

SIPROTEC 5 Devices and Fields of Application

Feeder and Overcurrent Protection – SIPROTEC 7SJ85

Description

The SIPROTEC 7SJ85 overcurrent protection has been designed specifically for the protection of feeders and lines. Due to its modular structure and flexibility and the powerful engineering tool DIGSI 5, SIPROTEC 7SJ85 offers future-oriented system solutions with high investment security and low operating costs.

Main function	Feeder and overcurrent protection for all voltage levels
Inputs and outputs	5 predefined standard variants with 4 current transformers, 4 voltage transformers, 11 to 59 binary inputs, 9 to 33 binary outputs
Hardware flexibility	I/O quantity structure that can flexibly be adapted and expanded within the scope of the modular SIPROTEC 5 system. 1/6 expansion modules can be added, available with large, small or without display
Housing width	1/3 × 19" to 2/1 × 19"

Functions

DIGSI 5 permits all functions to be configured and combined as required.

- Directional and non-directional overcurrent protection with additional functions
- Protection of up to 9 feeders with up to 40 analog inputs
- Optimized tripping times due to directional comparison and protection data communication
- Detection of static and transient ground faults (fleeting contact function) in arc-suppression-coil-ground and isolated power systems
- Arc protection
- Overvoltage and undervoltage protection
- Power protection, configurable as active or reactive power protection
- Frequency protection and frequency change protection for load shedding applications
- Protection functions for capacitor banks, such as overcurrent, overload, current unbalance, peak overvoltage, or differential protection
- Reactive power-undervoltage protection (QU protection)
- Recognition of current and voltage signals up to the 50th harmonic with high accuracy for selected protection functions (such as peak overvoltage protection for capacitors) and operational measured values.
- Control, synchrocheck and switchgear interlocking protection
- Circuit-breaker failure protection
- Circuit-breaker reignition monitoring
- Graphical logic editor to create powerful automation functions in the device
- Single line representation in small or large display
- Integrated electrical Ethernet RJ45 for DIGSI 5 and IEC 61850 (reporting and GOOSE)



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Figure 2.4/5 SIPROTEC 7SJ85

- Two optional pluggable communication modules, usable for different and redundant protocols (IEC 61850, IEC 60870-5-103, IEC 60870-5-104, Modbus TCP, DNP3 (serial and TCP))
- Serial protection data communication via optical fibers, two-wire connections and communication networks (IEEE C37.94, and others), including automatic switchover between ring and chain topology.
- Redundancy protocols PRP and HSR
- Cyber security in accordance with NERC CIP and BDEW White-paper requirements
- Phasor measurement unit (PMU) for synchrophasor measured values and IEEE C37.118 protocol
- Time synchronization with IEEE 1588
- Powerful fault recording (buffer for a max. record time of 80 s at 8 kHz or 320 s at 2 kHz)
- Auxiliary functions for easy tests and commissioning.

Applications

- Detection and selective 3-pole tripping of short circuits in electrical equipment of star networks, lines with infeed at one or two ends, parallel lines and open or closed ring systems of all voltage levels
- Backup protection for differential protection devices of all kind for lines, transformers, generators, motors, and busbars
- Protection and monitoring of capacitor banks
- Phasor Measurement Unit (PMU)
- Reverse-power protection
- Load shedding applications
- Automatic switchover

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Application templates

Application templates are available in DIGSI for standard applications. They comprise all basic configurations and default settings.

The following application templates are available:

Non-directional overcurrent protection

- Overcurrent protection (non-directional) for phases and ground
- Transformer inrush current detection

Directional overcurrent protection – grounded system

- Overcurrent protection (directional and non-directional) for phases and ground
- Transformer inrush current detection
- Measuring voltage failure supervision

Directional overcurrent protection – resonant-grounded / isolated system

- Overcurrent protection (directional and non-directional) for phases
- Sensitive directional ground fault detection for static ground faults
- Sensitive directional ground fault detection for transient and static ground faults (transient function)
- Transformer inrush current detection
- Measuring voltage failure supervision.

Capacitor bank: H connection + 1 x RLC

- Time-overcurrent protection for phases and ground
- Capacitor bank unbalance protection

- Peak overvoltage protection
- Overload protection
- Undercurrent protection.

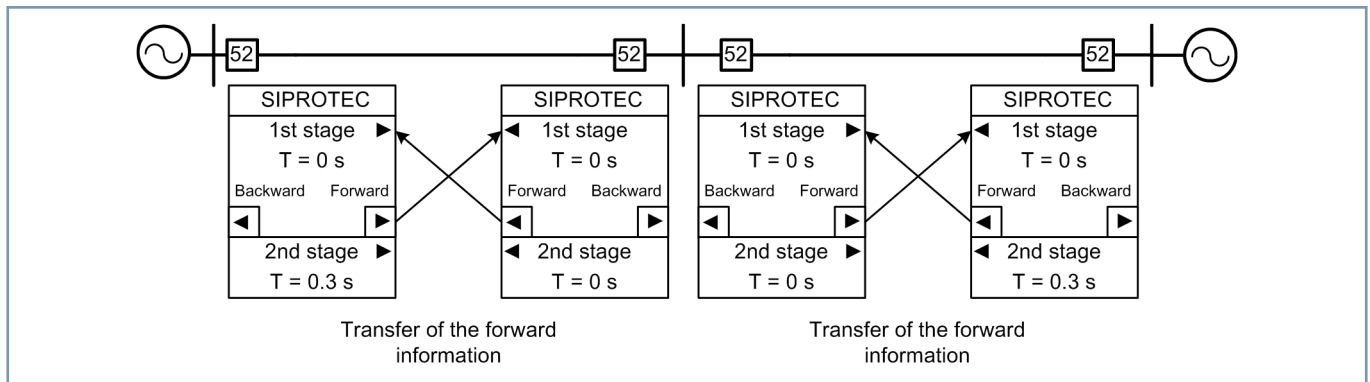
Capacitor bank: MSCDN

- Overcurrent protection for phase and ground
- Current-unbalance protection for capacitor banks
- Differential protection for capacitor
- Peak overvoltage protection
- Overload protection
- Undercurrent protection.

Application examples

Direction comparison protection via protection data interface for lines supplied from two sides

Direction comparison protection can be realized with the help of direction determination of the directional overcurrent protection in the case of lines which are supplied from two sides. The direction comparison protection is designed to selectively isolate a faulty line section (e.g., sections of rings) in high speed, i.e. no long graded times will slow down the tripping process. The precondition of this procedure is that direction information can be exchanged between the individual protective relays. This information exchange can be realized via an protection data interface, for instance. Alternatives to the protection data interface are IEC 61850 GOOSE or pilot wires for signal transmission with an additional voltage loop.



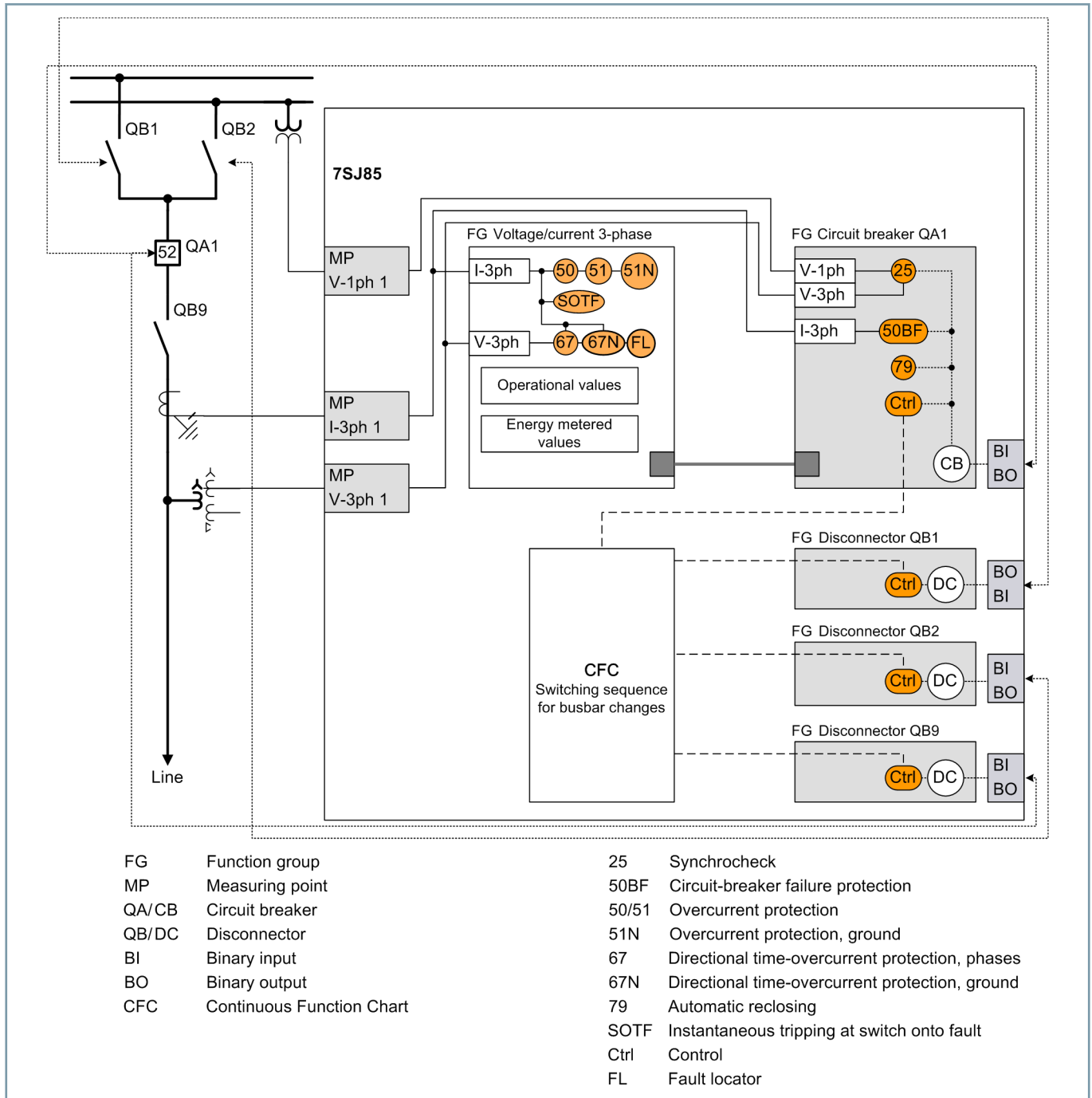
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Figure 2.4/6 Application example: Principle of the direction comparison protection of doubly fed line sections

The SIPROTEC 7SJ82 application example (Figure 2.4/4) shows the functions and the basic configuration for this application.

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Figure 2.4/7 Application example: Overcurrent protection 7SJ85 at a double busbar feeder

Protection and control at a double busbar

In the *Figure 2.4/7*, a double busbar feeder is protected and additionally controlled by a SIPROTEC 7SJ85. This example is based on the application template "Directional *V*inverse time-overcurrent protection - grounded power system". In addition to the application template, the functions Circuit-breaker failure protection, Automatic reclosing and Synchrocheck in the circuit-breaker function group are needed and configured. These functions can easily be added via "drag and drop" from the DIGSI 5

function library. Operational measured values and energy metered values are calculated in the "Voltage-current 3ph" function group. They are available for output on the display, transfer to the substation automation technology, and processing in the CFC. A switching sequence stored in the CFC that is activated via a function key starts an automatically executing busbar switch-over process.

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Protection of a capacitor bank

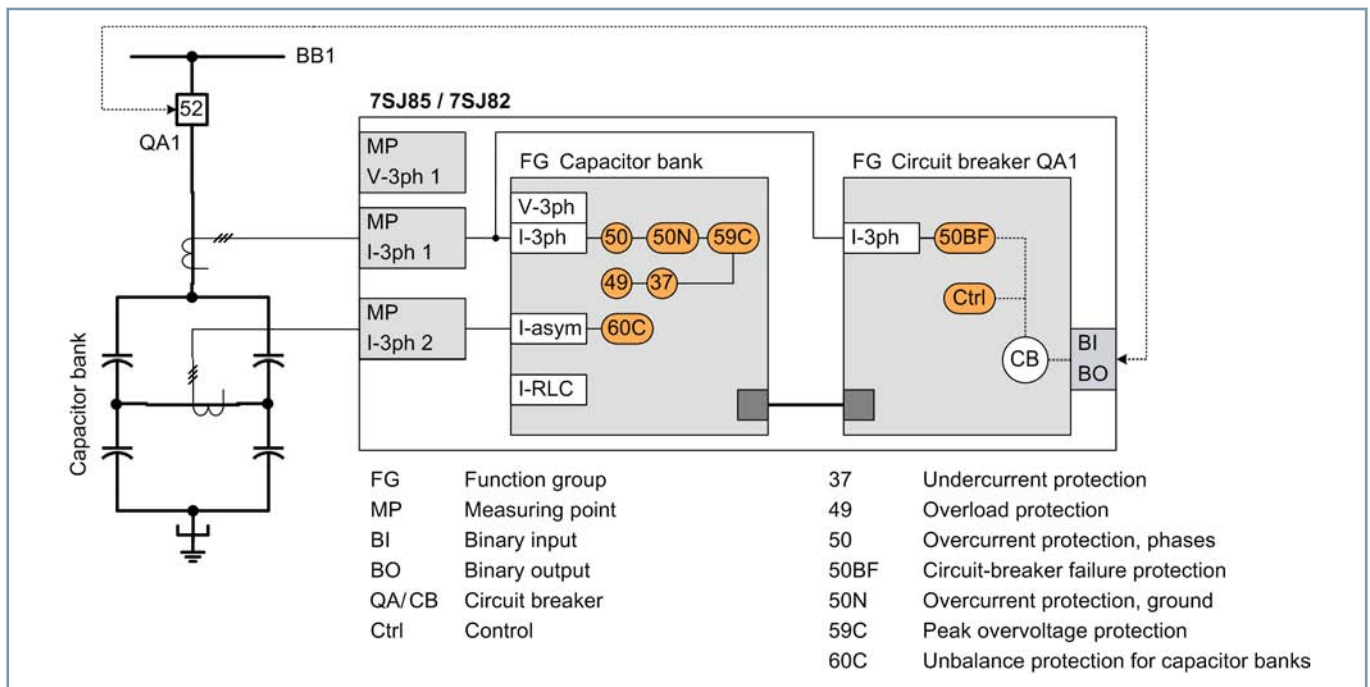
Figure 2.4/8 shows protection of a capacitor bank in an H connection. For this application, the device has special functions for the protection of capacitor banks. Thanks to the modularity and performance of SIPROTEC 5, the complete application can be protected by one device.

Properties:

- Short-circuit protection (ANSI 50, 50N) for phase and ground faults
- Peak voltage protection (ANSI 59C), for protection of the dielectric of the bank from harmful peak voltages, in particular, caused by harmonics; consideration of harmonics up to the 50th order, the peak voltage being calculated from the current by integration

- Overload protection (ANSI 49) for protection of the bank from thermal overload
- Very sensitive current-unbalance protection (ANSI 60C) for detecting the failure of a single capacitor element, as a monitoring and protection function; manual and automatic comparison in the bay. The automatic comparison permits consideration of dynamic unbalances, e.g. caused by temperature influences
- Undercurrent protection (ANSI 37) for tripping the local circuit breaker when the incoming feeder is disconnected; and therefore protection from hazardous energization of the nondischarged bank, e.g. in phase opposition
- Circuit-breaker failure protection (ANSI 50BF).

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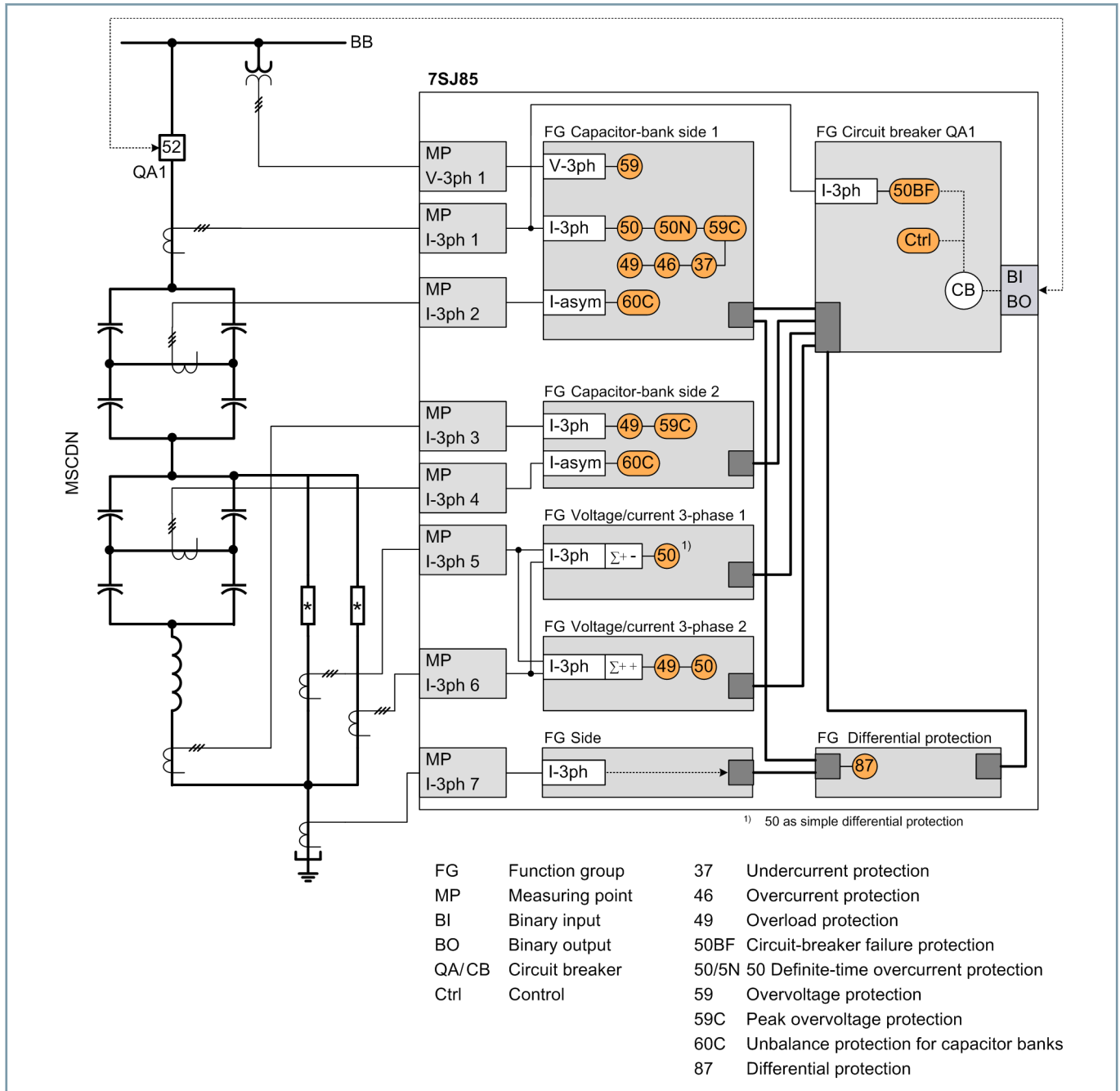


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Figure 2.4/8 Protection of a capacitor bank in H connection

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[dw_CapBank_MSCDN, 1, en_US]

Figure 2.4/9 Application example: MSCDN capacitor bank

Protection of an MSCDN capacitor bank (MSCDN = Mechanically Switched Capacitor with Damping Network)

In **Figure 2.4/9**, the SIPROTEC 7SJ85 protects the capacitor bank in H connection and additionally the associated damping network. Thanks to the modular structure and performance of SIPROTEC 5, the complete application can be protected with one single device.

Properties:

- Capturing up to seven 3-phase measuring points
- Short-circuit protection (ANSI 50, 50N) for phase and ground faults
- Peak overvoltage protection (ANSI 59C) to protect the dielectric medium of the bank against dangerous peak overvoltage, in particular caused by the harmonic components with consideration of up to the 50th harmonic component. The peak voltage is calculated by integration of the current.

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- Overload protection (ANSI 49) to protect the bank against thermal overload
- Very sensitive current-unbalance protection (ANSI 60C) to detect the outage of individual capacitor elements as monitoring and protection function. Manual and automatic adjustment in the bay. Automatic adjustment permits dynamic unbalances (caused by temperature influence, for example) to be taken into account
- Differential protection (87C) over the entire capacitor bank to protect against short circuits inside the entire installation
- Overload and overcurrent protection via the two resistors and a simple differential protection that is to detect an outage of one of the two resistors. For this purpose, current sum and current difference are determined with the current measuring points in the R branches, at the inputs of the V/I 3-phase function groups
- Undercurrent protection (ANSI 37) to trip the local circuit breaker when the infeed is disconnected providing protection against hazardous voltage at the non-discharged bank, for example, in phase opposition
- Circuit-breaker failure protection (ANSI 50BF).

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Functions, application templates

ANSI	Functions	Abbr.	Available	Template					
				1	2	3	4	5	6
	Protection functions for 3-pole tripping	3-pole	■	■	■	■	■	■	■
	Hardware quantity structure expandable	I/O	■	■	■	■	■	■	■
24	Overexcitation protection	V/f	■						
25	Synchrocheck, synchronizing function	Sync	■						
27	Undervoltage protection: "3-phase" or "pos.seq. V1" or "universal Vx"	V<	■						
	Undervoltage-controlled reactive power protection	Q>/V<	■						
32, 37	Power protection active/reactive power	P<>, Q<>	■						
32R	Reverse power protection	- P<	■						
37	Undercurrent	I<	■					■	■
38	Temperature Supervision	θ>	■						
46	Negative sequence overcurrent protection	I2>	■					■	■
46	Unbalanced-load protection (thermal)	I2² t>	■						
46	Negative sequence overcurrent protection with direction	I2>, ∠(V2,I2)	■						
47	Overvoltage protection, negative-sequence system	V2>	■						
49	Thermal overload protection	θ, I²t	■					■	■
49	Thermal overload protection for RLC filter elements of a capacitor bank	θ, I²t	■					■	
50/51 TD	Overcurrent protection, phases	I>	■	■	■	■	■	■	■
50N/ 51N TD	Overcurrent protection, ground	IN>	■	■	■	■		■	■
50HS	High speed instantaneous overcurrent protection	I>>>	■						
	Instantaneous tripping at switch onto fault	SOTF	■						
50N/ 51N TD	Overcurrent protection, 1-phase	IN>	■						
50Ns/ 51Ns	Sensitive ground-current protection for systems with resonant or isolated neutral	INs>	■						
	Intermittent ground fault protection	lie>	■						
50/51 TD	Overcurrent protection for RLC filter elements of a capacitor bank	I>	■						
50BF	Circuit-breaker failure protection, 3-pole	CBFP	■						■
50RS	Circuit-breaker restrike protection	CBRS	■						
51V	Voltage dependent overcurrent protection	t=f(I,V)	■						
	Peak overvoltage protection, 3-phase, for capacitors	V> cap.	■					■	■
59, 59N	Overvoltage protection: "3-phase" or "zero seq. V0" or "pos.seq. V1" or "universal Vx"	V>	■						■
60C	Current-unbalance protection for capacitor banks	Iunbal>	■					■	■
67	Directional overcurrent protection, phases	I>, ∠(V,I)	■			■	■		
67N	Directional overcurrent protection, ground	IN>, ∠(V,I)	■			■			
67Ns	Dir. sensitive ground-fault detection for systems with resonant or isolated neutral incl. a) 3I0>, b) V0>, c) Cos-/SinPhi, d) Transient fct., e) Phi(V,I), f) admittance		■				■		
	Directional intermittent ground fault protection	lie dir>	■						
74TC	Trip circuit supervision	TCS	■						
79	Automatic reclosing, 3-pole	AR	■						
81	Frequency protection: "f>" or "f<" or "df/dt"	f>,<; df/dt>,<	■						
86	Lockout		■	■	■	■	■	■	■
87N T	Restricted ground-fault protection	ΔIN	■						
87C	Differential protection, capacitor bank	ΔI	■						■

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ANSI	Functions	Abbr.	Available	Template					
				1	2	3	4	5	6
87V	Voltage differential protection, capacitor bank	ΔV	■						
90V	Automatic voltage control for 2 winding transformer		■						
90V	Automatic voltage control for 3 winding transformer		■						
90V	Automatic voltage control for grid coupling transformer		■						
FL	Fault locator, single-ended measurement	FL-one	■						
PMU	Synchrophasor measurement (1 PMU can be used for max. 8 voltages and 8 currents)	PMU	■						
AFD	Arc-protection (only with plug-in module ARC-CD-3FO)		■						
	Measured values, standard		■	■	■	■	■	■	■
	Measured values, extended: Min, Max, Avg		■						
	Switching statistic counters		■						
	Circuit breaker wear monitoring	$\Sigma I_x, I^2t, 2P$	■						
	CFC (Standard, Control)		■	■	■	■	■	■	■
	CFC arithmetic		■						
	Switching sequences function		■						
	Inrush current detection		■	■	■	■	■		
	External trip initiation		■						
	Control		■	■	■	■	■	■	■
	Fault recording of analog and binary signals		■	■	■	■	■	■	■
	Monitoring and supervision		■	■	■	■	■	■	■
	Protection interface, serial		■						
	Circuit Breaker		■	■	■	■	■	■	■
	Disconnecter		■	■	■	■	■		
Function-points class:				0	0	30	50	100	300

The configuration and function points for your application can be ascertained in the SIPROTEC 5 order configurator under: www.siemens.com/siprotec

Table 2.4/3 SIPROTEC 7SJ85 - Functions and application templates

- 1 Non-directional OC (4*I)
- 2 Non-directional OC (4*I, 4*V)
- 3 Directional OC - grounded system
- 4 Directional OC - resonant-grounded / isol. system
- 5 Capacitor bank: H-bridge + 1*RLC
- 6 Capacitor bank: MSCDN

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Standard variants

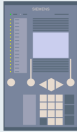
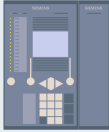
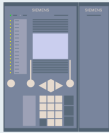


Standard variants for SIPROTEC 7SJ85		
S1	1/3, 11 BI, 9 BO, 4 I, 4 V Housing width 1/3 x 19" 11 binary inputs, 9 binary outputs (1 life contact, 2 standard, 6 fast), 4 current transformer inputs, 4 voltage transformer inputs Contains the modules: Base module with PS201 and IO202	
S2	1/2, 17 BI, 16 BO, 4 I, 4 V Housing width 1/2 x 19" 17 binary inputs, 16 binary outputs (1 life contact, 9 standard, 6 fast), 4 current transformer inputs, 4 voltage transformer inputs Contains the modules: Base module with PS201 and IO202 Expansion modules IO206	
S3	1/2, 27 BI, 17 BO, 4 I, 4 V Housing width 1/2 x 19" 27 binary inputs, 17 binary outputs (1 life contact, 10 standard, 6 fast), 4 current transformer inputs, 4 voltage transformer inputs Contains the modules: Base module with PS201 and IO202 Expansion modules IO207	
S4	2/3, 43 BI, 25 BO, 4 I, 4 V Housing width 2/3 x 19" 43 binary inputs, 25 binary outputs (1 life contact, 18 standard, 6 fast), 4 current transformer inputs, 4 voltage transformer inputs Contains the modules: Base module with PS201 and IO202 Expansion modules 2x IO207	
S5	5/6, 59 BI, 33 BO, 4 I, 4 V Housing width 5/6 x 19" 59 binary inputs, 33 binary outputs (1 life contact, 26 standard, 6 fast), 4 current transformer inputs, 4 voltage transformer inputs Contains the modules: Base module with PS201 and IO202 Expansion modules 3x IO207	

Table 2.4/4 Standard variants for SIPROTEC 7SJ85

The technical data of the devices can be found in the manual
www.siemens.com/siprotec