number) for RHM	02E1	R	3	-	-
Marking + type of equipment (3)	02E2	R	3	-	-
Type of connection (0 = Modbus)	02E3	R	3	-	-
Communication version	02E4	R	3	NG	-
MET1482 n° 1 module version	02E5/02E7	R	3	ASCII 6c	-
MET1482 n° 2 module version	02E8/02EA	R	3	ASCII 6c	-
MSA141 module version	02EB/02ED	R	3	ASCII 6c	-
DSM303 module version	02EE/02F0	R	3	ASCII 6c	-
Name of language	02F1/02FA	R	3	ASCII 20c	-
Customized languaged version number (2)	02FB	R	3	-	-
English language version number (2)	02FC	R	3	-	-
Boot version number (2)	02FD	R	3	-	-
Extension word (4)	02FE	R	3	-	-

(1) 40: not configured 41: S40 42: S41 43: S42 44: T40 45: T42 46: M41 47: G40.
(2) MSB: major index, LSB: minor index.
(3) 2E2 word: MSB: 10 h (Sepam™) LSB: hardware configuration.

Bit	7	6	5	4	3	2	1	0
Option	MD/MX	Extension	MET1482/2	DSM303	MSA141	MET1482/1	MES114	MES108
Mod.MX	0	z	x	x	x	x	y	y
Mod.MD	1	z	x	0	x	x	y	y

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

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

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

Examples:		
Ia	Unit = 1 A	Accuracy = 1/2 = 0.5 A
Vab	Unit = 10 V	Accuracy = 10/2 = 5 V

Test Zone

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

Test Zone	Word Address	Bit Address	Access	Modbus Function Enabled	Format	
Test	0C00	C000-C00F	Read/write	1, 2, 3, 4, 5, 6, 15, 16	None	Initialized to 0
	0C0F	C0F0-C0FF	Read/write	1, 2, 3, 4, 5, 6, 15, 16	None	Initialized to 0

Protection Setting Zone

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

Protection Setting	Word Address Zone 1	Word Address Zone 2	Access	Modbus Function Enabled
Setting read buffer	1E00/1E7C	2000/207C	R	3
Setting read request	1E80	2080	R/W	3/6/16
Remote setting request buffer	1F00/1F7C	2100/217C	R/W	3/16

See "Protection settings" chapter.

Fault Recorder zone

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

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

See "Disturbance recording" chapter.

Data Encoding

For all formats

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

16NS format

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

16S format signed measurements (temperatures,…)

The information is encoded in a 16-bit word as a complement of 2.
Example:

- 0001 represents +1
- FFFF represents -1.

32NS or 2 x 16NS format

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

32S format

The information is encoded as a complement of 2 in two words. The first word is the most significant word:

- 0000, 0001 represents +1
- FFFF, FFFF represents -1.

B format

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

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

X format: Sepam™ check-word

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

- Sepam™ operating mode
- time-tagging events.

Each data item contained in the Sepam™ check-word may be accessed bit by bit, from address **1000** for bit 0 to **100F** for bit 15.

- bit 15:event present in event zone 1
- bit 14:Sepam™ in “data loss” status in event zone 1
- bit 13:Sepam™ not synchronous
- bit 12:Sepam™ time not correct
- bit 11:presence of events in event zone 2
- bit 10:Sepam™ in "data loss" status in event zone 2
- bit 9:major fault in Sepam™
- bit 8:partial fault in Sepam™
- bit 7:setting group A in service
- bit 6:setting group B in service
- bit 1:Sepam™ in local setting mode
- other bits reserved (undetermined values).

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

Using Remote Indication Bits

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

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

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

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

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

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

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

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

TS	Application	S40	S41	S42	T40	T42	M41	G40
49	*Reserved*							
50	*Reserved*							
51	*Reserved*							
52	*Reserved*							
53	*Reserved*							
54	*Reserved*							
55	*Reserved*							
56	*Reserved*							
57	*Reserved*							
58	*Reserved*							
59	*Reserved*							
60	*Reserved*							
61	*Reserved*							
62	*Reserved*							
63	*Reserved*							
64	*Reserved*							

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

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

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

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

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

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

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

TS	Application	S40	S41	S42	T40	T42	M41	G40
113	Thermistor tripping	■	■	■	■	■	■	■
114	Thermistor alarm	■	■	■	■	■	■	■
115	External tripping 1	■	■	■	■	■	■	■
116	External tripping 2	■	■	■	■	■	■	■
117	External tripping 3	■	■	■	■	■	■	■
118	Buchholz tripping				■	■		
119	Thermostat tripping				■	■		
120	Pressure tripping				■	■		
121	Buchholz alarm				■	■		
122	Thermostat alarm				■	■		
123	Pressure alarm				■	■		
124	SF6 alarm	■	■	■	■	■	■	■
125	Recloser ready	■	■	■				
126	Inductive	■	■	■	■	■	■	■
127	Capacitive	■	■	■	■	■	■	■
128	Phase inverse rotation	■	■	■	■	■	■	■

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

TS	Application	S40	S41	S42	T40	T42	M41	G40
129	Send blocking input 2			■				
130	*Reserved*							
131	*Reserved*							
132	*Reserved*							
133	*Reserved*							
134	*Reserved*							
135	*Reserved*							
136	*Reserved*							
137	*Reserved*							
138	*Reserved*							
139	*Reserved*							
140	*Reserved*							
141	*Reserved*							
142	*Reserved*							
143	*Reserved*							
144	*Reserved*							

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Using Remote Control Commands

Remote control commands are pre-assigned to protection, control and metering functions. They can be carried out in two modes:

- direct mode
- confirmed SBO (select before operate) mode

It is possible to block all remote control commands with one logic input assigned to the function "block remote control"(1).

The logic input parameter setting can be done in two modes:

- block if the input is at 1
- block if the input is at 0 (negative input)

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

Direct Remote Control Command

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

Confirmed SBO Remote Control Command
(select before operate)

In this mode, remote control commands involve two steps:

- selection by the master of the command to be sent by writing the bit in the STC word and checking of the selection by rereading the word
- execution of the command to be sent by writing the bit in the TC word.

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

Deselection of the STC bit takes place:

- if the master deselects it by writing in the STC word
- if the master selects (write bit) a bit other than the one already selected
- if the master sets a bit in the TC word which does not match the selection. In this case, no remote control command is executed.

(1) The only exception is the remote control tripping command TC1 which can be activated at any time.

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

TC	Application	S40	S41	S42	T40	T42	M41	G40
1	Tripping	■	■	■	■	■	■	■
2	Closing	■	■	■	■	■	■	■
3	Swtiching to setting group A	■	■	■	■	■	■	■
4	Switching to setting group B	■	■	■	■	■	■	■
5	Sepam™ reset	■	■	■	■	■	■	■
6	Peak demand current zero reset	■	■	■	■	■	■	■
7	Block thermal protection				■	■	■	■
8	Block disturbance recording triggering (OPG (1))	■	■	■	■	■	■	■
9	Confirm disturbance recording triggering (OPG (1))	■	■	■	■	■	■	■
10	Manual disturbance recording triggering (OPG (1))	■	■	■	■	■	■	■
11	Enable recloser	■	■	■				
12	Disable recloser	■	■	■				
13	Confirm thermal protection				■	■	■	■
14	Reset undercurrent protection						■	
15	*Reserved*							
16	*Reserved*							

(1) OPG : French acronym for disturbance recording

Remote Control of the Analog Output

The analog output of the MSA141 module can be set up for remote control via the Modbus communication link (word address 010F). The usable range of the numerical value transmitted is defined by the "min. value" and "max. value" settings of the analog output.

This function is not affected by remote control block conditions.

Schneider Electric

Presentation

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

- logic inputs
- remote indications
- information pertaining to Sepam™ equipment (see Sepam™ check-word).

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

Time-Tagging

Sepam™ events time-tagging uses absolute time (see section on date and time). When an event is detected, it is tagged with the absolute time given by Sepam™'s internal clock.

All the Sepam™ internal clocks must be synchronized so as to avoid drifts and all be the same, thereby allowing inter-Sepam™ chronological sorting.

Sepam™ has two mechanisms for managing its internal clock:

- **time-setting**: to initialize or modify the absolute time. A special Modbus message, called "time message", is used to time-set each Sepam™
- **synchronization**: to avoid Sepam™ internal clock drifts and ensure inter-Sepam™ synchronization.

Synchronization may be carried out according to two principles:

- **internal synchronization**: via the communication network without any additional wiring
- **external synchronization**: via a logic input with additional wiring.

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

Initializating the Time-Tagging Function

Each time the communication system is initialized (energizing of Sepam™), the events are generated in the following sequence:

- appearance of "data loss"
- appearance of "incorrect time"
- appearance of "not synchronous"
- disappearance of "data loss".

The function is initialized with the current values of the remote indication and logic input status without creating any events related to those data. After the initialization phase, event detection is activated. It can only be interrupted by saturation of the internal event storage queue or by the presence of a major fault in Sepam™.

Date and Time

Presentation

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

Power Outage Protection

The internal clock of Sepam™ Series 40 is saved for 24 hours. After a power outage that lasts for more than 24 hours, the time must be reset. The period over which Sepam™ data and time settings are maintained in the event of a power outage depends on the ambient temperature and the age of the Sepam™ unit.
Typical values:

- at 77 °F
  - 24 hours for 7 years
  - 18 hours for 10 years
  - 14 hours for 15 years
- at 104 °F
  - 24 hours for 3 years
  - 16 hours for 10 years
  - 10 hours for 15 years

Resetting the Date and Time

The internal clock of Sepam™ Series 40 may be time-set in three different ways:

- by the remote monitoring and control system, through the Modbus link,
- through SFT2841 software tool, "General characteristics" screen
- Sepam™ display units equipped with advanced UMI.

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

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

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

Synchronization Clock

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

Reading Events

Sepam™ provides the master(s) with two event tables. Each master reads the event table and acknowledges by writing the exchange word. Sepam™ then updates its event table.

The events sent by Sepam™ are not sorted chronologically.

Structure of EventTable 1:

- exchange word 0040h
- event number 1

0041h ... 0048h

- event number 2

0049h ... 0050h

- event number 3

0051h ... 0058h

- event number 4

0059h ... 0060h

Structure of Event Table 2:

- exchange word 0070h
- event number 1

0071h ... 0078h

- event number 2

0079h ... 0080h

- event number 3

0081h ... 0088h

- event number 4

0089h ... 0090h

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

Exchange Word

The exchange word manages a special protocol that records events after a communication problem. The event table is numbered for that purpose.

The exchange word includes two fields:

- most significant byte (MSB) = exchange number (8 bits): 0..255

b15	b14	b13	b12	b11	b10	b09	b08
Exchange number: 0 .. 255							

Description of the MSB of the exchange word.

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

Sepam™ numbers the exchanges and the master acknowledges the numbering.

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

b07	b06	b05	b04	b03	b02	b01	b00
Number of events: 0 .. 4							

Description of the LSB of the exchange word.

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

Event Table Acknowledgment

To inform Sepam™ that the block read by the master has been correctly received, the master writes the number of the last exchange made in the "Exchange number" field, and resets the "Number of events" field of the exchange word to zero. After acknowledgment, the four events in the event table are initialized to zero and the old, acknowledged events are erased in Sepam™.

Until the exchange word written by the master becomes "X,0" (with X = number of the previous exchange that the master wishes to acknowledge), the exchange word in the table remains at "X, number of previous events".

Sepam™ only advances the exchange number when new events are present (X+1, number of new events).

If the event table is empty, Sepam™ performs no processing operations when the master reads the event table or the exchange word.
The data are encoded in binary format.

Clearing an Event Queue

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

Sepam™ in Data Loss (1) / No Data Loss (0) status

Sepam™ has two internal storage queues with a capacity of 64 events. If one of the queues becomes filled, namely, 63 events already present, the "**data loss**" event is generated by Sepam™ in the 64th position.

The event detection process stops and the most recent events are lost.

Event Encoding Description

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

Most Significant Byte	Least Significant Byte	
Word 1: Event Type		
08	00	For remote indications, internal data logic inputs
Word 2: Event Address		
		See bit adresses 1000 to 10BF
Word 3: Reserved		
00	00	
Word 4: Falling Edge: Disappearance or Rising Edge: Appearance		
00	00	Falling edge
00	01	Rising edge
Word 5: Year		
00	0 to 99 (year)	
Word 6: Month-Day		
1 to 12 (month)	1 to 31 (day)	
Word 7 : Hours-Minutes		
0 to 23 (hours)	0 to 59 (minutes)	
Word 8: Milliseconds		
0 to 59999		

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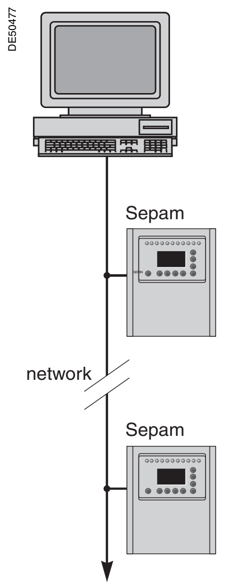


Architecture for "internal synchronization" via the communication network.

Synchronization

Sepam™ accommodates two synchronization modes:

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

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

Internal Synchronization via Network Mode

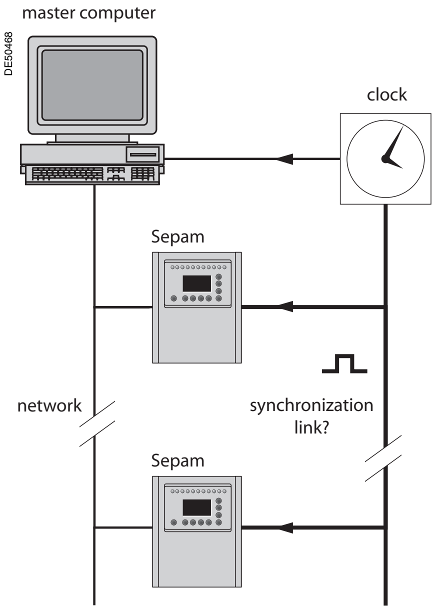
The “time message" frame is used for both time-setting and Sepam™ synchronization. It must be sent regularly at brief intervals (between 10 and 60 seconds) in order for synchronous time to be obtained.

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

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

Sepam™ is synchronized without delay at the end of the receipt of the frame. Time changes are made by sending a frame to Sepam™ with the new date and time. Sepam™ then switches into a transitional non-synchronous status.

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



Architecture for "external synchronization" via a logic input.

Synchronization (cont'd)

External Synchronization via a Logic Input Mode

Sepam™ can be synchronized externally by means of a logic input (I21) (the MES114 module is required). The synchronization pulse is determined by the rising edge of the logic input.

Sepam™ can adapt to all synchronization pulse periods from 10 to 60 s, by 10 s steps. The shorter the synchronization period, the more accurate time-tagging of status changes is.

The first time frame is used to initialize Sepam™ with the absolute date and time. The following frames are used to detect any time changes.

The synchronization pulse resets Sepam's internal clock. In the initialization phase, when Sepam™ is in "non-synchronous" mode, resetting is allowed within a window of ±4 seconds.

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

After switching to "synchronous" mode, the resetting process is based on measuring a difference between Sepam™'s current time and the nearest ten second period when a synchronization pulse is received. Resetting is adapted to match the synchronization pulse period.

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

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

Any time changes greater than ±4 seconds are made by sending a new time frame. The switch from summer time to winter time (and vice versa) is made in this way as well. There is a temporary loss of synchronism when the time is changed.

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

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

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

Remote Reading

Settings Accessible for Remote Reading
Reading of the settings of all the protection functions may be accessed remotely in two independent zones to enable operation with two masters.

Exchange Principle
Remote reading of settings (remote reading) takes place in two steps:
- first of all, the master indicates the code of the function for which it wishes to know the settings by means of a "request frame". The request is acknowledged, in the Modbus sense of the term, to free the network
- the master then reads a reply zone to find the required information by means of a "reply frame".

Each function has its own particular reply zone contents. The time needed between the request and the reply is linked to Sepam™'s low-priority cycle time and may vary from a few tens to several hundreds of milliseconds.
- setting zone 1
  - read: 1E00h-1E7Ch
  - read request: 1E80h
  - remote setting: 1F00h-1F7Ch
- setting zone 2
  - read: 2000h -207Ch
  - read request: 2080h
  - remote setting: 2100h -217Ch

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

1E80h/2080h

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

The content of the address 1E80h/2080h can be read using a Modbus "read word" operation (function 3).
The function code field may have the following values:
- 01h to 99h (BCD encoding) for protection functions.

The unit number field is used as follows:
- for protection functions, it indicates the unit involved, varying from 1 to N, N being the maximum number of relays available in the Sepam™
- when only one unit of a protection function is available, this number field is not controlled.

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

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

1E00h-1E7Ch/2000h-207Ch

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

This zone is read by a Modbus "read word" operation (function 3) at the address 2000h.

The length of the exchange may concern:
- first word only (validity test)
- maximum size of the zone (125 mots)
- usable size of the zone (determined by the function being addressed).

However, reading must always begin at the first word in the zone (any other address triggers an exception reply "incorrect address"). The first word in the zone (function code and unit number) can have the following values:
- **xxyy**: with
  - function code xx different from 00 and FFh
  - unit number yy different from FFh.

The settings are available and confirmed. They word is a copy of the "request frame". The zone contents remain valid until the next request is made.
- **FFFFh**: the "request frame" has been processed, but the results in the "reply zone" are not yet available. It is necessary to repeat "reply frame" reading. The other words are not significant.
- **xxFFh**: with the function code xx different from 00 and FFh. The read request for the settings of the designated function is not valid. The function is not included in the particular Sepam™, or remote reading of it is not authorized: refer to the list of functions which accommodate remote reading of settings.

CAUTION

RISK OF UNINTENDED OPERATION

- The device must only be configured and set by qualified personnel, using the results of the installation protection system study.
- During installation commissioning and following any modification, verify that the Sepam™ configuration and protection function settings are consistent with the results of this study.

Failure to follow these instructions can result in equipment damage.

Remote Setting

Data that can be Remotely Set

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

Exchange Principle

Remote setting is allowed for Sepam™ units.
Remote setting is carried out for a given function unit by unit.
It takes place in two steps:

- first of all, the master indicates the function code and unit number, followed by the values of all the settings in the "write request frame". The request is acknowledged to free the network
- the master then reads a reply zone designed for checking that the settings have been processed. Each function has its own particular reply zone contents.
  They are the same as those of the remote reading function reply frame.

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

Request Frame

The request is made by the master using a "write n words" operation (function 16) at the address 1F00h or 2100h. The zone to be written contains a maximum of 125 words.
It contains the values of all the settings and consists of the following:

1F00h/2100h

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

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

- the function code field may have the following values:
  01h to 99h (BCD encoding) for the list of protection functions F01 to F99
- the unit number field is used for protection functions. It indicates the unit involved, varying from 1 to N, N being the maximum number of units available in the Sepam™. It may never be equal to 0.

Exception Reply

In addition to the usual cases, le Sepam™ can send type 07 exception replies (not acknowledged) if:

- another remote reading or setting request is being processed
- the remote setting function is blocked.

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

1E00h-1E7Ch/2000h-207Ch

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

This zone is read by a "read n words" operation (function 3) at the address 1E00h or 2000h.
The length of the exchange may affect:
- first word only (validity test)
- maximum size of the zone (125 words)
- usable size of the zone (determined by the function being addressed).

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

The first word in the zone (function code and unit number) has the same values as those described for the remote reading reply frame.
- **xxyy**: with:
  - function code xx different from 00 and FFh
  - unit number yy different from FFh.

The settings are available and confirmed. The word is a copy of the "request frame".

The zone contents remain valid until the next request is made.
- **0000h**: no "request frame has yet been formulated.

This is espcially the case when Sepam™ is energized.

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

Description of Settings

Data format

All the settings are transmitted in signed 32-bit integer format (encoding, as a complement of 2).

Particular setting value:

7FFF FFFFh means that the setting is out of the validity range.

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

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

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

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

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

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

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

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

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

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

General Settings (Read Only)

Function number: 3002

Setting	Data	Format/Unit
1	Rated frequency	0 = 50 Hz, 1 = 60 Hz
2	Remote setting enabled	1 = disabled
3	Working language	0 = English, 1 = other
4	Active group of settings	0 = Group A 1 = Group B 3 = Choice by I13 4 = Choice by remote control
5	Setting mode	0 = TMS, 1 = I/Is
6	Phase CT rating	0 = 5 A, 1 = 1 A, 2 = LPCT
7	Number of phase CTs	0 = 3 CTs, 1 = 2 CTs
8	Rated current IN	A
9	Basic current IB	A
10	Residual current determination mode	0 = None 1 = 2 A CSH 2 = 20 A CSH 3 = 1 A CT 4 = 5 A CT 5 = ACE990 Range 1 6 = ACE990 Range 2 7 = 5 A CSH 8 = Sensitive 1 A CT 9 = Sensitive 5 A CT
11	Rated residual current (INr)	0.1 A
12	Integration period	0 = 5 mn, 1 = 10 mn 2 = 15 mn, 3 = 30 mn 4 = 60 mn
13	*Reserved*	
14	Rated primary voltage V_{LL}p	V
15	Rated secondary voltage V_{LL}s	0 = 100 V, 1 = 110 V 2 = 115 V, 3 = 120 V 4 = 200 V, 5 = 250 V
16	VT wiring	0 = 3 V, 1 = 2 V, 2 = 1 V
17	Residual voltage mode	0 = None 1 = Σ 3 V 2 = external VT – $V_{LL}s/\sqrt{3}$ 3 = external VT – $V_{LL}s/3$
18	Type of cubicle	0 = main 1= feeder
19	Increment active power	0.1 kW.h
20	Increment reactive power	0.1 kVAR

Protection Settings

Protection settings are organized according to increasing ANSI codes.

ANSI 27/27S - Undervoltage

Function number: 10xx

relay 1: xx = 01, relay 2: xx = 02

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Voltage mode	0 = phase-to-neutral, 1 = phase-to-phase
7	V_{LL}s (or V_{Ln}s) set point	% V_{LL}p (or V_{Ln}p)
8	Tripping time delay	10 ms
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-
12	*Reserved*	-

ANSI 27D - Positive Sequence Undervoltage

Function number: 08xx

relay 1 : xx = 01, relay 2 : xx = 02

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

ANSI 27R - Remanent Undervoltage

Function number: 0901

Setting	Data	Format/Unit
1	Latching	⑥
2	*Reserved*	-
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	V_{LL}s set point	% V_{LL}p
7	Tripping time delay	10 ms
8	*Reserved*	-
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-

ANSI 32P - Active Overpower

Function number: 2301

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

5

ANSI 32Q - Reactive Overpower
Function Number: 2401

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

ANSI 37 - Phase Undercurrent
Function number: 0501

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

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

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

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

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

ANSI 47 - Negative Sequence Overvoltage
Function number: 1901

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Vs2 set point	% V_{LL}p
7	Tripping time delay	10 ms
8	*Reserved*	-
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-

ANSI 48/51LR/14 - Locked Rotor, Excessive Starting Time
Function number: 0601

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

ANSI 49RMS - Thermal Overload
Function number: 0401

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

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

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

ANSI 50BF - Breaker Failure
Function number: 2001

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

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

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

ANSI 51V - Voltage-Restrained Phase Overcurrent
Function number: 2501

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

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

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Voltage mode	0 = phase-to-neutral 1 = phase-to-phase
7	V_{LL}s (or V_{Ln}s) set point	% V_{LL}p (or V_{Ln}p)
8	Tripping time delay	10 ms
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-
12	*Reserved*	-

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

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Vsr set point	% V_{LL}p
7	Tripping time delay	10 ms
8	*Reserved*	-
9	*Reserved*	-
10	*Reserved*	-
11	*Reserved*	-

ANSI 66 - Starts per Hour
Function number: 0701

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

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

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

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

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

ANSI 79 - Recloser
Function number: 1701

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

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

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

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

Setting	Data	Format/Unit
1	Latching	⑥
2	CB control	⑥
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Fs set point	0.1 Hz
7	Tripping time delay	10 ms
8	Restraint	0 none 1 on frequency variation
9	Vs set point	% V_{LL}p
10	Blocked threshold	on frequency variation

Other Protection Settings

ANSI 60 - CT Supervision

Function number: 2601

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

ANSI 60FL - VT Supervision

Function number: 2701

Setting	Data	Format/Unit
1	*Reserved*	-
2	*Reserved*	-
3	Activity	①
4	*Reserved*	-
5	*Reserved*	-
6	Check loss of 3 V/2 V_{LL}	⑥
7	Test current	⑥
8	Use V2, I2 criterion	⑥
9	Behavior on 27/27S, 27D, 32P, 32Q, 47, 51V, 59, 59N functions	0 none, 1 block
10	Behavior on 67 function	0 non directional, 1 block
11	Behavior on 67N function	0 non directional, 1 block
12	V2 set point	% Vn
13	I2 set point	% In
14	Time delay loss 3 V/ 2 V_{LL}	10 ms
15	Time delay V2, I2	10 ms
16	*Reserved*	-
17	*Reserved*	-
18	*Reserved*	-
19	*Reserved*	-

Presentation

The disturbance recording function is used to record analog and logical signals during a time interval.
Sepam™ Series 40 can store up to 19 records.
Each record is made up of two files:

- configuration file with suffix .CFG
- data file with suffix .DAT.

The data of each record may be transferred via the Modbus link.

It is possible to transfer 15 records at 60 Hz to a remote monitoring and control system. A record can be transferred as many times as possible until it is overwritten by a new record.

If a record is made by Sepam™ while the oldest record is being transferred, the oldest record is stopped.

If a command (such as a remote read or remote setting request) is carried out during the transfer of a disturbance recording record, the record in not disturbed.

Time-Setting

Each record can be dated.
Time-setting of Sepam™ is described in the "Time-Tagging Events" section.

Transferring Records

Transfer requests are made record by record. A configuration file and a data file are produced for each record.

The master sends the commands to:

- determine the characteristics of the records stored in an identification zone
- read the contents of the different files
- acknowledge each transfer
- reread the identification zone to ensure that the record still appears in the list of records available.

Two transfer zones are available:

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

Reading the Identification Zone

Given the volume of data to be transmitted, the master must ensure that there are data to be recovered and prepare the exchanges when necessary.
The identification zone, described below, is read by the reading of N words starting at the address 2204h/2404h:

- two reserve words forced to 0
- size of record configuration files encoded in one word
- size of record data files encoded in two words
- number of records encoded in one word
- date of record 1 (most recent) encoded in four words (see format below)
- date of record 2 encoded in four words (see format below)
- ...
- date of record 19 (least recent) encoded in four words (see format below)
- 28 reserve words.

These data are all consecutive.

Reading the Contents of the Different Files

Request Frame

The master makes the request by writing the date of the record to be transferred (function 16) in four words starting at the address 2200h.

Requesting a new record amounts to stopping the transfers that are in progress. This is not the case for an identification zone transfer request.

2200h/2400h

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

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

Reply Frame

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

2300h/2500h

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

Reading should always begin with the first word in the address zone (any other address triggers an exception reply "incorrect address").

The configuration and data files are read in their entirety in Sepam™. They are transferred adjacently.

If the master requests more exchanges than necessary, the exchange number remains unchanged and the number of usable bytes is forced to 0. To guarantee data transfers, a response time of about 500 ms between each read operation at 2300h is allowed

The first word transmitted is an exchange word. The exchange word comprises two fields:
- the most significant byte contains the exchange number. It is initialized to zero after an energizing operation. It is incremented by 1 by Sepam™ each time a transfer takes place successfully. When it reaches the value FF, it automatically goes back to zero
- the least significant byte contains the number of usable bytes in the data zone. It is initialized to zero after an energizing operation and must be different from FFh.

The exchange word may also have the following values:
- **xxyy**: the number of usable bytes in the data zone yy must be different from FFh
- **0000h**: no "read requeste frame" has yet been formulated. This is especially true when Sepam™ is energized. The other words are not significant.
- **FFFFh**: the "request frameé has been processed, but the results in the reply zone are not yet available.

It is necessary to repeat "reply frame" reading. The other words are not significant. The words that follow the exchange word make up the data zone.

SInce the configuration and data files are adjacent, a frame may contain the edn of the configuration and the beginning of the data file of a record.

The remote monitoring and control system software must reconstruct the files in accordance with the transmitted number of usable bytes and the size of the files indicated in the identification zone.

Acknowledging a Transfer

To inform Sepam™ that a record block that it has just read has been received correctly, the master must write the number of the last exchange that it has carried out in the "exchange number" field and set the "number of usable bytes in the data zone" of the exchange word to zero.

Sepam™ only increments the exchange number if new acquisition bursts are present.

Rereading the Identification Zone

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

Presentation

The "Read Device Identification" function is used to access the information required (in a standardized manner) in order to clearly identify a device. The description is made up of a set of objects (ASCII character strings).

Sepam™ Series 40 accepts the "read identification" function (conformity level 02).

For a complete description of the function, go to **www.modbus.org**. The description below covers a subset of the function, adapted to Sepam™ Series 40.

Implementation

Request Frame

The request frame is made of the following components.

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

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

Reply Frame

The reply frame is made of the following components.:

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

Exception Frame

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

Field	*Size (bytes)*	
Slave number	1	
171 (ABh)	1	*Generic access exception (2Bh + 80h)*
14 (0Eh)	1	*Read device identification*
01 or 03	1	*Type of error*
CRC16	2	

Sepam™ Series 40 Identification

The objects making up the Sepam™ Series 40 identification are listed below.

Number	Type	Value
0	VendorName	"Square D"
1	ProductCode	Application EAN13 code
2	MajorMinorRevision	Application version number (Vx.yy)
3	VendorURL	"www.schneider-electric.com"
4	ProductName	"Sepam™ Series 40"
5	ModelName	Application name ("M41 Motor")
6	UserAppName	Sepam™ marking

5

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Contents

Safety Instructions
Before Starting

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

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. In the USA, see NFPA 70E.
- Only qualified electrical workers should install this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Before performing visual inspections, tests, or maintenance of this equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Turn off all power supplying the power meter and the equipment in which it is installed before working on it.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Before closing all covers and doors, carefully inspect the work area for tools and objects that may have been left inside the equipment.
- Use caution while removing or installing panels so that they do not extend into the energized bus; avoid handling the panels, which could cause personal injury.
- Successful equipment operation requires proper handling, installation, and operation. Neglecting fundamental installation requirements may lead to personal injury as well as damage to electrical equipment or other property.
- NEVER bypass external fusing.
- NEVER short the secondary of a Power Transformer (PT).
- NEVER open circuit a Current Transformer (CT); use the shorting block to short circuit the leads of the CT before remooving the connection from the power meter.
- Before performing Dielectric (Hi-Pot) or Megger testing on any equipment in which the Sepam™ is installed, disconnect all input and output wires to the Sepam™. High voltage testing may damage electronic components contained in the Sepam™.
- Sepam™ should be installed in a suitable electrical enclosure.

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

Schneider Electric

We recommend following the instructions given in this document for quick, correct installation of your Sepam™ unit:

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

Handling,Transport and storage

Sepam™ in its Original Packaging

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

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

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

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

Periodic, yearly checking of the environment and the packaging condition is recommended.

Sepam™ should be energized as soon as possible once it has been unpacked.

Sepam™ Installed in a Cubicle

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

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

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

Environment of the Installed Sepam™

Operating in a Damp Environment
The temperature/relative humidity factors must be compatible with the unit's environmental withstand characteristics.

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

Operating in a Polluted Atmosphere
A contaminated industrial atmosphere (such as the presence of chlorine, hydrofluoric acid, sulfur, solvents, etc.) can cause corrosion of the electronic components, in which case environmental control arrangements should be made (such as pressurized premises with filtered air, etc.) before commissioning.

The effect of corrosion on Sepam™ has been tested according to the IEC 60068-2-60 standard. Sepam™ is certified level C under the following test conditions:

- 2-gas test: 21 days, 77°F (25°C), 75% relative humidity, 0.5 ppm H_2S, 1 ppm SO_2
- 4-gas test: 21 days, 77°F (25°C), 75% relative humidity, 0.01 ppm H_2S, 0.2 ppm SO_2, 0.2 ppm NO_2, 0.01 ppm Cl_2.

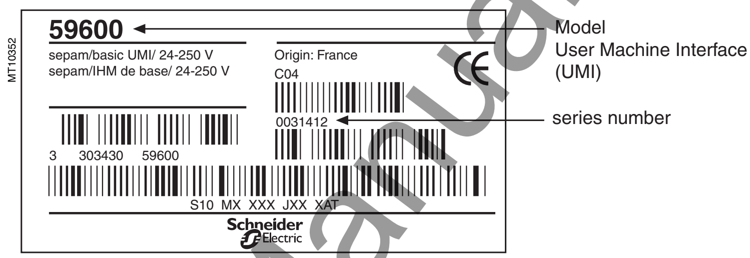
Base Unit Identification

Each Sepam™ comes in a single package which contains
The base unit and two connectors:

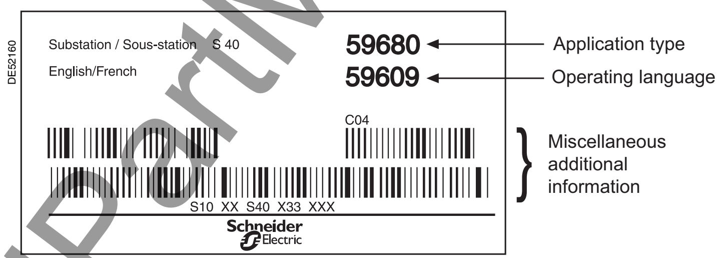
- 1 x 20-pin connector (CCA620 or CCA622)
- 1 x 6-pin connector (CCA626 or CCA627)

The other optional accessories such as modules, current input connectors or voltage and cables are supplied in separate packages.
To identify a Sepam™, check the 2 labels on the right side panel of the base unit describing the product's functional and hardware features.

- Hardware reference and designation label



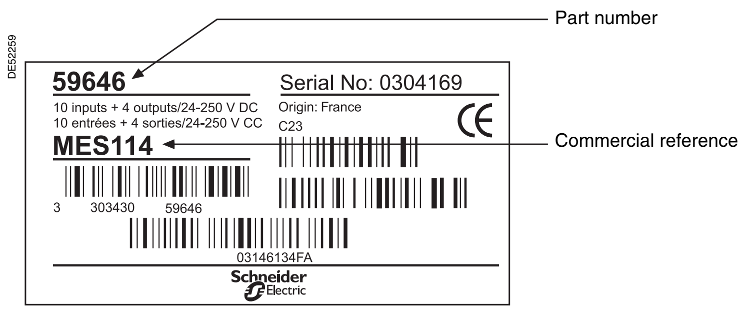
- Software reference and designation label



Identification of Accessories

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

- Example of MES114 module identification label:



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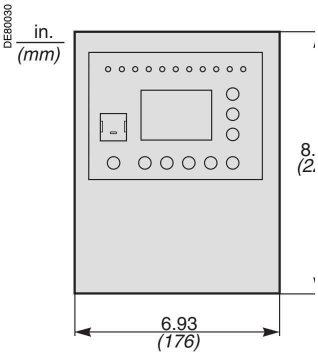
List of Sepam™ Series 40 References

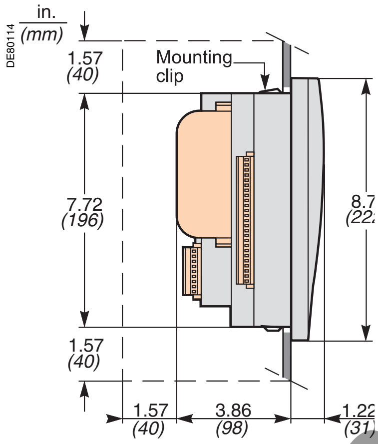
US Catalog	Description
SQ1S40	S40 Substation application with advanced UMI, 24-250 V DC and 100-240 V AC power supply
DSM303	Remote advanced UMI module
CCA630	Connector for 1 A/5 A CT current sensors
CCA634	Connector for 1 A/5 A CT + Ir current sensors
CCA670	Connector for LPCT current sensors
CSH30	Interposing ring CT for Ir input
CSH120	Zero sequence sensor, diameter 4.75 in (120 mm)
CSH200	Zero sequence sensor, diameter 7.87 (200 mm)
AMT852	Lead sealing accessory
MET1482	8-temperature sensor module
ACE9492	2-wire RS485 network interface
ACE959	4-wire RS485 network interface
ACE937	Optical fiber interface
MES114	10 input + 4 output module/24-250 V DC (1)
MSA141	1 analog output module
ACE9092	RS485/RS232 converter
ACE919CA	RS485/RS485 interface (AC power supply)
ACE919CC	RS485/RS485 interface (DC power supply)
MES114E	10 input + 4 output module/110-125 V DC and V AC
MES114F	10 input + 4 output module/220-250 V DC and V AC
CCA626	6-pin screw type connector
CCA627	6-pin ring lug connector
CCA770	Remote module connection cable, L = 2 ft. (0.6 m)
CCA772	Remote module connection cable, L = 6.6 ft (2 m)
CCA774	Remote module connection cable, L = 13.1 ft (4 m)
CCA612	Communication network interface cable, L = 9.8 ft (3 m)
CCA783	PC connection cable
CCA613	LPCT test plug
ACE917	LPCT injection adapter
CCA620	20-pin screw type connector
CCA622	20-pin ring lug connector
AMT840	Mounting plate
ACE990	Zero sequence CT interface for Ir input
2640KIT	Two sets of spare connectors for MES114
SFT2841CD	CD-ROM with SFT2841 and SFT2826 software (w/o CCA783 cable)
ACE969TP	2-wire RS485 multi-protocol interface (Modbus, DNP3 or IEC 60870-5-103)
ACE969FO	Fiber-optic multi-protocol interface (Modbus, DNP3 or IEC 60870-5-103)

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

Dimensions

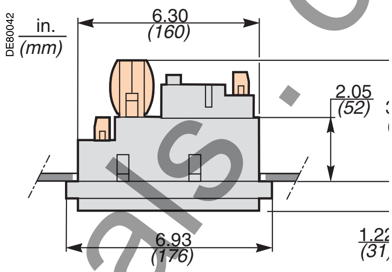


Front view of Sepam™.



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

Clearance for Sepam™ assembly and wiring.



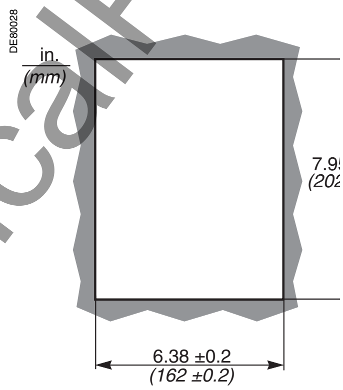
Sepam™ with advanced UMI and MES114, flush-mounted in front panel.

(1) With basic UMI: 0.91 in (23 mm)

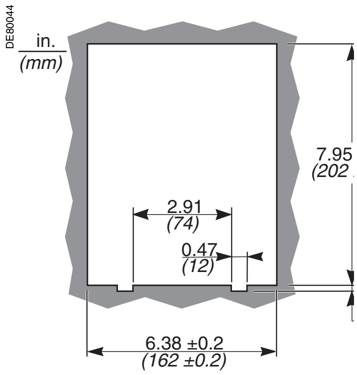
Cut-out

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

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



For mounting plate 0.125 in (3.17 mm) thick

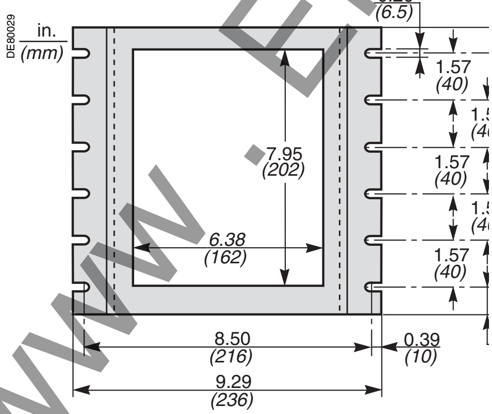


CAUTION
HAZARD OF CUTS Trim the edges of the cut-out plates to remove any jagged edges. **Failure to follow this instruction can cause serious injury.**

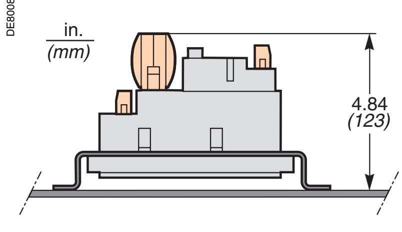
6

Assembly with AMT840 Mounting Plate

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



AMT840 mounting plate



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

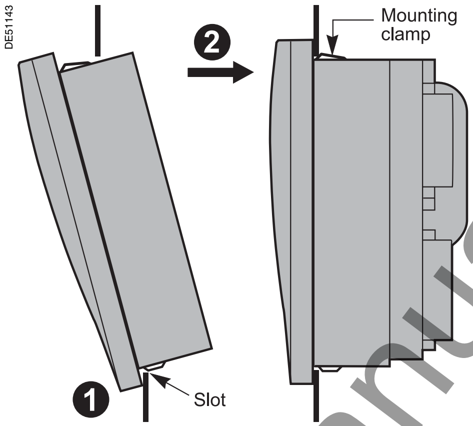
⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

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

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

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



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

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

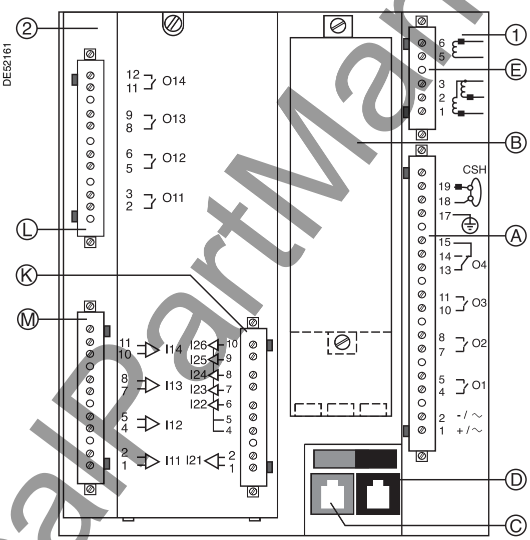
Sepam™ Components

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

Screw-type connector shown (CCA620), or ring lug connector (CCA622)

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

DE52161



Connection of the Base Unit

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

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.

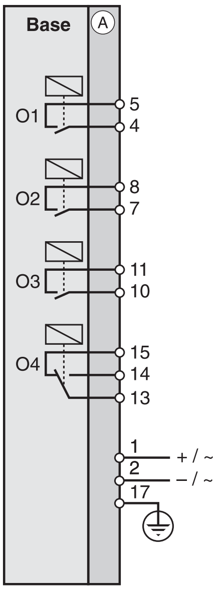
DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

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

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

DE51131



Wiring Connectors CCA620 and CCA626:

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

Wiring Connectors CCA622 and CCA627:

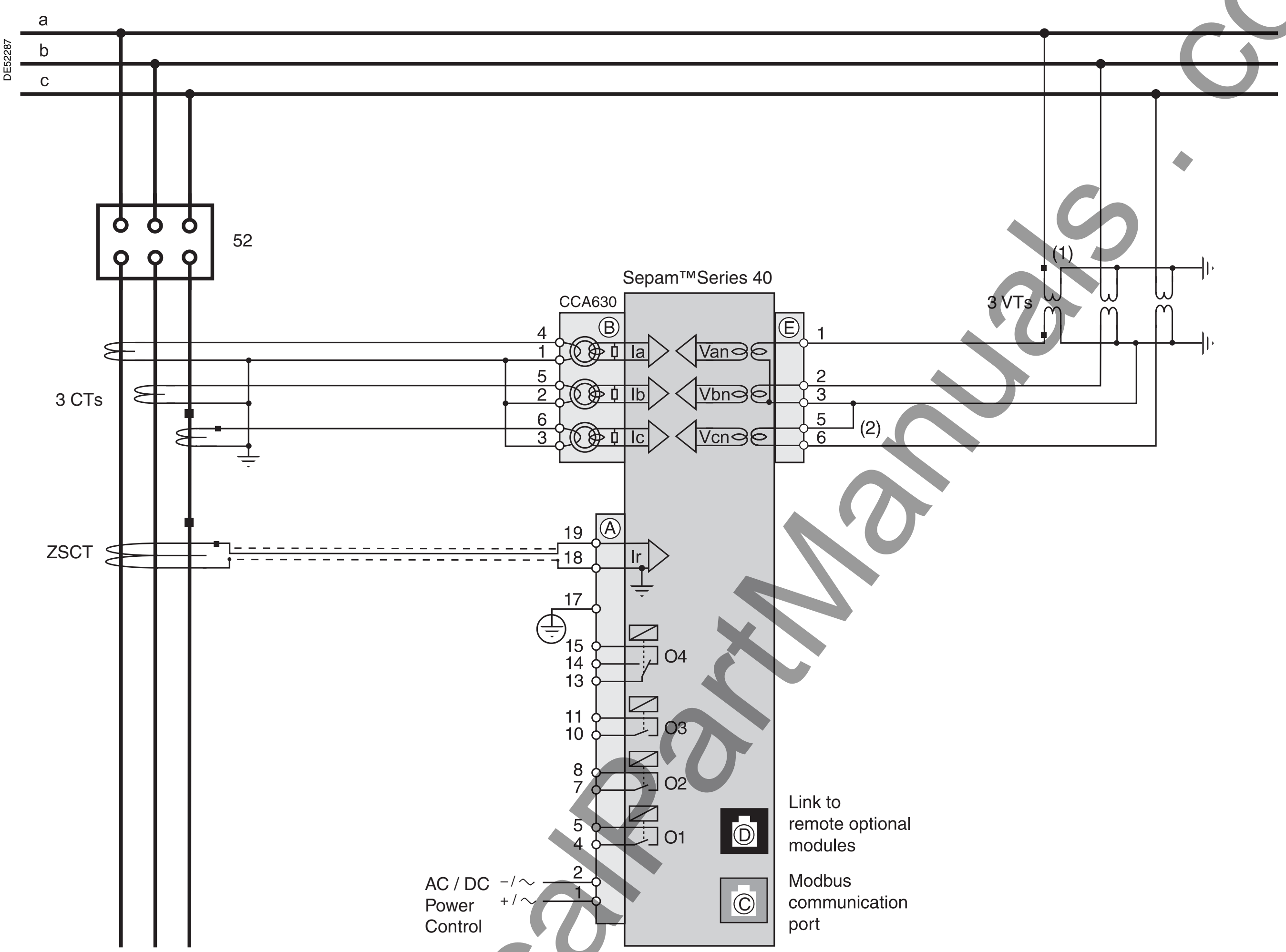
Ring lug connectors 0.25 in (6.35 mm).

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

- O1 and O2 are two control outputs, used by the breaking device control function for:
  - O1: breaking device tripping
  - O2: breaking device closing blocked
- O3 and O4 are indication outputs, only O4 can be activated by the watchdog function.

6

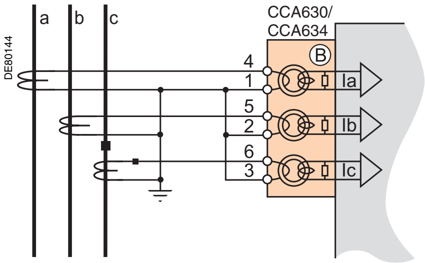
Base Unit
Current Input Connection



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

Base Unit
Other Phase Current Input Connection Schemes

Variant 1: Phase Current Measurements by Three 1A or 5A CTs (Standard Connection)

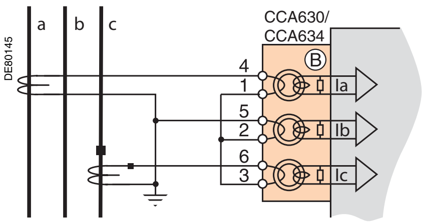


Description
The simplified schematic shows a basic connection of three 1A or 5A sensors to the CCA630 or CCA634 connector. Measuring the three phase currents provides for calculating residual current.

Parameters

Sensor type	5 A CT or 1 A CT
Number of CTs	Ia, Ib, Ic
Rated current (IN)	1 A to 6250 A

Variant 2: Phase Current Measurement by Two 1A or 5A CTs



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

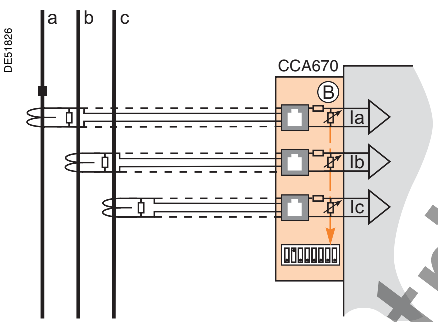
Measuring phase a and phase c currents is sufficient to ensure all the phase current-based protection functions. Phase current Ib is only assessed for metering functions, assuming that Ir = 0.

This arrangement does provide for calculating residual current.

Parameters

Sensor type	5 A CT or 1 A CT
Number of CTs	Ia, Ic
Rated current (IN)	1 A to 6250 A

Variant 3: Phase Current Measurement by Three LPCT Type Sensors



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

Measuring the three phase currents provides for calculating residual current.

Parameters

Sensor type	LPCT
Number of CTs	Ia, Ib, Ic
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 CCA670 connector*

Base Unit
Other Residual Current Input Connection Schemes

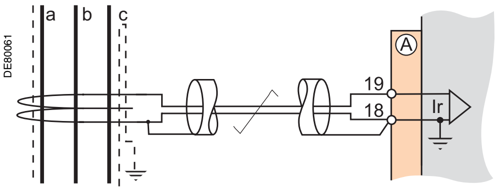
Variant 1: Residual Current Calculation by Summing Three Phase Currents

Description
Residual current is calculated by the vector sum of the three phase currents Ia, Ib, and Ic, measured by three 1A or 5A CTs or by three LPCT type sensors.
See the current input connection diagrams for more information.

Parameters

Residual Current	Rated Residual Current	Measuring Range
None	INr = In, CT primary current	0.1 to 40 INr

Variant 2: Residual Current Measurement by CSH120 or CSH200 Zero Sequence CT (standard connection)

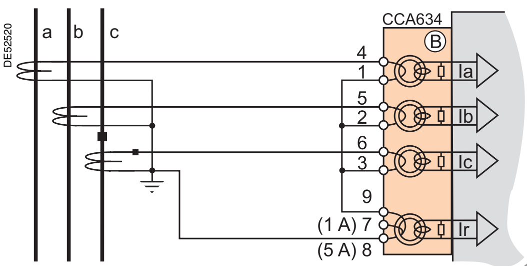


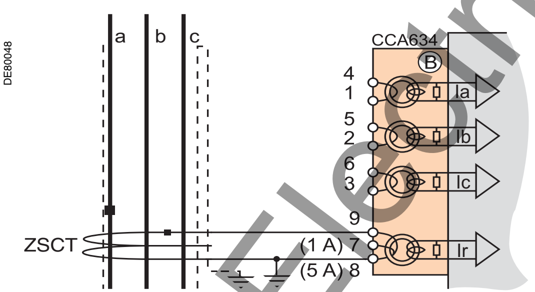
Description
Arrangement recommended for the protection of effectively ungrounded or compensated neutral systems (designed to compensate for system capacitance using a tuned inductor in the neutral. This is not common in North America)., in which very low fault currents need to be detected.

Parameters

Residual Current	Rated Residual Current	Measuring Range
2 A rating CSH	INr = 2 A	0.2 to 40 A
5 A rating CSH	INr = 5 A	0.5 to 100 A
20 A rating CSH	INr = 20 A	2 to 400 A

Variant 3: Residual Current Measurement by 1A or 5A CTs and CCA634





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

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

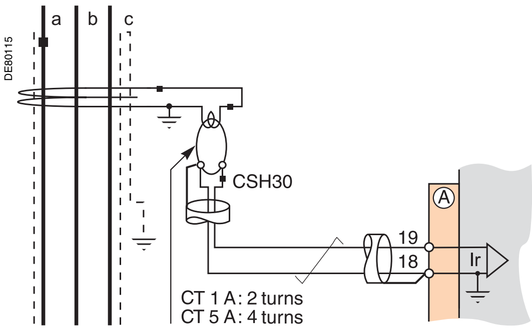
Parameters

Residual Current	Rated Residual Current	Measuring Range
1 A CT	INr = IN, CT primary current	0.1 to 20 INr
Sensitive 1 A CT	INr = IN/10	0.1 to 20 INr
5 A CT	INr = IN, CT primary current	0.1 to 20 INr
Sensitive 5 A CT	INr = IN/10	0.1 to 20 INr

Schneider Electric

Base Unit
Other Residual Current Input Connection Schemes

Variant 4: Residual Current Measurement by 1A or 5A CTs and CSH30 Interposing Ring CT



Description

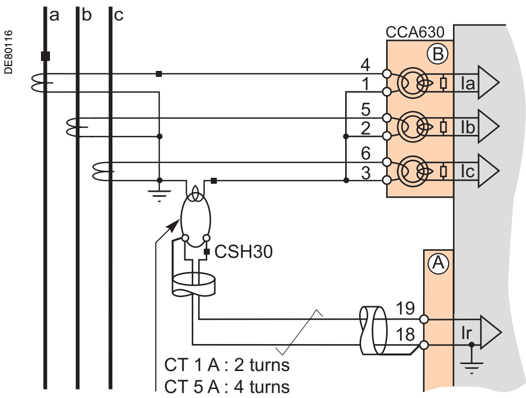
The CSH30 interposing ring CT is used to connect 1A or 5A CTs to Sepam™ to measure residual current:

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

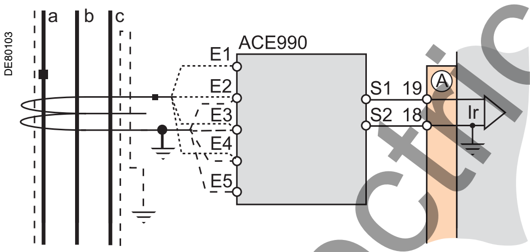
The sensitivity can be multiplied by 10 using the "sensitive" parameter setting with $I_{Nr} = I_N/10$.

Parameters

Residual Current	Rated Residual Current	Measuring Range
1 A CT	$I_{Nr} = I_N$, CT primary current	0.1 to 20 I_{Nr}
Sensitive 1 A CT	$I_{Nr} = I_N/10$	0.1 to 20 I_{Nr}
5 A CT	$I_{Nr} = I_N$, CT primary current	0.1 to 20 I_{Nr}
Sensitive 5 A CT	$I_{Nr} = I_N/10$	0.1 to 20 I_{Nr}



Variant 5: Residual Current Measurement by Zero Sequence CT with Ratio of 1/n (n between 50 and 1500)



Description

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

This arrangement allows the continued use of existing zero sequence CTs on the installation.

Parameters

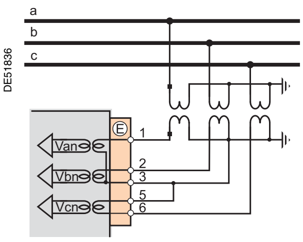
Residual Current	Rated Residual Current	Measuring Range
ACE990 - range 1 ($0.00578 \leq k \leq 0.04$)	$I_{Nr} = Ik.n$ (1)	0.1 to 20 I_{Nr}
ACE990 - range 2 ($0.0578 \leq k \leq 0.26316$)	$I_{Nr} = Ik.n$ (1)	0.1 to 20 I_{Nr}

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

Base Unit
Other Voltage Input Connection Schemes

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

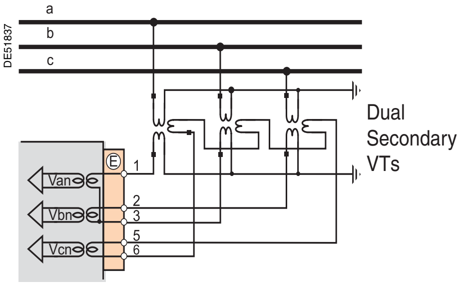
Variant 1: Measuring Three Phase-to-Neutral Voltages (standard connection)



Parameters	
Voltages measured by VTs	Van, Vbn, Vcn
Residual voltage	None

Functions Available	
Voltages measured	Van, Vbn, Vcn
Values calculated	Vab, Vbc, Vac, Vr, V1, V2, f
Measurements available	All
Protection functions available (by Sepam™ type)	All

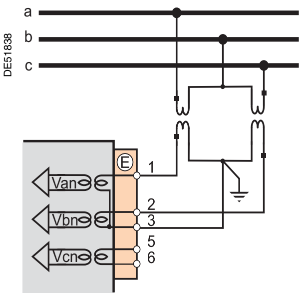
Variant 2: Measuring Two Phase-to-Phase Voltages and Residual Voltage



Parameters	
Voltages measured by VTs	Vab, Vbc
Residual voltage	External VT

Functions Available	
Voltages measured	Vab, Vbc, Vr
Values calculated	Vca, Van, Vbn, Vcn, V1, V2, f
Measurements available	All
Protection functions available (by Sepam™ type)	All

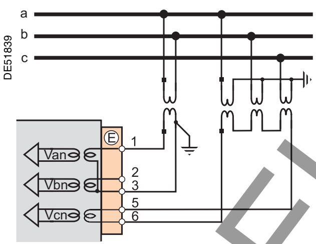
Variant 3: Measuring Two Phase-to-Phase Voltages



Parameters	
Voltages measured by VTs	Vab, Vbc
Residual voltage	None

Functions Available	
Voltages measured	Vab, Vbc
Values calculated	Vca, V1, V2, f
Measurements available	Vab, Vbc, Vca, V1, V2, f
Protection functions available (by Sepam™ type)	All except 67N/67NC, 59N

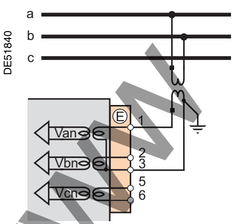
Variant 4: Measuring One Phase-to-Phase Voltage and Residual Voltage



Parameters	
Voltages measured by VTs	Vab
Residual voltage	External VT

Functions Available	
Voltages measured	Vab, Vr
Values calculated	f
Measurements available	Vab, Vr, f
Protection functions available (by Sepam™ type)	All except 67, 47, 27D,32P, 32Q/40, 27S

Variant 5: Measuring One Phase-to-Phase Voltage



Parameters	
Voltages measured by VTs	Vab
Residual voltage	None

Functions Available	
Voltages measured	Vab
Values calculated	f
Measurements available	Vab, f
Protection functions available (by Sepam™ type)	All except 67, 47, 27D,32P, 32Q/40, 67N/67NC, 59N, 27S

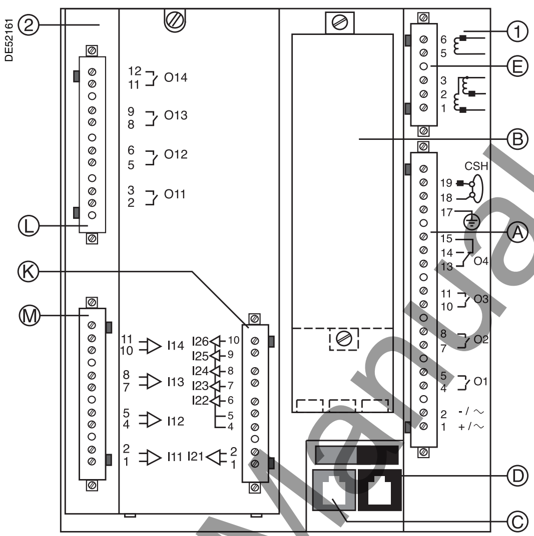
⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Before performing visual inspections, tests, or maintenance of this equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Start by connecting the device to the protective ground and to the functional ground.
- Screw tight all terminals, even those not in use.

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

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



Connections

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

Wiring of the CCA626 connector:

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

Wiring of the CCA627 connector:

- Ring lug connectors 0.25 in (6.35 mm).

6

Function

Sepam™ can be connected to any standard 1A and 5A current transformer. Schneider Electric offers a range of current transformers to measure primary currents from 50 A to 4000 A.

Please contact a customer service representative for more information.

Sizing Current Transformers

The current transformers should be large enough to minimize saturation . CTs should be selected per ANSI C37.110. This can be critical for high X/R systems and systems with generators larger than 2MW.

For Overcurrent Protection

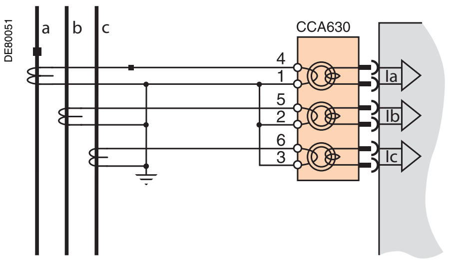
- **Definite time**: The saturation current must be more than 1.5 times the setting value.
- **IDMT**: The saturation current must be more than 1.5 times the highest working value on the curve.

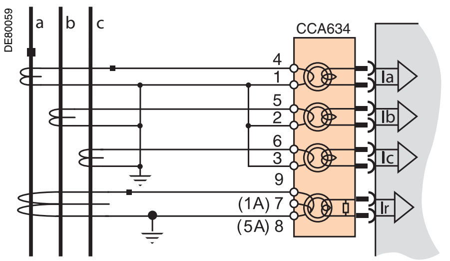
Practical solution when there is no information on the settings

		Normal Performance			Higher Performance		
Rated Secondary Current IN	CT Ratio(1)	Burden Designation	ANSI Class(2)	IEC Class(3)	Burden Designation	ANSI Class(4)	IEC Class(3)
5	100/5	B-0.1	C10	2.5VA 5P20	B-0.2	C20	5VA 5P20
5	500/5	B-0.5	C50	15VA 5P20	B-1.0	C100	30VA 5P20
5	1200/5	B-2.0	C200	50VA 5P20	B-4.0	C400	100VA 5P20
1	100/5	B-0.1	C50	2.5/VA 5P20	B-0.2	C100	5VA 5P20
1	500/5	B-0.5	C200	10VA 5P20	B-1.0	C400	30VA 5P20
1	1200/5	B-2.0	C1000(5)	40VA 5P20	B-4.0	C2000(5)	80VA 5P20

(1) CT ratio rule of thumb is to size primary to be 1.5 x connected load.
Example: 600/5. CT for 400A load.
(2) Typical usual product offering from switchgear manufacturers in North Americe for 50/51 products.
(3) Highest listed VA in IEC 60044 is 30VA
(4) Suitable for systems with X/R=15, or small generator connected to bus. Minimum for 87 protection.
(5) Not listed in C57.13

6





CCA630/CCA634 Connector

Function

Current transformers (1A or 5A) connect to CCA630 or CCA634 connectors on the rear panel of Sepam™:

- The CCA630 connects three phase current transformers to Sepam™
- The CCA634 connects three phase current transformers and a residual current transformer to Sepam™.

The CCA630 and CCA634 connectors contain interposing ring CTs with through primaries, which ensure impedance matching and isolation between the 1 A or 5 A circuits and Sepam™ when measuring phase and residual currents.

The connectors can be disconnected with the power on since disconnection does not open the CT secondary circuit.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

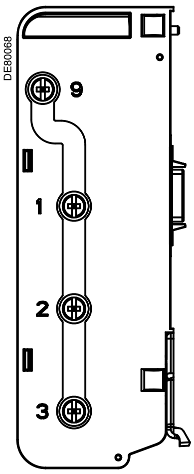
- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Before performing visual inspections, tests, or maintenance of this equipment, disconnect all sources of electric power. Assume all circuits are live until they have been completely de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- To remove current inputs to the Sepam™ unit, unplug the CCA630 or CCA634 connector without disconnecting the wires from it. The CCA630 and CCA634 connectors ensure continuity of the current transformer secondary circuits.
- Before disconnecting the wires connected to the CCA630 or CCA634 connector, short-circuit the current transformer secondary circuits.

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

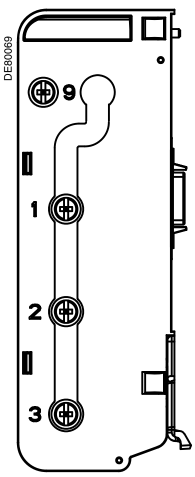
6

Connecting and Assembling the CCA630 Connector

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



Bridging of terminals 1, 2, 3 and 9



Bridging of terminals 1, 2 and 3

Connecting and Assembling the CCA634 Connector

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

CAUTION

HAZARD OF IMPROPER OPERATION

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

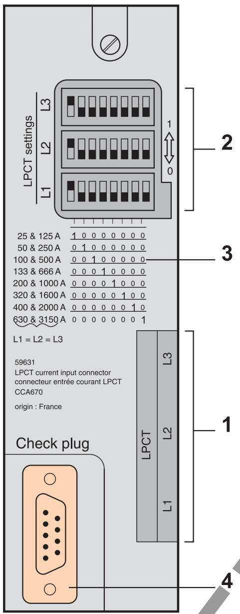
Failure to follow this instruction can cause equipment damage.

CLP1 LPCT sensor

Function

Low Power Current Transducer (LPCT) type sensors are voltage-output sensors, which are compliant with the IEC 60044-8 standard.

The Schneider Electric range of LPCTs includes the following sensors: CLP1, CLP2, CLP3, TLP160 and TLP190.



CCA670/CCA671 Connector

Function

The three LPCT sensors are connected to the CCA670 or CCA671 connector on the rear panel of Sepam™.
The connection of only one or two LPCT sensors is not allowed and causes Sepam™ to go into fail-safe position.
The two CCA670 and CCA671 interface connectors serve the same purpose, the difference being the position of the LPCT sensor plugs:

- CCA670: lateral plugs, for Sepam™ Series 20 and Series 40
- CCA671: radial plugs, for Sepam™ Series 80.

Description

- 3 RJ45 plugs to connect the LPCT sensors.
- 3 blocks of microswitches to set the CCA670/CCA671 to the rated phase current value.
- Microswitch setting/selected rated current equivalency table (2 IN values per position).
- 9-pin sub-D connector to connect test equipment (ACE917 for direct connector or via CCA613).

CCA670/CCA671 Connectors Rating

The CCA670/CCA671 connector must be rated according to the rated primary current In measured by the LPCT sensors. In is the current value that corresponds to the rated secondary current of 22.5 mV. The possible settings for IN are (in A): 25, 50, 100, 125, 133, 200, 250, 320, 400, 500, 630, 666, 1000, 1600, 2000, 3150.

The selected In value should be entered as a Sepam™ general setting and configured by microswitch on the CCA670/CCA671 connector.

Operating Mode:

1 Use a screwdriver to remove the shield located in the "LPCT settings" zone; the shield protects 3 blocks of 8 microswitches marked L1, L2, L3.
2 On the L1 block, set the microswitch for the selected rated current to "1" (2 IN values per microswitch).
- The table of equivalencies between the microswitch settings and the selected rated current In is printed on the connector
- Leave the 7 other microswitches set to "0".

3 Set the other two blocks of switches L2 and L3 to the same position as the L1 block and close the shield.

CAUTION

HAZARD OF NON-OPERATION

- Set the microswitches for the CCA670/CCA671 connector before commissioning the device.
- Check that only one microswitch is in position 1 for each block L1, L2, L3 and that no microswitch is in the center position.
- Check that the microswitch settings on all 3 blocks are identical.

Failure to follow these instructions can cause incorrect operation.

6

LPCT Type Current Sensors
Test Accessories

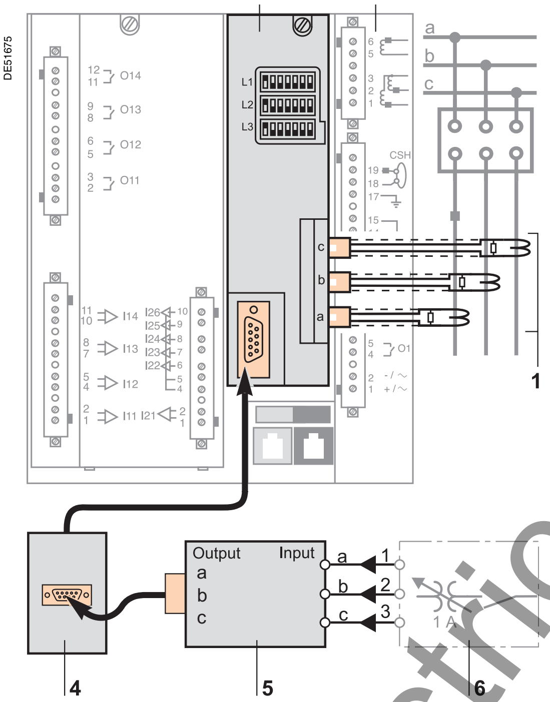
Accessory Connection Principle

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Before performing visual inspections, tests, or maintenance of the equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.

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



1 LPCT sensor, equipped with a shielded cable fitted with a yellow RJ 45 plug which is plugged directly into the CCA670/CCA671 connector.

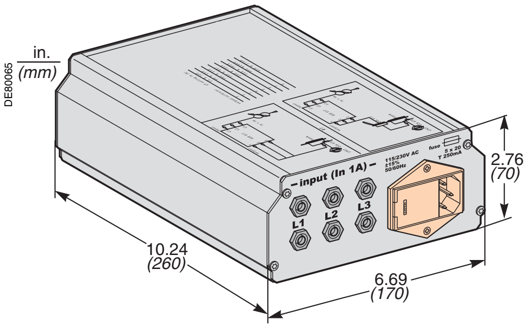
2 Sepam™ protection unit.

3 CCA670/CCA671 connector, LPCT voltage interface, with microswitch setting of rated current:
- CCA670: lateral plugs, for Sepam™ Series 20 and Sepam™ Series 40
- CCA671: radial plugs, for Sepam™ Series 80.

4 CCA613 remote test plug, flush-mounted on the front of the cubicle and equipped with a 9.8 ft (3-meter) cable to be plugged into the test plug of the CCA670/CCA671 interface connector (9-pin sub-D).

5 ACE917 injection adapter, to test the LPCT protection chain with a standard injection box.

6 Standard injection box.



ACE917 Injection Adapter

Function

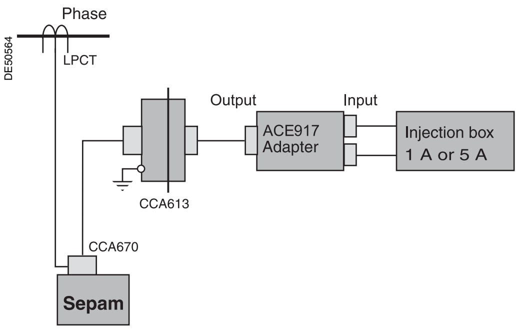
The ACE917 adapter is used to test the protection chain with a standard injection box, when Sepam™ is connected to LPCT sensors.
The ACE917 adapter is inserted between:

- The standard injection box
- The LPCT test plug:
  - integrated in the Sepam™ CCA670/CCA671 interface connector
  - or transferred by means of the CCA613 accessory.

The following are supplied with the ACE917 injection adapter:

- Power supply cable
- 9.8 ft (3-meter) cable to connect the ACE917 to the LPCT test plug on CCA670/CCA671 or CCA613.

Characteristics	
Power supply	115/230 V AC
Protection by time-delayed fuse 0.2 x 0.79 in (5 mm x 20 mm)	0.25 A rating



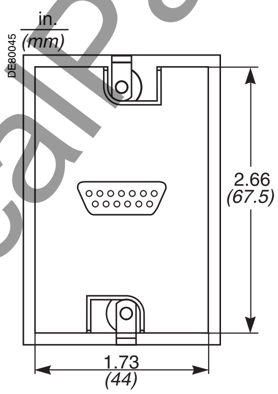
Accessory connection principle

CCA613 Remote Test Plug

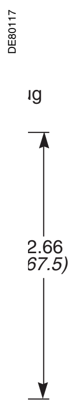
Function

The CCA613 test plug, flush-mounted on the front of the cubicle, is equipped with a 9.8 ft (3-meter) cable to transfer data from the test plug integrated in the CCA670/CCA671 interface connector on the rear panel of Sepam™.

Dimensions

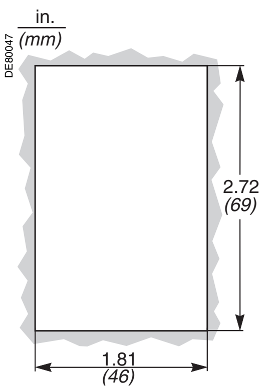


Front view with cover lifted.



Right side view.

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.**



Cut-out.

CSH120 and CSH200 Zero Sequence CTs

PE50032

CSH120 and CSH200 zero sequence CTs.

Function

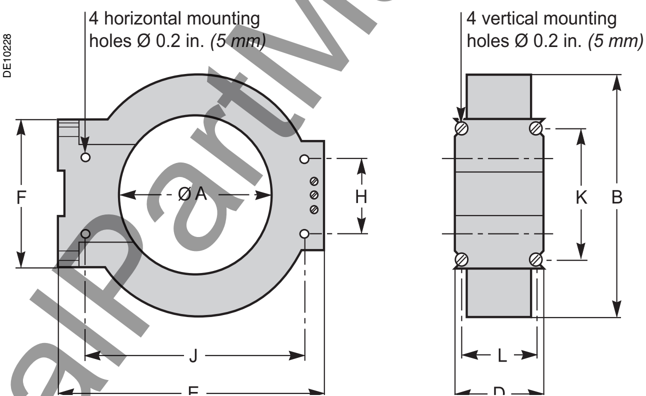
The specifically designed CSH120 and CSH200 zero sequence CTs are for direct zero sequence current measurement. The only difference between them is the diameter. Due to their low voltage insulation, they can only be used on cables.

Characteristics

	CSH120	CSH200
Inner diameter	4.7 in (120 mm)	7.9 in (200 mm)
Weight	1.32 lb. (0.6 kg)	3.09 lb. (1.4 kg)
Accuracy	±5% at 68°F (20°C)	
	±6% max. from –13°F to +158°F (–25°C to 70°C)	
Transformation ratio	1/470	
Maximum permissible current	20 kA - 1 s	
Operating temperature	–13°F to +158°F (–25°C to +70°C)	
Storage temperature	–40°F to +185°F (–40°C to +85°C)	

Dimensions

DE10228



Dimensions	A	B	D	E	F	H	J	K	L
CSH120 (mm)	4.75 (120)	6.46 (164)	1.73 (44)	7.48 (190)	2.99 (76)	1.57 (40)	6.54 (166)	2.44 (62)	1.38 (35)
CSH200 (mm)	7.87 (200)	10.1 (256)	1.81 (46)	10.8 (274)	4.72 (120)	2.36 (60)	10.1 (257)	4.09 (104)	1.46 (37)

CSH120 and CSH200 Zero Sequence CTs

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Before performing visual inspections, tests, or maintenance of the equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Only CSH120, CSH200 and CSH280 zero sequence CTs can be used for direct residual current measurement. Other residual current sensors require the use of an intermediate device, CSH30, ACE990 or CCA634.
- Install the zero sequence CTs on insulated cables.
- Cables with a rated voltage of more than 1000 V must also have a grounded shielding.

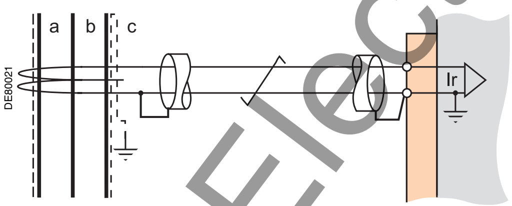
Failure to follow these instructions will result in death or serious injury.

CAUTION

HAZARD OF NON-OPERATION

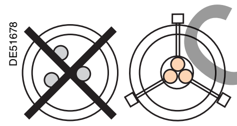
Do not connect the secondary circuit of the CSH zero sequence CTs to ground.
This connection is made in Sepam™.

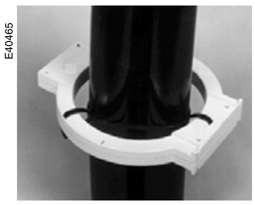
Failure to follow this instruction can cause Sepam™ to operate incorrectly.



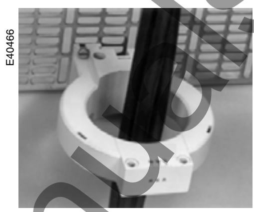
Assembly

Group the MV cable (or cables) in the middle of the zero sequence CT.
Use non-conductive binding to hold the cables.
Remember to insert the three medium voltage cable shielding grounding cables through the zero sequence CT.





Assembly on MV cables.



Assembly on mounting plate.

Connection

Connecting to Sepam™ Series 20 and Series 40

To residual current Ir input, on connector (A), terminals 19 and 18 (shielding).

Connecting to Sepam™ Series 80

- To residual current Ir input, on connector (E), terminals 15 and 14 (shielding)
- To residual current I'r input, on connector (E), terminals 18 and 17 (shielding).

Recommended Cable

- Sheathed cable, shielded by tinned copper braid
- Minimum cable cross-section AWG 18 (0.93 mm²)
- Resistance per unit length < 30.5 mΩ/ft (100 mΩ/m)
- Minimum dielectric strength: 1000 V (700 Vrms)
- Connect the cable shielding in the shortest manner possible to Sepam™
- Flatten the connection cable against the metal frames of the cubicle.

The connection cable shielding is grounded in Sepam™. Do not ground the cable by any other means.

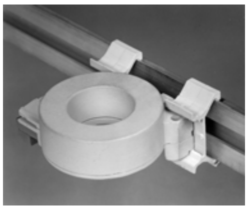
The maximum resistance of the Sepam™ connection wiring must not exceed 4 Ω (66 ft maximum for 30.5 mΩ/ft or 20 m maximum for 100 mΩ/m).

6

E40468

Vertical assembly of CSH30 interposing ring CT.

E44717



Horizontal assembly of CSH30 interposing ring CT.

Function

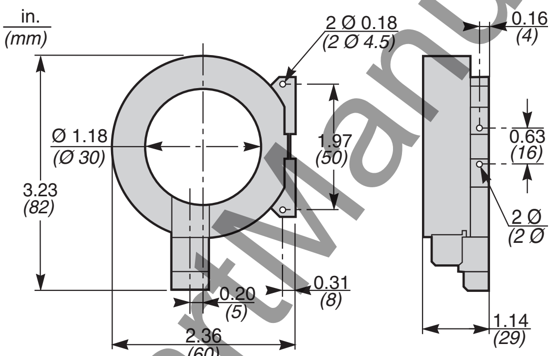
The CSH30 interposing ring CT is used as an interface when the residual current is measured using 1A or 5A current transformers.

Characteristics

Weight	0.265 lb. (0.12 kg)
Assembly	On symmetrical DIN rail In vertical or horizontal position

Dimensions

DE80023



6

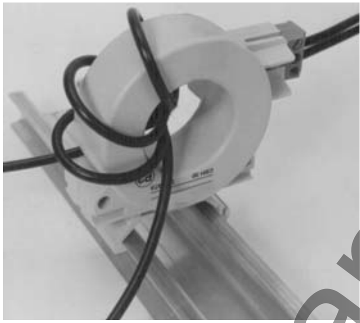
Connection

The CSH30 is adapted for the type of current transformer, 1 A or 5 A, by the number of turns of the secondary wiring through the CSH30 interposing ring CT:

- 5 A rating - 4 turns
- 1 A rating - 2 turns

Connection to 5A secondary circuit

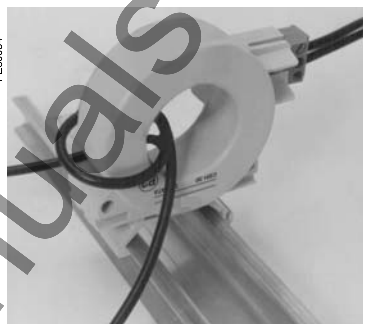
PE50033



1 Plug into the connector.
2 Insert the transformer secondary wire through the CSH30 interposing ring CT four times.

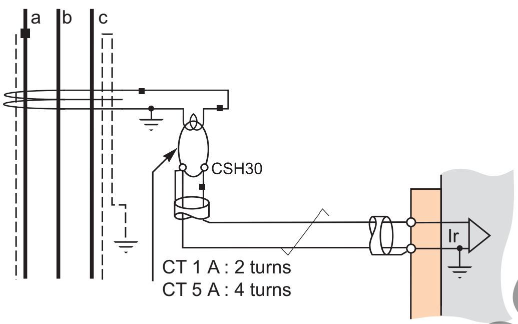
Connection to 1A secondary circuit

PE50034

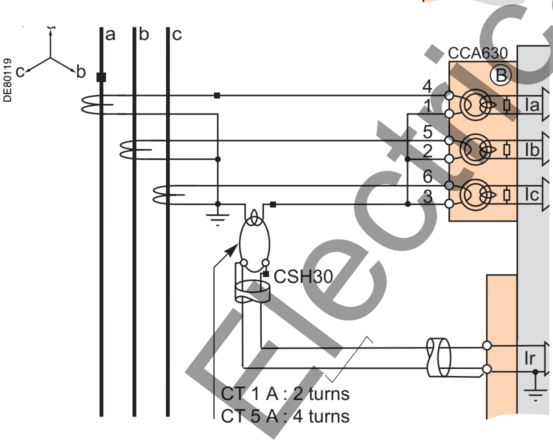


1 Plug into the connector.
2 Insert the transformer secondary wire through the CSH30 interposing ring CT twice.

DE80118



DE80119



Connecting to Sepam™ Series 20 and Series 40
To residual current Ir input, on connector (A), terminals 19 and 18 (shielding).

Connection to Sepam™ Series 80

- To residual current Ir input, on connector (E), terminals 15 and 14 (shielding)
- To residual current I'r input, on connector (E), terminals 18 and 17 (shielding).

Recommended Cable

- Sheathed cable, shielded by tinned copper braid
- Minimum cable cross-section AWG 18 (0.93 mm²) (max. AWG 12 or 2.5 mm²)
- Resistance per unit length < 30.5 mΩ/ft (100 mΩ/m)
- Minimum dielectric strength: 1000 V (700 Vrms)
- Maximum length: 6.6 ft (2 m).

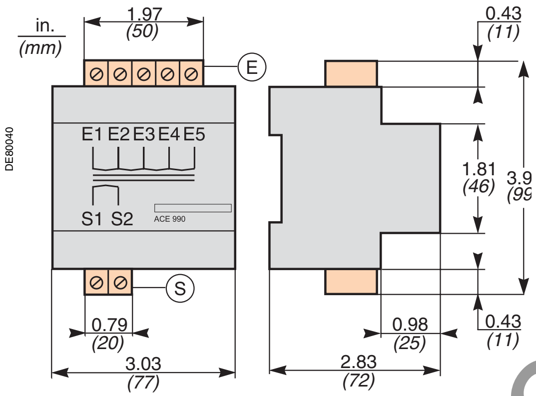
The CSH30 interposing ring CT must be installed near Sepam™ (Sepam™ - CSH30 link less than 2 m (6.6 ft) long).

Flatten the connection cable against the metal frames of the cubicle.
The connection cable shielding is grounded in Sepam™. Do not ground the cable by any other means.

6

ACE990 Zero Sequence CT Interface

ACE990 zero sequence CT interface.



Function

The ACE990 is used to adapt measurements between an MV zero sequence CT with a ratio of 1/n (50 ≤ n ≤ 1500), and the Sepam™ residual current input.

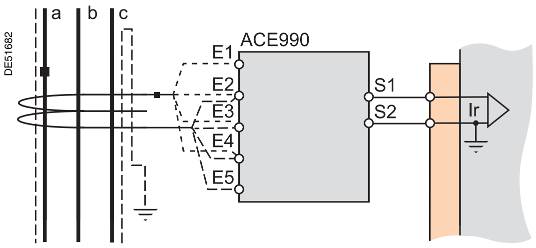
Characteristics

Weight	1.41 lb (0.64 kg)
Assembly	Mounted on symmetrical DIN rail
Amplitude accuracy	±1%
Phase accuracy	< 2°
Maximum permissible current	20 kA - 1 s (on the primary winding of an MV zero sequence CT with a ratio of 1/50 that does not saturate)
Operating temperature	+23°F to +131°F (–5°C to +55°C)
Storage temperature	–13°F to +158°F (–25°C to +70°C)

Description and Dimensions

Ⓔ ACE990 input terminal block, for connection of the zero sequence CT.
Ⓢ ACE990 output terminal block, for connection of the Sepam™ residual current.

ACE990 Zero Sequence CT Interface



Connection

Connecting Zero Sequence CT

Only one zero sequence CT can be connected to the ACE990 interface.
The secondary circuit of the MV zero sequence CT is connected to 2 of the 5 ACE990 interface input terminals. To define the 2 input terminals, it is necessary to know the following:

- Zero sequence CT ratio (1/n)
- Zero sequence CT power
- Close approximation of rated current Inr
  (INr is a general setting in Sepam™ and defines the ground fault protection setting range between 0.1 INr and 15 INr).

The table below can be used to determine:

- The two ACE990 input terminals to be connected to the MV zero sequence CT secondary
- The type of zero sequence current sensor to set
- The exact value of the rated residual current INr setting, given by the following formula: **INr = k x number of zero sequence CT turns**
  with k the factor defined in the table below.

The zero sequence CT must be connected to the interface in the right direction for correct operation: the MV zero sequence CT secondary output terminal S1 must be connected to the terminal with the lowest index (Ex).

K Value	ACE990 Input Terminals to be Connected	Residual Current Sensor Setting	Min. MV Zero Sequence CT Power
0.00578	E1 - E5	ACE990 - range 1	0.1 VA
0.00676	E2 - E5	ACE990 - range 1	0.1 VA
0.00885	E1 - E4	ACE990 - range 1	0.1 VA
0.00909	E3 - E5	ACE990 - range 1	0.1 VA
0.01136	**E2 - E4**	**ACE990 - range 1**	**0.1 VA**
0.01587	E1 - E3	ACE990 - range 1	0.1 VA
0.01667	E4 - E5	ACE990 - range 1	0.1 VA
0.02000	E3 - E4	ACE990 - range 1	0.1 VA
0.02632	E2 - E3	ACE990 - range 1	0.1 VA
0.04000	E1 - E2	ACE990 - range 1	0.2 VA
0.05780	E1 - E5	ACE990 - range 2	2.5 VA
0.06757	E2 - E5	ACE990 - range 2	2.5 VA
0.08850	E1 - E4	ACE990 - range 2	3.0 VA
0.09091	E3 - E5	ACE990 - range 2	3.0 VA
0.11364	E2 - E4	ACE990 - range 2	3.0 VA
0.15873	E1 - E3	ACE990 - range 2	4.5 VA
0.16667	E4 - E5	ACE990 - range 2	4.5 VA
0.20000	E3 - E4	ACE990 - range 2	5.5 VA
0.26316	E2 - E3	ACE990 - range 2	7.5 VA

Example:
Given a zero sequence CT with a ratio of 1/400 2 VA, used within a measurement range of 0.5 A to 60 A.
How should it be connected to Sepam™ via the ACE990?

1. *Choose a close approximation of the rated current INr, such as 5A.*
2. *Calculate the ratio: approx. INr/number of turns = 5/400 = 0.0125.*
3. *Find the closest value of k in the table opposite to k = 0.01136.*
4. *Check the mininum power required for the zero sequence CT: 2 VA zero sequence CT > 0.1 VA V OK.*
5. *Connect the zero sequence CT secondary to ACE990 input terminals E2 and E4.*
6. *Set Sepam™ up with: INr = 0.0136 x 400 = 4.5 A.*

   This value of INr can be used to monitor current between 0.45 A and 67.5 A.

   Wiring of MV zero sequence CT secondary circuit:
   - *MV zero sequence CT S1 output to ACE990 E2 input terminal*
   - *MV zero sequence CT S2 output to ACE990 E4 input terminal.*

Connecting to Sepam™ Series 20 and Series 40

To residual current Ir input, on connector (A), terminals 19 and 18 (shielding).

Connecting to Sepam™ Series 80

- To residual current Ir input, on connector (E), terminals 15 and 14 (shielding)
- To residual current I'r input, on connector (E), terminals 18 and 17 (shielding).

Recommended Cables

- Cable between zero sequence CT and ACE990: less than 160 ft (50 m) long
- Sheathed cable, shielded by tinned copper braid between the ACE990 and Sepam™, maximum length 6.6 ft (2 m)
- Cable cross-section between AWG 18 (0.93 mm²) and AWG 12 (2.5 mm²)
- Resistance per unit length less than 30.5 mΩ/ft (100 mΩ/m)
- Minimum dielectric strength: 100 Vrms.

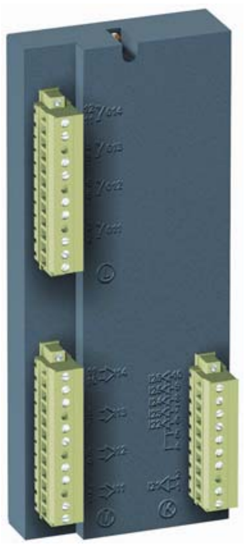
Connect the connection cable shielding in the shortest manner possible (5.08 in or 2 cm maximum) to the shielding terminal on the Sepam™ connector.

Flatten the connection cable against the metal frames of the cubicle. The connection cable shielding is grounded in Sepam™. Do not ground the cable by any other means.

6

MES114 Modules
10 Inputs and 4 Outputs

PE50476



10 input/4 output MES114 module.

Function

The four outputs included on the Sepam™ Series 20 and 40 base units can be extended by adding an optional MES114 module with 10 inputs and 4 outputs, available in three versions:

- MES114: 10 inputs, voltage from 24 V DC to 250 V DC
- MES114E: 10 inputs, voltage 110-125 V AC or V DC
- MES114F: 10 inputs, voltage 220-250 V AC or V DC.

Characteristics

MES114 Module	
Weight	0.617 lb (0.28 kg)
Operating temperature	–13°F to +158°F (–25°C to +70°C)
Environmental characteristics	Same characteristics as Sepam™ base units

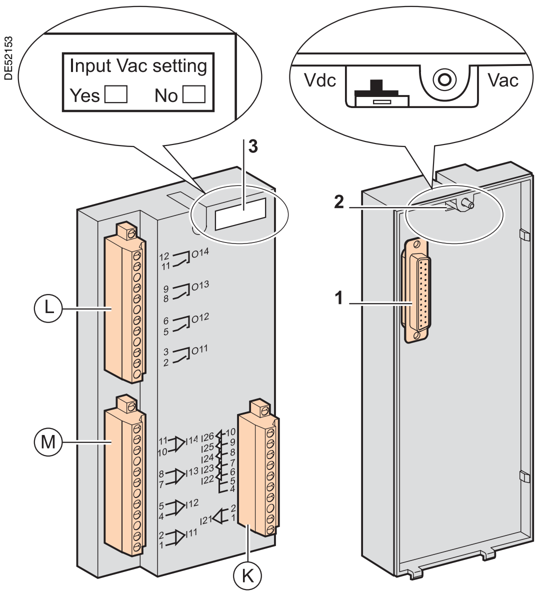
Logic Inputs		MES114	MES114E		MES114F	
Voltage		24 to 250 V DC	110 to 125 V DC	110 V AC	220 to 250 V DC	220 to 240 V AC
Range		19.2 to 275 V DC	88 to 150 V DC	88 to 132 V AC	176 to 275 V DC	176 to 264 V AC
Frequency		-	-	47 to 63 Hz	-	47 to 63 Hz
Typical burden		3 mA	3 mA	3 mA	3 mA	3 mA
Typical switching threshold		14 V DC	82 V DC	58 V AC	154 V DC	120 V AC
Input limit voltage	At state 1	≥ 19 V DC	≥ 88 V DC	≥ 88 V AC	≥ 176 V DC	≥ 176 V AC
	At state 0	≥ 6 V DC	≤ 75 V DC	≤ 22 V AC	≤ 137 V DC	≤ 48 V AC
Isolation of inputs from other isolated groups		Enhanced	Enhanced	Enhanced	Enhanced	Enhanced

O11 Control Relay Output					
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	8/4 A	0.7 A	0.3 A	8 A
	L/R load < 20 ms	6/2 A	0.5 A	0.2 A	
	L/R load < 40 ms	4/1 A	0.2 A	0.1 A	
	p.f. load > 0.3				5 A
Making capacity		< 15 A for 200 ms			
Isolation of outputs from other isolated groups	Enhanced				

Annunciation Relay Output O12 to O14					
Voltage	DC	24/48 V DC	125 V DC	250 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	L/R load < 20 ms	2/1 A	0.5 A	0.15 A	
	p.f. load > 0.3				1 A
Making capacity		< 15 A for 200 ms			
Isolation of outputs in relation to other isolated groups	Enhanced				

Schneider Electric

DE52153



Description

(L), (M) and (K) : 3 removable, lockable screw-type connectors
(L) : connectors for 4 relay outputs:
- O11: 1 control relay output
- O12 to O14: 3 annunciation relay outputs

(M) : connectors for 4 independent logic inputs I11 to I14
(K) : connectors for 6 logic inputs:
- I21: 1 independent logic input
- I22 to I26: 5 common point logic inputs.

1 25-pin sub-D connector to connect the module to the base unit.
2 Voltage selector switch for MES114E and MES114F module inputs, to be set to:
- V DC for DC voltage inputs (default setting)
- V AC for AC voltage inputs.

3 Label to be filled in to indicate the chosen parameter setting for MES114E and MES114F input voltages.

The parameter setting status can be accessed in the "Sepam™ Diagnosis" screen of the SFT2841 software tool.

Parameter setting of the inputs for AC voltage (V AC setting) blocks the "operating time measurement" function.

DE51683

Assembly

1. Insert the two pins on the MES module into the slots **1** on the base unit.
2. Flush mount the module against the base unit to plug it into the connector **2**.
3. Tighten the mounting screw **3**.

6

Connection

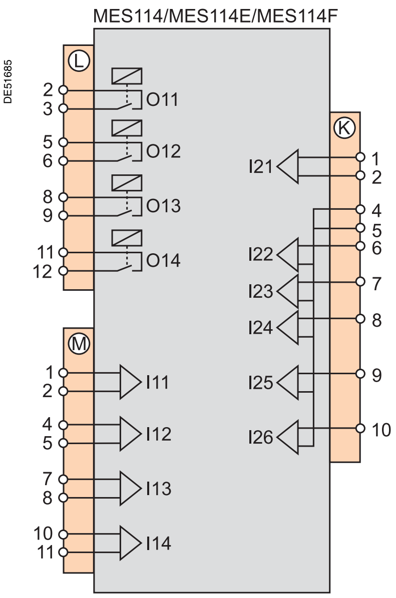
The inputs are potential-free and the DC power supply source is external.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Before performing visual inspections, tests, or maintenance of the equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Screw tight all terminals, even those not in use.

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



Wiring of connectors Ⓛ, Ⓜ and Ⓚ :

- Wiring with no fittings:
  - One wire with maximum cross-section AWG 24-12 (0.2 to 2.5 mm²)
  - Two wires with maximum cross-section AWG 24-18 (0.2 to 1 mm²)
  - stripped length: 0.315 to 0.39 in (8 to 10 mm)
- Wiring with fittings:
  - terminal 5, recommended wiring with Telemecanique fitting:
    - DZ5CE015D for one wire AWG 16 (1.5 mm²)
    - DZ5CE025D for one wire AWG 12 (2.5 mm²)
    - AZ5DE010D for two wires AWG 18 (1 mm²)
  - wire length: 0.32 in (8.2 mm)
  - stripped length: 0.31 in (8 mm).

Optional Remote Modules
Connection

The optional MET1482, MSA141 or DSM303 modules are connected to the base unit connector Ⓓ by a series of links using prefabricated cables which come in 3 different lengths with black fittings.

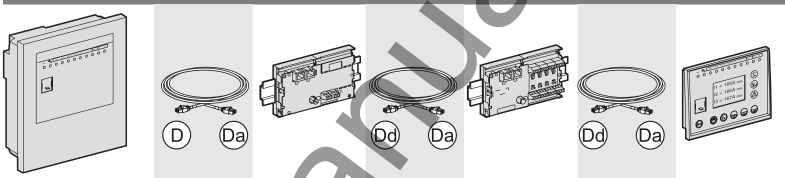
- CCA770 (L = 2 ft or 0.6 m)
- CCA772 (L = 6.6 ft or 2 m)
- CCA774 (L = 13.1 ft or 4 m).

The DSM303 module may only be connected at the end of the series.

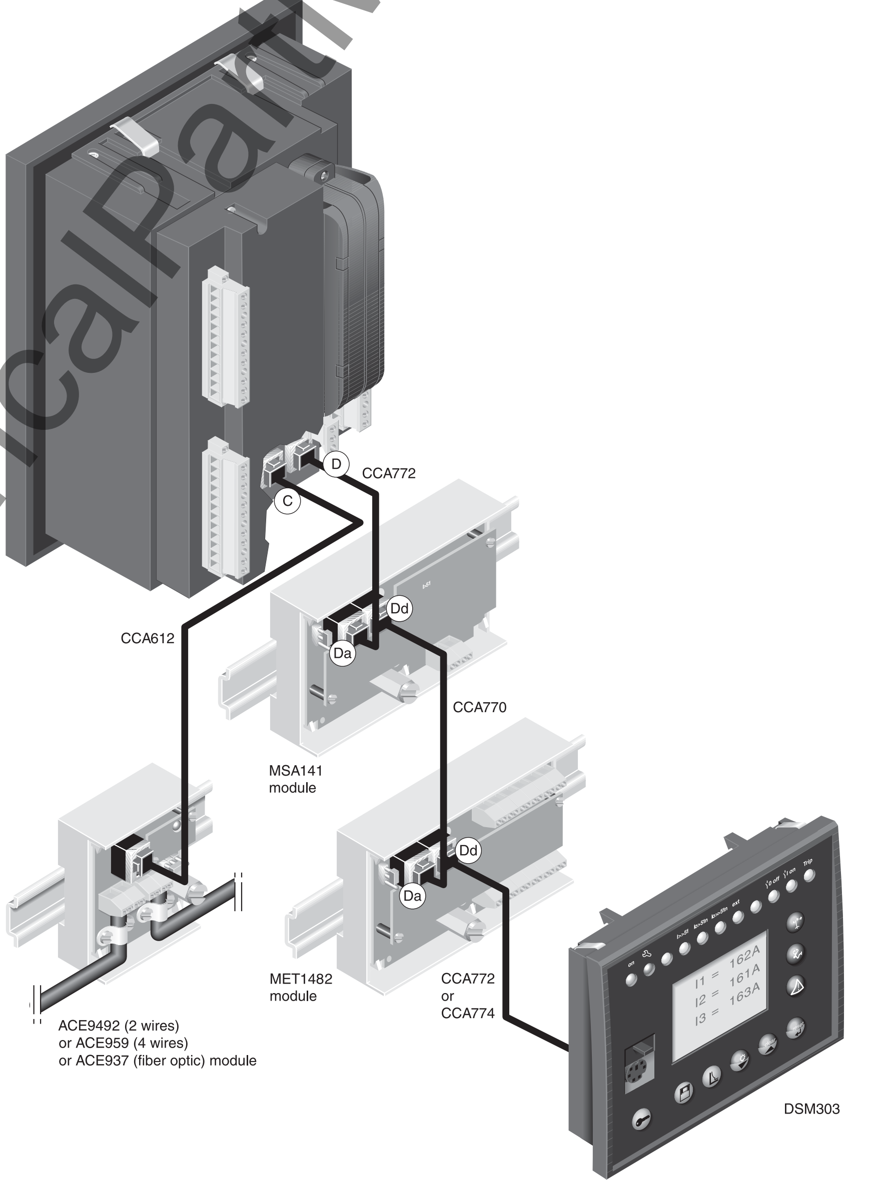
Maximum Configuration

A maximum of three modules can be connected to the base unit, in compliance with the module order and maximum connection lengths indicated in the table:

DE50089

Base	cable	Module 1	cable	Module 2	cable	Module 3
	D Da		Dd Da		Dd Da	
	CCA772	MSA141	CCA770	MET1482	CCA774	DSM303
	CCA772	MSA141	CCA770	MET1482	CCA772	MET1482
	CCA772	MET1482	CCA770	MET1482	CCA774	DSM303

DE50566



6

MET1482
Temperature Sensor Module

PE50021

Function

The MET1482 module can be used to connect 8 temperature sensors (RTDs) of the same type:

- Pt100, Ni100 or Ni120 type RTDs, according to parameter setting
- 3-wire temperature sensors
- A single module for each Sepam™ Series 20 base unit, to be connected by one of the CCA770 (2 ft or 0.6 m), CCA772 (6.6 ft or 2 m), or CCA774 (13.1 ft or 4 m) cables
- Two modules for each Sepam™ Series 40 or Series 80 base unit, to be connected by CCA770 (0.6 or 2 ft), CCA772 (6.6 ft or 2 m) or CCA774 (13.1 ft or 4 m) cables

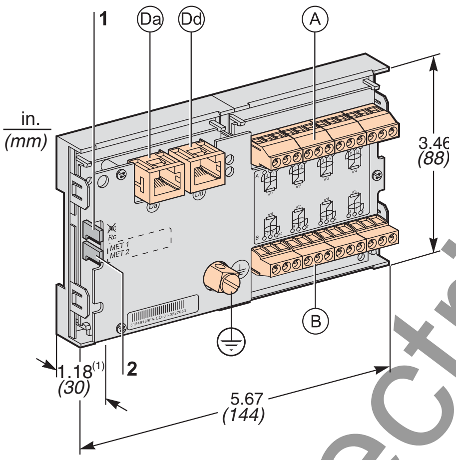
The temperature measurement (as in a transformer or motor winding) is used by the following protection functions:

- Thermal overload (to take ambient temperature into account)
- Temperature monitoring.

Characteristics

MET1482 Module		
Weight	0.441 lb (0.2 kg)	
Assembly	On symmetrical DIN rail	
Operating temperature	–13°F to +158°F (–25°C to +70°C)	
Environmental characteristics	Identical to Sepam™ base units	
Temperature Sensors	**Pt100**	**Ni100/Ni120**
Isolation from ground	None	None
Current injected in RTD	4 mA	4 mA

DE80031



(1) 2.8 in (70 mm) with CCA77x cable connected

Description and Dimensions

Ⓐ Terminal block for RTDs 1 to 4

Ⓑ Terminal block for RTDs 5 to 8

(Da) RJ45 connector to connect the module to the base unit with a CCA77x cable

(Dd) RJ45 connector to link up the next remote module with a CCA77x cable (according to application)

⏚ Grounding/grounding terminal

1 Jumper for impedance matching with load resistor (Rc), to be set to:

- ~~Rc~~, if the module is not the last interlinked module (default position)
- Rc, if the module is the last interlinked module.

2 Jumper used to select module number, to be set to:

- MET1: First MET1482 module, to measure temperatures T1 to T8 (default position)
- MET2: Second MET1482 module, to measure temperatures T9 to T16 (for Sepam™ Series 40 and Series 80 only).

6

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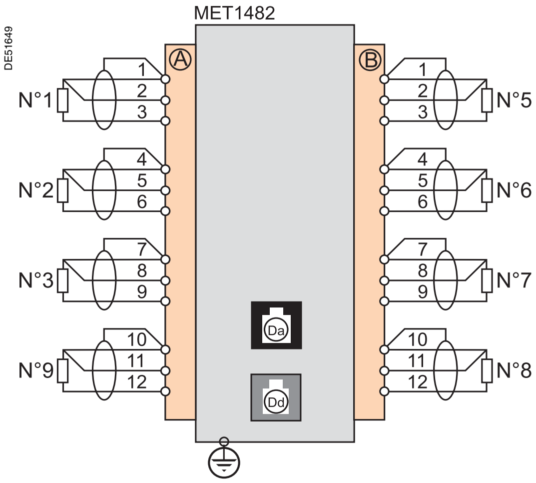
Connection

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Check that the temperature sensors are isolated from dangerous voltages.

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



Connecting the Grounding Terminal

By tinned copper braid with cross-section ≥ AWG 10 (6 mm²) or cable with cross-section ≥ AWG 12 (2.5 mm²) and length ≤ 7.9 in (200 mm), fitted with a 0.16 in (4 mm) ring lug.

Check the tightness (maximum tightening torque 19.5 lb-in or 2.2 Nm).

Connecting RTDs to Screw-type Connectors

- 1 wire with cross-section AWG 24-12 (0.2 to 2.5 mm²)
- or 2 wires with cross-section AWG 24-18 (0.2 to 1 mm²)

Recommended cross-sections according to distance:

- Up to 330 ft (100 m) ≥ AWG 18 (1 mm²)
- Up to 990 ft (300 m) ≥ AWG 16 (1.5 mm²)
- Up to 0.62 mi (1 km) ≥ AWG 12 (2.5 mm²)

Maximum distance between sensor and module: 0.62 mi (1 km)

Wiring Precautions

- It is preferable to use shielded cables
  The use of unshielded cables can cause measurement errors which vary in degree according to the level of surrounding electromagnetic disturbance
- Only connect the shielding at the MET1482 end, in the shortest manner possible, to the corresponding terminals of connectors (A) and (B)
- Do not connect the shielding at the RTD end.

Accuracy Derating According to Wiring

The error Δt is proportional to the length of the cable and inversely proportional to the cable cross-section:

$$\Delta t(°C) = 2 \times \frac{L(km)}{S(mm^2)}$$

- ±2.1°C/km for AWG 18 cross-section (0.93 mm²)
- ±1°C/km for AWG 14 cross-section (1.92 mm²).

6

MSA141 Analog Output Module

MSA141 analog output module.

Function

The MSA141 module converts one of the Sepam™ measurements into an analog signal:

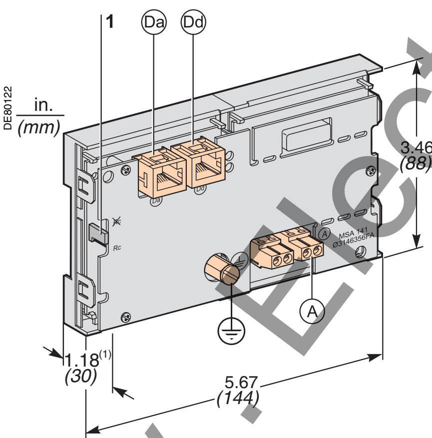
- Selection of the measurement to be converted by parameter setting
- 0-10 mA, 4-20 mA, 0-20 mA analog signal according to parameter setting
- Scaling of the analog signal by setting minimum and maximum values of the converted measurement.
  Example: the setting used to have phase current 1 as a 0-10 mA analog output with a dynamic range of 0 to 300 A is:
  - minimum value = 0
  - maximum value = 3000
- A single module for each Sepam™ base unit connected by either CCA770 (2 ft or 0.6m), CCA772 (6.6 ft or 2m) or CCA774 (13.1 ft or 4m) cables.

The analog output can also be remotely managed via the communication network.

Characteristics

MSA141 Module				
Weight	0.441 lb (0.2 kg)			
Assembly	On symmetrical DIN rail			
Operating temperature	-13°F to +158°F (-25°C to +70°C)			
Environmental characteristics	Same characteristics as Sepam™ base units			
Analog Output				
Current	4 -20 mA, 0-20 mA, 0-10 mA			
Scaling (no data input checking)	Minimum value Maximum value			
Load impedance	< 600 Ω (including wiring)			
Accuracy	0.5%			
Measurements	**Unit**	**Series 20**	**Series 40**	**Series 80**
Phase and residual currents	0.1 A	■	■	■
Phase-to-neutral and phase-to-phase voltages	1 V	■	■	■
Frequency	0.01 Hz	■	■	■
Thermal capacity used	1%	■	■	■
Temperatures	1°C (1°F)	■	■	■
Active power	0.1 kW		■	■
Reactive power	0.1 kvar		■	■
Apparent power	0.1 kVA		■	■
Power factor	0.01			■
Remote setting via communication link		■	■	■

Description and Dimensions



(1) *70 mm (2.8 in) with CCA77x cable connected.*

Ⓐ Terminal block for analog output

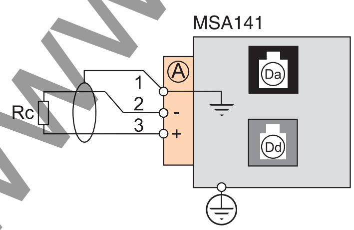
Ⓓa RJ45 socket to connect the module to the base unit with a CCA77x cable

Ⓓd RJ45 socket to link up the next remote module with a CCA77x cable (according to application)

⏚ Grounding terminal

1 Jumper for impedance matching with load resistor (Rc), to be set to:
- R̸c̸, if the module is not the last interlinked module (default position)
- Rc, if the module is the last interlinked module.

Connection



Connecting the Grounding Terminal

By tinned copper braid with cross-section ≥ AWG 10 (6 mm²) or cable with cross-section ≥ AWG 12 (2.5 mm²) and length ≤ 7.9 in 200 mm), equipped with a 0.16 in (4 mm) ring lug.

Check the tightness (maximum tightening torque 19.5 in.-lb. or 2.2 Nm).

Connection of analog output to screw-type connector
- One wire with cross-section AWG 24-12 (0.2 to 2.5 mm²)
- Two wires with cross-section AWG 24-18 (0.2 to 1 mm²).

Wiring precautions
- Shielded cables are preferred
- Use tinned copper braid to connect the shielding at least at the MSA141 end.

DSM303
Remote Advanced UMI Module

PE50127

DSM303 remote advanced UMI module

Function

When used with a Sepam™ that is not equipped with its own advanced user-machine interface, the DSM303 offers all the functions available on a Sepam™ integrated advanced UMI. It can be installed on the front panel of the cubicle in the most suitable operating location:

- Reduced depth < 1.2 in (30 mm)
- A single module for each Sepam™, to be connected by one of the CCA772 (6.6 ft or 2 m) or CCA774 (13.1 ft or 4 m) cables.

The module cannot be connected to Sepam™ units with integrated advanced UMIs.

Characteristics

DSM303 Module	
Weight	0.661 lb (0.3 kg)
Assembly	Flush-mounted
Operating temperature	–13°F to +158°F (–25°C to +70°C)
Environmental characteristics	Same characteristics as Sepam™ base units

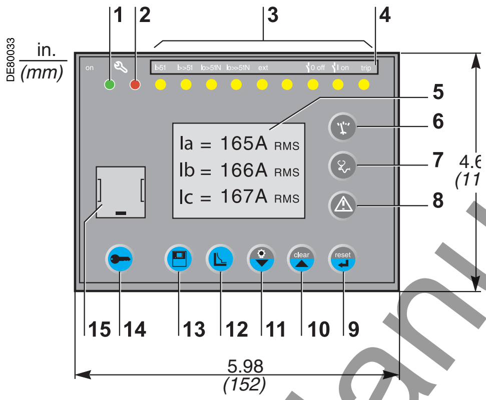
6

DSM303
Remote Advanced UMI Module

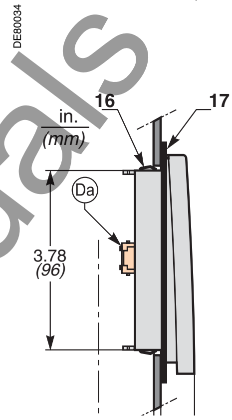
Description and Dimensions

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

Front View



Side View



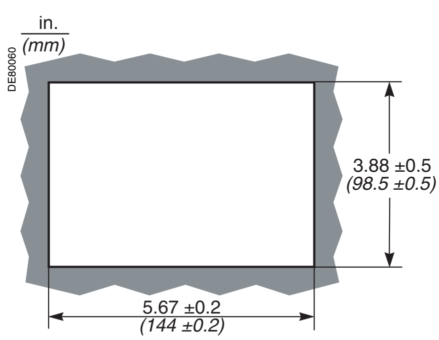
1 Green LED: Sepam™ on
2 Red LED:
- steadily on: module unavailable
- flashing: Sepam™ link unavailable
3 9 yellow LEDs
4 Label identifying the LEDs
5 Graphic LCD screen
6 Display of measurements
7 Display of switchgear, network and machine diagnosis data
8 Display of alarm messages
9 Sepam™ reset (or confirm data entry)
10 Alarm acknowledgment and clearing (or move cursor up)
11 LED test (or move cursor down)
12 Access to protection settings
13 Access to Sepam™ parameters
14 Entry of two passwords
15 PC connection port
16 Mounting clip
17 Gasket to ensure NEMA 12 tightness
(gasket supplied with the DSM303 module, to be installed if necessary)

(Da) RJ45 lateral output connector to connect the module to the base unit with a CCA77x cable.

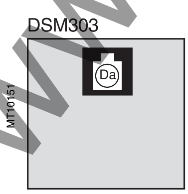
CAUTION

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.

Cut-out for flush-mounting (mounting plate thickness < 0.12 in or 3 mm)



Connection



(Da) RJ45 socket to connect the module to the base unit with a CCA77x cable.

The DSM303 module is always the last interlinked remote module and it systematically ensures impedance matching by load resistor (Rc).

Communication Accessories Selection Guide

There are two types of Sepam™ communication accessory:
- Communication interfaces, which are essential for connecting Sepam™ to the communication network
- Converters and other accessories, as options, which are used for complete implementation of the communication network.

Communication-Interface Selection Guide

		ACE9492	ACE959	ACE937	ACE969TP		ACE969FO	
Type of network								
		S-LAN or E-LAN (1)	S-LAN or E-LAN (1)	S-LAN or E-LAN (1)	S-LAN	E-LAN	S-LAN	E-LAN
Protocol								
Modbus		■	■	■	■	■	■	■
DNP3					■		■	
IEC 60870-5-103					■		■	
Physical interface								
RS485	2-wire	■			■	■		■
	4-wire		■					
Fiber optic ST	Star			■			■	
	Ring						■ (2)	
See details on page		**6/201**	**6/202**	**6/203**	**6/204**		**6/204**	

***(1)** Only one connection possible, S-LAN or E-LAN.*
***(2)** Except with the Modbus protocol.*

Converter Selection Guide

	ACE9092	ACE919CA	ACE919CC	EGX100	EGX400
Converter					
Port to supervisor	1 RS232 port	1 2-wire RS485 port	1 2-wire RS485 port	1 Ethernet port 10T/100Tx Auto	1 Ethernet port 10/100 base Tx and 1 Ethernet port 100 base FX
Port to Sepam™	1 2-wire RS485 port	1 2-wire RS485 port	1 2-wire RS485 port	1 2-wire RS485 or 4-wire RS485 port	2 2-wire RS485 or 4-wire RS485 ports
Distributed power supply RS485	Supplied by ACE	Supplied by ACE	Supplied by ACE	Not supplied by EGX	Not supplied by EGX
Protocol					
Modbus	■	■	■	■	■
IEC 60870-5-103	■	■	■		
DNP3	■	■	■		
Power Supply					
DC			24 to 48 V DC	24 V DC	24 V DC
AC	110 to 220 V AC	110 to 220 V AC			100 to 240 V AC (with adapter)
See details on page	**6/209**	**6/211**	**6/211**	**See EGX100 manual**	**See EGX400 manual**

6

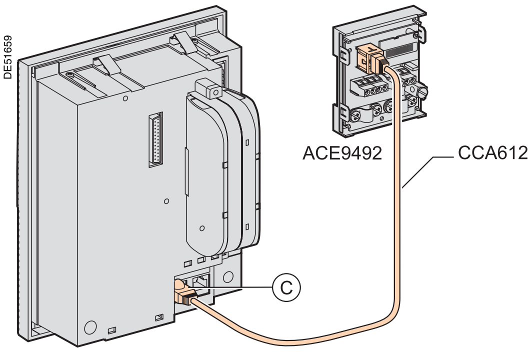
CCA612 Connection Cable

Plugging into Sepam™

cable used to connect a communication interface to a Sepam™ base unit:

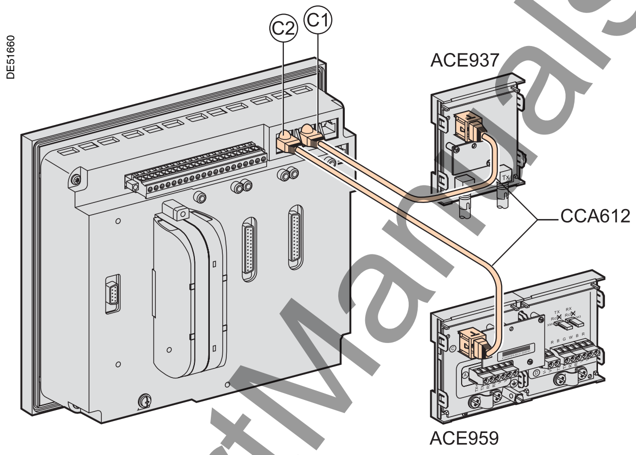
- Length = 9.8 ft (3 m)
- Fitted with two green RJ45 plugs.

Sepam™ Series 20 and Series 40



Sepam™ Series 20 and Series 40: 1 communication port.

Sepam™ Series 80



Sepam™ series 80: 2 communication ports.

Connecting to the Communication Network

RS485 Network Cable	2-wire	4-wire
RS485 medium	1 shielded twisted pair	2 shielded twisted pairs
Distributed power supply	1 shielded twisted pair	1 shielded twisted pair
Shielding	Tinned copper braid, coverage > 65%	
Characteristic impedance	120 Ω	
Gauge	AWG 24	
Resistance per unit length	< 62.1 Ω/mi (100 Ω/km)	
Capacitance between conductors	< 18.3 pF/ft (60 pF/m)	
Capacitance between conductor and shielding	< 30.5 pF/ft (100 pF/m)	
Maximum length	4270 ft (1300 m)	

Fiber Optic	
Fiber type	Graded-index multimode silica
Wavelength	820 nm (invisible infra-red)
Type of connector	ST (BFOC bayonet fiber optic connector)

Fiber Optic Diameter (µm)	Numerical Aperture (NA)	Maximum Attenuation (dBm/km)	Minimum Optical Power Available (dBm)	Maximum Fiber Length
50/125	0.2	2.7	5.6	2300 ft (700 m)
62.5/125	0.275	3.2	9.4	5900 ft (1800 m)
100/140	0.3	4	14.9	9200 ft (2800 m)
200 (HCS)	0.37	6	19.2	8500 ft (2600 m)

6

ACE9492
2-wire RS485 Network Interface

ACE9492 2-wire RS485 network connection interface.

Function

The ACE9492 interface performs two functions:

- Electrical interface between Sepam™ and a 2-wire RS485 communication network
- Main network cable branching box for the connection of a Sepam™ with a CCA612 cable.

Characteristics

ACE9492 Module

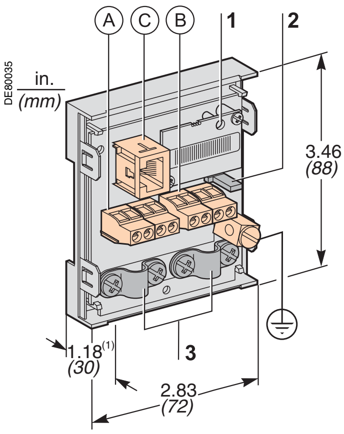
Weight	0.22 lb (0.1 kg)
Assembly	On symmetrical DIN rail
Operating temperature	–13°F to +158°F (–25°C to +70°C)
Environmental characteristics	Same characteristics as Sepam™ base units

2-wire RS485 Electrical Interface

Standard	EIA 2-wire RS485 differential
Distributed power supply	External, 12 V DC or 24 V DC ±10%
Power consumption	16 mA in receiving mode
	40 mA maximum in sending mode

Maximum Length of 2-wire RS485 Network with Standard Cable

Number of Sepam™ Units	Maximum Length with 12 V DC Power Supply	Maximum Length with 24 V DC Power Supply
5	1000 ft (320 m)	3300 ft (1000 m)
10	590 ft (180 m)	2500 ft) (750 m)
20	520 ft (160 m)	1500 ft (450 m)
25	410 ft (125 m)	1200 ft (375 m)



(1) *2.8 in (70 mm) with CCA612 cable connected.*

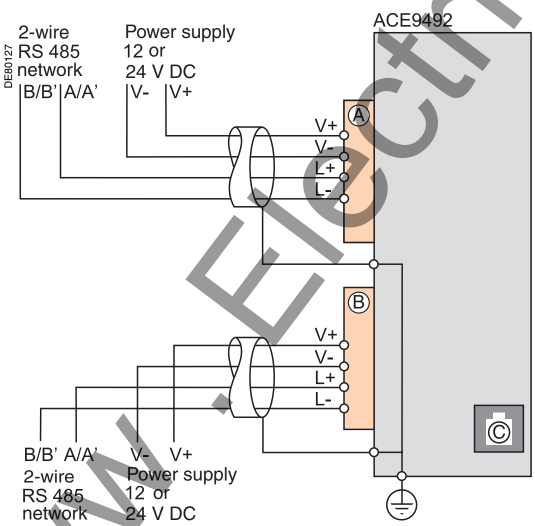
Description and Dimensions

(A) and (B) Terminal blocks for network cable

(C) RJ45 socket to connect the interface to the base unit with a CCA612 cable

(t) Grounding terminal

1. Link activity LED, flashes when communication is active (sending or receiving in progress).
2. Jumper for RS485 network line-end impedance matching with load resistor (Rc = 150 Ω), to be set to:
   - R̸c̸, if the module is not at one end of the network (default position)
   - Rc, if the module is at one end of the network.
3. Network cable clamps (inner diameter of clamp = 0.24 in or 6 mm).



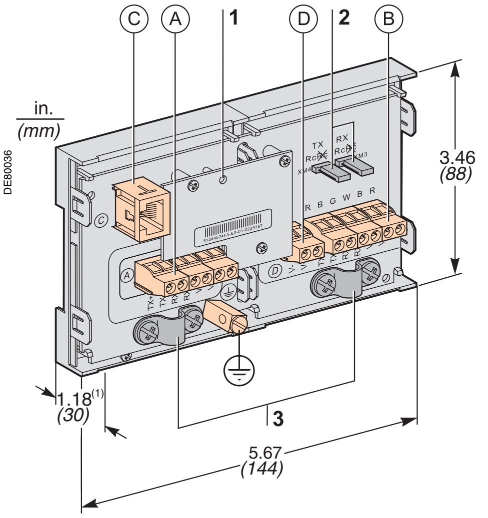
Connection

- Connection of network cable to screw-type terminal blocks (A) and (B)
- Connection of the grounding terminal by tinned copper braid with cross-section ≥ AWG 10 (6 mm²) or cable with cross-section ≥ AWG 12 (2.5 mm²) and length ≤ 7.9 in (200 mm), fitted with a 0.16 in (4 mm) ring lug. Check the tightness (maximum tightening torque 19.5 lb-in or 2.2 Nm).
- The interfaces are fitted with clamps to hold the network cable and recover shielding at the incoming and outgoing points of the network cable:
  - the network cable must be stripped
  - the cable shielding braid must be around and in contact with the clamp
- The interface is to be connected to connector (C) on the base unit using a CCA612 cable (length = 9.8 ft or 3 m, green fittings)
- The interfaces are to be supplied with 12 V DC or 24 V DC.

6

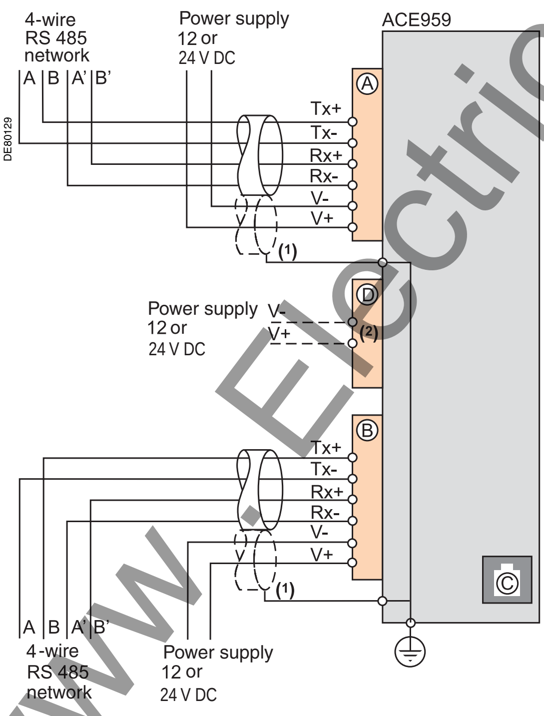
ACE959
4-wire RS485 Network Interface

ACE959 4-wire RS485 network connection interface.



(1) 2.8 in (70 mm) with CCA612 cable connected.

6



(1) Distributed power supply with separate wiring or included in the shielded cable (3 pairs).
(2) Terminal block for connection of the distributed power supply module.

Function

The ACE959 interface performs two functions:
- Electrical interface between Sepam™ and a 4-wire RS485 communication network
- Main network cable branching box for connecting a Sepam™ with a CCA612 cable.

Characteristics

ACE959 Module	
Weight	0.441 lb (0.2 kg)
Assembly	On symmetrical DIN rail
Operating temperature	–13°F to +158°F (–25°C to +70°C)
Environmental characteristics	Same as Sepam™ base units
4-wire RS485 Electrical Interface	
Standard	EIA 4-wire RS485 differential
Distributed power supply	External, 12 V DC or 24 V DC ±10%
Power consumption	16 mA in receiving mode
	40 mA maximum in sending mode

Maximum Length of 4-wire RS485 Network with Standard Cable

Number of Sepam™ Units	Maximum Length with 12 V DC Power Supply	Maximum Length with 24 V DC Power Supply
5	1000 ft (320 m)	3300 ft (1000 m)
10	590 ft (180 m)	2500 ft (750 m)
20	520 ft (160 m)	1500 ft (450 m)
25	410 ft (125 m)	1200 ft (375 m)

Description and Dimensions

(A) and (B) Terminal blocks for network cable
(C) RJ45 socket to connect the interface to the base unit with a CCA612 cable
(D) Terminal block for a separate auxiliary power supply (12 V DC or 24 V DC)
(⏚) Grounding terminal

1 Link activity LED, flashes when communication is active (sending or receiving in progress).
2 Jumper for 4-wire RS485 network line-end impedance matching with load resistor (Rc = 150 Ω), to be set to:
- ~~Rc~~, if the module is not at one end of the network (default position)
- Rc, if the module is at one end of the network.

3 Network cable clamps
(inner diameter of clamp = 0.24 in or 6 mm).

Connection

- Connection of network cable to screw-type terminal blocks (A) and (B)
- Connection of the grounding terminal by tinned copper braid with cross-section ≥ AWG 10 (6 mm²) or cable with cross-section ≥ AWG 12 (2.5 mm²) and length ≤ 7.9 in (200 mm), fitted with a 0.16 in (4 mm) ring lug. Check the tightness (maximum tightening torque 19.5 lb-in or 2.2 Nm).
- The interfaces are fitted with clamps to hold the network cable and recover shielding at the incoming and outgoing points of the network cable:
  - the network cable must be stripped
  - the cable shielding braid must be around and in contact with the clamp
- The interface is to be connected to connector (C) on the base unit using a CCA612 cable (length = 9.8 ft (3 m, green fittings)
- The interfaces are to be supplied with 12 V DC or 24 V DC
- The ACE959 can be connected to a separate distributed power supply (not included in shielded cable). Terminal block (D) is used to connect the distributed power supply module.

ACE937
Fiber Optic Interface

PE50024

ACE937 fiber optic connection interface.

Function

The ACE937 interface is used to connect Sepam™ to a fiber optic communication star system.
This remote module is connected to the Sepam™ base unit by a CCA612 cable.

Characteristics

ACE937 Module	
Weight	0.22 lb (0.1 kg)
Assembly	On symmetrical DIN rail
Power supply	Supplied by Sepam™
Operating temperature	–13°F to +158°F (–25°C to +70°C)
Environmental characteristics	Same as Sepam™ base units

Fiber Optic Interface	
Fiber type	Graded-index multimode silica
Wavelength	820 nm (invisible infra-red)
Type of connector	ST (BFOC bayonet fiber optic connector)

Fiber Optic Diameter (µm)	Numerical Aperture (NA)	Maximum Attenuation (dBm/km)	Minimum Optical Power Available (dBm)	Maximum Fiber Length
50/125	0.2	2.7	5.6	2300 ft (700 m)
62.5/125	0.275	3.2	9.4	5900 ft (1800 m)
100/140	0.3	4	14.9	9200 ft (2800 m)
200 (HCS)	0.37	6	19.2	8500 ft (2600 m)

CAUTION

HAZARD OF BLINDING

Never look directly into the end of the fiber optic.

Failure to follow this instruction can cause serious injury.

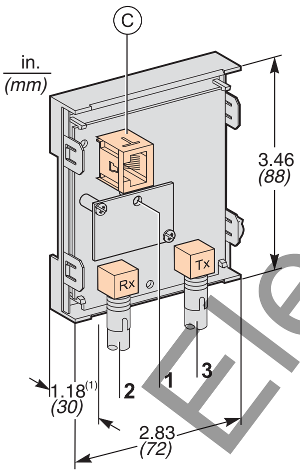
Maximum length calculated with:

- Minimum optical power available
- Maximum fiber attenuation
- Losses in two ST connectors: 0.6 dBm
- Optical power margin: 3 dBm (according to IEC 60870 standard).

Example for a 62.5/125 µm fiber

Lmax = (9.4 - 3 - 0.6)/3.2 = 1.12 mi (1.8 km)

DE80037



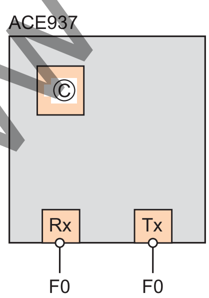
(1) *2.8 in (70 mm) with CCA612 cable connected.*

Description and Dimensions

(C) RJ45 socket to connect the interface to the base unit with a CCA612 cable.

1 Link activity LED, flashes when communication is active (sending or receiving in progress).
2 Rx, female ST type connector (Sepam™ receiving).
3 Tx, female ST type connector (Sepam™ sending).

DE51666



Connection

- The sending and receiving fiber optic fibers must be equipped with male ST type connectors
- Fiber optics screw-locked to Rx and Tx connectors.

The interface is to be connected to connector (C) on the base unit using a CCA612 cable (length = 9.8 ft or 3 m, green fittings).

ACE969TP and ACE969FO Multi-Protocol Interfaces

PE50470

ACE969TP communication interface.

PE50471

ACE969FO communication interface.

Function

The ACE969 multi-protocol communication interfaces are for Sepam™ Series 20, Series 40, and Series 80. They have two communication ports to connect Sepam™ to two independent communication networks:

- The S-LAN (Supervisory Local Area Network) port is used to connect Sepam™ to a communication network dedicated to supervision, using one of the three following protocols:
  - IEC 60870-5-103
  - DNP3
  - Modbus RTU.

The communication protocol is selected at the time of Sepam™ parameter setting.

- The E-LAN (Engineering Local Area Network) port, reserved for Sepam™ remote parameter setting and operation using the SFT2841 software.

There are two versions of the ACE969 interfaces, which are identical except for the S-LAN port:

- ACE969TP (Twisted Pair), for connecting to an S-LAN network using a 2-wire RS 485 serial link
- ACE969FO (Fiber Optic), for connection to an S-LAN network using a fiber-optic connection (star or ring).

The E-LAN port is always a 2-wire RS485 type port.

Characteristics

ACE969 Module

Technical Characteristics	
Weight	0.629 lb (0.285 kg)
Assembly	On symmetrical DIN rail
Operating temperature	–13°F to +158°F (–25°C to +70°C)
Environmental characteristics	Same as Sepam™ base units

Power Supply		
Voltage	24 to 250 V DC	110 to 240 V AC
Range	-20%/+10%	-20%/+10%
Maximum consumption	2 W	3 VA
Inrush current	< 10 A 100 µs	
Acceptable ripple content	12%	
Acceptable momentary outages	20 ms	

2-wire RS485 Communication Ports

Electrical Interface	
Standard	EIA 2-wire RS485 differential
Distributed power supply	External, 12 V DC or 24 V DC ±10%
Power consumption	16 mA in receiving mode
	40 mA in sending mode
Max. number of Sepam™ units	25

Maximum Length of 2-wire RS485 Network

Number of Sepam™ Units	With Distributed Power Supply	
	12 V DC	24 V DC
5	1000 ft (320 m)	3300 ft (1000 m)
10	590 ft (180 m)	2500 ft (750 m)
20	430 ft (130 m)	1500 ft (450 m)
25	410 ft (125 m)	1200 ft (375 m)

Fiber Optic Communication Port

Fiber Optic Interface	
Fiber type	Graded-index multimode silica
Wavelength	820 nm (invisible infra-red)
Type of connector	ST (BFOC bayonet fiber optic connector)

Maximum Length of Fiber Optic Network

Fiber Diameter (µm)	Numerical Aperture (NA)	Attenuation (dBm/km)	Minimum Optical Power Available (dBm)	Maximum Fiber Length
50/125	0.2	2.7	5.6	2300 ft (700 m)
62.5/125	0.275	3.2	9.4	5900 ft (1800 m)
100/140	0.3	4	14.9	9200 ft (2800 m)
200 (HCS)	0.37	6	19.2	8500 ft (2600 m)

Maximum length calculated with:

- Minimum optical power available
- Maximum fiber attenuation
- Losses in two ST connectors: 0.6 dBm
- Optical power margin: 3 dBm (according to IEC 60870 standard).

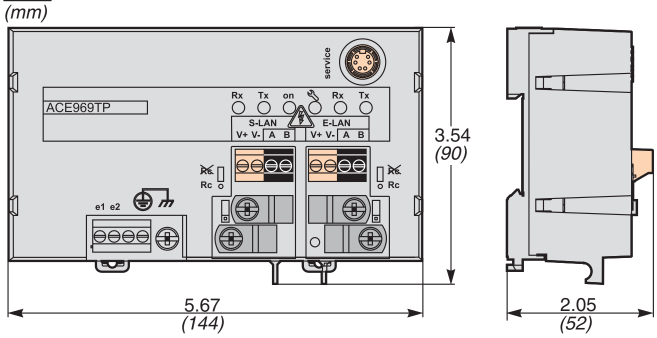
Example for a 62.5/125 µm fiber

Lmax = (9.4 - 3 - 0.6)/3.2 = 1.12 mi (1.8 km).

Dimensions

in.
(mm)

DE80043



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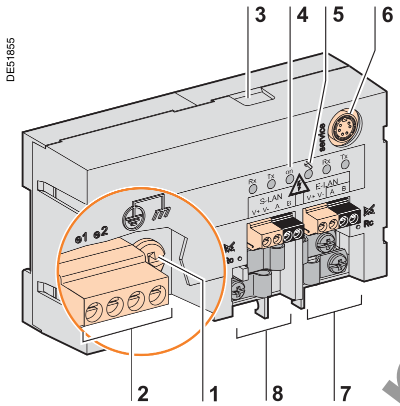
ACE969TP and ACE969FO Multi-Protocol Interfaces
Description

ACE969 Communication Interfaces

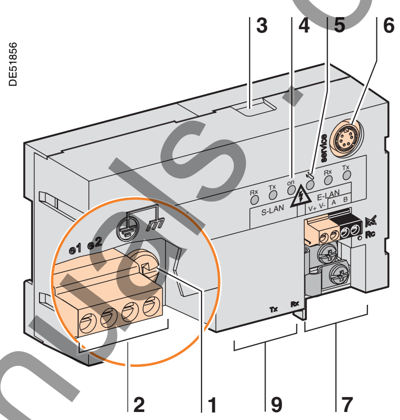
1 Grounding terminal using supplied braid
2 Power-supply terminal block
3 RJ45 socket to connect the interface to the base unit with a CCA612 cable
4 Green LED: ACE969 energized
5 Red LED: ACE969 interface status
- LED off = ACE969 set up and communication operational
- LED flashing = ACE969 not set up or setup incorrect
- LED remains on = ACE969 failed

6 Service connector: reserved for software upgrades
7 E-LAN 2-wire RS485 communication port (ACE969TP and ACE969FO)
8 S-LAN 2-wire RS485 communication port (ACE969TP)
9 S-LAN fiber-optic communication port (ACE969FO).

ACE969TP



ACE969FO



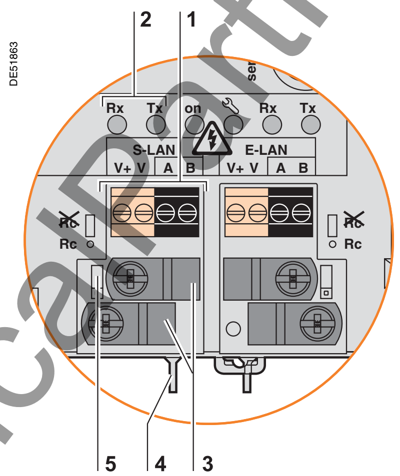
2-wire RS485 Communication Ports

1 2-wire RS485 network terminal block:
- two black terminals: connection of 2-wire RS485 twisted pair
- two green terminals: connection of twisted pair for distributed power supply

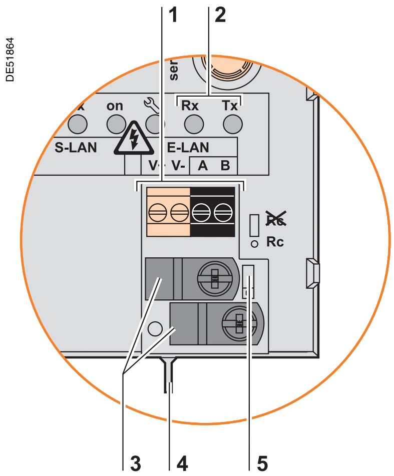
2 LEDs:
- Flashing Tx LED: Sepam™ sending
- Flashing Rx LED: Sepam™ receiving

3 Clamps and recovery of shielding for two network cables, incoming and outgoing (inner diameter of clamps = 0.24 in or 6 mm)
4 Fixing stud for network cable ties
5 Jumper for 2-wire RS485 network line-end impedance matching with load resistor (Rc = 150 Ω), to be set to:
- ~~Rc~~, if the interface is not at one end of the network (default position)
- Rc, if the interface is at one end of the network.

S-LAN Port (ACE969TP)



E-LAN Port (ACE969TP or ACE969FO)

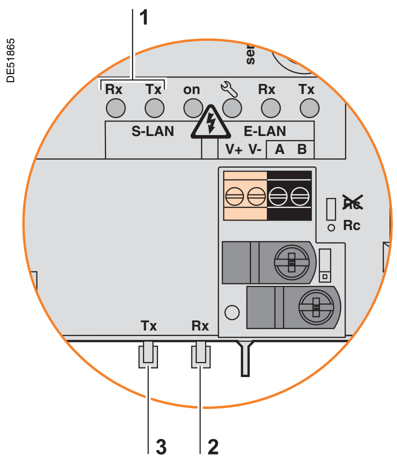


Fiber Optic Communication Port

1 LEDs:
- Flashing Tx LED: Sepam™ sending
- Flashing Rx LED: Sepam™ receiving

2 Rx, female ST type connector (Sepam™ receiving)
3 Tx, female ST type connector (Sepam™ sending).

S-LAN Port (ACE969FO)



Schneider Electric

Power Supply and Sepam™

- The ACE969 interface connects to connector **C** on the Sepam™ base unit using a CCA612 cable (length = 9.8 ft or 3 m, green RJ45 fittings)
- The ACE969 interface must be supplied with 24 to 250 V DC or 110 to 230 V AC in order to operate

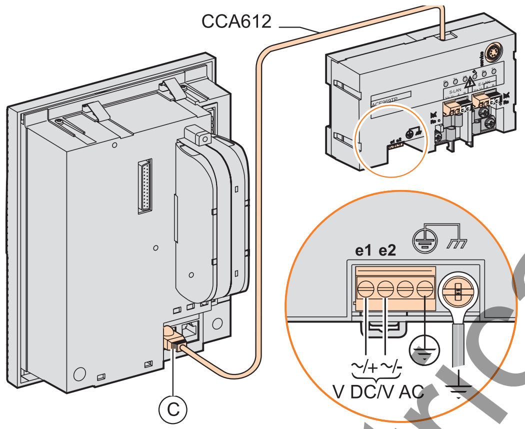
⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Before performing visual inspections, tests, or maintenance of the equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Start by connecting the device to the protective ground and to the functional ground.
- Screw tight all terminals, even those not in use.

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

DE52166



Terminals	Type	Wiring
e1-e2 - supply	Screw terminals	■ Wiring with no fittings: □ 1 wire with maximum cross-section ≥ AWG 24-12 (0.2 to 2.5 mm²) or 2 wires with maximum cross-section ≥ AWG 24-18 (0.2 to 1 mm²) □ stripped length: 0.31 to 0.39 in (8 to 10 mm) ■ Wiring with fittings: □ recommended wiring with Telemecanique fitting: - DZ5CE015D for 1 wire AWG 16 (1.5 mm²) - DZ5CE025D for 1 wire AWG 12 (2.5 mm²) - AZ5DE010D for 2 wires AWG 18 (1 mm²) □ wire length: 0.32 in (8.2 mm) □ stripped length: 0.31 in (8 mm).
DE51962 ⏚ Protective ground	Screw terminal	1 green/yellow wire, max. length 9.8 ft (3 m) and max. cross-section AWG 12 (2.5 mm²)
DE51845 ⏚ Functional ground	0.16 in (4 mm) ring lug	Grounding braid, supplied for connection to cubicle grounding

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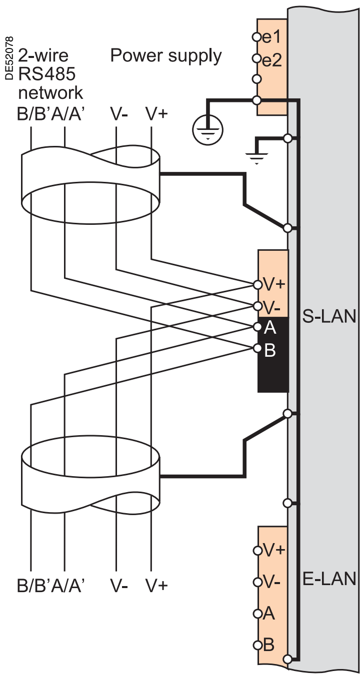
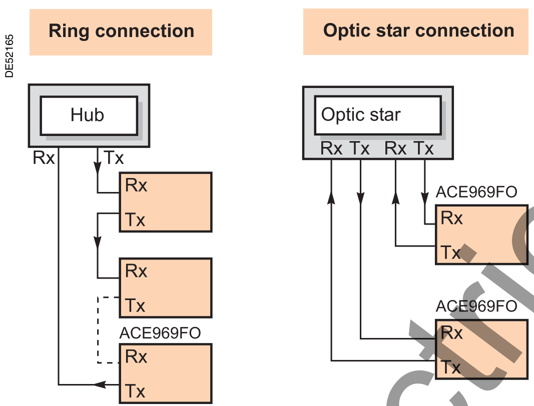


2-wire RS485 Communication Ports (S-LAN or E-LAN)

- Connecting RS485 twisted pair (S-LAN or E-LAN) to black terminals A and B
- Connecting twisted pair for distributed power supply to green terminals V+ and V-
- The interfaces are fitted with clamps to hold the network cable and recover shielding at the incoming and outgoing points of the network cable:
  - the network cable must be stripped
  - the cable shielding must be around and in contact with the clamp
  - shielding continuity of incoming and outgoing cables is ensured by the electrical continuity of the clamps
- All cable clamps are linked by an internal connection to the grounding terminals of the ACE969 interface (protective and functional grounding), i.e. the shielding of the RS 485 cables is grounded as well
- On the ACE969TP interface, the cable clamps for the S-LAN and E-LAN RS 485 networks are grounded.



Fiber Optic Communication Port (S-LAN)

CAUTION

HAZARD OF BLINDING
Never look directly into the fiber optic.
Failure to follow this instruction can cause serious injury.

The fiber optic connection can be made:
- point-to-point to an optic star system
- in a ring system (active echo).

The Transmit and Receive fiber optic strands must be equipped with male ST type connectors.

The fiber optics are screw-locked to Rx and Tx connectors.

Schneider Electric

PE50035

ACE9092 RS232/RS485 converter.

Function

The ACE9092 converter is used to connect a master/central computer equipped with a V24/RS232 type serial port as a standard feature to stations connected to a 2-wire RS485 network.

After setting the parameters, the ACE9092 converter performs conversion, network polarization, and automatic frames dispatching between the master and the stations by two-way simplex (half-duplex, single-pair) transmission. It accomplishes this without the need for flow control signals.

The ACE9092 converter also provides a 12 V DC or 24 V DC supply for the distributed power supply of the Sepam™ ACE9492, ACE959 or ACE969 interfaces. The communication settings should be the same as the Sepam™ and supervisor communication settings.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

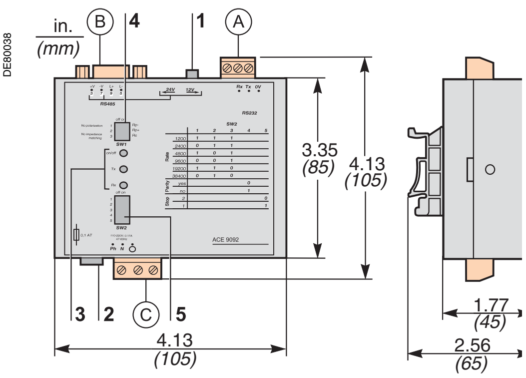
- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Before performing visual inspections, tests, or maintenance of the equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Start by connecting the device to the protective ground and to the functional ground.
- Screw tight all terminals, even those not in use.

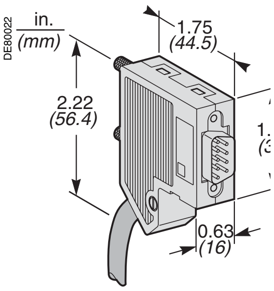
Failure to follow these instructions will result in death or serious injury.

Characteristics

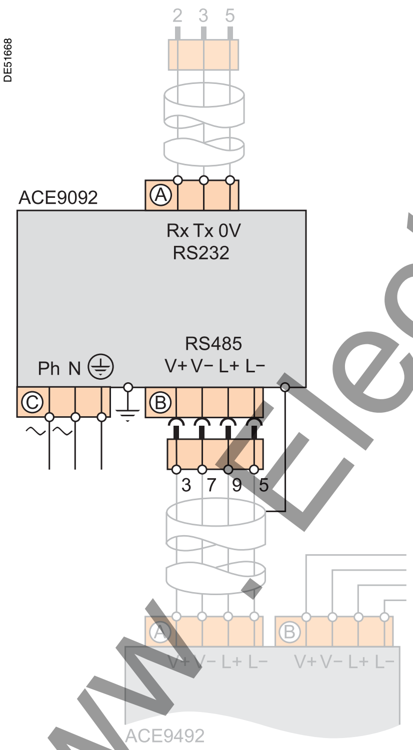
Mechanical Characteristics		
Weight	0.617 lb (0.280 kg)	
Assembly	On symmetrical or asymmetrical DIN rail	
Electrical Characteristics		
Power supply	110 to 240 V AC ± 10%, 47 to 63 Hz	
Galvanic isolation between ACE power supply and frame, and between ACE power supply and interface supply	2000 Vrms, 50 Hz, 1 min	
Galvanic isolation between RS232 and RS485 interfaces	1000 Vrms, 50 Hz, 1 min	
Protection by time-delayed fuse 5 mm x 20 mm (0.2 in x 0.79 in)	1 A rating	
Communication and Sepam™ Interface Distributed Supply		
Data format	11 bits: 1 start, 8 data, 1 parity, 1 stop	
Transmission delay	< 100 ns	
Distributed power supply for Sepam™ interfaces	12 V DC or 24 V DC	
Maximum number of Sepam™ interfaces with distributed supply	12	
Environmental Characteristics		
Operating temperature	+23°F to +131°F (–5°C to +55°C)	
Electromagnetic Compatibility	**IEC Standard**	**Value**
Fast transient bursts, 5 ns	60255-22-4	4 kV with capacitive tie breaker in common mode 2 kV with direct tie breaker in common mode 1 kV with direct tie breaker in differential mode
1 MHz damped oscillating wave	60255-22-1	1 kV common mode 0.5 kV differential mode
1.2/50 µs impulse waves	60255-5	3 kV common mode 1 kV differential mode

6





Male 9-pin sub-D connector supplied with the ACE9092.



Description and Dimensions

Ⓐ Terminal block for RS232 link limited to 10 m (33 ft).

Ⓑ Female 9-pin sub-D connector to connect to the 2-wire RS485 network, with distributed power supply.
1 screw-type male 9-pin sub-D connector is supplied with the converter.

Ⓒ Power-supply terminal block

1 Distributed power supply voltage selector switch, 12 V DC or 24 V DC.
2 Protection fuse, unlocked by a 1/4 turn.
3 LEDs:
- ON/OFF: on if ACE9092 is energized
- Tx: on if RS232 sending by ACE9092 is active
- Rx: on if RS232 receiving by ACE9092 is active.

4 SW1, parameter setting of 2-wire RS485 network polarization and line impedance matching resistors.

Function	SW1/1	SW1/2	SW1/3
Polarization at 0 V via Rp -470 Ω	ON		
Polarization at 5 V via Rp +470 Ω		ON	
2-wire RS 485 network impedance matching by 150 Ω resistor			ON

5 SW2, parameter setting of asynchronous data transmission rate and format (same parameters as for RS232 link and 2-wire RS485 network).

Rate (baud)	SW2/1	SW2/2	SW2/3		
1200	1	1	1		
2400	0	1	1		
4800	1	0	1		
9600	0	0	1		
19200	1	1	0		
38400	0	1	0		
Format				**SW2/4**	**SW2/5**
With parity check				0	
Without parity check				1	
1 stop bit (compulsory for Sepam™)					0
2 stop bits					1

Converter Configuration when Delivered
- 12 V DC distributed power supply
- 11-bit format, with parity check
- 2-wire RS485 network polarization and impedance matching resistors activated.

Connection

RS232 link
- To AWG 12 (2.5 mm²) screw type terminal block Ⓐ
- Maximum length 33 ft (10 m)
- Rx/Tx: RS232 receiving/sending by ACE9092
- 0V: Rx/Tx common, do not ground.

2-wire RS485 link with distributed power supply
- To connector Ⓑ female 9-pin sub-D
- 2-wire RS485 signals: L+, L-
- Distributed power supply: V+ = 12 V DC or 24 V DC, V- = 0 V.

Power supply
- To AWG 12 (2.5 mm²) screw type terminal block Ⓒ
- Reversible phase and neutral
- Grounded via terminal block and metal case (ring lug on back of case).

ACE919CA and ACE919CC RS 485/RS485 Converters

PE50036

ACE919CC RS485/RS485 converter.

Function

The ACE919 converters are used to connect a master/central computer equipped with an RS485 type serial port as a standard feature to stations connected to a 2-wire RS485 network.

Without requiring any flow control signals, the ACE919 converters perform network polarization and impedance matching. The ACE919 converters also provide a 12 V DC or 24 V DC supply for the distributed power supply of the Sepam™ ACE9492, ACE959 or ACE969 interfaces.

There are two types of ACE919 converter:

- ACE919CC, DC-powered
- ACE919CA, AC-powered.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Only qualified personnel should install this equipment. Such work should be performed only after reading this entire set of instructions and checking the technical characteristics of the device.
- NEVER work alone.
- Before performing visual inspections, tests, or maintenance of the equipment, disconnect all sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Start by connecting the device to the protective ground and to the functional ground.
- Screw tight all terminals, even those not in use.

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

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Characteristics

Mechanical Characteristics		
Weight	0.617 lb (0.280 kg)	
Assembly	On symmetrical or asymmetrical DIN rail	
Electrical Characteristics	**ACE919CA**	**ACE919CC**
Power supply	110 to 240 V AC ±10%, 47 to 63 Hz	24 to 48 V DC ±20%
Protection by time-delayed fuse 5 mm x 20 mm (0.2 in x 0.79 in)	1 A rating	1 A rating
Galvanic isolation between ACE power supply and frame, and between ACE power supply and interface supply		2000 Vrms, 50 Hz, 1 min
Communication and Sepam™ Interface Distributed Supply		
Data format	11 bits: 1 start, 8 data, 1 parity, 1 stop	
Transmission delay	< 100 ns	
Distributed power supply for Sepam™ interfaces	12 V DC or 24 V DC	
Maximum number of Sepam™ interfaces with distributed supply	12	
Environmental Characteristics		
Operating temperature	+23°F to +131°F (–5°C to +55°C)	
Electromagnetic Compatibility	**IEC Standard**	**Value**
Fast transient bursts, 5 ns	60255-22-4	4 kV with capacitive coupling in common mode 2 kV with direct coupling in common mode 1 kV with direct coupling in differential mode
1 MHz damped oscillating wave	60255-22-1	1 kV common mode 0.5 kV differential mode
1.2/50 µs impulse waves	60255-5	3 kV common mode 1 kV differential mode

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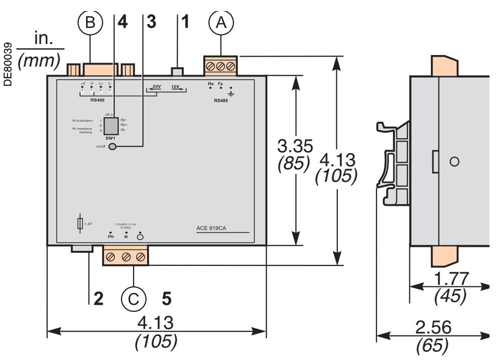
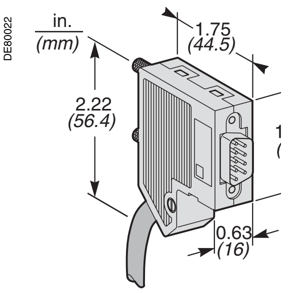
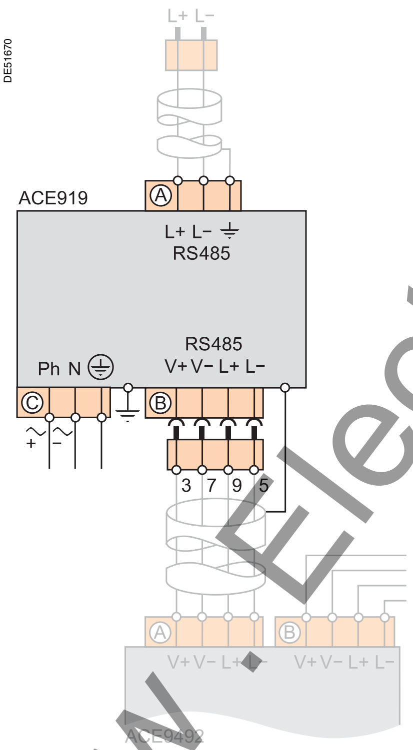
ACE919CA and ACE919CC RS 485/RS485 Converters





Male 9-pin sub-D connector supplied with the ACE919.



Description and Dimensions

(A) Terminal block for 2-wire RS485 link without distributed power supply.
(B) Female 9-pin sub-D connector to connect to the 2-wire RS485 network, with distributed power supply.
1 screw-type male 9-pin sub-D connector is supplied with the converter.
(C) Power supply terminal block.

1 Distributed power supply voltage selector switch, 12 V DC or 24 V DC.
2 Protection fuse, unlocked by a 1/4 turn.
3 ON/OFF LED: on if ACE919 is energized.
4 SW1, parameter setting of 2-wire RS485 network polarization and line impedance matching resistors.

Function	SW1/1	SW1/2	SW1/3
Polarization at 0 V via Rp -470 Ω	ON		
Polarization at 5 V via Rp +470 Ω		ON	
2-wire RS 485 network impedance matching by 150 Ω resistor			ON

Converter Configuration when Delivered

- 12 V DC distributed power supply
- 2-wire RS485 network polarization and impedance matching resistors activated.

Connection

2-wire RS485 Link without Distributed Power Supply

- To AWG 12 (2.5 mm²) screw type terminal block (A)
- L+, L-: 2-wire RS485 signals
- ⏚ Shielding.

2-wire RS485 Link with Distributed Power Supply

- To connector (B) female 9-pin sub-D
- 2-wire RS485 signals: L+, L-
- Distributed power supply: V+ = 12 V DC or 24 V DC, V- = 0 V.

Power Supply

- To AWG 12 (2.5 mm²) screw type terminal block (C)
- Reversible phase and neutral (ACE919CA)
- Grounded via terminal block and metal case (ring lug on back of case).

Contents

Sepam™ User Machine Interfaces

Two different levels of user machine interface (UMI) are offered on the front panel of Sepam™:

- Basic UMI, with LEDs, for installations operated via a remote system with no need for local operation
- Advanced UMI, with keypad and graphic LCD display, giving access to all the information necessary for local operation and Sepam™ parameter setting.

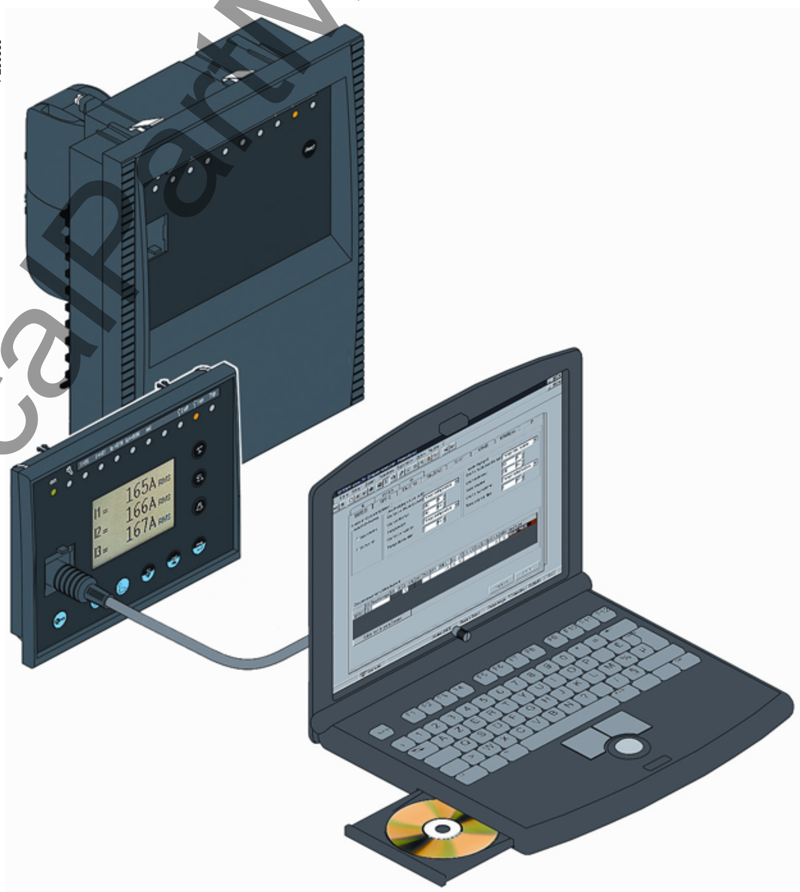
SFT2841 Setting and Operating Software

The UMI on the front panel of Sepam™ can be completed by the SFT2841 PC software tool, which can be used for all Sepam™ parameter setting, local operation and customization functions.

The SFT2841 setting and operating software is supplied on CD-ROM, along with the SFT2826 program for recovering disturbance recording files, the interactive introduction to the Sepam™ range, and all the Sepam™ documentation in PDF format.

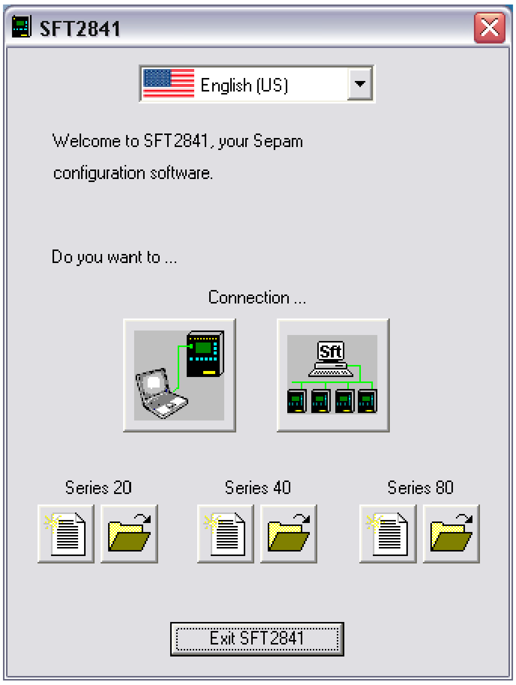
The CCA783 PC connecting cable (comes with SFT2841KIT) connects the PC to the port on the Sepam™ front panel to provide point-to-point connection between Sepam™ and the SFT2841 software.

PE50336



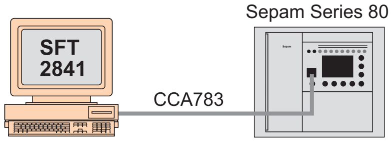
SFT2841 Setting & Operating Software
Welcome Window

PE50426



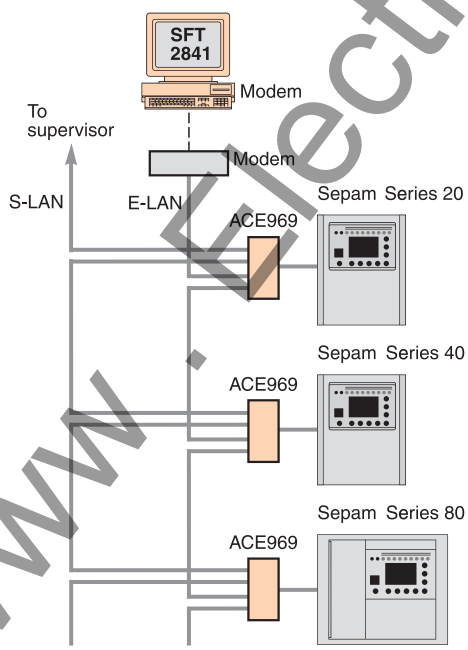
Welcome window

DE52069



SFT2841 connected to a single Sepam™ unit

DE52241



SFT2841 connected to a Sepam™ network

Description

The SFT2841 welcome window opens when the program is launched.
It lets you choose the language for the SFT2841 screens, and provides access to the Sepam™ parameter and protection setting files:

- In **disconnected** mode, you can open or create a parameter and protection setting file for a Sepam™ Series 20, Series 40 or Series 80
- When connected to a **single** Sepam™ unit, you can access the parameter and protection setting file for the Sepam™ unit connected to the PC
- When connected to a Sepam™ **network**, you can access the parameter and protection setting files for a group of Sepam™ units connected to the PC via a communication network.

Language Options for SFT2841 Software

SFT2841 software can be used in English, French or Spanish. The language is selected at the top of the window.

Using SFT2841 in Disconnected Mode

Disconnected mode allows you to prepare parameters and settings files for Sepam™ Series 20, Series 40 and Series 80 prior to commissioning.

The parameter and protection setting files prepared in disconnected mode will be downloaded later to the Sepam™ units in connected mode.

- To create a new setting file, click on the icon for the relevant Sepam™ family (Series 20, Series 40, or Series 80)
- To open an existing setting file, click on the icon for the relevant Sepam™ family (Series 20, Series 40, or Series 80).

Using SFT2841 Connected to a Single Sepam™ Unit

The SFT2841 software is connected to a single Sepam™ unit mode during commissioning to upload, download and modify Sepam™ parameters and settings. This connection also provides all the measurements and supporting data available for commissioning.

The PC loaded with the SFT2841 software is connected to the port on the front panel of Sepam™ via an RS232 port using the CCA783 cable.

To open the parameter and protection setting file on the Sepam™ once it is connected to the PC, click on the icon.

Using SFT2841 Connected to a Sepam™ Network

SFT2841 performs the following functions when connected to a Sepam™ network and used during operation:

- To manage the protection system
- To check the status of the power supply
- To diagnose any incident occurring on the power supply.

The PC loaded with the SFT2841 software is connected to a group of Sepam™ units by means of a communication network (by serial link, telephone line, or Ethernet). This network forms the E-LAN engineering network.

The connection window allows configuration of the Sepam™ network, and provides access to the parameter and protection setting files of the Sepam™ units on the network.

To open the connection window, click on the icon.

See "Configuration of a Sepam™ network" for details of how to configure the E-LAN engineering network from the connection window.

The setting and operating functions are available on a PC equipped with SFT2841 software and connected to the front panel of Sepam™ (run in a Windows 98 / NT or better environment).

The data used for the same task are grouped together in the same screen to facilitate operation. Menus and icons are used for fast and direct access to required information.

Current Operation
SFT2841 software displays the following information:
- all metering and operation data
- all alarm messages with the time of appearance (date, hour, mn, s, ms)
- diagnosis data such as: tripping current, number of switchgear operations and cumulative breaking current
- all protection and parameter settings
- logic status of inputs, outputs and signal lamps.

The SFT2841 software is the solution suited to occasional local operation for fast access to information.

Parameter and Protection Setting (1)
- display and setting of all the parameters of each protection function in the same page
- program logic parameter setting, parameter setting of general installation and Sepam™ data
- input data may be prepared ahead of time and transferred into the corresponding Sepam™ units in a single operation (downloading function).

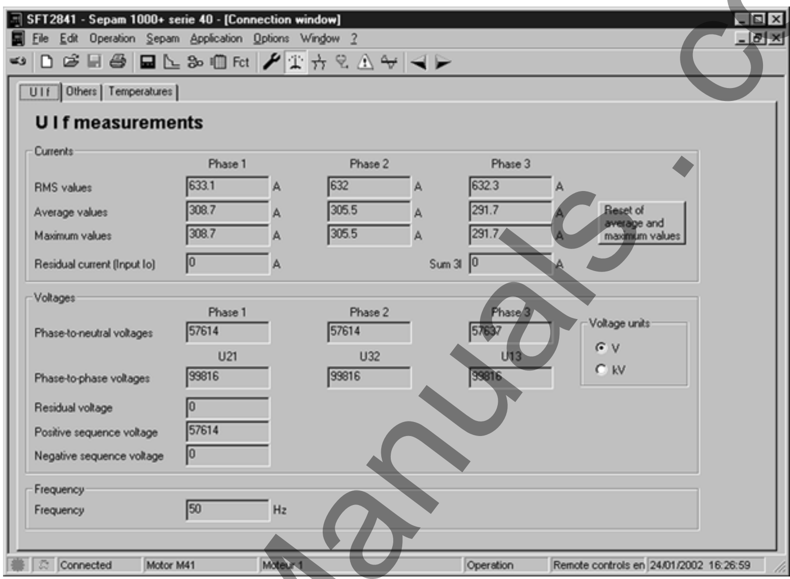
Main functions performed by SFT2841:
- changing passwords
- entering general characteristics (ratings, integration period)
- setting Sepam™ date and time
- entering protection settings
- changing program logic assignments
- enabling/disabling functions
- saving files.

Saving
Protection and parameter setting data can be saved, as well as printing reports
.
The SFT2841 software can also be used to recover disturbance recording files and provide graphic display using the SFT2826 software tool.

Operating Assistance
Access from all the screens to a help section which contains all the technical data required for Sepam™ installation and use.

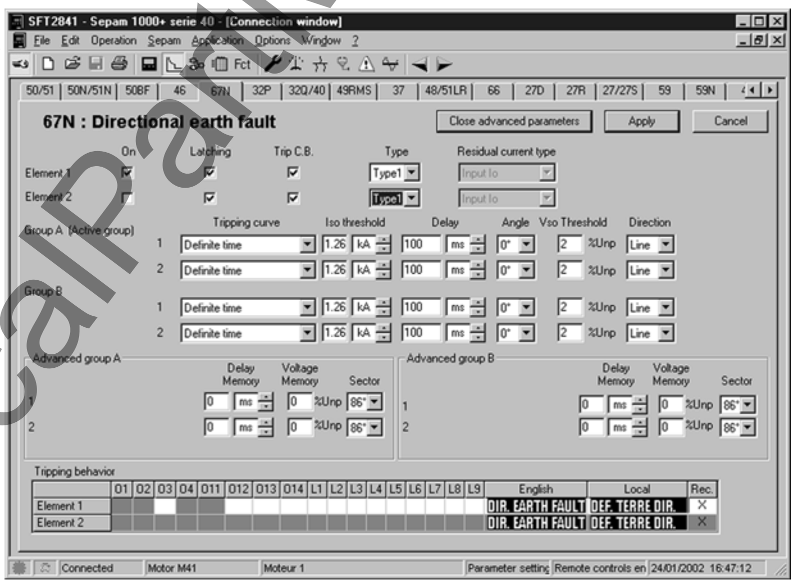
(1) Modes accessed via 2 passwords (protection setting level, parameter setting level).

MT11190



Example of a measurement display screen.

MT11191



Example of a protection setting screen.

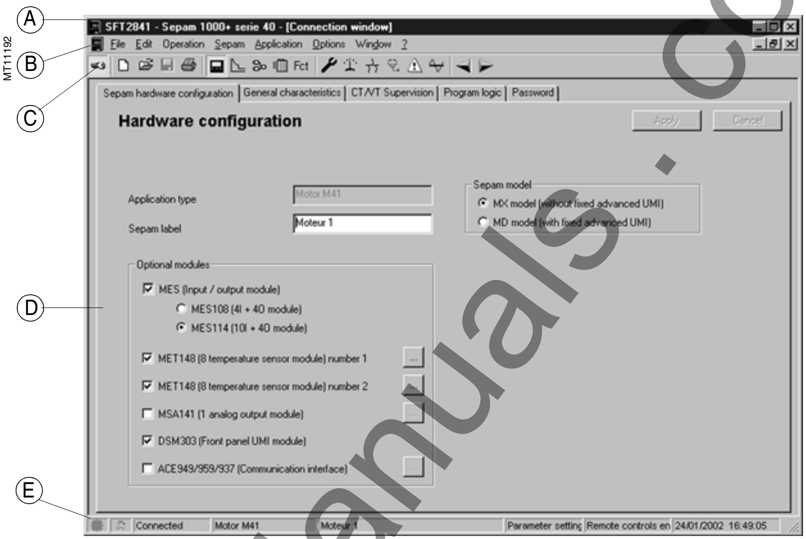
7

SFT2841 Setting & Operating Software
General Screen Organization

A Sepam™ document displayed on the screen has conventional Windows features. All SFT2841 software screens are set up in similar fashion:

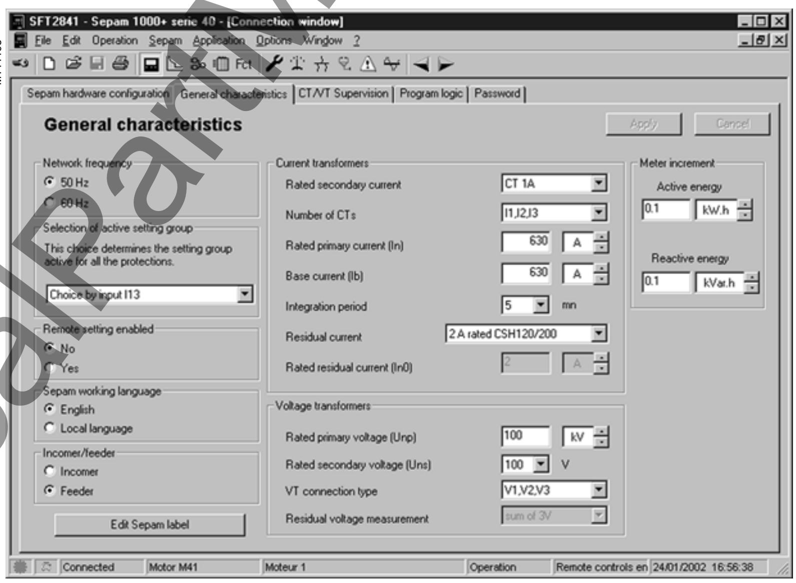
- Ⓐ: title bar, with:
  - name of the application (SFT2841)
  - identification of the Sepam™ document displayed
  - window manipulation handles
- Ⓑ: menu bar, to access all the SFT2841 software functions (unavailable functions are dimmed)
- Ⓒ: toolbar, a group of contextual icons for quick access to the main functions (also accessed via the menu bar)
- Ⓓ: work zone available to the user, presented in the form of tab boxes
- Ⓔ: status bar, with the following information relating to the active document:
  - alarm on
  - identification of the connection window
  - SFT2841 operating mode, connected or not connected,
  - type of Sepam™
  - Sepam™ editing identification
  - identification level
  - Sepam™ operating mode
  - PC date and time.

MT11192



Example of Sepam™ configuration screen

MT11193



Example of general characteristics screen

Guided Navigation

A guided navigation mode provides easier access to all Sepam™ parameter and protection settings. It allows users to go through the data input screens in the natural order.

The sequencing of the screens in guided mode is controlled by clicking on two icons in the toolbar Ⓒ:

- ◄: to go back to the previous screen
- ►: to go to the next screen.

The screens are linked up in the following sequence:

1 Sepam™ hardware configuration
2 General characteristics
3 CT/VT supervision
4 Program logic
5 Password
6 Setting screens for the protection functions available, according to the type of Sepam™
7 Logical equation editor
8 Various tabs of the control matrix
9 Disturbance recording setup.

On-Line Help

The operator may look up on-line help at any time by using the "?" command in the menu bar.
The use of on-line help requires a browser such as Netscape Navigator or Internet Explorer.

7

Not Connected to Sepam™ Mode

Sepam™ Parameter and Protection Setting
The parameter and protection setting of a Sepam™ using SFT2841 consists of preparing the Sepam™ file containing all the characteristics that are specific to the application. This file is then downloaded into Sepam™ at the time of commissioning.

CAUTION

HAZARD OF UNINTENDED OPERATION

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

Failure to follow these instructions can cause equipment damage.

Operating Mode:
1 Create a Sepam™ file for the type of Sepam™ being set up. The newly created file contains the Sepam™ factory-set parameter and protection settings.
2 Modify the Sepam™ general settings and protection function settings:
   - all the data relating to the same function are grouped together in the same screen
   - it is advisable to enter all the parameters and protection settings in the natural order of the screens proposed by the guided navigation mode.

Entering Parameter and Protection Settings:
The parameter and protection setting input fields are suited to the type of value:
- choice buttons
- numerical value input fields
- dialogue box (Combo box)

The user must "Apply" or "Cancel" the new values entered before going on to the following screen, where the consistency of the new values applied is checked.

An explicit message identifies inconsistent values and specifies the authorized values

Values that have become inconsistent after a parameter modification are adjusted to the closest consistent value.

Connected to Sepam™ Mode

Precaution
Given the risks inherent to the accumulation of static electricity, the customary precaution when using a laptop consists of discharging in contact with a grounded metal frame before phsycially connecting the CCA783 cable.

Plugging into Sepam™
Connecting Sepam to a PC equipped with SFT 2841 involves the following:
- plugging the 9-pin connector (SUB-D type) into one of the PC communication ports. Configuration of the PC communciation port via the "Communication port" function in the "Options" menu
- plugging the 6-pin connector into the connector (round minidin type) situated behind the blanking plate on the front panel of Sepam™ or the DSM303 module.

Connection to Sepam™
There are two possibilities for setting up the connection between SFT2841 and Sepam™:
- "Connection" function in the "File" menu
- choice of "connect to the Sepam™" at the start-up of SFT2841.

Once the connection with Sepam™ has been established, "Connected" appears in the status bar, and the Sepam™ connection window may be accessed in the work zone.

User Identification
The window intended for the entry of the 4-digit password is activated:
- via the "Passwords" tab
- via the "Identification" function in the "Sepam™" menu
- via the "Identification" icon .

The "Return to Operating mode" function in the "Passwords" tab removes access rights to parameter and protection setting mode.

Downloading Parameters and Protection Settings
Parameter and protection setting files may only be downloaded in the connected Sepam™ in Parameter setting mode. Once the connection has been established, the procedure for downloading a parameter and protection setting file is as follows:
1 Activate the "Download Sepam™" function in the "Sepam™" menu.
2 Select the file(*.S40, *.S41, *.S42, *.T40, *.T42, *.M41, *.G40 according to the type of application) which contains the data to be downloaded.

Return to Factory Settings
This operation is only possible in Parameter setting mode, via the "Sepam™" menu. All of the Sepam™ general characteristics, protection settings and the control matrix go back to the default values.

Uploading Parameter and Protection Settings
The connected Sepam™ parameter and protection setting file may only be uploaded in Operating mode.

Once the connection has been established, the procedure for uploading a parameter and protection setting file is as follows:
1 Activate the "Upload Sepam™" function in the "Sepam™" menu.
2 Select the *.rpg file that is to contain the uploaded data.
3 Acknowledge the end of operation report.

Local Operation of Sepam™
When connected to Sepam™, SFT2841 offers all the local operating functions available in the advanced UMI screen, plus the following functions:
- setting the Sepam™ internal clock on the "general characteristics" tab
- implementing the disturbance recording function through the "Fault recording" menu "OPG": validation/blocking the function, recovery of Sepam™ files, start-up of SFT2826
- consulting the history of the last 64 Sepam™ alarms, with time-tagging
- access to Sepam™ diagnostic data, in the "Sepam™" tab box, included in ""Sepam™ diagnosis"
- in Parameter setting mode, the switchgear diagnositic values may be modified: operation counter, cumulative breaking current to reset the values after a change of breaking device.

SFT2841 Setting & Operating Software
Configuring a Sepam™ Network

Connection Window
The SFT2841 software connection window is used to:
- select an existing Sepam™ network or configure a new one
- set up the connection to the selected Sepam™ network
- select one Sepam™ unit from the network and access its parameters, settings, and operation and maintenance information.

Configuring a Sepam™ Network
Several configurations can be defined for the various Sepam™ installations.
A Sepam™ network configuration is identified by a name. It is saved on the SFT2841 PC in a file in the SFT2841 installation directory (default: C:\Program Files\Schneider\SFT2841\Net).

Configurnig a Sepam™ network is in two parts:
- Configuring the communication network
- Configuring the Sepam™ units.

Configuring the Communication Network
To configure the communication network, first define:
- The type of link between the PC and the Sepam™ network
- The communication parameters, according to the type of link selected:
  - direct serial link
  - link via Ethernet TCP/IP
  - link via telephone modem.

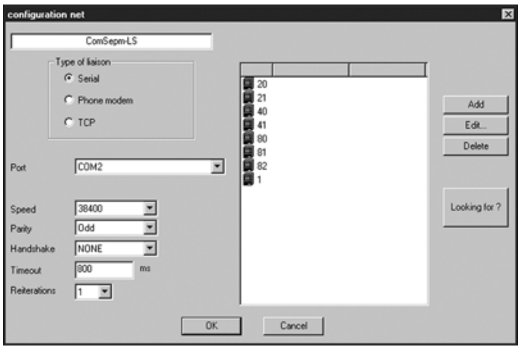
PE50603

Configuration windows for the communication network, according to the type of link: serial link, modem link (STN) or Ethernet link (TCP)

SFT2841 Setting & Operating Software

Configuring a Sepam™ Network

PE50588



Configuration window for the serial link communication network.

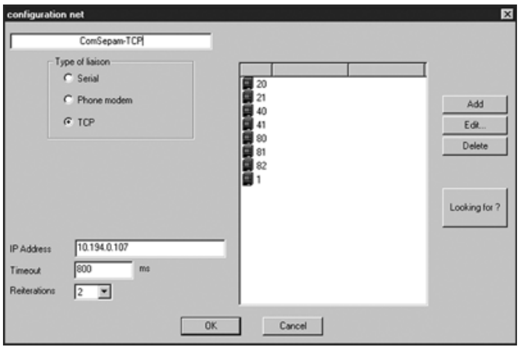
Direct Serial Link

The Sepam™ units are connected to an RS485 (or fiber-optic) multidrop network. Depending on the serial link interfaces available on the PC, the PC itself will be connected either directly to the RS485 network (or fiber-optic HUB), or via an RS232/RS485 converter (or fiber-optic converter).

The communication parameters to be defined are:

- port: communication port used on the PC
- speed: 4800, 9600, 19200 or 38400 bauds
- parity: None, Even or Odd
- handshake: None, RTS or RTS-CTS
- time-out: from 100 to 3000 ms.
- number of retries: from 1 to 6.

PE50589



Configuration window for the Ethernet TCP/IP communication network.

Link via TCP/IP Ethernet

The Sepam™ units are connected to an RS485 multidrop network over an Ethernet Modbus TCP/IP gateway (for example: EGX gateway).

Configuring the Modbus TCP/IP Gateway
See the setup manual for the gateway used.

The gateway should be assigned an IP address.

The configuration parameters for the gateway's RS485 interface must be defined in accordance with the Sepam™ communication interface configuration:

- speed: 4800, 9600, 19200 or 38400 bauds
- character format: 8 data bits + 1 stop bit + parity (none, even, odd).

Configuring Communication on SFT2841
When configuring a Sepam™ network on SFT2841, the following communication parameters must be defined:

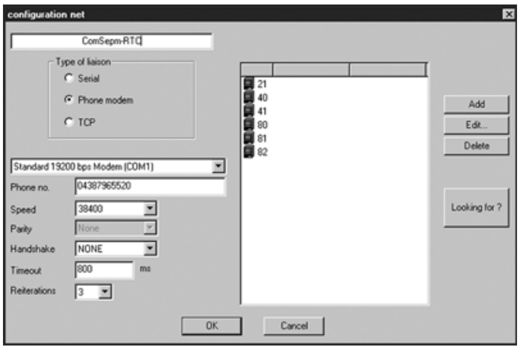
- IP address: IP address of the remote Modbus TCP/IP gateway
- time-out: from 100 to 3000 ms.
  A time-out of between 800 ms and 1000 ms is sufficient in most installations. Communication via the TCP/IP gateway may, however, be slowed down if other applications want Modbus TCP/IP access at the same time.
  The time-out value should then be increased (2 to 3 seconds).
- number of retries: from 1 to 6.

Note 1: *SFT2841 uses the Modbus TCP/IP communication protocol.*
Although communication is IP-based, use of SFT2841 is restricted to a local installation network based on an Ethernet network (LAN – Local Area Network).
The operation of SFT2841 over a WAN (Wide Area Network) cannot be guaranteed because of the presence of some routers or firewalls that may reject the Modbus protocol, causing communication times that would be incompatible with Sepam™.

Note 2: *SFT2841 allows Sepam™ protection settings to be modified, and direct activation of the outputs. These operations, which could involve the operation of electrical switchgear (opening and closing), and thus risk the safety of people and installations, are protected by the Sepam™ password. In addition to this protection, the E-LANs and S-LANs must be designed as private networks, protected from external actions by all suitable methods.*

Schneider Electric

PE50590



Configuration window for the communication network via telephone modem.

Link via Telephone Modem

The Sepam™ unitss are connected to an RS485 multidrop network using an industrial PSTN modem.

This modem is the ***called*** modem. It must first be configured, either via AT commands from a PC using HyperTerminal or the configuration tool that may have been supplied with the modem, or by setting switches. See the modem manufacturer's manual for more information.

The PC may use an internal or an external modem. This modem on the PC side is always the ***calling*** modem. It must be installed and configured in accordance with the Windows modem installation procedure.

Configuring the Calling Modem in SFT2841

When configuring a Sepam™ network, SFT2841 displays the list of all modems installed on the PC:

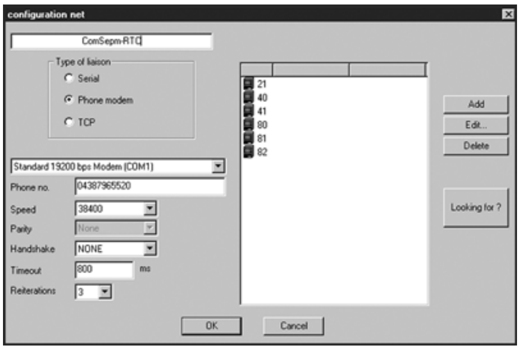
The communication parameters to be defined are:

- modem: select one of the modems listed by SFT2841
- telephone no.: no. of the remote modem to be called
- speed: 4800, 9600, 19200 or 38400 baud
- parity: none (not adjustable)
- handshake: none, RTS or RTS-CTS
- time-out: from 100 to 3000 ms.

Communication via modem and telephone network is slowed considerably because of the transit time through the modems. A time-out of between 800 ms and 1000 ms is sufficient in most 38400 baud installations. In some cases, the poor quality of the telephone network may require a slower speed (9600 or 4800 baud). The time-out value should then be increased (2 to 3 seconds), with the number of retries ranging from 1 to 6.

Note: *The speed and parity of the calling modem must be configured under Windows with the same values as for SFT2841.*

PE50590



Configuration window for the communication network via telephone modem

Configuring a Called Modem

The modem on the Sepam™ side is the called modem. It must first be configured, either via AT commands from a PC using HyperTerminal or the configuration tool that may have been supplied with the modem, or by setting switches (see the modem manufacturer's manual).

Modem RS485 Interface

In general, the configuration parameters for the modem's RS485 interface must be defined in accordance with the Sepam™ communication interface configuration:
- speed: 4800, 9600, 19200 or 38400 baud
- character format: 8 data bits + 1 stop bit + parity (none, even, odd).

Telephone Network Interface

Modern modems offer sophisticated features such as checking the quality of the telephone line, error correction and data compression. These options are not appropriate for communication between SFT2841 and Sepam™, which is based on the Modbus RTU protocol. Their effect on communication performance may be the opposite of the expected result.

It is therefore highly advisable to:
- Invalidate the error correction, data compression and telephone line quality monitoring options
- Use the same end-to-end communication speed between:
  - the Sepam™ network and the called modem
  - the called modem (Sepam™ side) and the calling modem (PC side)
  - the PC and the calling modem (see recommended configurations table).

Sepam™ Network	Telephone Network	PC Modem Interface
38400 baud	V34 modulation, 33600 baud	38400 baud
19200 baud	V34 modulation, 19200 baud	19200 baud
9600 baud	V32 modulation, 9600 baud	9600 baud

Industrial Configuration Profile

The following table shows the main characteristics of the modem on the Sepam™ side. These characteristics match a configuration profile commonly known as an "industrial profile", as opposed to the configuration of modems used in offices.

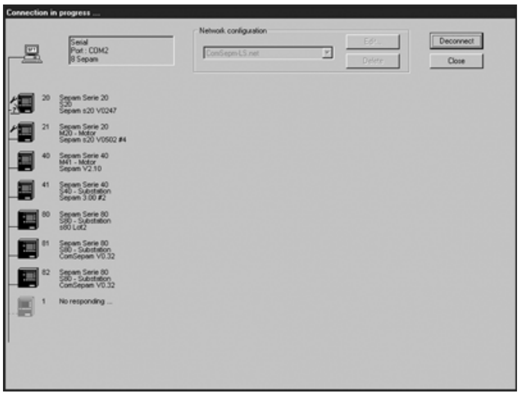
Depending on the type of modem used, the configuration will either be via AT commands from a PC using HyperTerminal or the configuration tool that may have been supplied with the modem, or by setting switches (see the modem manufacturer's manual).

"Industrial Profile" Configuration Characteristics	AT command
Transmission in buffered mode, without error correction	\N0 (force &Q6)
Data compression deactivated	%C0
Line quality monitoring deactivated	%E0
DTR signal assumed to be permanently off (allows the modem connection to be established automatically on an incoming call)	&D0
CD signal off when carrier is present	&C1
All reports made to Sepam™ blocked	Q1
Character echo suppression	E0
No flow control	&K0

7

SFT2841 Setting & Operating Software
Configuring a Sepam™ Network

PE50591



Sepam™ network connected to SFT2841

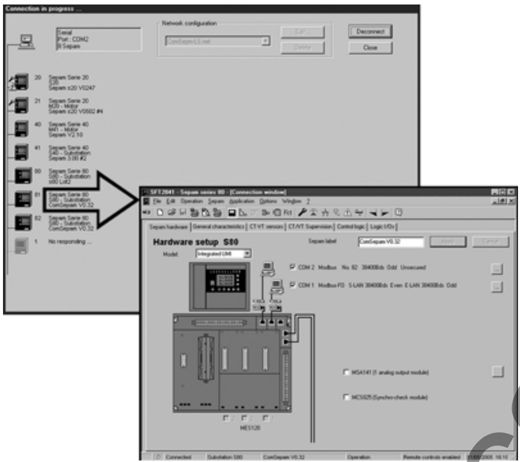
Identifying Sepam™ Units Connected to the Communication Network

The Sepam™ units connected to the communication network are identified by their Modbus address. These addresses can be configured in either of the following ways:

- Manually, one by one:
  - the "Add" button is used to define a new Sepam™ device; it is allocated a default Modbus address
  - the "Edit" button is used to modify the Modbus address if necessary
  - the "Delete" button removes a device from the configuration
- Automatically, by running an automatic search of the Sepam™ units connected:
  - the "Automatic search"/"Stop search" button starts or interrupts the search
  - when SFT2841 recognizes a Sepam™ unit, its Modbus address and type are shown on screen
  - when a Modbus device other than Sepam™ responds to SFT2841, its Modbus address is displayed. The text "???" indicates that the device is not a Sepam™.

The Sepam™ network configuration is saved in a file when the UMI window closes, by pressing the "OK" button.

PE50592



Access to parameters and settings for a Sepam™ Series 80 connected to a communication network.

Access to Sepam™ Information

To establish communication between SFT2841 and a Sepam™ network, select the Sepam™ network configuration you want, and press "Connect".
The Sepam™ network is displayed in the connection window. SFT2841 polls all the equipment defined in the selected configuration. Each Sepam™ queried is represented by an icon:

- Sepam™ Series 20 or Series 40 actually connected to the network 
- Sepam™ Series 80 actually connected to the network 
- Sepam™ configured but not connected to the network 
- A device other than Sepam™ connected to the network. 

A summary report of each Sepam™ detected as present is also displayed:

- Sepam™ Modbus address
- Type of application and Sepam™ identification
- Any alarms present
- Any minor/major faults present.

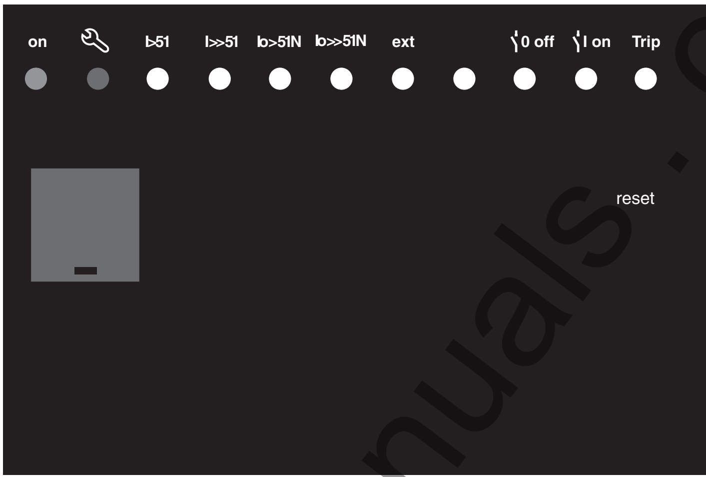
To access parameters, settings and operation and maintenance information for a particular Sepam™, click on the icon for that Sepam™. SFT2841 then establishes a point-to-point connection with the selected Sepam™.

Basic UMI

This UMI includes:

- two signal lamps indicating Sepam™ operating status:
  - green "**on**" indicator: device on
  - red (wrench) indicator: device unavailable (initialization phase or detection of internal problems)
- nine parameterizable yellow signal lamps, fitted with a standard label (with SFT2841, a customized label can be printed on a laser printer)
- (reset) key for clearing faults and resetting
- one connection port for the link with the PC (CCA783 cord), the connector is protected by a sliding cover.

MT10276



Fixed or Remote Advanced UMI

In addition to the basic UMI functions, this version provides:

- **a "graphic" LCD display** for the display of measurements, parameter/protection settings and alarm and operating messages.

The number of lines, size of characters and symbols are in accordance with the screens and language versions.

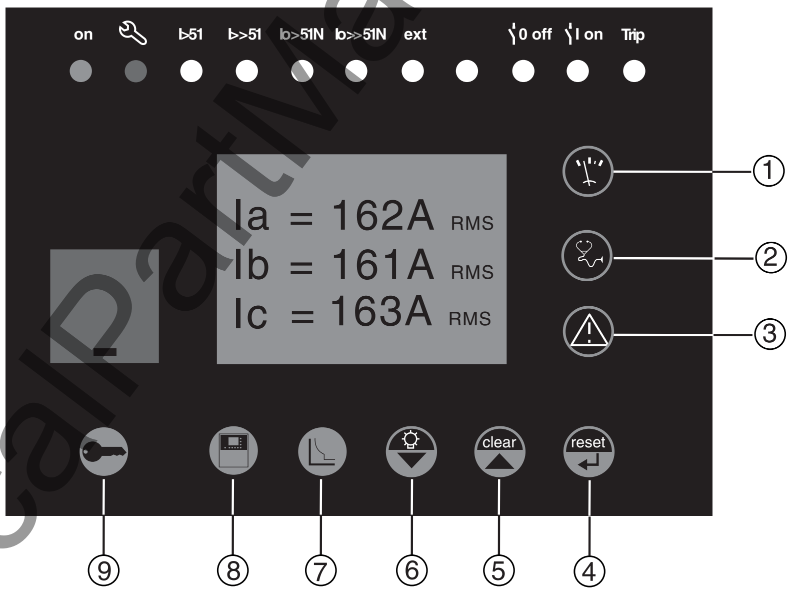
The LCD display is back-lit when the user presses a key.

- **a 9-key keypad with two operating modes:**

White keys for current operation:
① display of measurements,
② display of "switchgear, network diagnosis" data,
③ display of alarm messages,
④ resetting,
⑤ acknowledgment and clearing of alarms.

Blue keys activated in parameter and protection setting mode:
⑦ access to protection settings,
⑧ access to Sepam™ parameter setting,
⑨ used to enter the 2 passwords required to change protection and parameter settings.
The (enter), (up), (down) (④, ⑤, ⑥) keys are used to browse through the menus and to scroll and accept the values displayed.
⑥ **"lamp test" key:**
switching on sequence of all the signal lamps.

MT10277



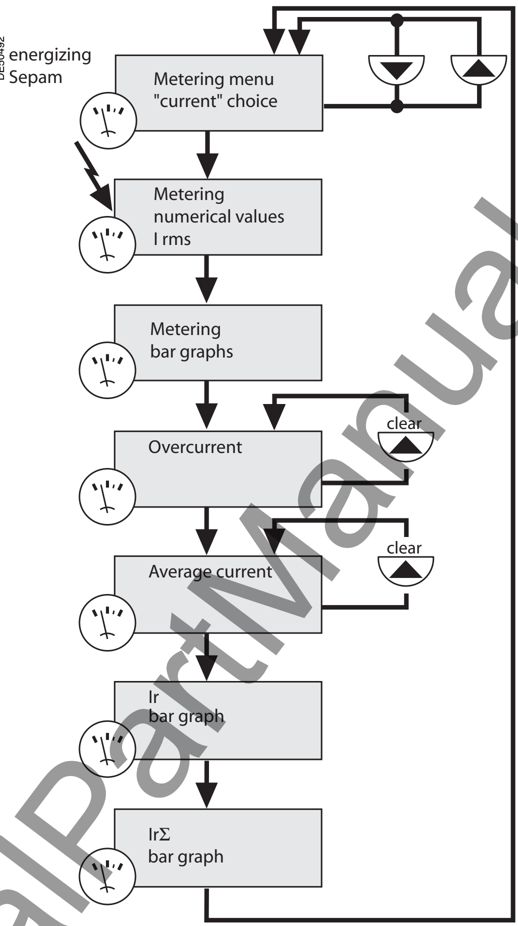
Access to Measurements and Parameters

The measurements and parameters can be accessed using the metering, diagnosis, status and protection keys. They are arranged in a series of screens as shown in the diagram opposite.

- the data are split up by category in 4 menus, associated with the following 4 keys:
  - key: measurements
    choice: current, voltage, frequency, power energy
  - key: switchgear diagnosis and additional measurements
    choice: diagnosis, tripping contexts (x5)
  - key: general settings
    choice: general, modules, I/U sensors, CT/VT supervision, program logic, I/O test
  - key: protection settings
    choice: phase I, residual I, directional I, voltage, frequency, power, machine, recloser
- when the user presses a key, the system moves on to the next screen in the loop. When a screen includes more than 4 lines, the user moves about in the screen via the cursor keys (,).

Example: Measurement Loop

DE50492



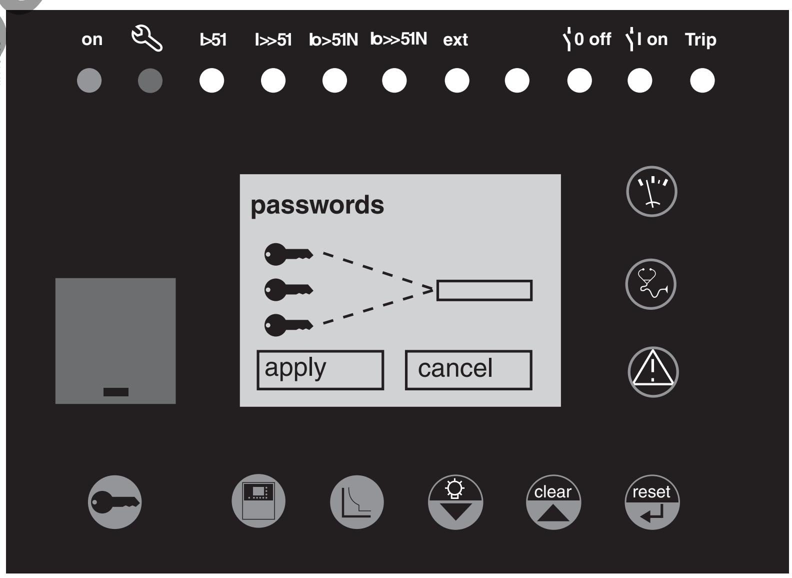
Protection and Parameter Setting Modes

There are three levels of use:

- operator level: used to access all the screens in read mode and does not require any passwords
- protection setter level: requires the entry of the first password (key), allows protection setting (key)
- parameter setter level: requires the entry of the second password (key), allows modification of the general settings as well (key).

Only general setters may modify the passwords.
The passwords have four digits.

MT10808

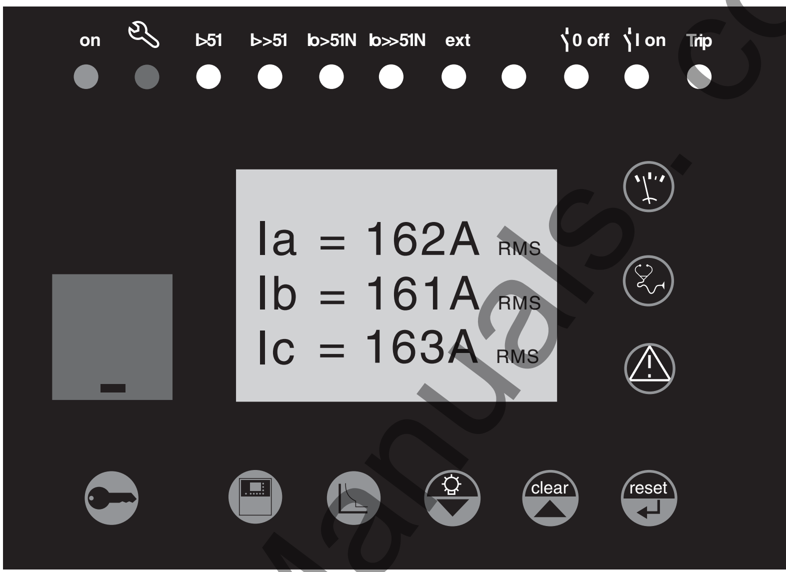


7

key

The "metering" key is used to display the variables measured by Sepam™.

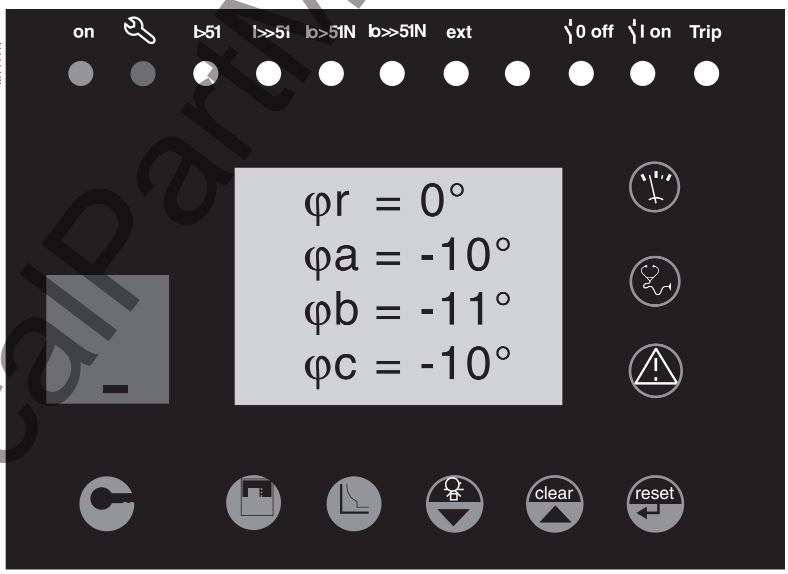
MT10283



key

The “diagnosis” key provides access to diagnostic data on the breaking device and additional measurements, to facilitate fault analysis.

MT11117

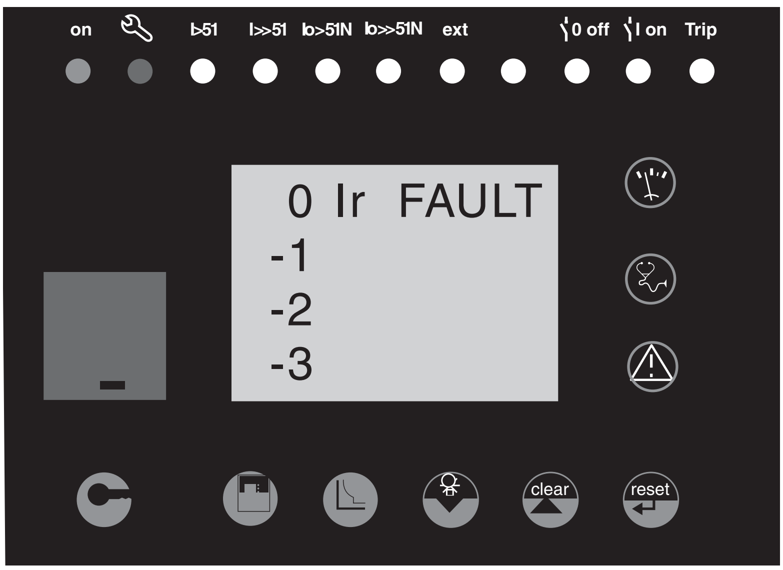


7

key

The “alarms” key is used to consult the 16 most recent alarms that have not yet been cleared.

MT10287



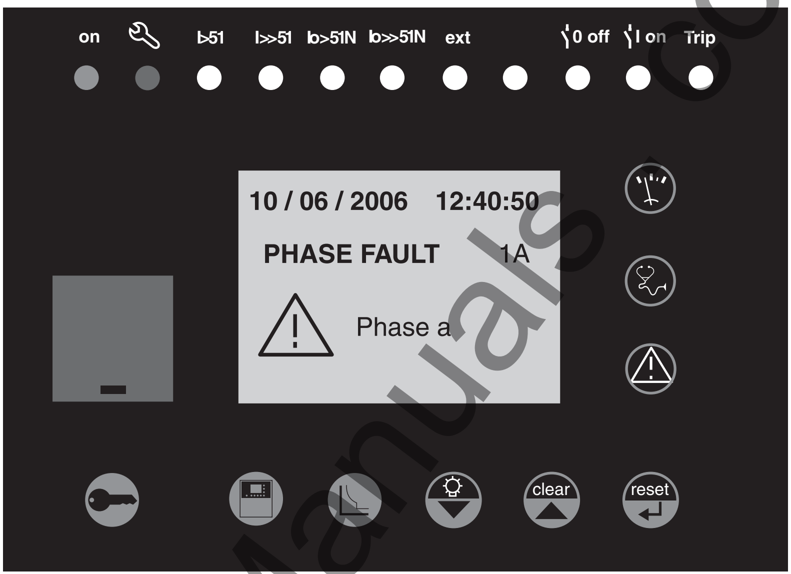
key

The “reset” key resets Sepam™ (extinction of signal lamps and resetting of protection units after the disappearance of faults).

The alarm messages are not erased.

Sepam™ resetting must be confirmed.

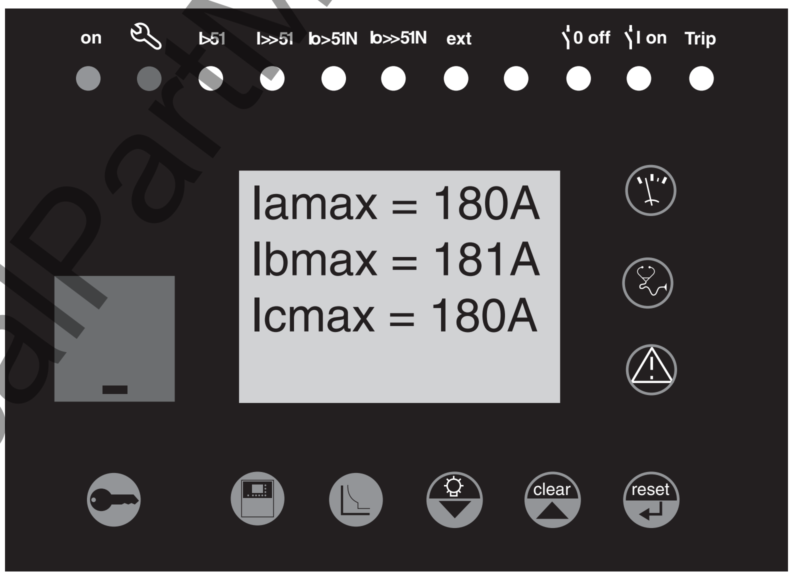
MT10301



key

When an alarm is present on the Sepam™ display, the "clear" key is used to return to the screen that was present prior to the appearance of the alarm or to a less recent unacknowledged alarm. Sepam™ is not reset. In the metering or diagnosis or alarm menus, the "clear" key may be used to reset the average currents, peak demand currents, running hours counter and alarm stack when they are shown on the display.

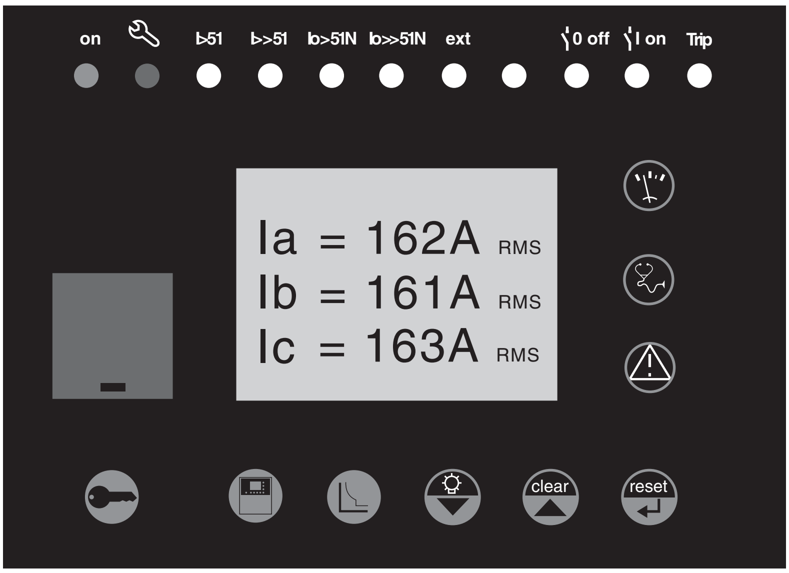
MT10284



key

Press the "lamp test" key for 5 seconds to start up a LED and display test sequence.
When an alarm is present, the "lamp test" key is disabled.

MT10283



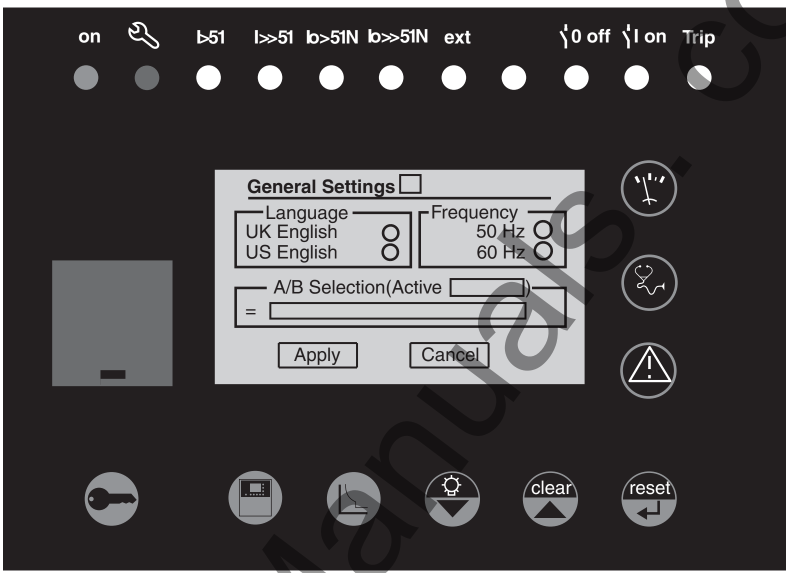
7

Advanced UMI
Blue Keys for Parameter and Protection Setting

key

The “status” key is used to display and enter the Sepam™ general settings. They define the protected equipment characteristics and the different optional modules.

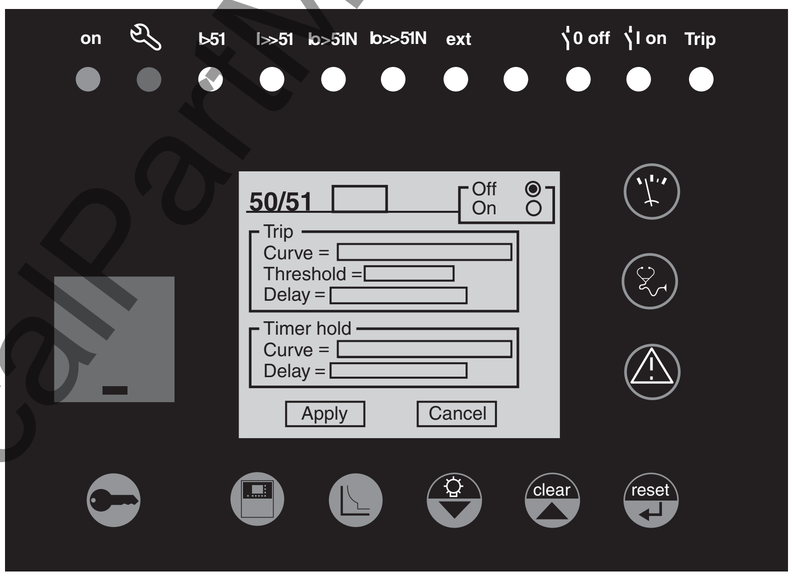
MT10810



key

The “protection” key is used to display, set and enable or disable the protection units.

MT10811

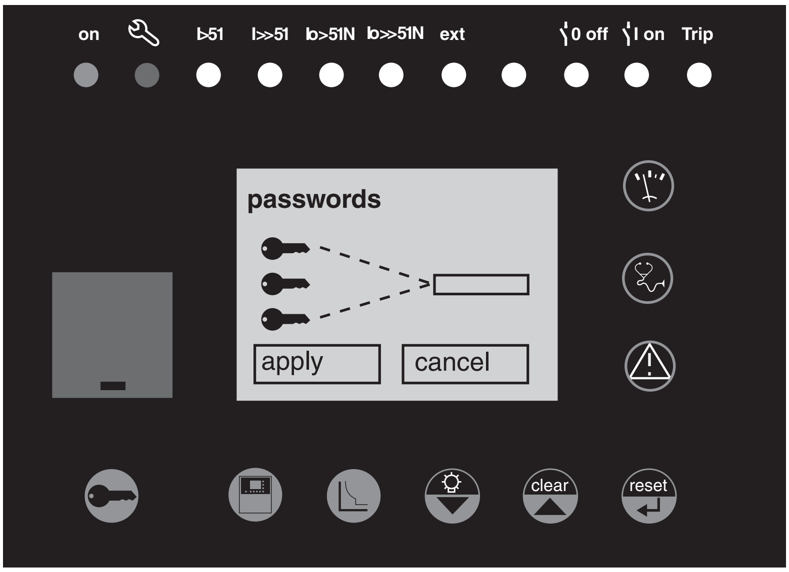


key

The "wrench" key is used to enter the passwords for access to the different modes:
- protection setting
- parameter setting.

and return to "operating" mode (with no passwords).

MT10808

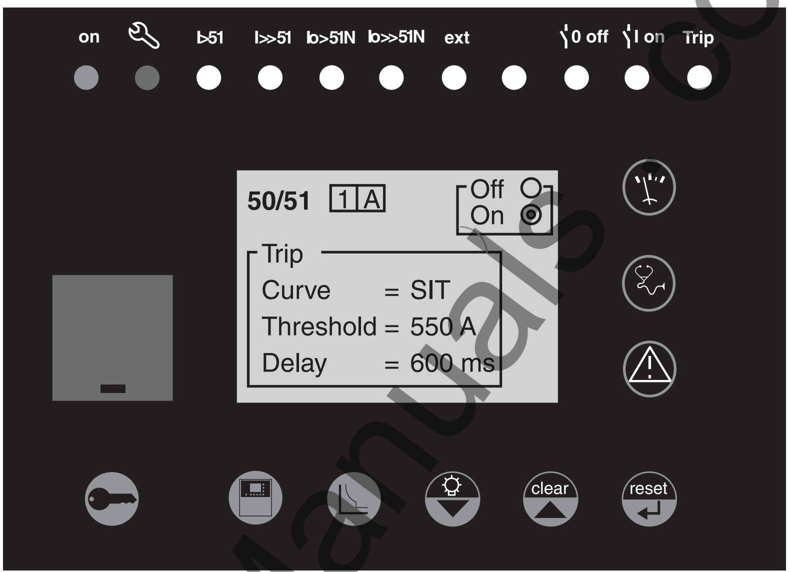


Note: *for parameter setting of signal lamps and output relays, it is necessary to use the SFT2841 software, "program logic" menu.*

reset key

The ↵ key is used to confirm the protection settings, parameter settings and passwords.

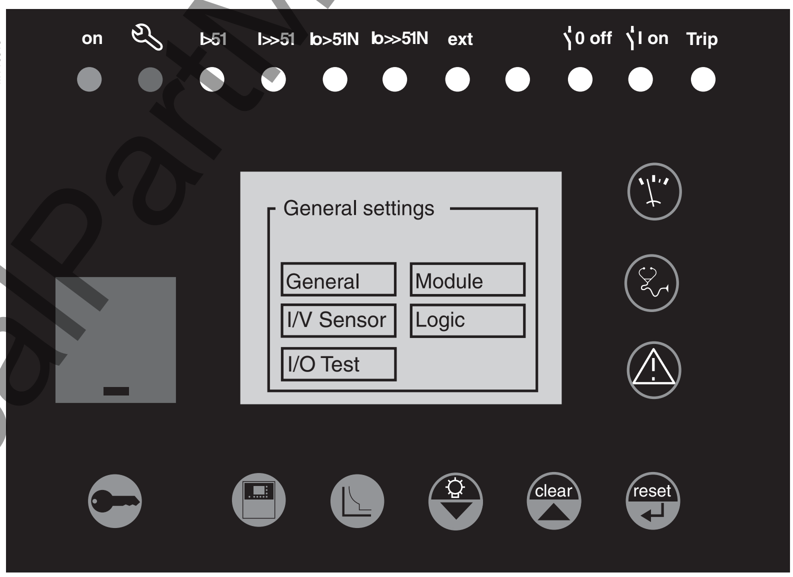
MT10812



clear key

When there are no alarms on the Sepam™ display and the user is in the status, protection or alarm menu, the ▲ key is used to move the cursor upward.

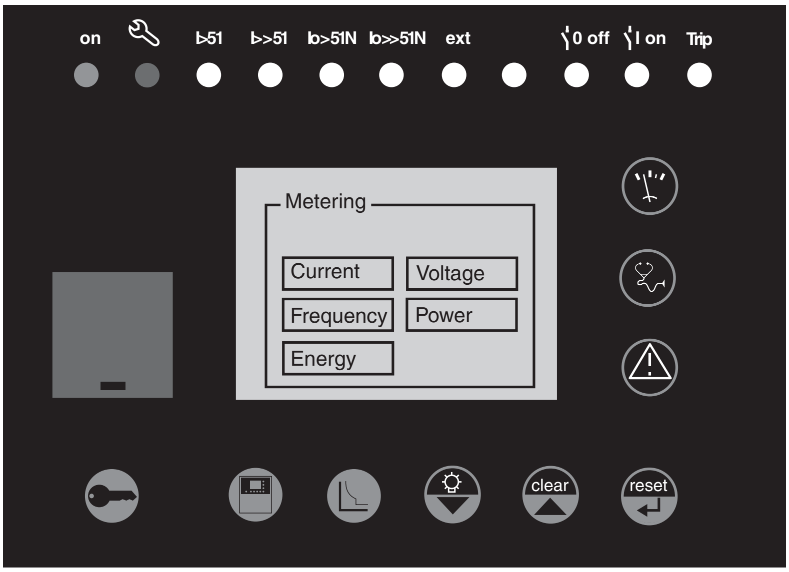
MT10813



key

When there are no alarms on the Sepam™ display and the user is in the status, protection or alarm menu, the ▼ key is used to move the cursor downward.

MT10814



Use of Passwords

Sepam™ has two 4-digit numeric passwords.

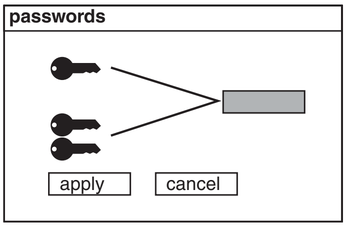
- The first password, symbolized by a key, is used to modify the protection settings
- The second password, symbolized by two keys, is used to modify the protection settings and all the general settings.

The two factory-set passwords are: 0000

Entering Passwords

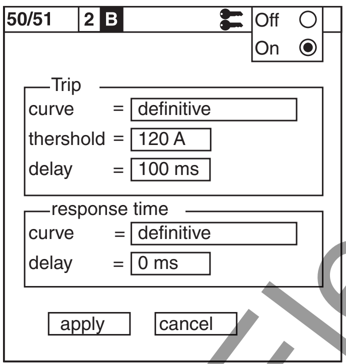
1 Press the key to display the following screen:

MT10816



6 Press the key to position the cursor on the first digit 0 X X X
7 Scroll through the digits using the cursor keys (,) then confirm to go on to the next digit by pressing the key. Do not use characters other than numbers 0 to 9 for each of the 4 digits.
8 When the password for your qualification level is entered, press the key to position the cursor on the apply box. Press the key again to confirm.
9 When Sepam™ is in protection setting mode, a key appears at the top of the display.
10 When Sepam™ is in parameter setting mode, two keys appear at the top of the display.

MT10817



Access to the protection setting or parameter setting modes is disabled:

- By pressing the key
- Automatically if no keys are activated for more than 5 minutes.

Modifying Passwords

Only the parameter setting qualification level (2 keys) or the SFT2841 allow password modification. Passwords are modified in the general settings screen, key.

Loss of Passwords

If the factory-set passwords have been modified and the latest passwords entered have been irretrievably lost by the user, please contact your local after-sales service representative.

Entering Parameters or Settings

Principle Applicable to all Sepam™ Units

(example of phase overcurrent protection)

1 Enter the password
2 Access the corresponding screen by successively pressing the key
3 Move the cursor by pressing the key for access to the desired field (e.g. curve)
4 Press the key to confirm the choice, then select the type of curve by pressing the or key and confirm by pressing the key
5 Press the key to reach the following fields, up to the apply box. Press the key to confirm the setting.

Entering Numerical Values

(current threshold value)

1 Position the cursor on the required field using the keys, then confirm to go on to the next digit by pressing the key
2 Select the first digit to be entered and set the value by pressing the or key (choice of : 0……9)
3 Press the key to confirm the choice and go on to the following digit.

The values are entered with three significant digits and a period.

The unit (A or kA) is chosen using the last digit.

4 Press the key to confirm the entry, then press the key for access to the following field
5 All of the values entered are only effective after the user confirms by selecting the apply box at the bottom of the screen and presses the key.

Default Parameters, All Applications

Hardware Configuration

- identification: Sepam™ xxxx
- model: MX
- MES module: absent
- MET modules: absent
- MSA module: absent
- DSM module: present
- ACE module: absent

Output Parameter Setting

- outputs used: O1 to O4
- N.O. contacts: O1, O3
- N.C. contacts: O2, O4
- impulse mode: no (latched)

Program Logic

- circuit breaker control: yes
- zone selective interlocking: no
- recloser: no
- logic input assignment: not used

General Characteristics

- network frequency: 50 Hz
- group of settings: A
- enable remote setting: no
- working language: English
- type of cubicle: feeder (except G40: main)
- CT rating: 5A
- number of CTs: 3 (Ia, Ib, Ic)
- rated current IN: 630 A
- basic current IB: 630 A
- integration period: 5 mn
- residual current: none
- rated primary voltage ($V_{LL}p$): 20 kV
- rated secondary voltage ($V_{LL}s$): 100 V
- voltages measured by VTs: Vab, Vbc
- residual voltage: none
- disturbance recording: 9 x 2-second blocks
- pre-trig for disturbance recording: 36 cycles

Protection Functions

- all protections are "off"
- the settings comprise values and choices that are informative and consistent with the general characteristics by default (in particular rated current and voltage IN and $V_{LL}p$)
- tripping behavior:
  - latching: 50/51, 50N/51N, 50V/51V, 67, 67N, 46, 32P, 32Q/40, 48/51LR/14, 27D, 38/49T, 49RMS
  - participation in circuit breaker control: 50/51, 50N/51N, 50V/51V, 67, 67N, 46, 32P, 32Q/40, 48/51LR/14, 27D, 49RMS, 38/49T, 37
- disturbance recording triggering: with.

Control Matrix

- activation of signal lamps according to front panel markings
- watchdog on output O4
- disturbance recording triggering upon activation of pick up signal.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Only qualified personnel should commission this equipment. Such work should be performed only after reading this entire set of instructions.
- NEVER work alone.
- Obey all existing safety instructions when commissioning and maintaining high-voltage equipment
- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. In the USA, see NFPA 70E

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

Protection Relay Testing

Protection relays are tested prior to commissioning, with the dual aim of maximizing availability and minimizing the risk of malfunctioning of the assembly being commissioned. The problem consists of defining the consistency of the appropriate tests, keeping in mind that the relay is always involved as the main link in the protection chain.
Therefore, protection relays based on electromechanical and static technologies, the performances of which are not totally reproducible, must be systematically submitted to detailed testing, not only to qualify relay commissioning, but also to check that they actually are in good operating order and maintain the required level of performance.

The Sepam™ concept makes it possible to do away with such testing, since:

- the use of digital technology guarantees the reproducibility of the performances announced
- each of the Sepam™ functions has undergone full factory-qualification
- an internal self-testing system provides continuous information on the state of the electronic components and the integrity of the functions (e.g. automatic tests diagnose the level of component polarization voltages, the continuity of the analog value acquisition chain, non-alteration of RAM memory, absence of settings outside the tolerance range) and thereby guarantees a high level of availability

Sepam™ is therefore ready to operate without requiring any additional qualification testing that concerns it directly.

Sepam™ Commissioning Tests

The preliminary Sepam™ commissining tests may be limited to commissioning checks:

- checking compliance with BOMs and hardware installation diagrams and rules during a preliminary general check
- checking the compliance of the general settings and protection settings entered with the setting sheets
- checking current or voltage input connections by secondary injection tests
- checking logic input and output connections by simulation of input data and forcing output status
- validation the complete protection chain (possible customized logic functions included)
- checking the connection of the optional MET1482 and MSA141 modules.

The various checks are described further on.

General Principles

- all the tests should be carried out with the MV cubicle completely isolated and the MV circuit breaker racked out (disconnected and open)
- all the tests are to be performed in the operating situation: no wiring or setting changes, even temporary changes to facilitate testing, are allowed.
- the SFT2841 parameter setting and operating software is the basic tool for all Sepam™ users. It is especially useful during Sepam™ commissioning tests. The tests described in this document are systematically based on the use of that tool.

The commissioning tests may be performed without the SFT2841 software for Sepam™ units with advanced UMIs.

Method

For each Sepam™:

- only carry out the checks suited to the hardware configuration and the functions activated

(A comprehensive description of all the tests is given further on)

- use the test sheet provided to record the results of the commissioning tests.

Checking Current and Voltage Input Connections

The secondary injection tests to be carried out to check the connection of the current and voltage inputs are described according to:

- the type of current and voltage sensors connected to Sepam™, in particular for residual current and voltage measurement
- the type of injection generator used for the tests: three-phase or single-phase generator.

The different possible tests are described further on by:

- a detailed test procedure
- the connection diagram of the associated test generator.

The table below specifies the tests to be carried out according to the type of measurement sensors and type of generator used, and indicates the page on which each test is described.

Current Sensors	**3 CTs**	**3 CTs + 1 zero sequence CT**	**3 CTs**	**3 CTs + 1 zero sequence CT**
Voltage Sensors	**3 VTs**	**3 VTs**	**2 phase VTs + 1 residual VT**	**2 phase VTs + 1 residual VT**
Three-phase generator	Page 7/236	Page 7/236 Page 7/241	Page 7/237 Page 7/242	Page 7/237 Page 7/243
Single-phase generator	Page 7/238	Page 7/238 Page 7/241	Page 7/238 Page 7/242	Page 7/238 Page 7/243

Required Testing & Metering Equipment

Generators

- dual sinusoidal AC current and voltage generator:
  - 50 or 60 Hz frequency (according to the country)
  - current adjustable up to at least 5 Arms
  - adjustable up to the rated secondary phase-to-phase voltage of the VTs
  - adjustable relative phase displacement (V, I)
  - three-phase or single-phase type
- DC voltage generator:
  - adjustable from 48 to 250 V DC, for adaptation to the voltage level of the logic input being tested.

Accessories

- plug with cord to match the "current" test terminal box installed
- plug with cord to match the "voltage" test terminal box installed
- electric cord with clamps, wire grip or touch probes.

Metering Devices (built into the generator or separate)

- 1 ammeter, 0 to 5 A rms
- 1 voltmeter, 0 to 230 V rms
- 1 phasemeter (if phase displacement (V, I) is not identified on the voltage and current generator).

Computer Equipment

- PC with minimal configuration:
  - Microsoft Windows 98/NT 4.0/2000/XP
  - 133 MHz Pentium processor,
  - 64 MB of RAM (or 32 MB with Windows 98)
  - 64 MB free on hard disk
  - CD-ROM drive
- SFT2841 software
- CCA783 serial connection cord between the PC and Sepam™.

Documents

- complete connection diagram of Sepam™ and additional modules, with:
  - phase current input connection to the corresponding CTs via the test terminal box
  - residual current input connection
  - phase voltage input connection to the corresponding VTs via the test terminal box
  - residual voltage input connection to the corresponding VTs via the test terminal box
  - logic input and output connection
  - temperature sensor connection
  - analog output connection
- hardware BOMs and installation rules
- group of Sepam™ parameter and protection settings, available in paper format.

Checks Required Prior to Energizing

Apart from the mechanical state of the equipment, use the diagrams and BOMs provided by the contractor to check:

- identification of Sepam™ and accessories determined by the contractor
- correct grounding of Sepam™ (via terminal 17 of the 20-pin connector)
- correct connection of auxiliary voltage (terminal 1: AC or positive polarity; terminal 2: AC or negative polarity)
- presence of a residual current measurement zero sequence CT and/or additional modules connected to Sepam™, when applicable
- presence of test terminal boxes upstream from the current inputs and voltage inputs
- conformity of connections between Sepam™ terminals and the test terminal boxes.

Connections

Check that the connections are tightened (with equipment non-energized).
The Sepam™ connectors must be correctly plugged in and locked.

Energizing

1 Switch on the auxiliary power supply.
2 Ensure that Sepam™ performs the following initialization sequence (lasts approximately 6 seconds) :
   - green ON and red indicators on
   - red indicator off
   - pick-up of "watchdog" contact.

The first screen displayed is the phase current measurement screen.

Implementing the SFT2841 Software for PC

1 Start up the PC.
2 Connect the PC RS232 serial port to the communication port on the front panel of Sepam™ using the CCA783 cord.
3 Start up the SFT2841 software, by clicking on the related icon.
4 Choose to connect to the Sepam™ to be checked.

Identification of Sepam™

1 Note the Sepam™ serial number given on the label stuck to the right side plate of the base unit
2 Note the Sepam™ type and software version using the SFT2841 software, "Sepam™ Diagnosis" screen
3 Enter them in the test sheet.

Checking Parameter & Protection Settings

Determining Parameter and Protection Settings

All Sepam™ parameter and protection settings are determined beforehand by the design department in charge of the application, and should be approved by the customer.

It is presumed that the study has been carried out with all the attention necessary, or even consolidated by a network coordination study.

All Sepam™ parameter and protection settings should be available at the time of commissioning:

- in hard copy format (with the SFT2841 software, the parameter and protection setting file for a Sepam™ can be printed directly or exported to a text file for editing)
- when applicable, in the format of a file to be downloaded into Sepam™ using the SFT2841 software

Checking Parameters and Protection Settings

These checks are made when the Sepam™ parameter and protection settings have not been entered or downloaded during commissioning testing. This is to verify the conformity of the parameter and protection settings entered with the values determined during the study(1).

1 Go through all the parameter and protection setting screens in the SFT2841 software, in the order proposed in guided mode.
2 For each screen, compare the values entered in the Sepam™ with the values recorded in the parameter and protection setting file.
3 Correct any parameter and protection settings that have not been entered correctly, proceeding as indicated in the "Use of the (SFT2841) software" section of this manual.

Conclusion

Once the checking has been done and proven to be conclusive, as of that phase, the parameter and protection settings should not be changed any further and are considered to be final.

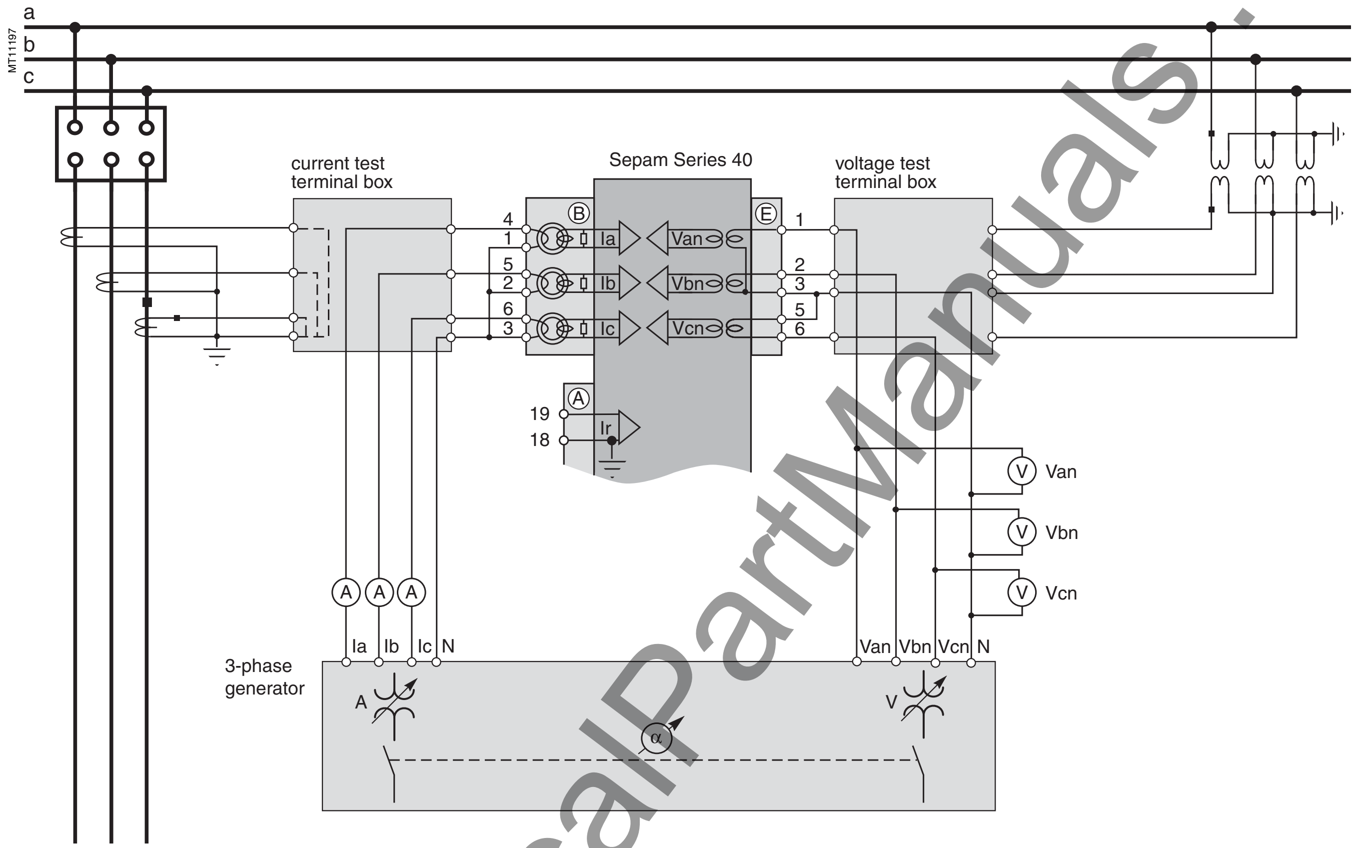
In order to be conclusive, the tests which follow must be performed with these parameter and protection settings; no temporary modification of any of the values entered, with the aim of facilitating a test, is permissible.

(1) The aim of this check is not to confirm the relevance of the parameter and protection settings.

Checking Phase Current & Voltage Input Connection
With 3-Phase Generator

Procedure

1 Connect the 3-phase voltage and current generator to the corresponding test terminal boxes, using the plugs provided, according to the appropriate diagram in terms of the number of VTs connected to Sepam™:
- block diagram with three VTs connected to Sepam™



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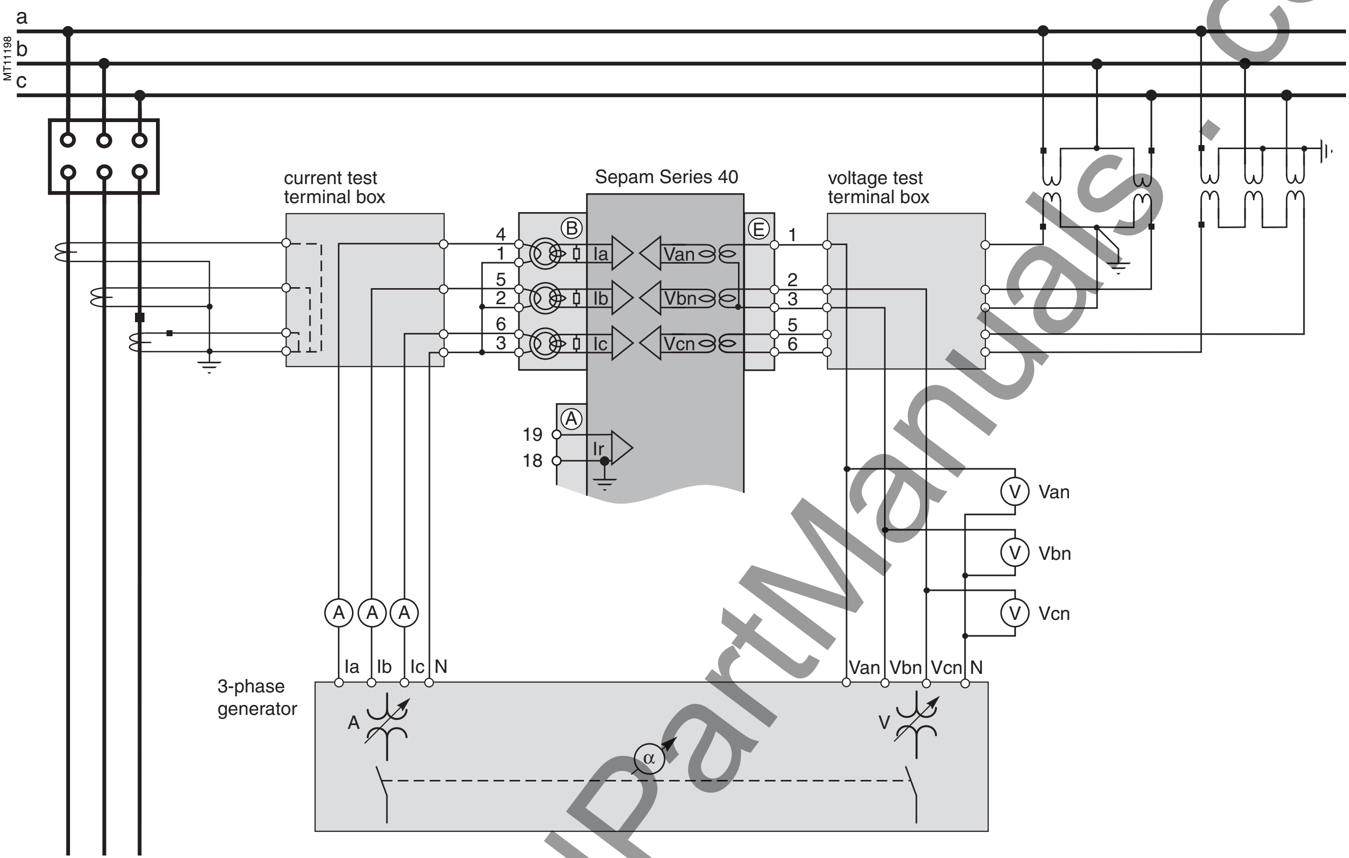
Checking Phase Current & Voltage Input Connection
With 3-Phase Generator

Block Diagram with Two VTs connected to Sepam™.



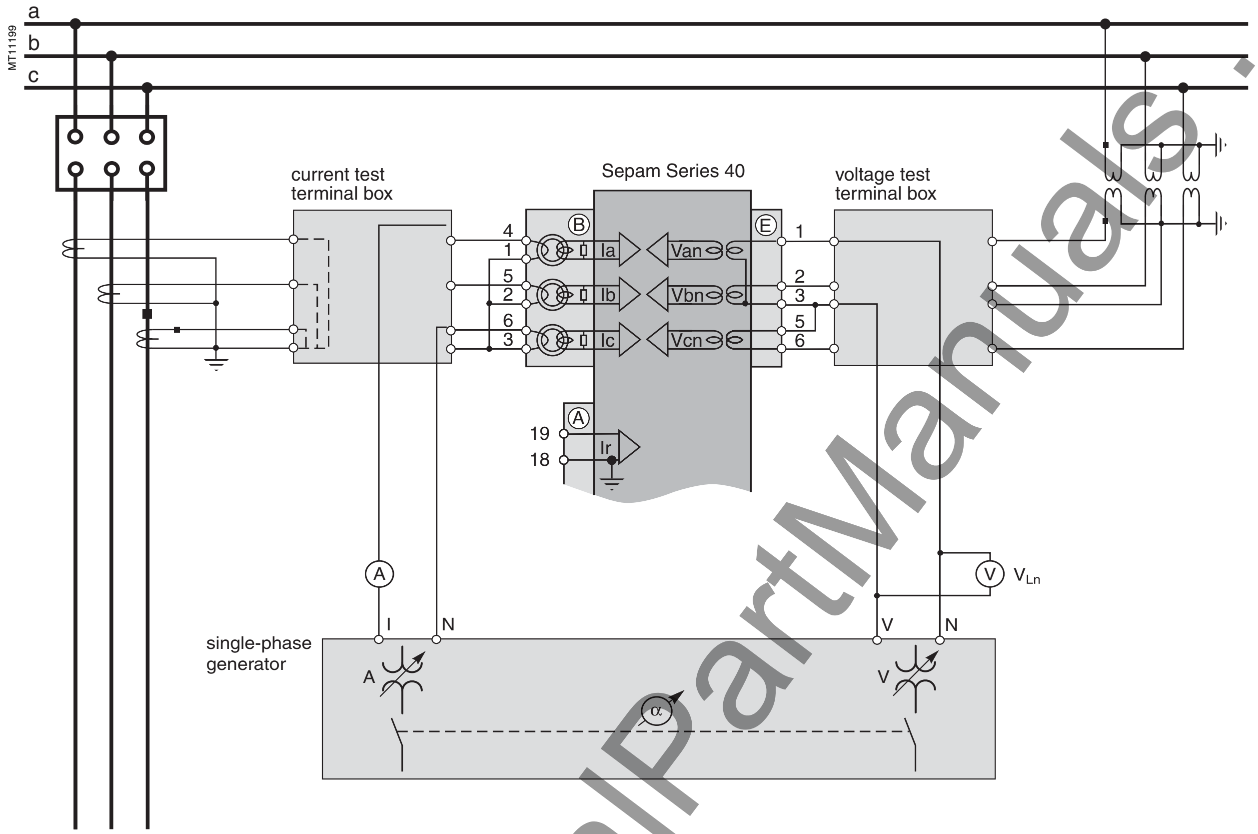
2 Turn the generator on.
3 Apply the three generator voltages Van, Vbn and Vcn, balanced and set to the rated secondary phase-to-neutral voltage of the VTs ($V_{Ln}s = V_{LL}s/\sqrt{3}$).
4 Inject the three generator currents Ia, Ib and Ic, balanced and set to the rated secondary current of the CTs (1A or 5A) and in phase with the voltages applied (generator phase displacement:
$\alpha1$(Van Ia) = $\alpha2$(Vbn, Ib) = $\alpha3$(V3cn, Ic) = 0°).
5 Use the SFT2841 software to check the following:
- the value indicated for each of the phase currents Ia, Ib and Ic is approximately equal to the rated primary current of the CTs
- the value indicated for each of the phase-to-neutral voltages Van, Vbn, and Vcn is approximately equal to the rated primary phase-to-neutral voltage of the VT ($V_{Ln}p = V_{LL}p/\sqrt{3}$)
- the value indicated for each phase displacement φa(Van, Ia), φb(Vbn, Ib), and φc(Vcn, Ic) between currents Ia, Ib, or Ic and voltages Van, Vbn, or Vcn respectively is approximately equal to 0°.

6 Turn the generator off.

Checking Phase Current & Voltage Input Connection
With Single-Phase Generator & Voltages Delivered by Three VTs

Procedure

1 Connect the single-phase voltage and current generator to the corresponding test terminal boxes, using the plugs provided, according to the block diagram below:



2 Turn the generator on.

3 Apply the generator V_{Ln} voltage set to the rated secondary phase-to-neutral voltage of the VTs ($V_{Ln}s = V_{LL}s/\sqrt{3}$) between Sepam™'s phase a voltage input terminals (via the test box).

4 Inject the generator I current, set to the rated secondary current of the CTs (1A or 5A) and in phase vith the V_{Ln} voltage applied (generator phase displacement $\alpha(V_{Ln}, I) = 0°$) to Sepam™'s phase a current input (via the text box).

5 Use the SFT2841 software to check the following:
- the value indicated for Ia phase current is approximately equal to the rated primary current of the CT
- the value indicated for Van phase-to-neutral voltage is approximately equal to the rated primary phase-to-neutral voltage of the VT ($V_{Ln}p = V_{LL}n/\sqrt{3}$)
- the value indicated for the phase displacement φa(Van, Ia) between the Ia current and Van voltage is approximately equal to 0°.

6 Proceed in the same way by circular permutation with the phase b and c voltages and currents, to check the Ib, Vbn, φb(Vbn, Ib) and Ic, Vcn, φc(Vcn, Ic) values.

7 Turn the generator off.

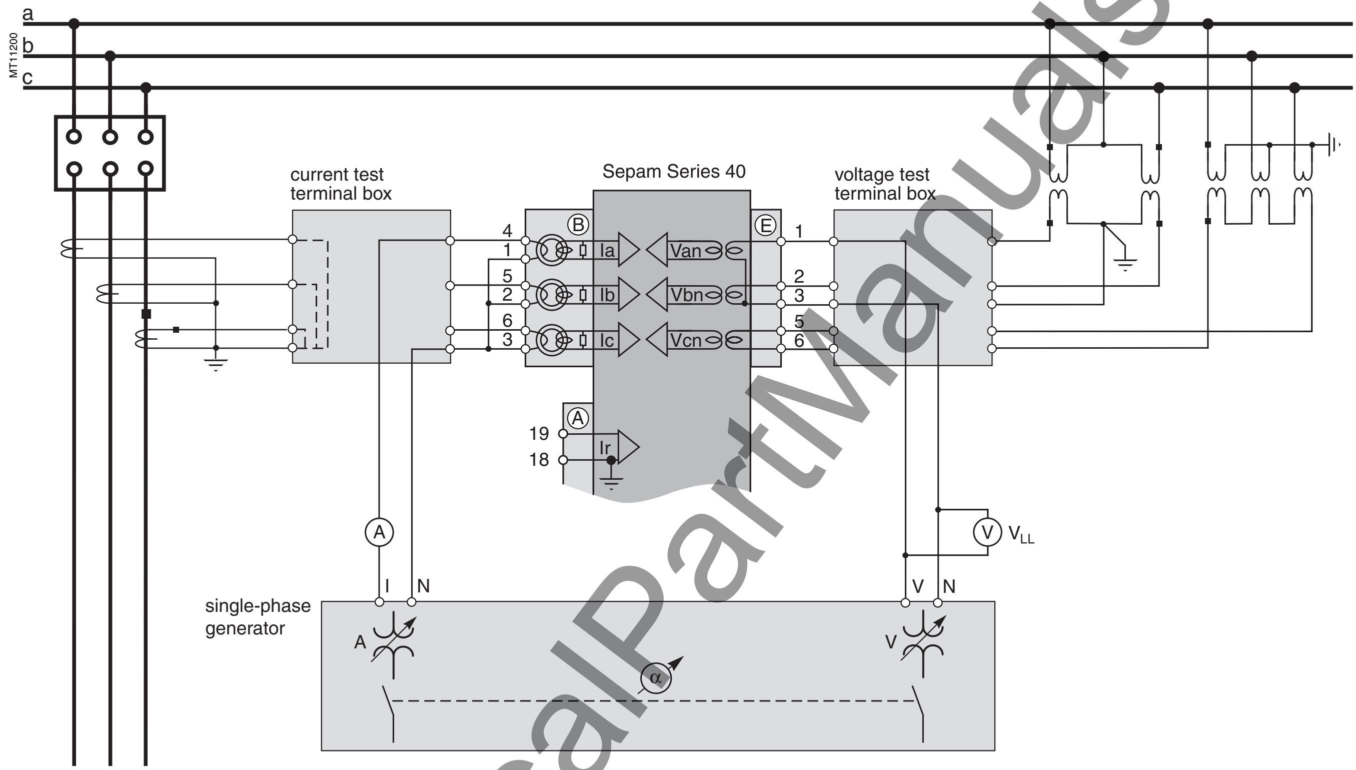
Checking Phase Current & Voltage Input Connection
With Single-Phase Generator & Voltages Delivered by Two VTs

Description

This check is made when the voltages are supplied by a two VT assembly, with VT primary circuits connected between phases of the distributed voltage, which means that the residual voltage is obtained outside Sepam™ (by three VTs connected via their secondary circuits in an open delta arrangement) or, when applicable, is not used for the protection function.

Procedure

1 Connect the single-phase voltage and current generator to the corresponding test terminal boxes, using the plugs provided, according to the block diagram below:



2 Turn the generator on.

3 Apply (via the test box) the voltage delivered at the V_{Ln} terminals of the generator, set to $\sqrt{3}/2$ times the rated secondary phase-to-phase voltage of the VTs ($\sqrt{3}\ V_{LL}s/2$) between terminals 1-3 of Sepam's voltage inputs.

4 Inject the generator I current, set to the rated secondary current of the CTs (1A or 5A) and in phase with the V_{Ln} voltage applied (generator phase displacement $\alpha(V_{Ln}, I) = 0°$) to Sepam™'s phase a current input (via the test box).

5 Use the SFT2841 software to check the following:
- the value indicated for Ia phase current is approximately equal to the rated primary current of the CT (INp)
- the value indicated for Van phase-to-neutral voltage is approximately equal to the rated primary phase-to-neutral voltage of the VT ($V_{Ln}p = V_{LL}p/\sqrt{3}$)
- the value indicated for the phase displacement φa(Van, Ia) between the Ia current and Van voltage is approximately equal to 0°.

6 Proceed in the same way to check the Ib, Vbn, φb(Vbn, Ib) values:
- apply the generator V_{Ln} voltage set to $\sqrt{3}V_{LL}s/2$ in parallel between terminals 1-3 and 2-3 of Sepam's voltage inputs (via the test box)
- inject an I current set to 1A or 5A and in phase opposition with the V_{Ln} voltage ($\alpha(V_{Ln}, I) = 180°$) to Sepam's phase b current input (via the test box)
- obtain Ib $\cong$ INp, Vbn $\cong V_{Ln}p = V_{LL}p/\sqrt{3}$ and φb $\cong$ 0°.

7 Check the Ic, Vcn, φc(Vcn, Ic) values as well:
- apply the generator V_{Ln} voltage set to $\sqrt{3}V_{LL}s/2$ between terminals 2-3 of Sepam's voltage inputs (via the test box)
- inject a current equal to 1A or 5A and in phase with the V_{Ln} voltage $\alpha(V_{Ln}, I) = 0°$) to Sepam's phase c current input (via the test box)
- obtain Ic $\cong$ INp, Vcn $\cong V_{Ln}p = V_{LL}p/\sqrt{3}$ and φc $\cong$ 0°.

8 Turn the generator off.

Checking Phase Current & Voltage Input Connection
LPCT Type Current Sensors

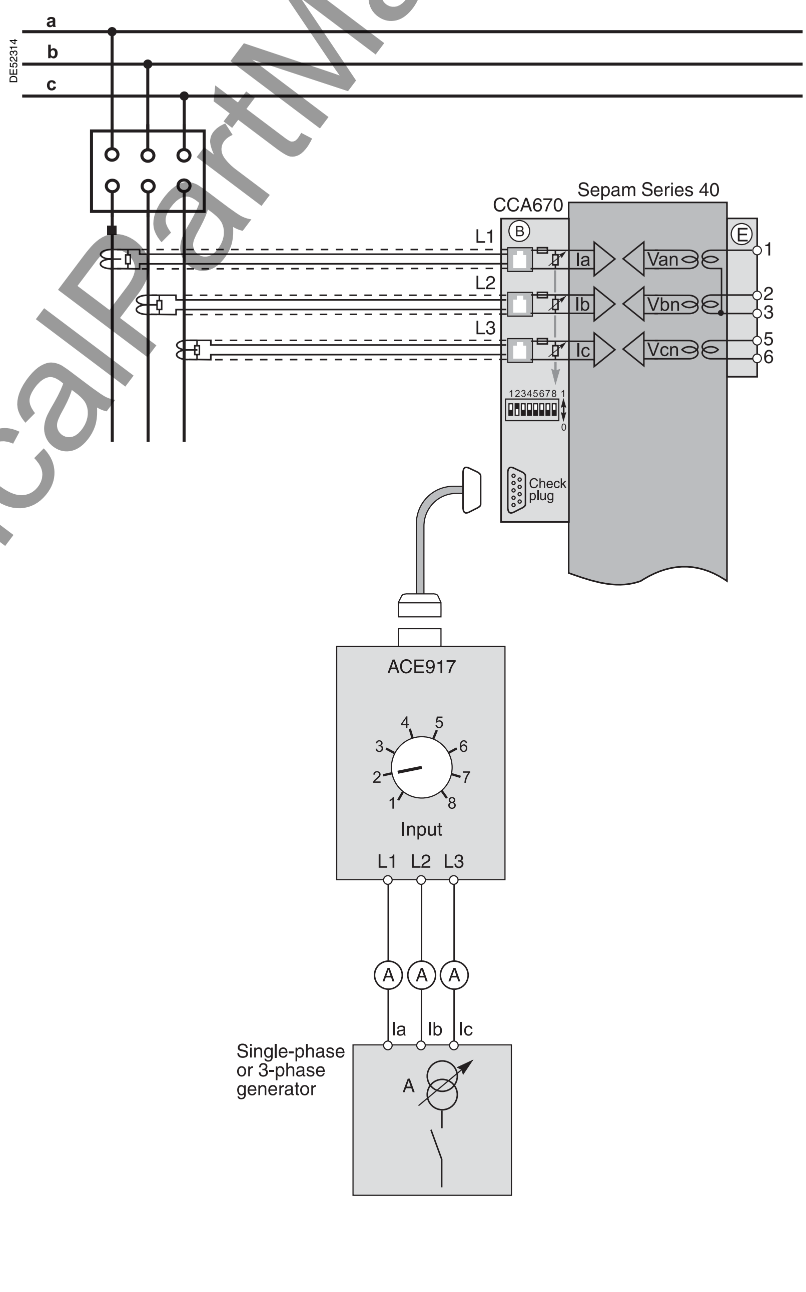
Description
Check to be performed when phase currents are measured by LPCT-type current sensors.

Phase Current Measurement by LPCT Sensors
- The three LPCT current sensors are connected through an RJ45 plug to the CCA670 connector that is mounted on the rear panel of Sepam™, identified as (B)
- Connecting only one or two LPCT sensors will cause Sepam™ to go into the fail-safe position
- The rated primary current IN measured by the LPCT sensors is entered as a Sepam™ general setting and configured by microswitches on the CCA670 connector.

Procedure
The tests for checking phase current input connections are the same whether the phase currents are measured by CTs or LPCT sensors. Only the Sepam™ current input connection procedure and current injection values change.
To test current inputs connected to LPCT sensors with a standard injection box, the ACE917 injection adapter is required.
The ACE917 adapter is inserted between:
- the standard injection box
- the LPCT test plug:
  - integrated in the Sepam™ CCA670 connector
  - or transferred by means of the CCA613 accessory.

The ACE917 injection adapter should be set according to the currents selected on the CCA670 connector: the ACE917 setting should be equal to the number of the microswitch that is set to 1 on the CCA670.
The injection value depends on the rated primary current selected on the CCA670 connector and entered in the Sepam™ general settings:
- 1 A for the following values (in Amps): 25, 50, 100, 133, 200, 320, 400, 630
- 5 A for the following values (in Amps): 125, 250, 500, 666, 1000, 1600, 2000, 3150.

Block Diagram (Without CCA613 Accessory)



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Checking Phase Current & Voltage Input Connection

Description

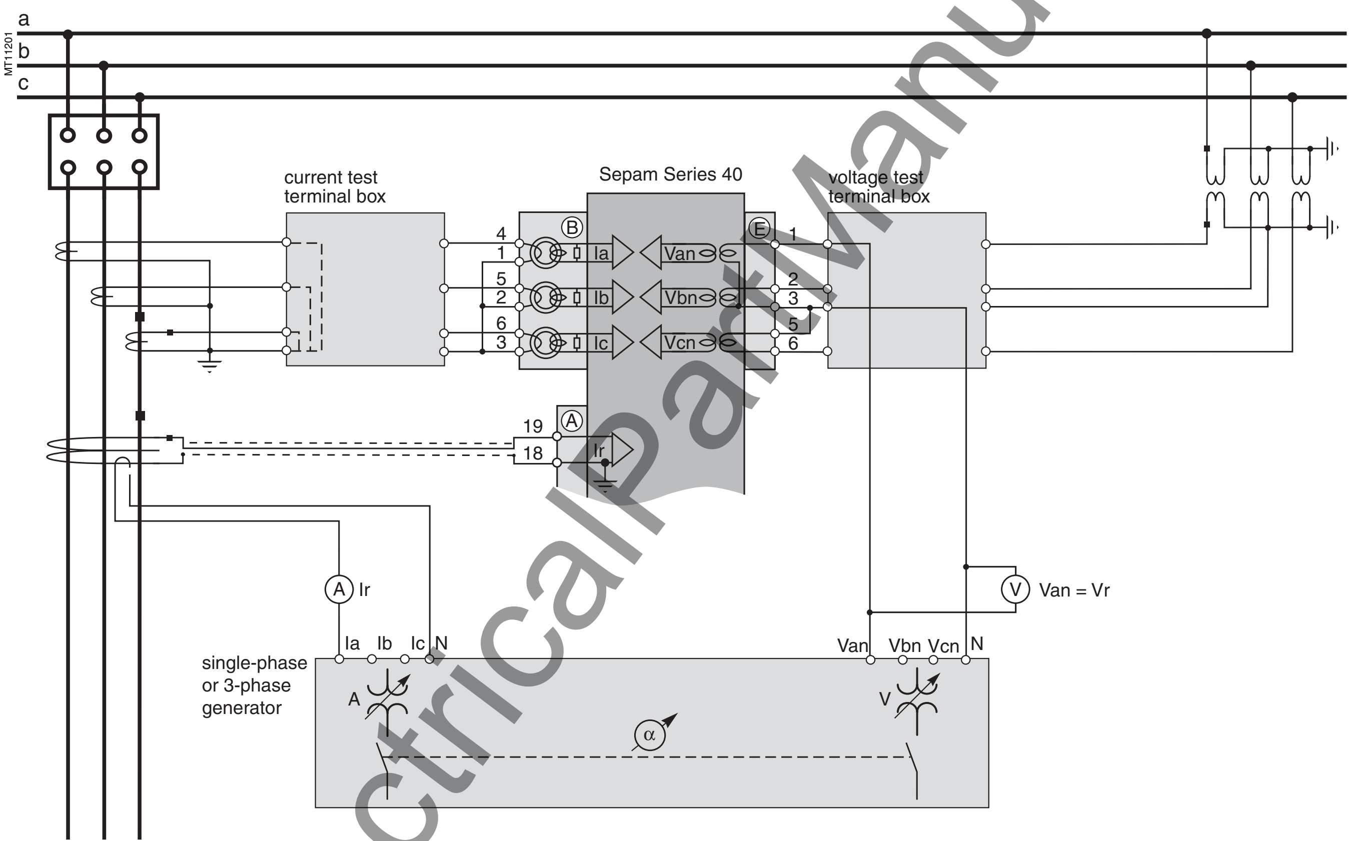
These checks are carried out when the zero sequence current is measured by a specific sensor such as:

- CSH120 or CSH200 zero sequence CT
- CSH30 interposing ring CT (whether it is installed on the secondary circuit of a single 1A or 5A CT, which encompasses the three phases, or on the neutral connection of the three 1A or 5A phase CTs)
- other zero sequence CT connected to an ACE990 interface,

The checks are also made when the residual voltage is calculated in Sepam™ or cannot be calculated (and is therefore not available for the protection function).

Procedure

1 Connect according to the diagram below:
- a wire between the generator current terminals to inject current into the primary circuit of the zero sequence CT or CT, with the wire passing through the zero sequence CT or CT in the P1-P2 direction, with P1 the bus end and P2 the cable end
- when applicable, the generator voltage terminals to the voltage test terminal box, so as to only supply Sepam™'s phase a voltage input and therefore obtain a residual voltage Vr = Van.



2 Turn the generator on.

3 When applicable, apply a V_{Ln} voltage set to the rated secondary phase-to-neutral voltage of the VT ($V_{Ln}s = V_{LL}s/\sqrt{3}$).

4 Inject an I current set to 5A, and when applicable in phase with the V_{Ln} voltage applied (generator phase displacement $\alpha(V_{Ln}, I) = 0°$).

5 Use the SFT2841 software to check the following:
- the value indicated for the measured Ir residual current is approximately equal to 5A
- when applicable, the value indicated for calculated Vr residual voltage is approximately equal to the rated primary phase-to-neutral voltage of the VTs ($V_{Ln}p = V_{LL}p/\sqrt{3}$)
- when applicable, the value indicated for the phase displacement $\varphi r(Vr, Ir)$ between the Ir current and Vr voltage is approximately equal to 0°.

6 Turn the generator off.

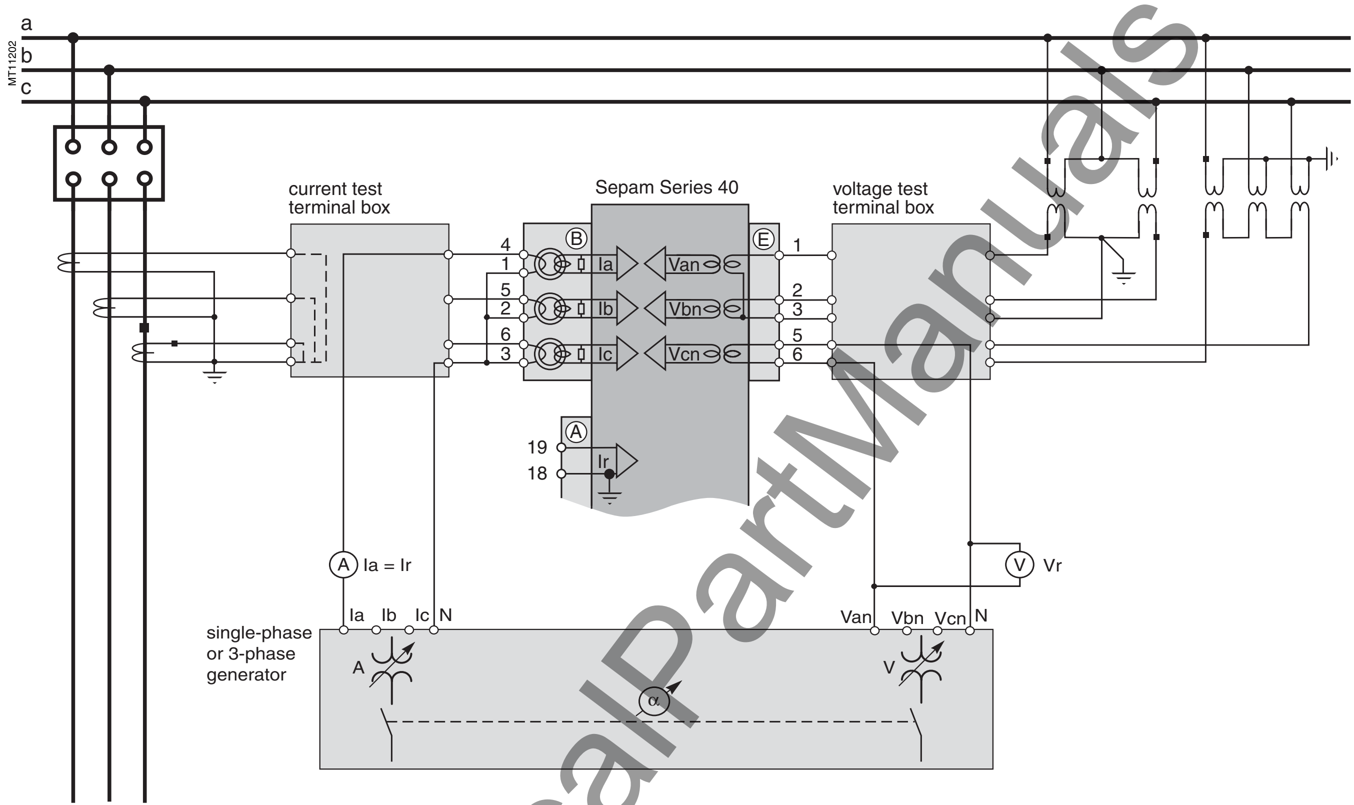
Checking Residual Voltage Input Connection

Description

This check is done when residual voltage is delivered by three VTs on the secondary circuits connected in an open delta assembly, and when the residual current is calculated in Sepam™ or, when applicable, is not used for the protection function.

Procedure

1 Connect according to the diagram below:
- the generator voltage terminals to the voltage test terminal box, so as to only supply Sepam™'s residual voltage input
- when applicable, the generator current terminals to the current test terminal box, so as to only supply Sepam™'s phase a current input, and therefore obtain a residual current IrΣ = Ia.



2 Turn the generator on.

3 Apply a V_{Ln} voltage set to the rated secondary voltage of the VTs installed in an open delta arrangement (depending on the case, $V_{Ln}s/\sqrt{3}$ or $V_{LL}s/3$).

4 When applicable, inject an I current set to the rated secondary current of the CTs (1 A or 5 A) and in phase with the voltage applied (generator phase displacement $\alpha(V_{Ln}, I) = 0°$).

5 Use the SFT2841 software to check the following:
- the value indicated for the measured Vr residual voltage is approximately equal to the rated primary phase-to-neutral voltage of the VTs (i.e. $V_{Ln}p = V_{LL}p/\sqrt{3}$)
- when applicable, the value indicated for the calculated IrΣ residual current is approximately equal to the rated primary current of the CTs
- when applicable, the value indicated for the phase displacement φrΣ (Vr, IrΣ) between the IrΣ current and Vr voltage is approximately equal to 0°.

6 Turn the generator off.

Schneider Electric

Checking Residual Current & Residual Voltage Input Connection

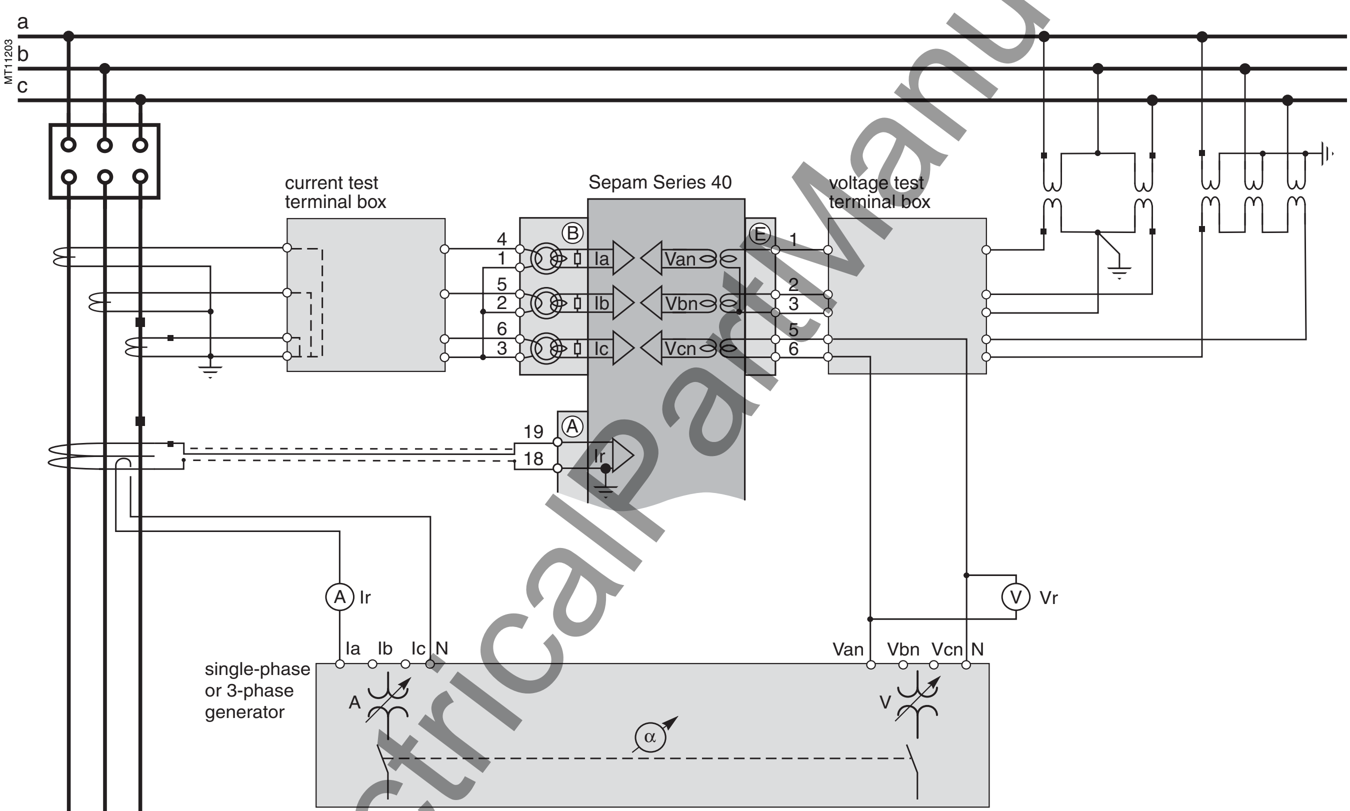
Description

Check to be carried out when the residual voltage is delivered by three VTs on the secondary circuits connected in an open delta assembly and when the residual current is obtained by a specific sensor such as:

- CSH120 or CSH200 zero sequence CT
- CSH30 interposing ring CT (whether it is installed on the secondary circuit of a single 1A or 5A CT which encompasses the three phases, or on the neutral connection of the three 1A or 5A phase CTs)
- other zero sequence CT connected to an ACE990 interface.

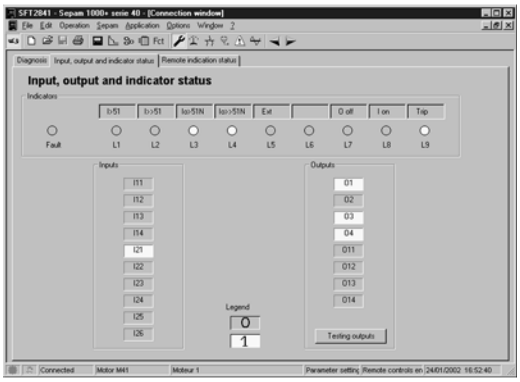
Procedure

1 Connect according to the diagram below:
   - the generator voltage terminals to the voltage test terminal box using the plug provided,
   - a wire between the generator current terminals to inject current into the primary circuit of the zero sequence CT or CT, with the wire passing through the zero sequence CT or CT in the P1-P2 direction, with P1 the bus end and P2 the cable end.



2 Turn the generator on.
3 Apply a V_{Ln} voltage set to the rated secondary voltage of the VTs connected in an open delta arrangement ($V_{LL}s/\sqrt{3}$ or $V_{LL}s/3$).
4 Inject an I current set to 5A, and in phase with the voltage applied (generator phase displacement $\alpha(V_{Ln}, I) = 0°$).
5 Use the SFT2841 software to check the following:
   - the value indicated for the measured Ir zero sequence current is approximately equal to 5A
   - the value indicated for the measured Vr residual voltage is approximately equal to the rated primary phase-to-neutral voltage of the VTs ($V_{Ln}p = V_{LL}p/\sqrt{3}$)
   - the value indicated for the phase displacement φr(Vr, Ir) between the Ir current and Vr voltage is approximatelyequal to 0°.
6 Turn the generator off.

MT11194



"Input, output, indicator status" screen

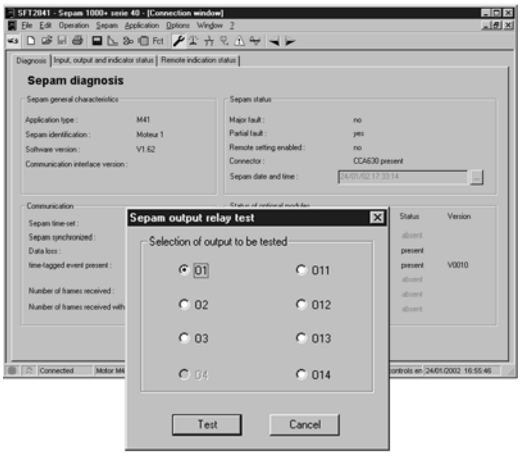
Checking Logic Input Connection

Procedure

Proceed as follows for each input:

1 **If the input supply voltage is present,** use an electric cord to short-circuit the contact that delivers logic data to the input.
2 If **the input supply voltage is not present,** apply a voltage supplied by the DC voltage generator to the terminal of the contact linked to the chosen input, being sure to comply with the suitable polarity and level.
3 **Observe the change of status of the input** using the SFT2841 software, in the "Input, output, indicator status" screen.
4 At the end of the test, if necessary, press the SFT2841 Reset key to clear all messages and deactivate all outputs.

MT11195



"Sepam™ diagnosis and output relay test" screen

Checking Logic Output Connection

Procedure

This check is carried out using the "Output relay test" function. It is activated through the SFT2841 software, in the "Sepam™ Diagnosis" screen.

Only output O4, when used for the watchdog, can be tested.

This function requires prior entry of the "Parameter setting" password.

1 Activate each output relay using the buttons in the SFT2841 software.
2 The activated output relay changes status over a period of 5 seconds.
3 Observe the change of status of the output relay through the operation of the related switchgear (if it is ready to operate and is powered), or connect a voltmeter to the terminals of the output contact (the voltage cancels itself out when the contact closes).
4 At the end of the test, press the SFT2841 Reset key to clear all messages and deactivate all outputs.

Validating the Complete Protection Chain

Principle

The complete protection chain is validated during the simulation of a fault that causes tripping of the breaking device by Sepam™.

Procedure

1 Select one of the protection functions that initiates the breaking device tripping.
2 According to their incidence in the chain, separate the function or functions related to the programmed or reprogrammed parts of the program logic.
3 Inject a current and/or apply a voltage corresponding to the fault, according to the selected function or functions.
4 Observe the breaking device tripping and the operation of the adapted parts of the program logic.

At the end of all the voltage and current application type checks, put the covers back on the test terminal boxes.

Checking the Optional Module Connection

Checking the RTD Inputs to the MET1482 Module

The temperature monitoring function provided by Sepam™ T40, T42, M41 and G40 units checks the connection of each configured RTD.

An "RTD FAULT" alarm is generated whenever one of the RTDs is detected as being short-circuted or disconnected (absent).

To identify the faulty RTD or RTDs:
1 Display the temperature values measured by Sepam™ using the SFT2841 software.
2 Check the consistency of the temperatures measured:
- the temperature displayed is "****" if the RTD is short-circuited (T < –35 °C)
- the temperature displayed is "-****" if the RTD is disconnected (T > 205 °C).

Checking the Analog Output Connection to the MSA141 Module

1 Identify the measurement associated by parameter setting to the analog output using the SFT2841 software.
2 Simulate, if necessary, the measurement linked to the analog output by injection.
3 Check the consistency between the value measured by Sepam™ and the indication given by the device connected to the analog output.

Test Sheet
Sepam™ Series 40

Project: .... **Type of Sepam™** ☐☐☐

Switchboard: .... **Serial Number** ☐☐☐☐☐☐☐

Cubicle: .... **Software Version** V☐☐☐☐

Overall Checks

Check off the box ☐ when the check has been made and been conclusive

Type of check	
Preliminary general examination, prior to energizing	☐
Energizing	☐
Parameter and protection settings	☐
Logic input connection	☐
Logic output connection	☐
Validation of the complete protection chain	☐
Validation of the customized logic functions (if necessary)	☐
Analog output connection to the MSA141 module (if necessary)	☐
Temperature sensor input connection to the MET1482 module (for type T40, T42, M41, G40))	☐

Checking Phase Current and Voltage Inputs

Check off the box ☐ when the check has been made and been conclusive

Type of Check	Test Performed	Result	Display	
Phase current and phase voltage input connection	Secondary injection of CT rated current, (1 A or 5 A)	CT rated primary current	Ia = ...	☐
			Ib = ...	
			Ic = ...	
	Secondary injection of phase voltage (the value to be injected depends on the test being performed)	VT rated primary phase-to-neutral voltage $V_{LL}s/\sqrt{3}$	Van = ...	☐
			Vbn = ...	
			Vcn = ...	
		Phase displacement φ(V, I) ≈ 0°	φa = ...	☐
			φb = ...	
			φc = ...	

Tests performed on:	**Signatures**
By:	

Comments:

....

....

....

Project: ....

Type of Sepam™ ☐☐☐

Switchboard: ....

Serial Number ☐☐☐☐☐☐☐

Cubicle: ....

Software Version V ☐☐☐☐☐

Checking Residual Current and Residual Voltage Inputs

Check off the box ☐ when the check has been made and been conclusive

Type of Check	Test Performed	Result	Display	
Residual current input connection	Injecting 5A into the zero sequence CT primary circuit	Zero sequence	Ir =....................	☐
	When applicable, secondary injection of the rated phase-to-neutral voltage of a phase VT $V_{LL}s/\sqrt{3}$	VT rated primary phase-to-neutral voltage $v_{LL}p/\sqrt{3}$	Vr = ...	
		Phase displacement φr(Vr, Ir) ≈ 0°	φr = ...	
Residual voltage input connection	Secondary injection of the rated voltage of the VTs in an open delta arrangement ($v_{LL}s/\sqrt{3}$ or $v_{LL}s/3$)	VT rated primary phase-to-neutral voltage $v_{LL}p/\sqrt{3}$	Vr = ...	☐
	When applicable, secondary injection of CT rated current, (1 A or 5 A)	CT rated primary current	Ir =....................	
		Phase displacement φr(Vr, Ir) ≈ 0°	φr = ...	
Residual current and residual voltage input connection	Injecting 5A into the zero sequence CT primary circuit	Zero sequence	Ir =....................	☐
	Secondary injection of the rated voltage of the VTs in an open delta arrangement ($v_{LL}s/\sqrt{3}$ or $v_{LL}s/3$)	VT rated primary phase-to-neutral voltage $v_{LL}p/\sqrt{3}$	Vr = ...	
		Phase displacement φr(Vr, Ir) ≈ 0°	φr = ...	

7

Tests performed on: ....

By: ....

Signatures

Comments:

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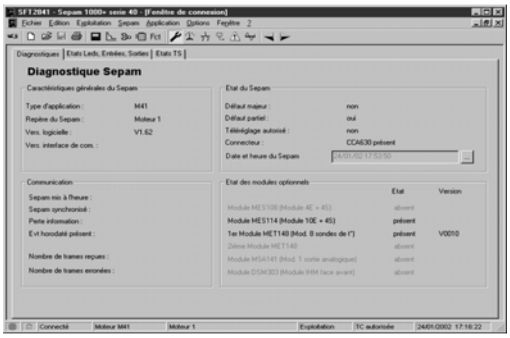
Sepam™ has a large number of self-tests that are carried out in the base unit and additional modules. The purpose of the self-tests is:

- to detect events that may lead to nuisance tripping or does not trip when a fault occurs
- to put Sepam™ in the fail-safe position to avoid user errors
- to notify the operator that a maintenance operation is required.

The "Sepam™ diagnosis" screen of the SFT2841 software provides access to data on the status of the base unit and optional modules.

MT11196



Sepam™ Diagnosis" screen

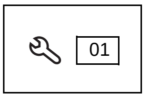
Shutdown of the Base Unit in Fail-Safe Position

The base unit goes into the fail-safe position in the following conditions:

- detection of an internal problem by the self-tests
- sensor interface connector missing (CCA630, CCA634 or CCA670)
- no connection of one of the three LPCT sensors to the CCA670 (connectors L1, L2 and L3)
- MES module configured but missing.

The fail-safe position is conveyed by:

- ON indicator on
- indicator on the base unit steadily on
- relay O4 "watchdog" in fault position
- output relays dropped out
- all protection units blocked
- display showing fault message



- indicator on DSM303 module (remote advanced UMI option) flashing.

Downgraded Operation

The base unit is in working order (all the protection functions activated are operational) and indicates that one of the optional modules such as DSM303, MET1482 or MSA141 is faulty or else that a module is configured but not connected.
According to the model, this operating mode is conveyed by:

- Sepam™ with integrated advanced UMI (MD base):
  - ON indicator on
  - indicator on the base unit flashing, including when the display is out of order (off)
  - indicator on the MET or MSA module faulty, steadily on.

The display shows a partial fault message and indicates the type of fault by a code:

- code 1: inter-module link fault
- code 3: MET module unavailable
- code 4: MSA module unavailable.

- Sepam™ with remote advanced UMI, MX base + DSM303:
  - ON indicator on
  - indicator on the base unit flashing
  - indicator on the MET or MSA module faulty, steadily on
  - the display indicates the type of fault by a code (same as above).

Special case of faulty DSM303:

- ON indicator on
- indicator on base unit flashing
- indicator on DSM steadily on
- display off.

This Sepam™ operating mode is also transmitted via the communication link.

RTD Fault

Each temperature monitoring function, when activated, detects whether the RTD associated with the MET148-2 module is short-circuited or disconnected.
When this is the case, the alarm message "RTD FAULT" is generated.
Since this alarm is common to the 8 functions, the identification of the faulty RTD or RTDs is obtained by looking up the measured values:

- measurement displayed "****" if the sensor is short-circuited (T < -35 °C or -31 °F)
- measurement displayed "-****" if the sensor is disconnected (or T > +205 °C or +401 °F)

Other Faults

Specific faults indicated by a screen:

- DSM303 version incompatible (if version < V0146).

Replacement and Repair

When Sepam™ or a module is considered to be faulty, have it replaced by a new product or module, since the components cannot be repaired.

CAUTION

HAZARD OF DAMAGE TO SEPAM™

- Do not open the Sepam™ base unit.
- Do not attempt to repair any components in the Sepam™ range, either in the base unit or an accessory.

Failure to follow these instructions can cause equipment damage.

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

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