Busbar Differential Protection

SIPROTEC 7SS60
Centralized Numerical Busbar Protection

Fig. 9/1 7SS601 measuring system

Description

The SIPROTEC 7SS60 system is an inexpensive numerical differential current protection for busbars in a centralized configuration.

It is suitable for all voltage levels and can be adapted to a large variety of busbar configurations with an unlimited number of feeders. The components are designed for single busbars, 1½-breaker configurations and double busbars with or without couplers.

Different primary CT ratios can be matched by using appropriate windings of the input current transformers.

The use of matching transformers allows phase-selective measurement. Single-phase measurement can be achieved by using summation current transformers.

Function overview

Features

- Optimized for single busbar and 1½ circuit-breaker configurations
- Suitable for double busbars with or without couplers
- Separate check zone possible
- Short trip times
- Unlimited number of feeders
- Matching of different primary CT ratios
- Differential current principle
- Low-impedance measuring method
- Numerical measured-value processing
- Suitable for all voltage levels
- Low demands on CTs thanks to additional restraint
- Measured-value acquisition via summation current transformer or phase-selective matching transformers
- Maintained TRIP command (lockout function)
- Centralized, compact design
- Combinative with separate breaker failure protection

Monitoring functions

- Primary current transformers including supply leads
- Operational measured values: Differential and restraint current
- Self-supervision of the relay
- 30 event logs
- 8 fault logs
- 8 oscillographic fault records

Communication interface

- RS485 interface for local and remote operation with DIGSI

Hardware

- Concept of modular components
- Reduced number of module types
- Auxiliary voltage 48 V DC to 250 V DC
- 7SS601 measuring system in 1/6 19-inch housing 7XP20
- Peripheral components in ½ 19-inch housing 7XP20

Front design

- Display for operation and measured values
- 6 LEDs for local indication

Application

The 7SS60 system is an easily settable numerical differential current protection for busbars.

It is suitable for all voltage levels and can be adapted to a large variety of busbar configurations. The components are designed for single busbars, 1½-breaker configurations and double busbars with or without couplers.

The use of matching transformers allows phase-selective measurement.

Single-phase measurement can be achieved by using summation current transformers.

The 7SS60 is designed to be the successor of the 7SS1 static busbar protection. The existing summation current or matching transformers can be reused for this protection system.

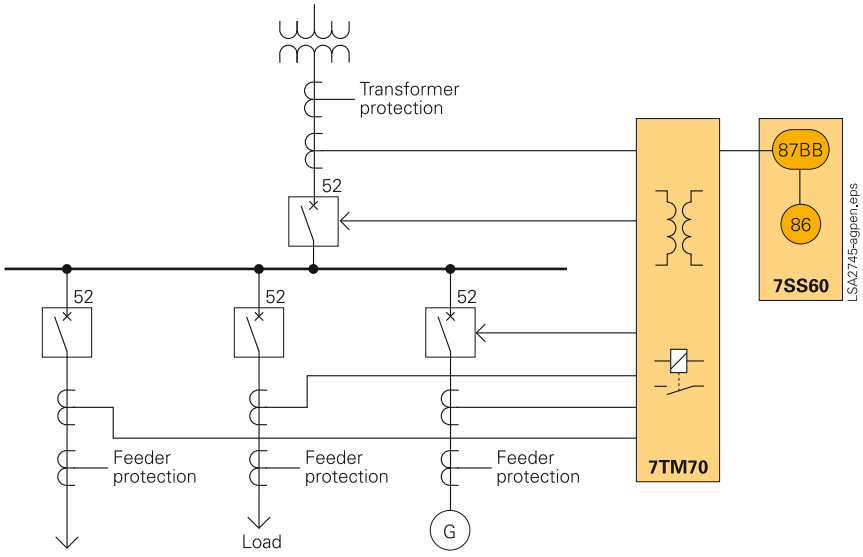

Fig. 9/2 Basic connection scheme 7SS60

Construction/Functions

Design

The 7SS60 compactly-built protection system contains all components for:

- Measured-value acquisition and evaluation
- Operation and LC display
- Annunciation and command output
- Input and evaluation of binary signals
- Data transmission via the RS485 interface with bus capability
- Auxiliary voltage supply

The 7SS60 system comprises the following components:

- 7SS601 measuring system and the peripheral modules
- 7TM70 restraint/command output module
- 7TR71 isolator replica/preference module
- 7TS72 command output module

The number of modules required is determined by the substation configuration and the measuring principle used (summation current transformers or phase-selective measurement). The 7SS601 measuring system is accommodated in a separate housing (1/6 19-inch 7XP20) that is suited for panel flush mounting or cubicle mounting. The 7XP2040 peripheral module housing has a width of ½ 19 inches and can hold up to four peripheral modules. It is suited for panel flush mounting or cubicle mounting and has plug-on connectors fitted at the rear.

The primary current transformers are connected to summation current transformers of type 4AM5120-3DA/4DA or to matching transformers of type 4AM5120-1DA/2DA. With a rated current of 1 or 5 A, the current output at these transformers is 100 mA. This output current is fed onto the 7SS601 measuring system (for differential current formation) and onto the 7TM70 restraint units (for restraint current formation). The summated restraint current is fed onto the 7SS601 measuring system as well.

Functions of the components

- The 7SS601 measuring system comprises:
  – One measuring input for acquisition and processing of the differential and the restraint current
  – 3 binary inputs for acquisition of information, e.g. a blocking condition
  – 2 command relays for activation of other, feeder-specific command relays on the 7TM70 and 7TS72 peripheral modules.

In circuits with summation current transformer, one 7SS601 measuring system is required per protected zone. For phase-selective measurement, one 7SS601 measuring system is required per phase and protected zone.

- 7TM70 restraint/command output module
  This module contains 5 current transformers with rectifiers for the formation of the restraint current. It has also 5 command relays with 2 NO contacts each for output of a direct TRIP command to the circuit-breakers.
- 7TR71 isolator replica/preference module
  This module enables the two bus isolators to be detected in a double busbar. The feeder current is assigned to the corresponding measuring system on the basis of the detected isolator position.
  The module is also designed for an additional function. In the case of a double busbar system, for example, where both bus isolators of a feeder are closed at a time, no selective protection of the two busbars is possible. During this state, one of the two measuring systems is given priority. The module 7TR71 appropriately assigns feeder currents to the corresponding measuring system 7SS601.
  The module also contains an auxiliary relay with two changeover contacts.
- 7TS72 command output module
  The 7TM70 contains 5 trip relays with 2 NO contacts each. If more trip contacts are needed, the 7TS72 module can be used, providing 8 relays with 2 NO contacts each.

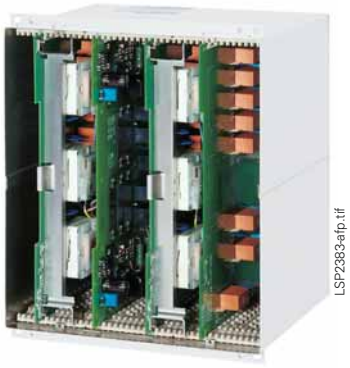

Fig. 9/3 Housing for peripheral modules (front cover removed)

Fig. 9/4 Rear view

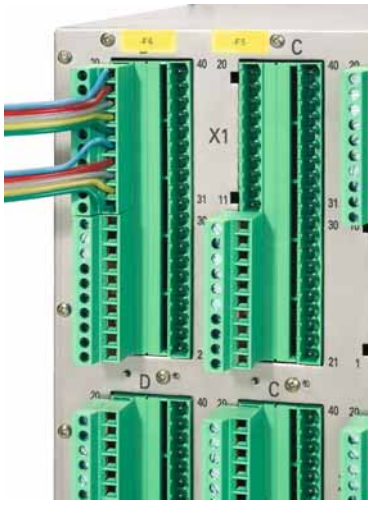

Fig. 9/5 Rear view detail

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Protection functions

Measuring principles

The feeder currents can be measured and processed according to different principles.

- Summation current transformer principle
  In the summation current transformer variant, the three secondary currents of the primary CTs are fed onto the three primary windings of the summation current transformers with a winding ratio of n1:n2:n3 = 2:1:3. According to the expected fault currents two different circuits for connecting the summation current transformer are possible. For power systems with low-resistance or solid earthing of the starpoint, the 1-phase earth-faults are sufficiently high to use the circuit with normal sensitivity (see Fig. 9/7). An increased sensitivity for earth-faults can be achieved by use of a circuit according to Fig. 9/8. With a symmetrical, three-phase current of 1 x I_N, the secondary current of the summation current transformers is 100 mA.
  Different primary CT transformation ratios can usually be compensated directly by appropriate selection of the summation CT primary windings. Where the circuit conditions do not allow this, additional matching transformers, such as the 4AM5272-3AA, should be used, preferably in the form of autotransformers (see Fig. 9/9: Protection with summation current transformer and matching transformers). The autotransformer circuit reduces the total burden for the primary CTs.

- Phase-selective measurement
  In this variant, each phase current is measured separately. To do so, each of the secondary currents of the primary transformers is fed onto a matching transformer. This transformer allows, if its primary windings are selected accordingly, to generate a normalized current from a variety of different primary CT transformation ratios (see Fig. 9/10: Phase-selective measurement). With a primary current of 1 x I_N, the secondary current of the matching transformers is 100 mA.

Function principle of the differential protection

The main function of the 7SS60 protection system is a busbar protection that operates with the differential current measuring principle. Its algorithm relies on Kirchhoff's current law, which states that in fault-free condition the vectorial sum I_d of all currents flowing into an independent busbar section must be zero. Some slight deviations from this law may be caused by current transformer error, inaccuracies in the matching of the transformation ratios and measuring inaccuracies. Further errors, which may be due to e.g. transformer saturation in case of high-current external short-circuits, are counteracted by a load-dependent supplementary restraint.

The restraint current I_R is derived from the load condition. This restraint current is formed as the summated magnitudes of all currents. The differential and the restraint current are fed into the 7SS601 measuring system (see Fig. 9/6: Block diagram). With double busbars or sectionalized busbars, one measuring system 7SS601 (summation CT), respectively 3 measuring systems (phase-selective measurement) will be used for each selective section. The module 7TS71 (isolator replica/preference) appropriately assigns feeder currents to the corresponding measuring system 7SS601.

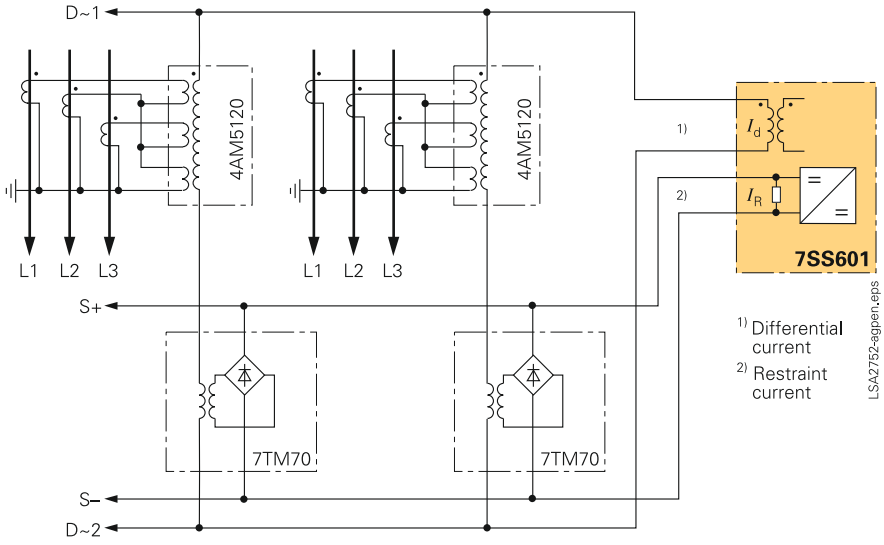


Fig. 9/6 Block diagram: Acquisition of measured values

Typical connections

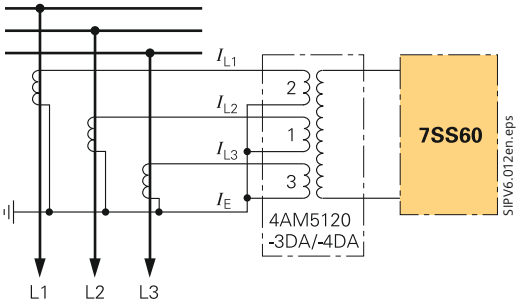


Fig. 9/7 Protection with summation current transformer (L1-L2-L3 circuit)

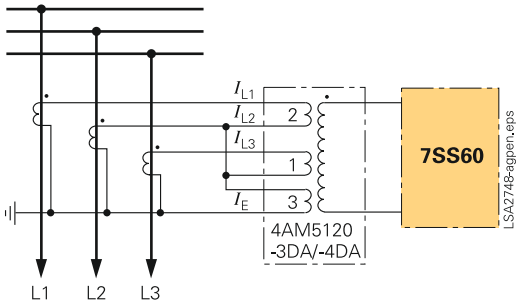


Fig. 9/8 Protection with summation current transformer (L1-L3-N circuit)

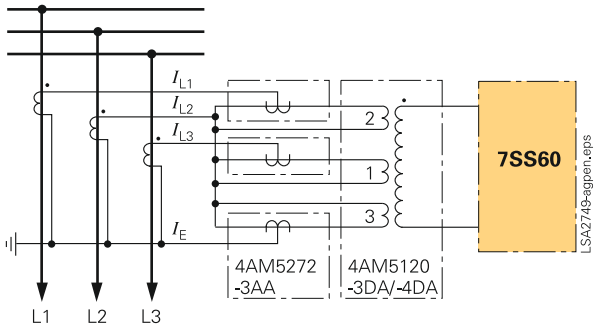


Fig. 9/9 Protection with summation current transformer and matching transformers

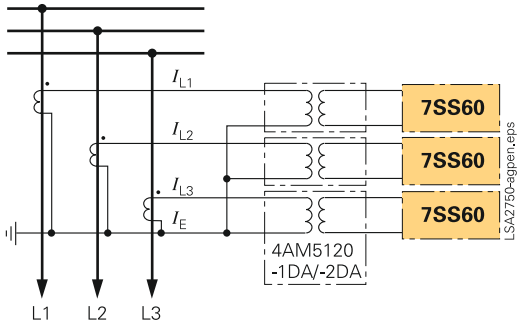


Fig. 9/10 Phase-selective measurement

Protection functions/Functions

Pickup characteristic of the differential protection

The characteristic can be set in the parameters for $I_d >$ (pickup value) and for the k factor which considers the linear and non-linear current transformer errors. Differential currents above the set characteristic lead to tripping.

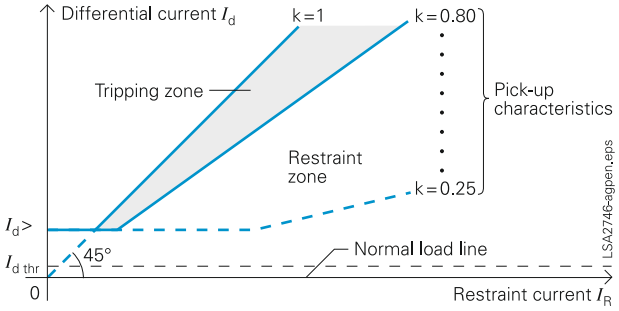


Fig. 9/11 Tripping characteristic

Current transformer monitoring

An independent sensitive differential current monitoring with its parameter $I_{d\,thr}$ detects faults (short-circuits, open circuit) of current transformers and their wiring even with load currents. The affected measuring system is blocked and an alarm is given. By this, the stability of the busbar protection is ensured in case of external faults.

Trip command lockout (with manual reset)

Following a trip of the differential protection, the TRIP command can be kept (sealed-in). The circuit-breakers are not reclosed until the operator has obtained information on the fault; the command must be manually reset by pressing a key or by a binary input.

The logical state of the TRIP command is buffered against a loss of the auxiliary power supply, so that it is still present on restoration of the auxiliary voltage supply.

Test and commissioning aids

The protection system provides user support for testing and commissioning. It has a wide range of integrated aids that can be activated from the keypad or from a PC using the DIGSI program. For some tests a codeword must be entered.
The following test aids are available:

- Display of operational measured values
- Interrogation of status of binary inputs and LED indicators
- Blocking of the TRIP function during testing

Communication/Functions

Serial data transmission

The device is equipped with an RS485 interface. The interface has bus capability and allows a maximum of 32 units to be connected via a serial two-wire interface. A PC can be connected to the interface via an RS232↔RS485 converter, so that configuration, setting and evaluation can be performed comfortably via the PC using the DIGSI operating program. The PC can also be used to read out the fault record that is generated by the device when a fault occurs.

With RS485↔820 nm optical converters, which are available as accessories (7XV5650, 7XV5651), an interference-free, isolated connection to a control center or a DIGSI-based remote control unit is possible; this allows to design low-cost stations concepts that permit e.g. remote diagnosis.

Comfortable setting

The parameter settings are made in a menu-guided procedure from the integrated operator panel and the LC display. It is, however, more comfortable to use a PC for this purpose, together with the standard DIGSI operating program.

Fault recording

If a fault leads to a trip, a fault record is generated, in which the differential and the restraint current are recorded with a sampling frequency of 2 kHz. In addition, signals are stored as binary traces, which represent internal device states or binary input states. Up to eight fault records can be stored. When a ninth fault occurs, the oldest record is overwritten. A total storage capacity of 7 s is available. The most recent 2.5 s are buffered against power failure.

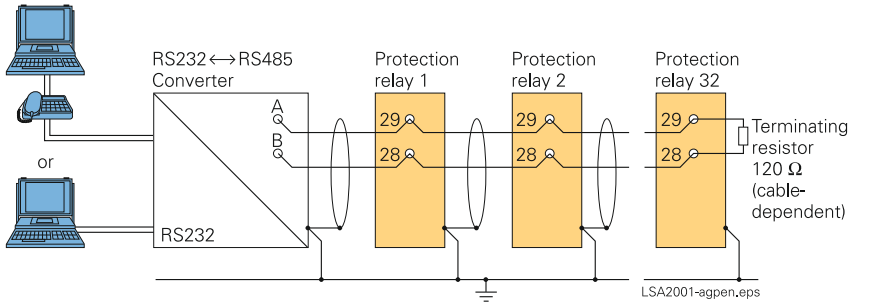


Fig. 9/12 Communication scheme

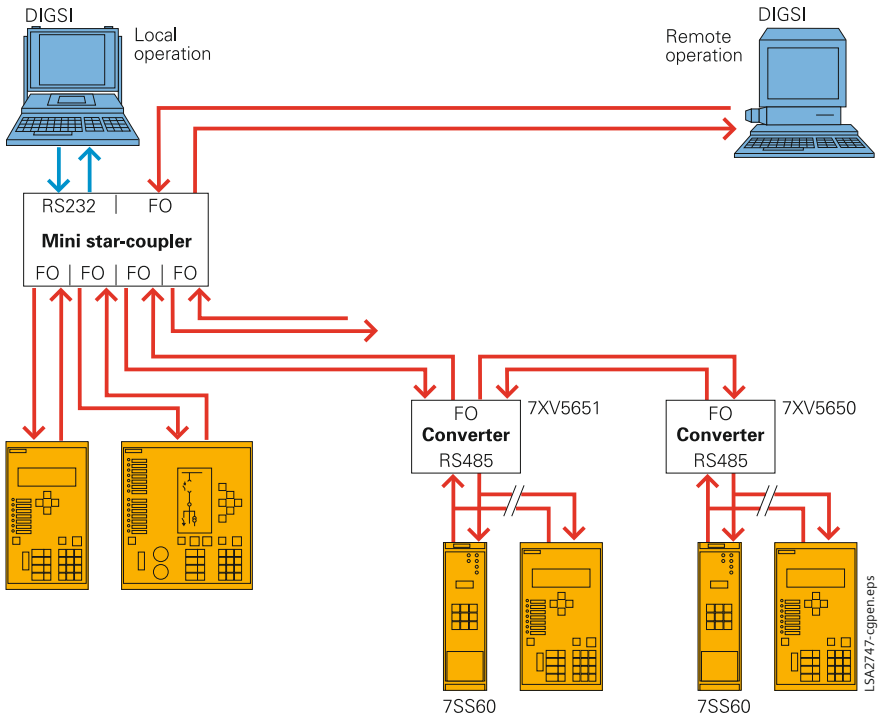


Fig. 9/13 Communication scheme

Technical data

7SS60 measuring system

Measuring input I_d

Rated current	100 mA
Rated frequency	50/60 Hz settable, 16.7 Hz
Dynamic overload capacity (pulse current)	250 x I_N one half cycle
Thermal overload capacity (r.m.s.) (where external summation or matching current transformers are used, their limit data must be observed)	100 x I_N for ≤ 1 s 30 x I_N for ≤ 10 s 4 x I_N continuous
Isolating voltage	2.5 kV (r.m.s.)
Measuring range for operational measured values	0 to 240 %
Measuring dynamics	100 x I_N without offset 50 x I_N with full offset

Measuring input I_R

Rated current	1.9 mA
Dynamic overload capability (pulse current)	250 x I_N for 10 ms
Thermal overload capability (r.m.s.) (where external summation or matching current transformers are used, their limit data must be observed)	100 x I_N for ≤ 1 s 30 x I_N for ≤ 10 s 4 x I_N continuous
Isolating voltage	2.5 kV (r.m.s.)
Measuring dynamics	0 to 200 x I_N

Auxiliary voltage

Via integrated DC/DC converter Rated auxiliary voltage V_{aux} (permissible voltage)	24/48 V DC 60/110/125 V DC 220/250 V DC 115 V AC	(19 to 58 V DC) (48 to 150 V DC) (176 to 300 V DC) (92 to 133 V AC)
Superimposed AC voltage (peak-to-peak)	≤ 15 % of rated voltage	
Power consumption	Quiescent Energized	Approx. 3 W Approx. 5 W
Bridging time during failure/ short-circuit of auxiliary voltage	≥ 50 ms at V_{aux} ≥ 100 V DC ≥ 20 ms at V_{aux} ≥ 48 V DC	

Binary inputs

Number	3 (marshallable)
Operating voltage range	24 to 250 V DC
Current consumption when energized	Approx. 2.5 mA Independent of operating voltage
Pickup threshold	Can be changed by setting jumpers
Rated aux. voltage 48/60 V DC	
V_{pickup}	≥ 17 V DC
$V_{drop\text{-}off}$	< 8 V DC
Rated aux. voltage 110/125/220/250 V DC	
V_{pickup}	≥ 74 V DC
$V_{drop\text{-}off}$	< 45 V DC
Max. voltage	300 V DC

Command contacts

Number of relays	1 (2 NO contacts) 1 (1 NO contact)
Switching capacity	
Make	1000 W/VA
Break	30 W/VA
Switching voltage	250 V AC/DC
Permissible current	
Continuous	5 A
0.5 s	30 A

Signal contacts

Number of relays	3 (2 marshallable)
Contacts	2 changeover contacts and 1 NO contact (can be changed to NC by jumper)
Switching capacity	
Make	1000 W/VA
Break	30 W/VA
Switching voltage	250 V AC/DC
Permissible current	
Continuous	5 A
0.5 s	30 A

Serial interface

Standard	Isolated RS485
Test voltage	3.5 kV DC
Connection	Data cable at housing terminals, 2 data lines For connection of a personal computer or similar Cables must be shielded, and shields must be earthed.
Transmission rate	As delivered 9600 baud min. 1200 baud, max. 19200 baud

Unit design

Housing 7XP20	$^1/_6$ 19"
Dimensions	See part 15
Weight	Approx. 4.0 kg
Degree of protection according to IEC 60529-1	
For the unit	IP 51
For operator protection	IP 2X

Technical data

Functions

Differential current protection

Setting ranges for pickup threshold	
Differential current I_d>	0.20 to 2.50 I_{NO}
Restraint factor	0.25 to 0.80
Tolerance of pickup value	
Differential current I_d>	± 5 % of setpoint
Minimum duration of trip command	0.01 to 32.00 s (in steps of 0.01 s)
Time delay of trip	0.00 to 10.00 s (in steps of 0.01 s)
Times	
Minimum tripping time 50/60 Hz [1]	10 ms
Typical tripping time 50/60 Hz [1]	12 ms (rapid measurement) 40 ms (repeated measurement)
Minimum tripping time 16.7 Hz [1]	12 ms
Typical tripping time 16.7 Hz [1]	14 ms (rapid measurement) 40 ms (repeated measurement)
Reset time [2]	28 ms at 50 Hz 26 ms at 60 Hz 70 ms at 16.7 Hz
Differential current supervision	
Pickup threshold	0.10 to 1.00 I_{NO}

Lockout function

Lockout seal-in of trip command	Until reset
Reset	By binary input and/or local operator panel

Additional functions

Operational measured values	
Operating currents	I_d, I_R
Measuring range	0 to 240 % I_{NO}
Tolerance	5 % of rated value
Fault logging	Buffered storage of the annunciations of the last 8 faults
Time stamping	
Resolution for operational annunc.	1 ms
Resolution for fault annunciation	1 ms
Fault recording (max. 8 fault)	Buffered against voltage failure (last 2.5 s)
Recording time (from fault detection)	Max. 7.1 s total Pre-trigger and post-fault time can be set
Max. length per record	0.2 to 5.0 s (in steps of 0.01 s)
Pre-trigger time	0.05 to 1.5 s (in steps of 0.01 s)
Post-fault time	0.01 to 1.5 s (in steps of 0.01 s)
Sampling frequency	2 kHz

Peripheral modules

7TM700 restraint/command output module

Measuring input I_R

Number of restraint units	5
Rated current	100 mA
Rated frequency	16.7, 50, 60 Hz
Dynamic overload capacity (pulse current)	250 x I_N one half cycle
Thermal overload capacity (r.m.s.) (where external summation or matching current transformers are used, their limit data must be observed)	100 x I_N for ≤ 1 s 30 x I_N for ≤ 10 s 4 x I_N continuous

Auxiliary voltage (7TM700)

Rated auxiliary voltage V_{aux} (permitted voltage range)	48/60 V DC (38 to 72 V DC) 110/125 V DC (88 to 150 V DC) 220/250 V DC (176 to 300 V DC) Settable As delivered: 220/250 V DC

Command contacts (7TM700)

Number of relays	5
Contacts per relay	2 NO contacts
For short-term operation < 10 s [3]	
Pickup time	Approx. 7 ms
Switching capacity	
Make	1000 W/VA
Break	30 W/VA
Switching voltage	250 V AC/DC
Permissible currents	
Continuous	5 A
0.5 s	30 A
Weight	Approx. 2.0 kg

7TR710 isolator replica/preferential treatment module

NOTE: The module 7TR710 can be used to implement 2 different functions: isolator replica or preferential treatment

Isolator replica

Number of feeders (single busbar and double busbar)	1
Number of isolators per feeder	2

Preferential treatment

Number of preferential treatment circuits	2
Number of contacts per preferential treatment	3 changeover contacts
Switching time	< 20 ms
Number of auxiliary relays	1
Contacts of auxiliary relay	2 changeover contacts

Auxiliary voltage

Rated auxiliary voltage V_{aux} (permissible voltage range)	48/60 V DC (38 to 72 V DC) 110/125 V DC (88 to 150 V DC) 220/250 V DC (176 to 300 V DC) Depending on the design

Relay contacts

Switching capacity	
Make	1000 W/VA
Break	30 W/VA
Switching voltage	250 V AC/DC
Permissible current	
Continuous	5 A
0.5 s	10 A
Weight	Approx. 0.6 kg

1) Each additional intermediate relay increases the tripping time by 7 ms.

2) Each additional intermediate relay increases the reset time by 8 ms.

3) Limited by the continuous power dissipation of the device.

Technical data

***Peripheral modules** (cont'd)*

7TS720 command output module

Auxiliary voltage

Rated auxiliary voltage V_{aux} (permissible voltage range)	48/60 V 110/125 V 220/250 V	(38 to 72 V DC) (88 to 150 V DC) (176 to 300 V DC)
	Settable As delivered: 220/250 V DC	

Command contacts

Number of relays	8
Contacts per relay	2 NO contacts
For short term operation < 10 s [1]	
Pickup time	Approx. 7 ms
Switching capacity	
Make	1000 W/VA
Break	30 W/VA
Switching voltage	250 V AC/DC
Permissible current	
Continuous	5 A
0.5 s	30 A
Weight	Approx. 0.5 kg

7SS601 measuring system

Current connections (terminals 1 to 6)

Screw-type terminals (ring-type cable lug)	For bolts of 6 mm
Max. outside diameter	13 mm
Type	e.g. PDIG of AMP
For conductor cross-sections of	2.7 to 6.6 mm^2 AWG 12 to 10
In parallel double leaf-spring-crimp contact for conductor cross-sections of	2.5 to 4.0 mm^2 AWG 13 to 11
Max. tightening torque	3.5 Nm

Control connections (terminals 7 to 31)

Screw-type terminals (ring-type cable lug)	For 4 mm bolts
Max. outside diameter	9 mm
Type	e.g. PDIG of AMP
For conductor cross-sections of	1.0 to 2.6 mm^2 AWG 17 to 13
In parallel double leaf-spring-crimp contact for conductor cross-sections of	0.5 to 2.5 mm^2 AWG 20 to 13
Max. tightening torque	1.8 Nm

1) Limited by the continuous power dissipation of the device.

Connectors with screw-type terminals

Type	COMBICON system of PHOENIX CONTACT Front-MSTB 2.5/10-ST-5.08
For conductor cross-sections of	0.2 to 2.5 mm^2 (rigid and flexible) AWG 24 to 12 0.25 to 2.5 mm^2 (with end sleeve)
Multiple conductor connection (2 conductors of same cross-section)	0.2 to 1.0 mm^2 (rigid) 0.2 to 1.5 mm^2 (flexible) 0.25 to 1.0 mm^2 (flexible with end sleeve, without plastic collar) 0.5 to 1.5 mm^2 (flexible with TWIN end sleeve with plastic collar)
Stripping length	7 mm
Recommended tightening torque	0.5 to 0.6 Nm

Unit design

Housing 7XP204	½ 19"
Dimensions	See part 15
Weight	Approx. 3.5 kg
Degree of protection according to IEC 60529-1	
For the device	IP 51 (front panel) IP 20 (rear)
For the operator protection	IP 2X (if all connectors and blanking plates are fitted)

Matching transformers

4AM5120-1DA00-0AN2

For connection to current transformers with a rated current I_N of		1 A						
Rated frequency f_N		45-60 Hz						
Winding		A-B	B-C	D-E	E-F	G-H	H-J	
Number of turns			Y-Z					
		1	2 500	4	8	16	32	
Max. current, continuous	A	6.8	6.8	6.8	6.8	6.8	6.8	
Max. voltage	V		0.85					
		0.4	0.8 200	1.6	3.2	6.4	12.8	
Max. burden	VA	1.0						

4AM5120-2DA00-0AN2

For connection to current transformers with a rated current I_N of		5 A			
Rated frequency f_N		45-60 Hz			
Winding		A-B	B-C	D-E	E-F
Number of turns					Y-Z
		1	2	4	8 500
Max. current, continuous	A	26	26	26	26
Max. voltage	V				0.85
		0.4	0.8	1.6	3.2 200
Max. burden	VA	1.2			

Technical data

Summation current matching transformers

4AM5120-3DA00-0AN2

For connection to current transformers with a rated current I_N of		1 A							
Rated frequency f_N		45-60 Hz							
Winding		A-B	C-D	E-F	G-H	J-K	L-M	N-O	Y-Z
Number of turns		3	6	9	18	24	36	90	500
Max. current, continuous	A	4	4	4	4	4	4	2	0.85
Max. voltage	V	1.2	2.4	3.6	7.2	9.6	14.4	36	200
Max. burden	VA	1.8							

4AM5120-4DA00-0AN2

For connection to current transformers with a rated current I_N of		5 A							
Rated frequency f_N		45-60 Hz							
Winding		A-B	C-D	E-F	G-H	J-K	L-M	N-O	Y-Z
Number of turns		1	2	3	4	6	8	12	500
Max. current, continuous	A	17.5	17.5	17.5	17.5	17.5	17.5	8.0	0.85
Max. voltage	V	0.4	0.8	1.2	1.6	2.4	3.2	4.8	200
Max. burden	VA	2.5							

Matching transformer

4AM5272-3AA00-0AN2

Multi-tap auxiliary current transformer to match different c.t. ratios									
Rated frequency f_N		45-60 Hz							
Winding		A-B	C-D	E-F	G-H	J-K	L-M	N-O	P-Q
Number of turns		1	2	7	16	1	2	7	16
Max. current, continuous	A	6	6	6	1.2	6	6	6	1.2
Max. voltage	V	4	8	28	64	4	8	28	64
resistance	Ω	0.018	0.035	0.11	1.05	0.018	0.035	0.11	1.05

Electrical tests

Specifications

Standards: IEC 60255-5; ANSI/IEEE C37.90.0

Insulation tests

High voltage test (routine test), measuring input I_d and relay outputs	2.5 kV (r.m.s.); 50 Hz
High voltage test (routine test), auxiliary voltage input and RS485 interface, binary inputs and measuring input I_R	3.5 kV DC
Impulse voltage test (type test), all circuits, class III	5 kV (peak); 1.2/50 µs; 0.5 J; 3 positive and 3 negative impulses in intervals of 5 s

EMC tests for interference immunity; type tests

Standard	IEC 60255-6, IEC 60255-22 (international product standards) EM 50082-2 (technical generic standard) DIN VDE 57435 part 303 (German product standard for protection devices)
High-frequency test IEC 60255-22-1, DIN 57435 part 303; class III	2.5 kV (peak); 1 MHz; t = 15 ms; 400 surges per s; test duration 2 s
Electrostatic discharge IEC 60255-22-2; IEC 61000-4-2; class IV	8 kV contact discharge; 15 kV air discharge; both polarities; 150 pF; R_i = 330 Ω
Irradiation with RF field, non-modulated IEC 60255-22-3 (report); class III	10 V/m; 27 to 500 MHz
Irradiation with RF field, amplitude-modulated IEC 61000-4-3, class III	10 V/m; 80 to 1000 MHz; 80 % AM; 1 kHz
Irradiation with RF field, pulse-modulated IEC 61000-4-3/ENV 50204; class III	10 V/m; 900 MHz; repetition frequency 200 Hz; ED 50 %
Fast transient disturbance/bursts IEC 60255-22-4; IEC 61000-4-4; class III	4 kHz; 5/50 ns; 5 kHz, burst length = 15 ms; repetition rate 300 ms; both polarities; R_i = 50 Ω; test duration 1 min
High-energy surge voltages (SURGE), IEC 61000-4-5, installation, class III	Auxiliary voltage: Longitudinal test: 2 kV; 12 Ω; 9 µF Transversal test: 1 kV; 2 Ω; 18 µF Measuring inputs, binary inputs and relay outputs: Longitudinal test: 2 kV; 42 Ω; 0.5 µF Transversal test: 1 kV; 42 Ω; 0.5 µF
Line-conducted HF, amplitude-modulated IEC 61000-4-6; class III	10 V; 150 kHz to 80 MHz; 80 % AM; 1 kHz
Magnetic field with power frequency IEC 61000-4-8; class IV IEC 60255-6	30 A/m; continuous; 300 A/m for 3 s; 50 Hz; 0.5 mT
Oscillatory surge withstand capability ANSI/IEEE C37.90.1	2.5 to 3 kV (peak); 1 to 1.5 MHz; damped wave; 50 surges per s; duration 2 s; R_i = 150 to 200 Ω
Fast transient surge withstand capability ANSI/IEEE C37.90.1	4 to 5 kV; 10/150 ns; 50 surges per s; both polarities; duration 2 s; R_i = 80 Ω
Radiated electromagnetic interference ANSI/IEEE C37.90.2	35 V/m; 25 to 1000 MHz
Damped oscillations IEC 61000-4-12 IEC 60694	2.5 kV (peak, alternating polarity); 100 kHz; 1, 10 and 50 MHz; damped wave; R_i = 50 Ω

EMC tests for interference emission; type test

Standard	EN 50081-* (technical generic standard)
Conducted interference voltage on lines only auxiliary voltage, EN 55022, DIN VDE 0878 part 22, IEC CISPR 22	150 kHz to 30 MHz, limit value, class B
Radio interference field strength EN 55011; DIN VDE 0875 part 11, IEC CISPR 11	30 to 1000 MHz, limit value, class A

Technical data

Mechanical stress tests

Vibration, shock stress and seismic vibration

During operation	
Standards	IEC 60255-21-1 IEC 60068-2
Vibration IEC 60255-21-1, class II IEC 60068-2-6	Sinusoidal 10 to 60 Hz, ± 0.075 mm amplitude 60 to 150 Hz; 1 *g* acceleration Sweep rate 1 octave/min 20 cycles in 3 orthogonal axes
Shock IEC 60255-21-2, class I IEC 60068-2-27	Half-sinusoidal Acceleration 5 *g*; duration 11 ms 3 shocks in each direction of the 3 orthogonal axes
Seismic vibration IEC 60255-21-3, class I IEC 60068-3-3	Sinusoidal
Horizontal axis	1 to 8 Hz: ± 3.5 mm amplitude 8 to 35 Hz: 1 *g* acceleration
Vertical axis	1 to 8 Hz: ± 1.5 mm amplitude 8 to 35 Hz: 0.5 *g* acceleration
	Frequency sweep 1 octave/min 1 cycle in 3 orthogonal axes
During transport	
Standards	IEC 60255-21 IEC 60068-2
Vibration IEC 60255-21-1, class II IEC 60068-2-6	Sinusoidal 5 to 8 Hz: ± 7.5 mm amplitude 8 to 150 Hz: 2 *g* acceleration sweep rate 1 octave/min 20 cycles in 3 orthogonal axes
Shock IEC 60255-21-2, class I IEC 60068-2-27	Half-sinusoidal Acceleration 15 *g*; duration 11 ms 3 shocks in each direction of the 3 orthogonal axes
Continuous shock IEC 60255-21-2, class I IEC 60068-2-29	Half-sinusoidal Acceleration 10 *g*; duration 16 ms 1000 shocks in each direction of the 3 orthogonal axes

Climatic stress test

Temperatures

Standards	IEC 60255-6
Permissible ambient temperatures – In service	-20 to +45/55 °C
– During storage	-25 to +55 °C
– During transport	-25 to +70 °C
Storage and transport with standard works packing	

Humidity

Standards	IEC 60068-2-3
Permissible humidity It is recommended to arrange the units in such a way that they are not exposed to direct sunlight or pronounced temperature changes that could cause condensation.	Annual average 75 % relative humidity; on 30 days in the year up to 95 % relative humidity; condensation not permissible!

CE conformity

This product is in conformity with the Directives of the European Communities on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC Council Directive 89/336/EEC) and electrical equipment designed for use within certain voltage limits (Council Directive 73/23/EEC).

This unit conforms to the international standard IEC 60255, and the German standard DIN 57435/Part 303 (corresponding to VDE 0435/Part 303).

The unit has been developed and manufactured for application in an industrial environment according to the EMC standards.

This conformity is the result of a test that was performed by Siemens AG in accordance with Article 10 of the Council Directive complying with the generic standards EN 50081-2 and EN 50082-2 for the EMC Directive and standard EN 60255-6 for the "low-voltage Directive".

Selection and ordering data

Description	Order No.
Centralized numerical busbar protection 7SS60	
Measuring system 50, 60, 16.7 Hz	*7SS601☐-☐☐A☐0-0AA0*
Rated current/frequency	
100 mA; 50/60 Hz AC — *0*	
100 mA; 16.7 Hz AC — *6*	
Rated auxiliary voltage	
24 to 48 V DC — *2*	
60 to 125 V DC — *4*	
220 to 250 V DC — *5*	
Unit design	
Housing 7XP20 1/6 19-inch, for panel flush mounting or cubicle mounting — *E*	
Measuring system	
Standard — *0*	
Stabilizing/command output module	
5 stabilizing CTs, 5 relays with 2 NO contacts	
48/60 V DC, 110/125 V DC, 220/250 V DC settable	*7TM7000-0AA00-0AA0*
Isolator replica/preference module	*7TR7100-☐AA00-0AA0*
48 to 60 V DC — *3*	
110 to 125 V DC — *4*	
220 to 250 V DC — *5*	
Command output module	
8 relays with 2 NO contacts	
48/60 V DC, 110/125 V DC, 220/250 V DC settable	*7TS7200-0AA00-0AA0*
Housing ½ 19-inch for peripheral modules 7SS60	
For panel flush mounting or cubicle mounting	*7XP2041-2MA00-0AA0*

Accessories

Copper interconnecting cable		
PC (9-pole socket) and converter/protection relay		*7XV5100-2*
Connector adapter		
9 pin female / 25 pin male		*7XV5100-8H*
RS232 - RS485 converter		
With power supply unit for 230 V AC		*7XV5700-0AA00*
With power supply unit for 110 V AC		*7XV5700-1AA00*
Converter		
Full duplex fiber-optic cable – RS485		
Auxiliary voltage: 24 V DC to 250 V DC, 110/230 V DC		
Line converter	ST connector	*7XV5650-0BA00*
Cascada converter	ST connector	*7XV5651-0BA00*
Connector for peripheral modules, as spare part		*W73078-B9005-A710*
Extraction tool for connector		*W73078-Z9005-A710*
Test adapter		*7XV6010-0AA00*
Angle bracket (set)		*C73165-A63-D200-1*

Accessories

Description	Order No.
Summation current matching transformer	
1 A, 50/60 Hz	*4AM5120-3DA00-0AN2*
5 A, 50/60 Hz	*4AM5120-4DA00-0AN2*
Matching transformer	
1 A, 50/60 Hz	*4AM5120-1DA00-0AN2*
5 A, 50/60 Hz	*4AM5120-2DA00-0AN2*
1 A, 5 A, 50/60 Hz	*4AM5272-3AA00-0AN2*
Manual 7SS60	
English	*E50417-G1176-C132-A3*

Connection diagrams

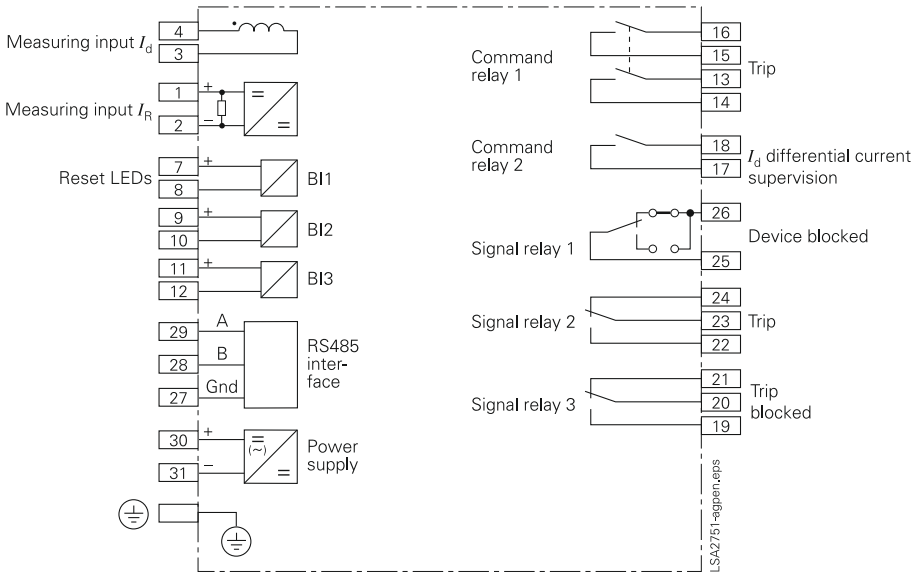


Fig. 9/14 Connection diagram for 7SS601

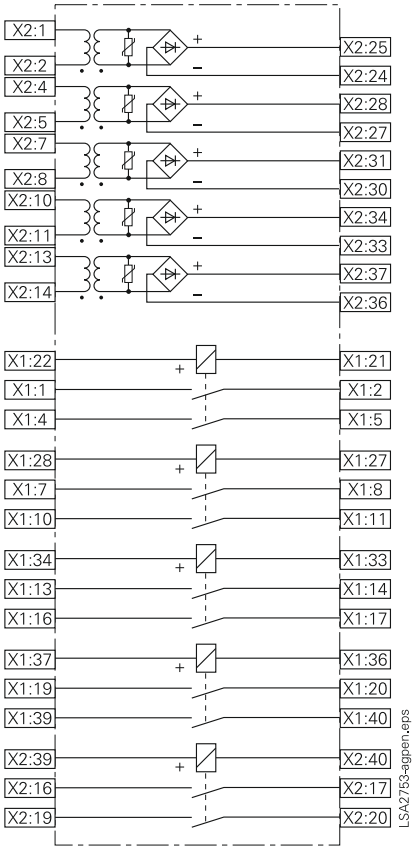


Fig. 9/15 Connection diagram for 7TM700

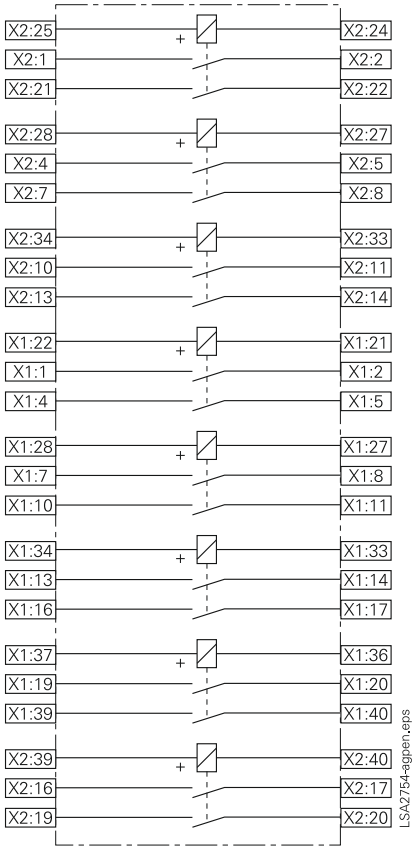


Fig. 9/16 Connection diagram for 7TS720

Connection diagram

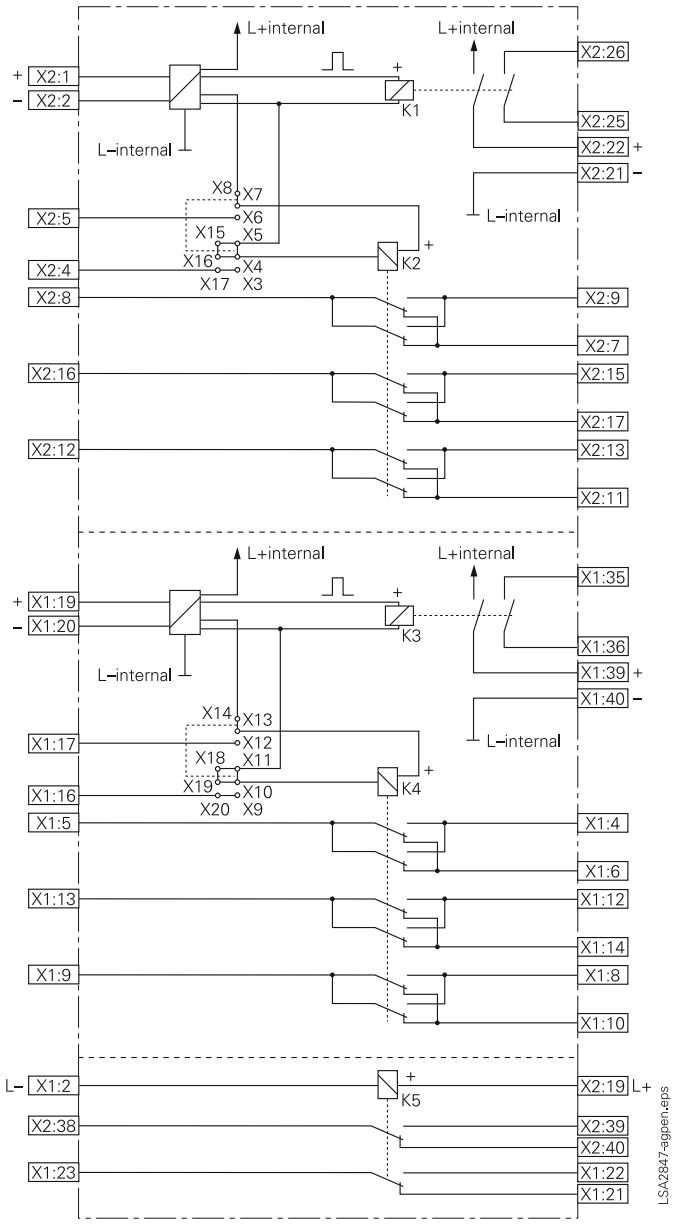


Fig. 9/17 Block diagram of 7TR710

SIPROTEC 4 7SS52 Distributed Numerical Busbar and Breaker Failure Protection

Fig. 9/18 SIPROTEC 4
7SS52 busbar protection system

Description

The SIPROTEC 7SS52 numerical protection is a selective, reliable and fast protection for busbar faults and breaker failure in medium, high and extra-high voltage substations with various possible busbar configurations.

The protection is suitable for all switchgear types with iron-core or linearized current transformers. The short tripping time is especially advantageous for applications with high fault levels or where fast fault clearance is required for power system stability.

The modular hardware allows the protection to be optimally matched to the busbar configuration. The decentralized arrangement allows the cabling costs in the substation to be drastically reduced. The 7SS52 busbar protection caters for single, double or triple busbar systems with or without and quadruple busbar systems without transfer bus with up to: 48 bays, 16 bus couplers, and 24 sectionalizing disconnectors and 12 busbar sections.

Function overview

Busbar protection functions

- Busbar differential protection
- Selective zone tripping
- Very short tripping time (<15 ms)
- Extreme stability against external fault, short saturation-free time (≥ 2 ms)
- Phase-segregated measuring systems
- Integrated check zone
- 48 bays can be configured
- 12 busbar sections can be protected
- Bay-selective intertripping

Breaker failure protection functions

- Breaker failure protection (single-phase with/without current)
- 5 operation modes, selectable per bay
- Separate parameterization possible for busbar and line faults
- Independently settable delay times for all operation modes
- 2-stage operation bay trip repeat/trip busbar
- Intertrip facility (via teleprotection interface)
- "Low-current" mode using the circuit-breaker auxiliary contacts

Additional protection functions

- End-fault protection with intertrip or bus zone trip
- Backup overcurrent protection per bay unit (definite-time or inverse-time)
- Independent breaker failure protection per bay unit

Features

- Distributed or centralized installation
- Easy expansion capability
- Integrated commissioning aids
- Centralized user-friendly configuration / parameterization with DIGSI
- Universal hardware

Communication interfaces

- FO interface
  – IEC 60870-5-103 protocol
- Electrical interface
  – IEC 61850 protocol
  with EN 100 module (firmware V4.6)

Application

The 7SS52 distributed numerical busbar and breaker failure protection system is a selective, reliable and fast protection for busbar faults and breaker failure in medium, high and extra-high voltage substations with various possible busbar configurations. The protection is suitable for all switchgear types with iron-core or linearized current transformers. The short tripping time is especially advantageous for applications with high fault levels or where fast fault clearance is required for power system stability.

The modular hardware design allows the protection system to be optimally matched to the busbar configuration.

The distributed arrangement allows the cabling costs between bay and substation to be drastically reduced. The 7SS52 busbar protection caters for single, double, triple and quadruple busbar systems with or without transfer bus with up to:
– 48 bays
– 16 bus couplers
– 24 sectionalizing disconnectors
– 12 busbar sections

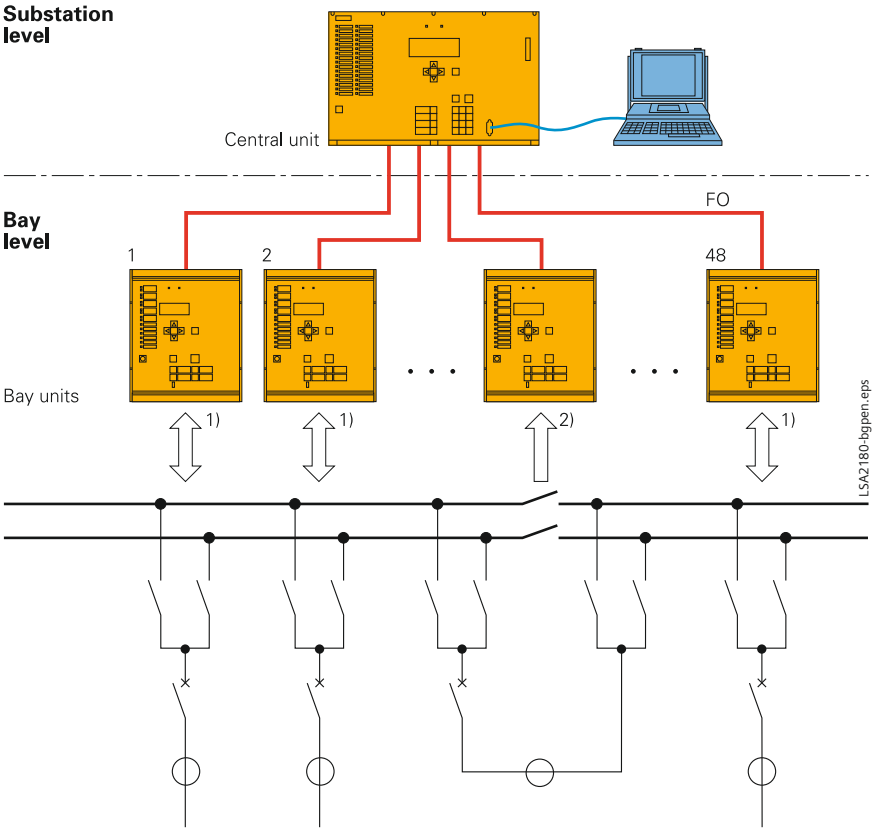


Fig. 9/19 Distributed system structure

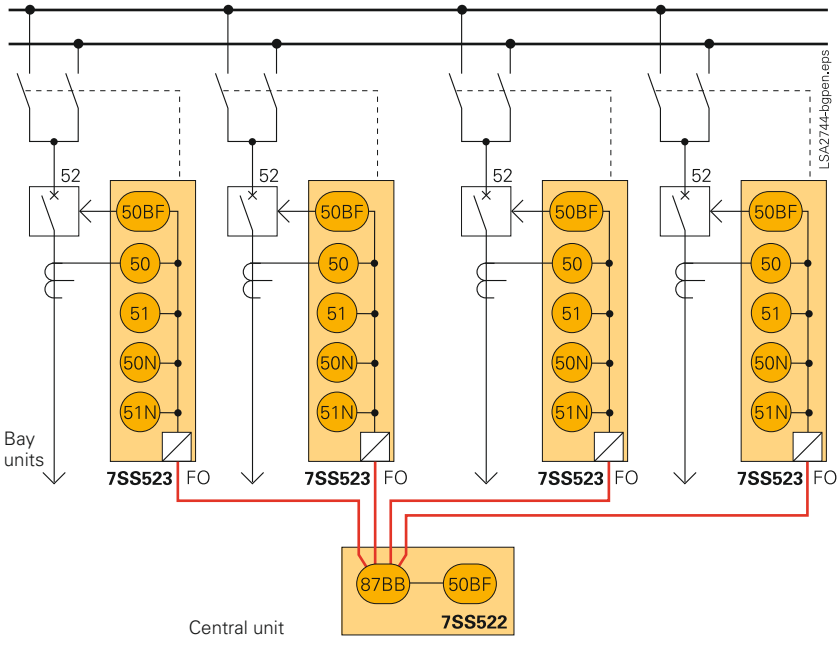


Fig. 9/20 Protection functions of the central unit and the bay units

Construction

The distributed bay units measure the 3 phase currents in each bay. The rated input current is 1 or 5 A and therefore eliminates the need for interposing current transformers. The disconnector status, breaker failure protection triggering, bay out-of- service and other bay status information is derived via marshallable binary inputs in the bay units. The complete information exchange is conveyed to the central unit via a fiber-optic interface. The bay unit also has an interface on the front side for connection to a PC for operation and diagnosis. The trip and intertrip commands are issued via trip contacts in the bay units. The 7XP20 standard housing is available in a flush or surface mounting version (7SS523).

The central unit is connected to the bay units via fiber-optic communication links. The connection is built up in a star configuration. The central unit also contains serial ports for system configuration via PC or communication with a substation control system, an integrated LC Display with keypad and marshallable binary inputs, LEDs and alarm relays. The central unit is available in a 19" SIPAC module rack version for either cubicle or wall mounting.

Because of its modular hardware design, it is easy to adapt the central unit to the substation or to expand it with further modules each being connected with up to 8 bay units.

Each bay unit and the central unit has its own internal power supply.

Fig. 9/21 7SS522 Central unit
Front view of SIPAC subrack version

Fig. 9/22 7SS522 Central unit
Rear view

Fig. 9/23 7SS523 Bay unit
Front view of panel/flush/cubicle mounting unit

Fig. 9/24 7SS525 Bay unit
Front view of panel/flush/cubicle mounting unit

Protection functions

Busbar protection

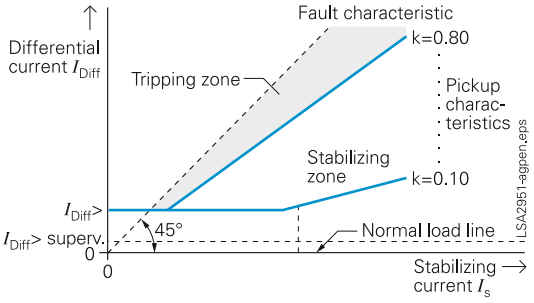
The main function of the 7SS52 is busbar protection, and has the following characteristics:

- Evaluation of differential currents, with stabilization by through-currents based on the proven performance of the Siemens busbar protection 7SS1 and 7SS50/51, currently in service worldwide
- Selective busbar protection for busbars with up to 12 busbar sections and 48 bays
- Integrated "check zone" (evaluation of all busbar section currents without use of the disconnector replica)
- Very short tripping time (15 ms typical)
- Selective detection of short-circuits, also for faults on the transfer bus, with transfer trip to the remote end.
- Detection and clearance of faults between the current transformer and the circuit-breaker via current measurement and selective unbalancing.
- Tripping only when all three fault detection modules recognize a busbar fault (2 measurement processors and check zone processor)
- No special CT requirements (stability is guaranteed, even when the CTs saturate after 2 ms)
- Selective output tripping relays per feeder in bay units.

Mode of operation

The 7SS52 protection relay offers complete numerical measured-value processing from sampling to digital conversion of the measured variables through to the circuit-breaker tripping decision. The bay units dispose of sufficient powerful contacts to directly trip the circuit-breaker.

For each busbar section and for all three phases, two independent processors execute the protection algorithm on alternate data samples. Based on the proven performance of the 7SS1 and 7SS50/51, this method of measurement ensures highest stability even in case of high short-circuit currents and CT saturation.



The pickup characteristic can be set independently for selective busbar protection, for the "check zone" and for the breaker failure protection.

Fig. 9/25
Standard characteristic

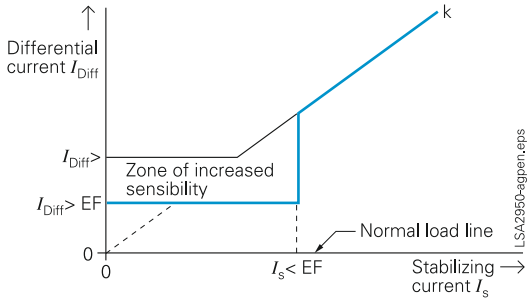


Fig. 9/26
Earth-fault characteristic

In addition, an disconnector status independent check-zone measurement is executed on a further processor thus increasing the protection against unwanted operation. All three processors must reach a trip decision independently before the trip command is released.

The disconnector status is monitored using normally open and normally closed contacts to enable plausibility checks for both status and transition time. The contact monitoring voltage is also supervised.

In case of an auxiliary voltage failure in the bay, the latest disconnector status is stored and a bay-selective indication of the failure is issued.

The assignment of the feeder currents to the corresponding busbar systems is controlled by software via the disconnector replica. The disconnector replica is applied for both busbar protection and breaker failure protection.

The integrated breaker failure protection function provides phase-segregated two-stage operation (bay-specific trip repeat, trip bus section). Alternatively, an external breaker failure protection relay can issue its trip commands via the disconnector replica in the 7SS52.

Breaker failure protection

The 7SS52 protection includes an integrated breaker failure protection with the following features:

- Five breaker failure protection modes that are selectable:

  1. Following the issue of a trip signal from a feeder protection, the busbar protection monitors the drop-off of the trip signal. If the feeder current is not interrupted before a set time delay the polarity of the feeder current is reversed, which results in a differential current in the corresponding section of the bus protection. For this function, a separate parameter set is used.

  2. Following a trip signal from a feeder protection, a trip signal will be output after a settable time delay from the 7SS52 protection to the corresponding feeder circuit-breaker. If this second trip signal is also unsuccessful, the unbalancing procedure according to mode 1) as described above will take place.

  3. With external stand-alone breaker failure protection, the disconnector replica of the 7SS52 may be used to selectively trip the busbar section with the faulty circuit-breaker.

Protection functions

4. Following a trip signal from the feeder protection, the 7SS52 monitors the drop-off of the trip signal. If, after a settable time, the current does not fall below a settable limiting value, busbar-selective feeder trip commands are issued with the help of the disconnector replica within the 7SS52.

5. Following a trip signal from a feeder protection, a trip signal will be output after a settable time delay from the 7SS52 protection to the corresponding feeder circuit-breaker. If this second trip signal is also unsuccessful, the tripping as described under 4) will take place.

- For single-pole or multi-pole starting, delay times are available.
- Breaker failure detection following a busbar fault by comparison of the measured current with a set value.
- For all modes of breaker failure protection, a transfer trip command output contact is provided for each feeder to initiate remote tripping.

Sensitive tripping characteristic

In some applications, e.g. within resistive earthed networks, single-phase short-circuit currents are limited to rated current values. In order to provide a busbar protection for these cases, an independent characteristic is available. This characteristic presents separate parameters for the pickup threshold, as well as for a limitation of efficiency. The activation of the characteristic takes place by means of a binary input in the central unit, e.g. by recognizing a displacement voltage.

End-fault protection

The location of the current transformer normally limits the measuring range of the busbar protection. When the circuit-breaker is open, the area located between the current transformer and the circuit-breaker can be optimally protected by means of the end-fault protection. In the event of a fault, depending on the mounting position of the current transformer, instantaneous and selective tripping of the busbar section or intertripping of the circuit-breaker at the opposite end occurs.

Backup protection

As an option, a two-stage backup protection, independent of the busbar protection is included in every bay unit. This backup protection is completed by means of a breaker failure protection. The parametrization and operation can be carried out in the central unit or locally in each bay unit with the DIGSI operating program.

Disconnector replica

The disconnector replica is used for both the busbar protection and the breaker failure protection.

The following features characterize the disconnector replica function:

- Includes up to 48 bays and 12 busbar sections
- Integrated bi-stable disconnector status characteristic (status stored on loss of auxiliary power).

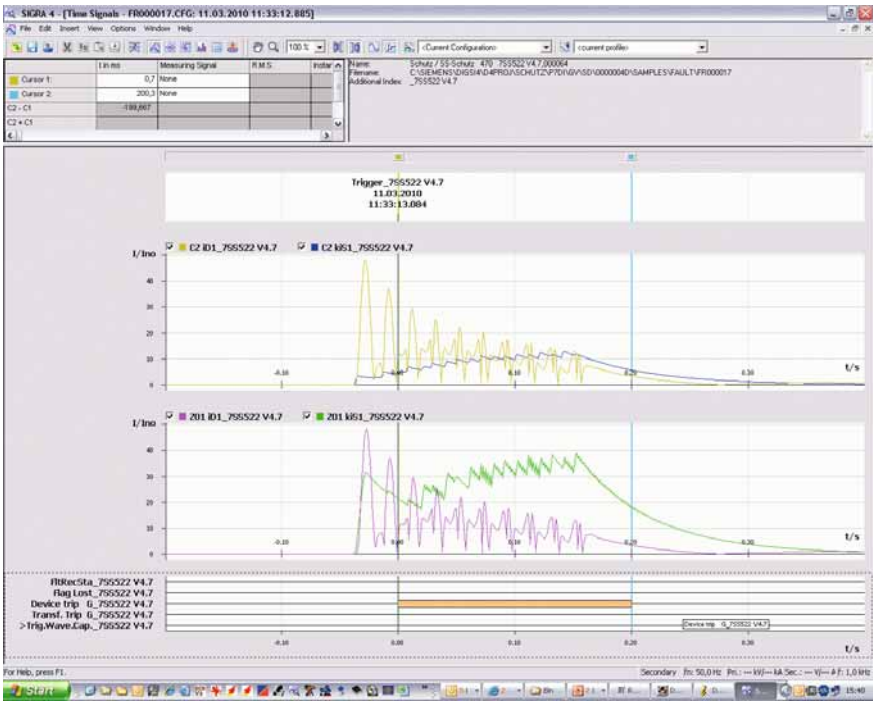


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Fig. 9/27 Fault record

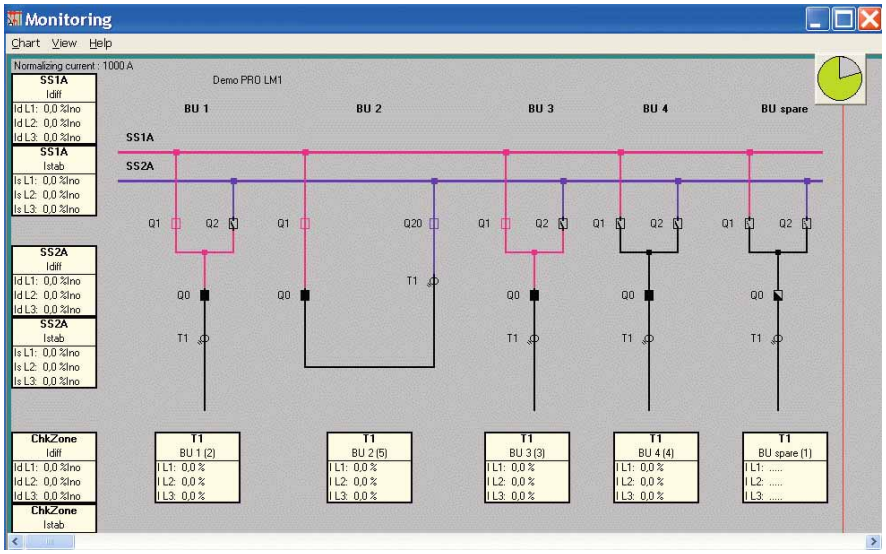

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Fig. 9/28 DIGSI plant monitoring

Protection functions/Functions

- Disconnector transition time monitoring.
- By the assignment "NOT open = closed", the disconnector is taken to be CLOSED during the transition time.
  Accurate matching of the disconnector auxiliary contacts with the main contact is not required.
- Menu-guided graphic configuration with DIGSI operating program.
- LEDs in the bay modules indicate the actual status of the busbar disconnector.
- Dynamic visualization of the substation with DIGSI on the central unit.

Tripping command/reset

The tripping output processing for the 7SS52 protection has the following features:

- Bay-selective tripping by bay units
- Settings provided for overcurrent release of the tripping command (to enable selective tripping of infeeding circuits only)
- Settable minimum time for the trip command.
- Current-dependent reset of the tripping command.

Disturbance recording

The digitized measured values from the phase currents and the differential and stabilizing currents of the busbar sections and check zone are stored following a trip decision by the 7SS52 or following an external initiation via a binary input. Pre-trigger and post-fault times with regard of the trip command can be set. Up to 8 fault recordings are stored in the 7SS52. The fault records may be input to a PC connected to the central unit, using the menu-guided DIGSI operating program. Then, the SIGRA graphics program makes it possible to easily analyze the fault recordings.

Marshallable tripping relays, binary inputs, alarm relays and LEDs

The bay units are equipped with marshallable command relays for direct circuit-breaker tripping. For each bay there are 9 (7SS523) or 8 (7SS525) duty contacts available.

For user-specific output and indication of events, 16 alarm relays and 32 LEDs in the central unit are freely marshallable.

Several individual alarms may be grouped together.

The central unit has marshallable binary inputs with:

- Reset of LED display
- Time synchronization
- Blocking of protection functions

The bay units have marshallable binary inputs:

- Disconnector status closed/open
- Phase-segregated start of circuit-breaker failure protection
- Release of circuit-breaker failure protection
- Release of TRIP command
- Circuit-breaker auxiliary contacts
- Bay out of service
- Test of circuit-breaker tripping

Measurement and monitoring functions

In the 7SS52 protection relay, a variety of measurement and monitoring functions is provided for commissioning and maintenance. These functions include:

- Measurement and display of the phase currents of the feeders in the central unit and bay units.
- Measurement and display (on the integrated LCD or PC) of the differential and stabilizing currents of all measuring systems in the central unit and the bay units.
- Monitoring of busbar-selective and phase-segregated differential currents with busbar-selective blocking/alarming
- Monitoring of the differential currents of the check zone with alarming/blocking
- Phase-segregated trip test including control of feeder circuit-breaker (by central or bay unit)
- Removal of a bay from the busbar measurement processing during feeder service and maintenance via central or bay units (bay out of service)
- Blocking of breaker failure protection or tripping command for testing purposes.
- Disconnector replica freezing (maintenance) with alarm indication ("Disconnector switching prohibition").
- Cyclic tests of measured-value acquisition and processing and trip circuit tests including coils of the command relays.

Event recording

The 7SS52 protection provides complete data for analysis of protection performance following a trip or any other abnormal condition and for monitoring the state of the relay during normal service.

Up to 200 operational events and 80 fault annunciations with a resolution of one millisecond may be stored in two independent buffers:

- Operational indications
  This group includes plant/substation operation events, for example disconnector switching, disconnector status discrepancies (transition time limit exceeded, loss of auxiliary voltage, etc.) or event/alarm indications
- Tripping following a busbar short-circuit fault or circuit-breaker failure.

Protection functions/Functions

Settings

A PC can be connected to the operator interface located at the front panel or the rear of the central unit. An operating program is available for convenient and clear setting, fault recording and evaluation as well as for commissioning. All settings of the busbar or breaker failure protection, as well as settings of additional functions such as backup protection, need only be parameterized at the central unit. Settings at the bay units are not necessary.
With the help of the integrated keypad and display on the central unit, all setting parameters may be read out.
Keypad, display (7SS523) and the front side interface of the bay units serve for commissioning, display of operational values and diagnosis.
All parameters are written into nonvolatile memories to ensure that they are retained even during loss of auxiliary voltage.

Configuration, visualization

The configuration of the 7SS52 is effected by means of a graphics-orientated editor included in the DIGSI operation program. For frequently used bay types, a symbol library is available. Enhancements can be easily effected anytime.
A graphical configuration visualizes the states of the disconnector position, the circuit-breaker and measuring values.

Self-monitoring

Hardware and software are continuously monitored and any irregularity is immediately detected and alarmed. The self-monitoring feature improves both the reliability and the availability of the 7SS52. The following quantities are monitored:

- The current transformer circuits
- The analog-to-digital conversion
- All internal supply voltages
- The program memory
- The program running times by a watch dog function
- The disconnector status
- The three channel tripping circuit

Maximum lifetime and reliability

The hardware of the 7SS52 units is guaranteed by more than 20 years of experience in numerical protection design at Siemens. The number of components employed is reduced through use of a powerful microprocessor in conjunction with highly-integrated components, thus enhancing the reliability. The experience gained by Siemens in production of over 1 million numerical protection units has been incorporated in the software design. The most modern manufacturing methods together with effective quality control ensure high reliability and a long service life.

Battery monitoring

The internal battery is used to back-up the clock and memory for storage of switching statistics, status and fault indications and fault recording, in the event of a power supply failure. The processor checks its capacity at regular intervals. If the capacity of the battery is found to be declining, an alarm is generated. Routine replacement is therefore not necessary. All setting parameters are stored in the Flash-EPROM, and therefore not lost if the power supply or the battery fails.

Functions for testing and commissioning

The 7SS52 offers auxiliary functions for commissioning. The physical status of all binary inputs and output relays of the central unit can be displayed and directly altered to facilitate testing.

All measured values can be clearly depicted by means of DIGSI and simultaneously displayed in different windows as primary or percentage values.

The 7SS52 units are provided with a circuit-breaker test function. Single-pole and three-pole TRIP commands can be issued.

Data transmission lockout

Data transmission lockout can be activated, so as to prevent transfer of information to the control center during work on a circuit bay.

Test mode

During commissioning, a test mode can be selected; all indications then have a test mode suffix for transmission to the control system.

Communication

Serial communication

With respect to communication, particular emphasis is placed on the customer requirements in energy automation:

- Every data item is time-stamped at the source, i.e. where it originates.
- Already during the process of communication, information is assigned to the cause thereof (e.g. assignment of the indication "circuit-breaker TRIP" to the corresponding command).
- The communication system automatically handles the transfer of large data blocks (e.g. fault recordings or parameter data files). The user has access to these features without any additional programming effort.

Local and remote communication

The 7SS52 central unit provides several serial communication interfaces for various tasks:

- Front interface for connecting a PC
- Rear-side service interface (always provided) for connection to a PC, either directly or via a modern
- System interface for connecting to a control system via IEC 60870-5-103 protocol.
- System interface (EN 100 module) for connecting to a control system via IEC 61850 protocol
- Time synchronization via IRIG-B/DCF/system interface

Serial front interface (central unit and bay units)

There is a serial RS232 interface on the front of all the units. All of the unit's functions can be set on a PC by means of the DIGSI 4 protection operation program. Commissioning tools and fault analysis are also built into the program and are available through this interface.

Communication (continued)

Rear-mounted interfaces (central unit only)

A number of communication modules suitable for various applications can be fitted in the rear of the flush-mounting housing. The interface modules support the following applications:

- Service interface
  The service interface was conceived for remote access to a number of protection units via DIGSI. It can be an electrical RS232/RS85 or an optical interface.
- RS485 bus
  With this data transmission via copper conductors, electromagnetic fault influences are largely eliminated by the use of twisted-pair conductors. Upon failure of a unit, the remaining system continues to operate without any problem.

System interface

Communication with a central control system takes place through this interface. Radial or ring type station bus topologies can be configured depending on the chosen interface. Furthermore, the units can exchange data through this interface via Ethernet and IEC 61850 protocol and can also be operated by DIGSI.

IEC 61850 protocol (retrofittable)

The Ethernet-based IEC 61850 protocol is the worldwide standard for protection and control systems used by power supply corporations. By means of this protocol, information can also be exchanged directly between protection units so as to set up simple masterless systems for bay and system interlocking. Access to the units via the Ethernet bus will also be possible with DIGSI.

IEC 60870-5-103 protocol

The IEC 60870-5-103 protocol is an international standard for the transmission of protective data and fault recordings. All messages from the unit and also control commands can be transferred by means of published, Siemens-specific extensions to the protocol.

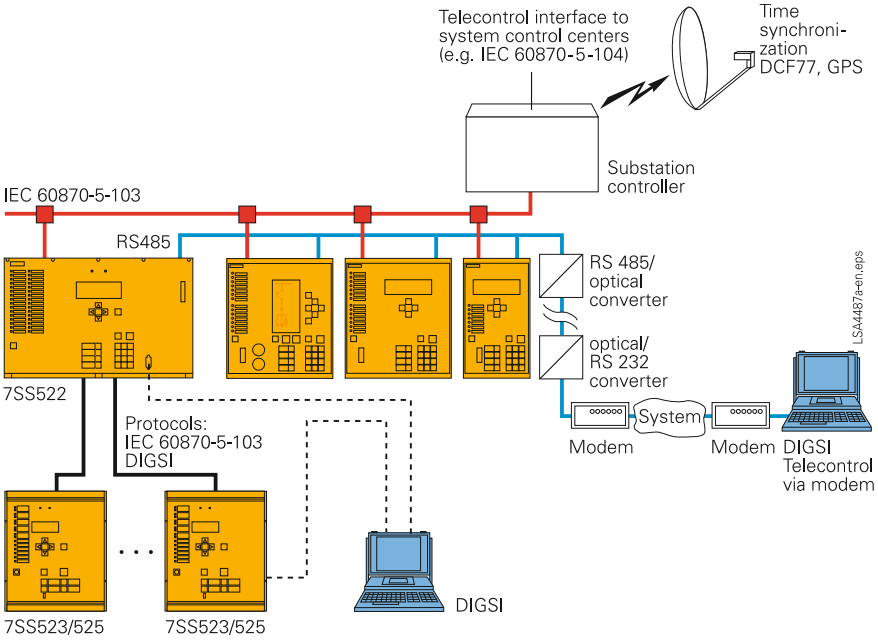

Fig. 9/29 Communication structure with DIGSI and IEC 60870-5-103

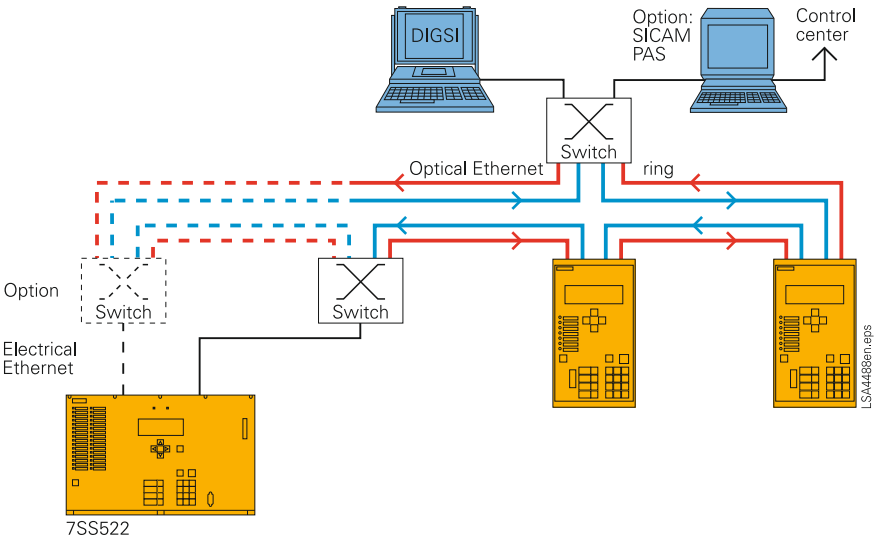

Fig. 9/30 Communication structure for station bus with Ethernet and IEC 61850, FO ring

Time synchronization

The battery-backed clock of the 7SS52 central unit can be synchronized via:

- DCF 77 signal via time synchronization receiver
- IRIG-B satellite signal via time synchronization receiver
- Minute-pulse via binary input
- System interface by the substation control, e.g. SICAM

Date and time with milliseconds resolution is assigned to every indication. The synchronization of the 7SS52 bay units is automatically effected with the central unit.

Technical data

General unit data

Input circuits

Rated current I_N		1 or 5 A
Rated frequency f_N		50/60 Hz
Thermal overload capability in current path	Continuous 10 s 1 s	4 x I_N 10 x I_N 100 x I_N
Dynamic overload capability		250 x I_N
Burden of current inputs	At I_N = 1 A At I_N = 5 A	< 0.1 VA < 0.2 VA

Auxiliary voltage

Rated auxiliary voltage V_{aux}	Central unit	48/60, 110/125, 220/250 V DC
Rated auxiliary voltage V_{aux}	Bay unit	48, 60 to 250 V DC
Permissible tolerance V_{aux}		–20 to +20 %
Maximum ripple		≤ 15 %
Power consumption		Configuration dependent
Central unit	Quiescent Energized	30 to 50 W 35 to 65 W

Bay unit		7SS523	7SS525
	Quiescent	12 W	10 W
	Energized	16 W	14 W

Max. bridging time during loss of voltage supply	> 50 ms at V_{aux} ≥ 60 V

Binary inputs

		7SS523	7SS525
Number of binary inputs	Bay unit	20	10
	Central unit	12	
Voltage range		24 to 250 V DC	
Current consumption		Approx. 1.5 mA/input	

Alarm/event contacts

Central unit			
Number of relays	Marshallable	16 (each 1 NO contact)	
	Fixed	1 (2 NC contacts)	
Switching capacity	Make/Break	20 W/VA	
Switching voltage		250 V AC/DC	
Permissible current		1 A	
Bay unit		7SS523	7SS525
Number of relays	Marshallable	1 (1 NO contact)	1 (1 NO contact)
	Fixed	1 (2 NC contacts)	1 (1 NC contacts)
Switching capacity	Make/Break	20 W/VA	
Switching voltage		250 V AC/DC	
Permissible current		1 A	

Command contacts

Number of relays (bay unit)		7SS523	7SS525
		4 (each 2 NO contacts) 1 (1 NO contact)	3 (each 2 NO contacts) 2 (1 NO contact)
Switching capacity	Make	1000 W/VA	
	Break	30 W/VA	
Switching voltage		250 V AC/DC	
Permissible current	Continuous	5 A	
	0.5 s	30 A	

LEDs

Central unit		
Operation indication	Green	1
Device failure	Red	1
Marshallable	Red	32
Bay unit		
Operation indication	Green	1
Device failure	Red	1
Indications	Green	5 (7SS523)/– (7SS525)
	Red	11 (7SS523)/1 (7SS525)

Control, displays

Central unit	
LC Display	4 lines x 20 characters
Membrane keyboard	24 keys
Bay unit (7SS523)	
LC Display	4 lines x 16 characters
Membrane keyboard	12 keys

Serial interfaces

Central unit

PC interface (front)

Connection, electrical	SUB-D, 9-pin (subminiature ISO 2110)
Baud rate	1200 to 115000 baud

System interface IEC 60870-5-103 (rear)

Connection, optical	ST connectors
electrical	SUB-D, 9-pin (subminiature ISO 2110)
Baud rate	1200 to 115000 baud

System interface IEC 61850 (rear)

Connection, electrical with EN 100 module	RJ45 connector
Baud rate	up to 100 Mbaud

Service interface (rear)

Connection, optical	ST connectors
electrical	SUB-D, 9-pin (subminiature ISO 2110)
Baud rate	1200 to 115000 baud

Bay unit

PC interface (front)

Connection, electrical	SUB-D, 9-pin (subminiature ISO 2110)
Baud rate	1200 to 19200 baud

Central/bay unit

Interface for high-speed data communication

Connection	ST connectors
Fiber-optic cable	Glass fiber 62.5/125 µm
Optical wavelength	820 nm
Permissible cable attenuation	Max. 8 dB
Transmission distance	Max. 1.5 km

Technical data

Unit design (degree of protection according to EN 60529)

Central unit		
Cubicle	IP 54	
Housing for wall mounting	IP 55	
SIPAC subrack	IP 20	
Bay unit	7SS523	7SS525
Housing	IP 51	IP 20
Terminals	IP 21	
Weight at max. configuration		
Central unit		
SIPAC subrack	14.3 kg	
Surface-mounting housing	43.0 kg	
Bay unit	7SS523	7SS525
Flush mounting	8.1 kg	5.5 kg
Surface mounting	11.8 kg	

Electrical tests

Specification

Standards	IEC 60255-5, DIN 57435 part 303
High-voltage test (routine test), except DC voltage supply input	2 kV (r.m.s.), 50 Hz
High-voltage test (routine test), only DC voltage supply input	2.8 kV DC
Impulse voltage test (type test), all circuits, class III	5 kV (peak), 1.2/50 µs, 0.5 J, 3 positive and 3 negative impulses at intervals of 5 s

EMC tests for interference immunity; type test

Standards	IEC 60255-6, IEC 60255-22 (international product standard), EN 50082-2 (European generic standard for industrial environment), VDE 0435 part 303 (German product standard)
High-frequency test with 1 MHz interference IEC 60255-2-1, class III and VDE 0435 part 303, class III	2.5 kV (peak), 1 MHz, τ = 15 µs, 400 surges/s, duration 2 s
Electrostatic discharge IEC 60255-22-2, class IV and IEC 61000-4-2, class IV	8 kV contact discharge, 15 kV air discharge, both polarities, 150 pF, R_i = 330 Ω
Irradiation with radio-frequency field, non-modulated IEC 60255-22-3, class III	10 V/m, 27 to 500 MHz
Irradiation with radio-frequency field, amplitude-modulated IEC 61000-4-3, class III	10 V/m, 80 to 1000 MHz, AM 80 %, 1 kHz
Irradiation with radio-frequency field, pulse-modulated ENV 50204, class III	10 V/m, 900 MHz, repetition rate 200 Hz, duty cycle 50 %
Fast transients interference/bursts IEC 60255-22-4, class IV; IEC 61000-4-4, class IV; IEC 60801-4	4 kV, 5/50 ns, 5 kHz, burst length = 15 ms, repetition rate 300 ms, both polarities, R_i = 50 Ω, duration 1 min
Line-conducted disturbances induced by radio-frequency fields, amplitude-modulated IEC 61000-4-6, class III	10 V, 150 kHz to 80 MHz, AM 80 %, 1 kHz
Power frequency magnetic field IEC 61000-4-8, class IV; IEC 60255-6	30 A/m continuous, 300 A/m for 3 s, 50 Hz 0.5 mT; 50 Hz

1) I_{NO} = highest c.t. ratio.

EMC tests for interference emission; type test

Standard	EN 50081-2 (European generic standard for industrial environment)
Conducted interference voltage, auxiliary voltage CISPR 11, EN 55011 and VDE 0875 part 11	150 kHz to 30 MHz, limit class B
Radio interference field strength CISPR 11, EN 55011 and VDE 0875 part 11	30 to 1000 MHz, limit class B

Mechanical stress tests

Specification

Standards	IEC 60255-21-1, IEC 6068-2
Permissible mechanical stress	
During service	10 to 60 Hz, 0.035 mm amplitude 60 to 500 Hz, 0.5 *g* acceleration
During transport	5 to 8 Hz, 7.5 mm amplitude 8 to 500 Hz, 2 *g* acceleration

Climatic stress tests

Temperatures

Standard	IEC 60255-6
Permissible ambient temperature	
– In service	–10 °C to +55 °C (bay unit) – 5 °C to +55 °C (central unit)
– For storage	–25 °C to +70 °C
– During transport	–25 °C to +70 °C
– During start-up	–10 °C to +55 °C (bay unit) 0 °C to +55 °C (central unit)

Humidity

Standards	IEC 60068-2-3
It is recommended to arrange the units in such a way that they are not exposed to direct sunlight or pronounced temperature changes that could cause condensation.	Annual average 75 % relative humidity; on 56 days a year up to 93 % relative humidity; condensation not permissible!

Busbar configuration

Quadruple or triple busbar with transfer busbar;	
Number of bays	48
Number of bus sections	12
Number of bus couplers	16
Number of sectionalizers	24
Number of coupler bus sections	12

Busbar protection

Tripping characteristics	
Setting ranges	
Overcurrent I/I_{NO} [1)]	0.2 to 4 (in steps of 0.01)
Stabilizing factor k for busbar-selective protection	0.1 to 0.8 (in steps of 0.01)
Stabilizing factor k for check zone	0 to 0.8 (in steps of 0.01)
Tripping time	
Typical trip time	15 ms
Differential current monitoring	
Setting ranges	
Current limit I/I_{NO} [1)]	0.05 to 0.8 (in steps of 0.01)
Time delay	1 to 10 s (in steps of 1 s)

Technical data

Breaker failure protection

Tripping	
Setting ranges	
Overcurrent I/I_N	0.05 to 2 (in steps of 0.01)
Stabilizing factor k	0 to 0.8 (in steps of 0.01)
Time delay for unbalancing / $I >$ query	0.05 to 10 s (in steps of 0.01 s)
Time delay for TRIP repeat	0.00 to 10 s (in steps of 0.01 s)
Modes of operation	
Individually selectable per feeder:	
$I >$ query	
TRIP repeat (1/3-phase) with $I >$ query	
Unbalancing (1-stage BF)	
Unbalancing with TRIP repeat (1/3-phase, 2-stage BF)	
TRIP by external BF protection (tripping via disconnector replica of busbar protection)	
Plus for each mode (except for TRIP by external BF): low-current mode	
Plus for modes with TRIP repeat: pulse mode	
Breaker failure protection for busbar short-circuit	
Setting value	
Overcurrent I/I_N	0.05 to 2 (in steps of 0.01)
Time delay	0.05 to 10.00 s (in steps of 0.01 s)

General data of the protection system

Min. time of TRIP commands	
Setting range	
Current threshold for command reset I/I_N	0.02 to 1 s (in steps of 0.01 s) 0.05 to 2 (in steps of 0.10)
Overcurrent release of TRIP commands	
Setting range	0 to 25 (in steps of 0.01)
Disconnector transition time	
Setting range	1 to 180 s (in steps of 0.01 s)

Overcurrent protection in the bay unit

Characteristics	Definite-time or inverse-time overcurrent protection
Setting ranges	
High-set stage; $I >>$ (phase) I/I_N	0.05 to 25.00 (in steps of 0.01)
High-set stage; $I_E >>$(earth) I/I_N	0.05 to 25.00 (in steps of 0.01)
Trip time delays; $T_I >>$, $T_{IE} >>$	0.00 to 60.00 s or ∞
Definite-time overcurrent protection	
Overcurrent stage; $I >$ (phase) I/I_N	0.05 to 25.00 (in steps of 0.01)
Overcurrent stage; $I_E >$ (earth) I/I_N	0.05 to 25.00 (in steps of 0.01)
Trip time delays; $T_I >$, $T_{IE} >$	0.00 to 60.00 s or ∞
Inverse-time overcurrent protection	
Inverse time O/C stage; I_p (phase) I/I_N	0.10 to 4.00 (in steps of 0.01)
Inverse time O/C stage; I_E (earth) I/I_N	0.10 to 4.00 (in steps of 0.01)
Trip time delays; T_{Ip}, T_{IE}	0.00 to 10.00 s or ∞
Characteristics	Inverse (IEC 60255-3 type A) Very inverse (IEC 60255-3 type B) Extremely inverse (IEC 60255-3 type C)

1) I_{NO} = normalizing current.

Additional functions

Self-diagnosis

Current monitoring per feeder	
Auxiliary voltage monitoring	
Cyclic test	
Check of the data transmission between central unit and bay units	
Memory tests	

Operational measured values: Central unit

Feeder currents	I_{L1}; I_{L2}; I_{L3} in A primary and in % I_N
Range	0 to 1000 % I_N
Tolerance	typically 2 % of measured value
Differential and restraint (stabilizing) currents of all bus sections (separate for ZPS-BSZ1 and ZPS-BSZ2)	I_{dL1}; I_{dL2}; I_{dL3} I_{sL1}; I_{sL2}; I_{sL3} in % I_N
Range	0 to 1000 % I_N

Operational measured values: Bay unit

Feeder currents	I_{L1}; I_{L2}; I_{L3}; I_E in A primary and in % I_N
Range	0 to 6 000 % I_N
Tolerance	typically 2 % of measured value
Differential and restraint (stabilizing) currents	I_{dL1}; I_{dL2}; I_{dL3} I_{sL1}; I_{sL2}; I_{sL3}
Range	0 to 6 000 % I_N
Frequency	f in Hz ($I > 0.1\ I_N$)
Range	$f_N \pm 5$ Hz
Tolerance	0.1 Hz

Event recording: Central unit

Storage of the last 200 operational events and 80 fault events	

Event recording: Bay unit

Storage of the last 50 operational events and 100 fault events	

Fault recording: Central unit

Resolution	1 ms at 50 Hz; 0.83 ms at 60 Hz
Storage time (from busbar TRIP or external initiation by binary input)	– 500 to + 500 ms at 50 Hz – 416 to + 416 ms at 60 Hz (up to 8 fault records)

Fault recording: Bay unit

Resolution	1 ms at 50 Hz; 0.83 ms at 60 Hz
Storage time (from busbar TRIP or external initiation by binary input)	– 500 to + 500 ms at 50 Hz – 416 to + 416 ms at 60 Hz (up to 8 fault records)

CE conformity

This product is in conformity with the Directives of the European Communities on the harmonisation of the laws the Member States relating to electromagnetic compatibility (EMC Council Directive 89/336/EEC) and electrical equipment designed for use within certain voltage limits (Council Directive 73/23/EEC).
This unit conforms to the international standard IEC 60255 and the German standard DIN 57435/Part 303 (corresponding to VDE 0435 part 303).
The unit has been developed and manufactured for application in an industrial environment according to the EMC standards.
This conformity is the result of a test that was performed by Siemens AG in accordance with Article 10 of the Council Directive complying with the generic standards EN 50081-2 and EN 50082-2 for the EMC Directive and standard EN 60255-6 for the "low-voltage Directive".

Selection and ordering data

Description	Order No.	Order code
7SS522 distributed busbar/breaker failure protection	7SS52☐0-☐☐☐☐☐-☐☐A0	☐☐☐
Central unit		
Central unit 50/60 Hz	2	
Rated auxiliary voltage		
48, 60 V DC	3	
110, 125 V DC	4	
220, 250 V DC	5	
Unit design		
In subrack ES902C	A	
Regional presettings/regional functions and languages		
Region DE, language German (language can be selected)	A	
Region World, language English (UK) (language can be selected)	B	
Region US, language English (US) (language can be selected)	C	
Region FR, language French (language can be selected)	D	
Region World, language Spanish (language can be selected)	E	
Region World, language Italian (language can be selected)	F	
Region World, language Russian (language can be selected)	G	
System interface		
Without	0	
IEC 60870-5-103 protocol, optical 820 nm, ST connector	3	
IEC 61850, 100 Mbit Ethernet, electrical, double, RJ45 connector	9	L 0 R
Service interface (on rear of relay)		
DIGSI 4/modem, electrical RS232	1	
DIGSI 4/modem, electrical RS485	2	
DIGSI 4/modem, optical 820 nm, ST connector	3	
Additional functions		
without	1	
with cross stabilisation	2	
Equipped for		
8 bays	A	
16 bays	B	
24 bays	C	
32 bays	D	
40 bays	E	
48 bays	F	
7SS523 distributed busbar/breaker failure protection	7SS52☐☐-☐☐A01-☐AA1	
Bay unit, frequency, housing, binary inputs and outputs		
Bay unit, 50/60 Hz, housing 1/2 x 19", 20 BI, 6 BO, 2 live status contacts	3	
Rated current		
1 A	1	
5 A	5	
Rated auxiliary voltage		
48 V DC	2	
60 to 250 V DC	5	
Unit design		
7XP2040-2 for flush mounting or cubicle mounting	C	
7XP2040-1 for surface mounting	D	
7XP2040-2 for flush mounting without glass cover	E	
Additional functions		
Without additional functions	0	
With overcurrent-time protection	1	

Selection and ordering data

Description	Order No.
7SS525 distributed busbar/breaker failure protection *Bay unit, frequency 50/60 Hz;* *Housing 1/3 x 19"; 10 BI, 6 BO, 1 live status contact*	*7SS525☐-☐☐A01-☐AA1*
Rated current at 50/60 Hz	
1 A	*1*
5 A	*5*
Rated auxiliary voltage at converter	
48 to 250 V DC	*5*
Unit design	
7XP2040-2 for panel flush mounting or cubicle mounting without glass cover	*F*
Additional functions	
Without additional functions	*0*
With overcurrent-time protection	*1*

Accessories

Description	Order No.
DIGSI 4	
Software for configuration and operation of Siemens protection relays running under MS Windows (version Windows 2000/XP Professional Edition) device templates, Comtrade Viewer, electronic manual included as well as "Getting started" manual on paper, connecting cables (copper)	
Basis Full version with license for 10 computers, on CD-ROM (authorization by serial number)	*7XS5400-0AA00*
Professional DIGSI 4 Basis and additionally SIGRA (fault record analysis), CFC Editor (logic editor), Display Editor (editor for default and control displays) and DIGSI 4 Remote (remote operation)	*7XS5402-0AA00*
Professional + IEC 61850 DIGSI 4 Basis and additionally SIGRA (fault record analysis), CDC Editor (logic editor), Display Editor (editor for default and control displays), and DIGSI 4 Remote (remote operation) + IEC 61850 system configurator	*7XS5403-0AA00*
IEC 61850 System configurator	
Software for configuration of stations with IEC 61850 communication under DIGSI, running under MS Windows 2000 or XP Professional Edition Optional package for DIGSI 4 Basis or Professional License for 10 PCs. Authorization by serial number. On CD-ROM	*7XS5460-0AA00*
SIGRA 4	
(generally contained in DIGSI Professional, but can be ordered additionally) Software for graphic visualization, analysis and evaluation of fault records. Can also be used for fault records of devices of other manufacturers (Comtrade format). Running under MS Windows 2000/XP Professional Edition. Incl. templates, electronic manual with license for 10 PCs. Authorization by serial number. On CD-ROM (contained in DIGSI 4, but can be ordered additionally)	*7XS5410-0AA00*
Connection cable	
Cable between PC/notebook (9-pin connector) and protection relay (9-pin connector) (contained in DIGSI 4, but can be ordered additionally)	*7XV5100-4*
Manual 7SS52 V4.7/V3.3	
English	*C53000-G1176-C182-5*

Connection diagram

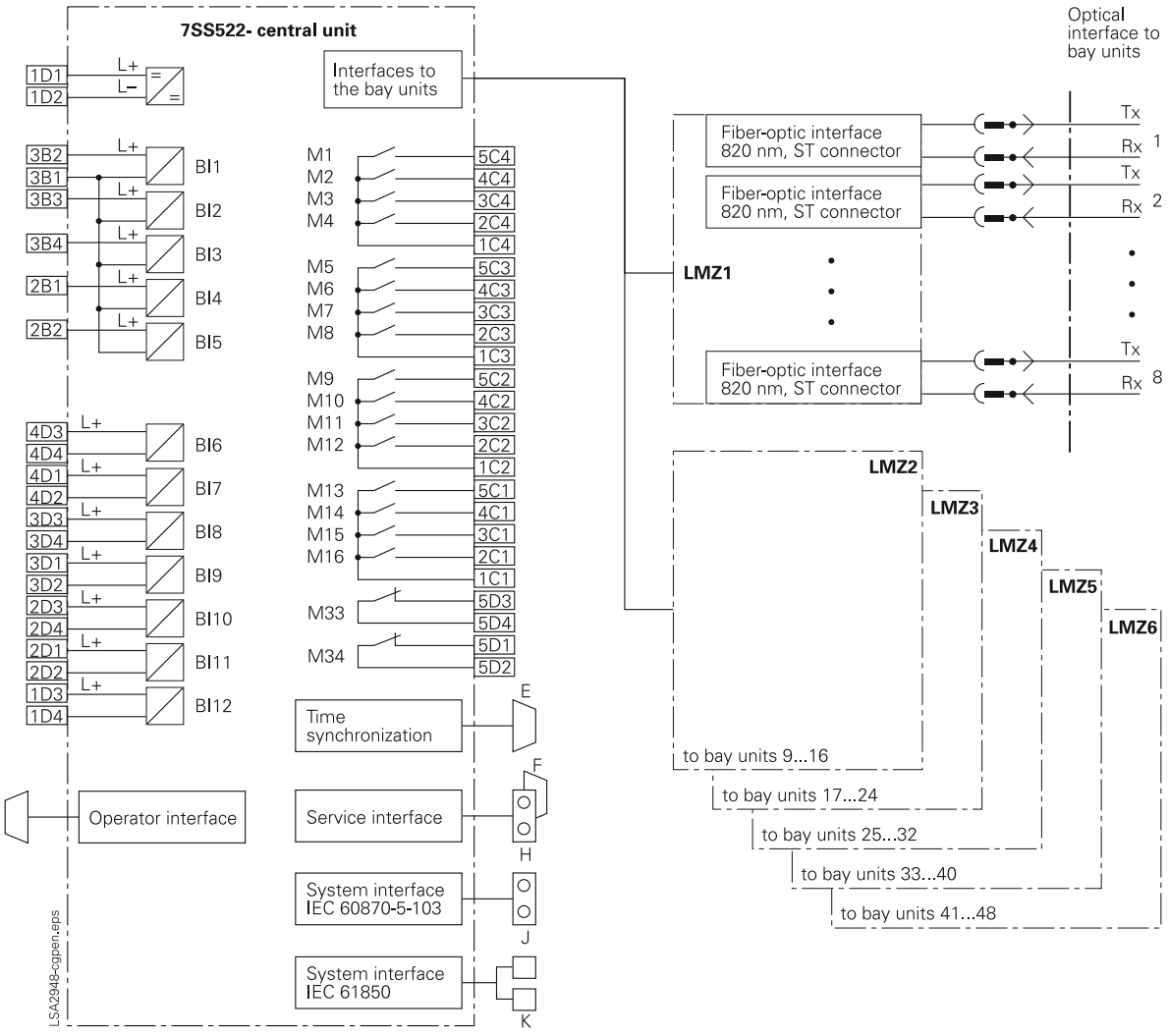

Fig. 9/31 Connection diagram 7SS522

Connection diagram

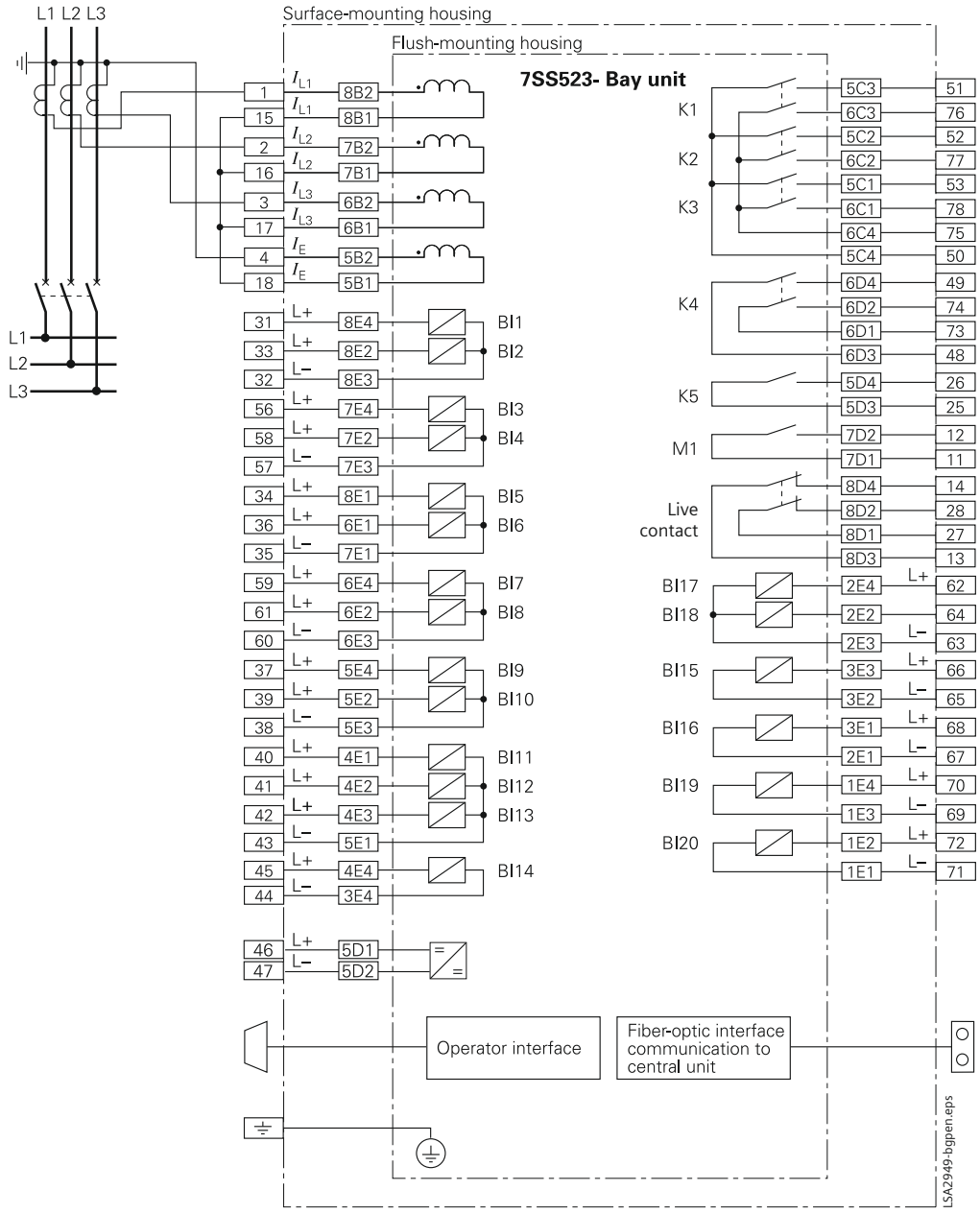

Fig. 9/32 Connection diagram 7SS523

Connection diagram

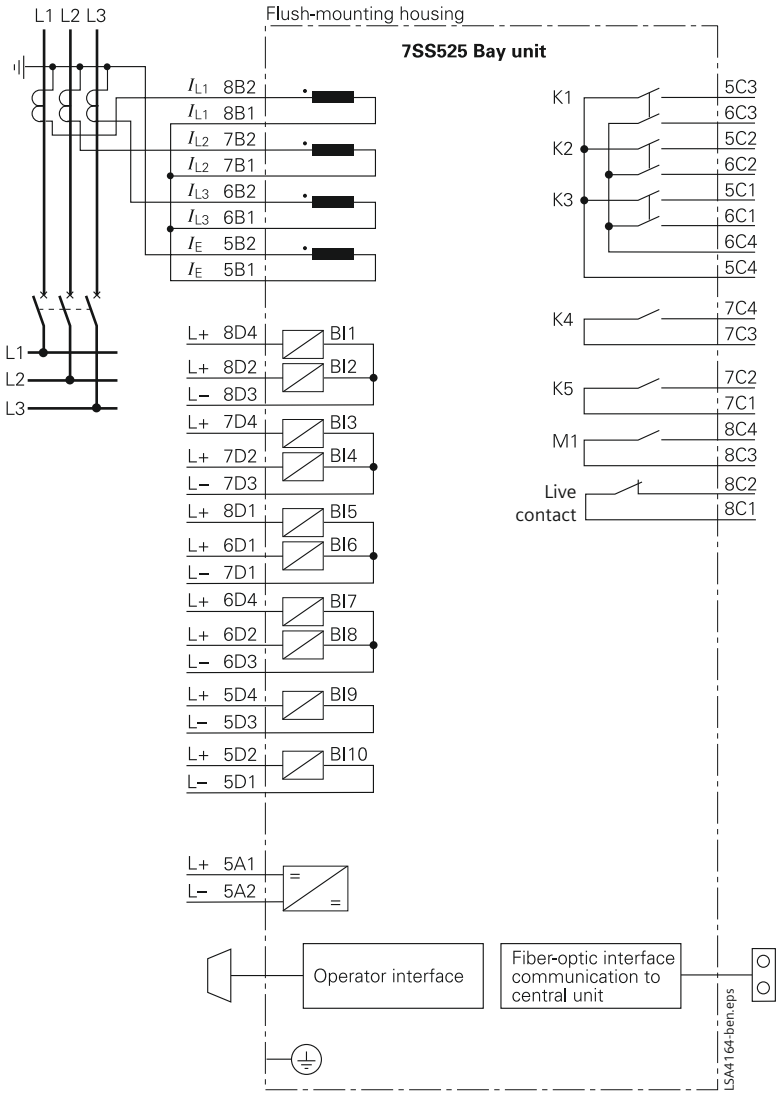

Fig. 9/33 Connection diagram 7SS525