Distance Protection – SIPROTEC 7SA87

Description

The SIPROTEC 7SA87 distance protection has been designed specifically for the protection of lines. With its modular structure, flexibility and the high-performance DIGSI 5 engineering tool, the SIPROTEC 7SA87 device offers future-oriented solutions for protection, control, automation, monitoring, and Power Quality – Basic.

Main function	Distance protection Interoperability of SIPROTEC 4 and SIPROTEC 5 line protection devices
Tripping	1-pole and 3-pole, minimum tripping time: 9 ms
Inputs and outputs	12 predefined standard variants with 4/4 or 8/8 current transformers/voltage transformers, 5 to 31 binary inputs, 8 to 46 binary outputs
Hardware flexibility	Flexibly adjustable I/O quantity structure within the scope of the SIPROTEC 5 modular system
Housing width	1/3 × 19 inches to 2/1 × 19 inches

Benefits

- Safety due to high-performance protection functions
- Purposeful and easy handling of devices and software thanks to a user-friendly design
- Cybersecurity in accordance with NERC CIP and BDEW Whitepaper requirements
- Highest availability even under extreme environmental conditions by standard coating of the modules
- Full compatibility between IEC 61850 Editions 1, 2.0, and 2.1

Functions

DIGSI 5 permits all functions to be configured and combined as required and as per the functional scope that has been ordered.

- Minimum tripping time: 9 ms
- 6 independent measuring loops (6-system distance protection)
- Several distance-protection functions can be selected: Classic, reactance method (RMD), impedance protection for transformers
- Directional backup protection and various additional functions
- Detection of ground faults of any type in compensated or isolated electrical power systems using the following functions: 3I0>, V0>, transient ground fault, cos φ, sin φ, dir. detection of intermittent ground faults, harmonic detection, and admittance measurement
- Ground-fault detection using the pulse-detection method
- Adaptive power-swing blocking, out-of-step protection
- Detection of current-transformer saturation for fast tripping with high accuracy
- Fault locator plus for accurate fault location with inhomogenous line sections and targeted automatic overhead-line section reclosing (AREC)
- Arc protection

[SIP5_GD_SS_W3, 2, --_--]

Figure 2.6/6 SIPROTEC 5 Device with Expansion Module

- Automatic frequency relief for underfrequency load shedding, taking changed infeed conditions due to decentralized power generation into consideration
- Power protection, configurable as active or reactive-power protection
- Directional reactive-power undervoltage protection (QU protection)
- Detection of current and voltage signals up to the 50th harmonic with high accuracy for selected protection functions (such as thermal overload protection) and operational measured values
- PQ – Basic: Voltage unbalance; voltage changes: overvoltage, dip, interruption; TDD, THD, and harmonics
- 1-pole automatic reclosing function with secondary arc detection (SAD)
- Control, synchrocheck, and switchgear interlocking protection
- Graphical logic editor to create high-performance automation functions in the device
- Single-line representation in the small or large display
- Point-on-wave switching
- Fixed integrated electrical Ethernet RJ45 interface for DIGSI 5 and IEC 61850 (reporting and GOOSE)
- Up to 4 optional, pluggable communication modules, usable for different and redundant protocols (IEC 61850-8-1, IEC 61850-9-2 Client, IEC 60870-5-103, IEC 60870-5-104, Modbus TCP, DNP3 serial and TCP, PROFINET IO, PROFINET IO S2 redundancy)
- Virtual network partitioning (IEEE 802.1Q - VLAN)
- Serial protection communication via optical fibers, two-wire connections, and communication networks (IEEE C37.94 and others), including automatic switchover between ring and chain topology.

- Reliable data transmission via PRP and HSR redundancy protocols
- Extensive cybersecurity functionality, such as role-based access control (RBAC), logging of security-related events, signed firmware, or authenticated IEEE 802.1X network access.
- Simple, fast, and secure access to the device via a standard Web browser to display all information and diagnostic data, vector diagrams, single-line and device display pages
- Phasor Measurement Unit (PMU) for synchrophasor measured values and IEEE C37.118 protocol
- Time synchronization using IEEE 1588
- High-performance fault recording (buffer for a max. record time of 80 s at 8 kHz or 320 s at 2 kHz)
- Auxiliary functions for simple tests and commissioning
- Flexibly adjustable I/O quantity structure within the scope of the SIPROTEC 5 modular system

Applications

- Detection and selective 1-pole and 3-pole tripping of short circuits in electrical equipment of star networks, lines with infeed at one or 2 ends, parallel lines, and open-circuited or closed ring systems of all voltage levels
- Detection of ground faults in isolated or arc-suppression-coil-ground systems in star, ring, or meshed arrangement
- Serial protection communication with SIPROTEC 5 and SIPROTEC 4 devices over different distances and physical media, such as optical fiber, two-wire connections, and communication networks
- Backup protection for differential protection devices of all kind for lines, transformers, generators, motors, and busbars
- Phasor Measurement Unit (PMU)
- Detection and recording of power-quality data in the medium-voltage and subordinate low-voltage power system

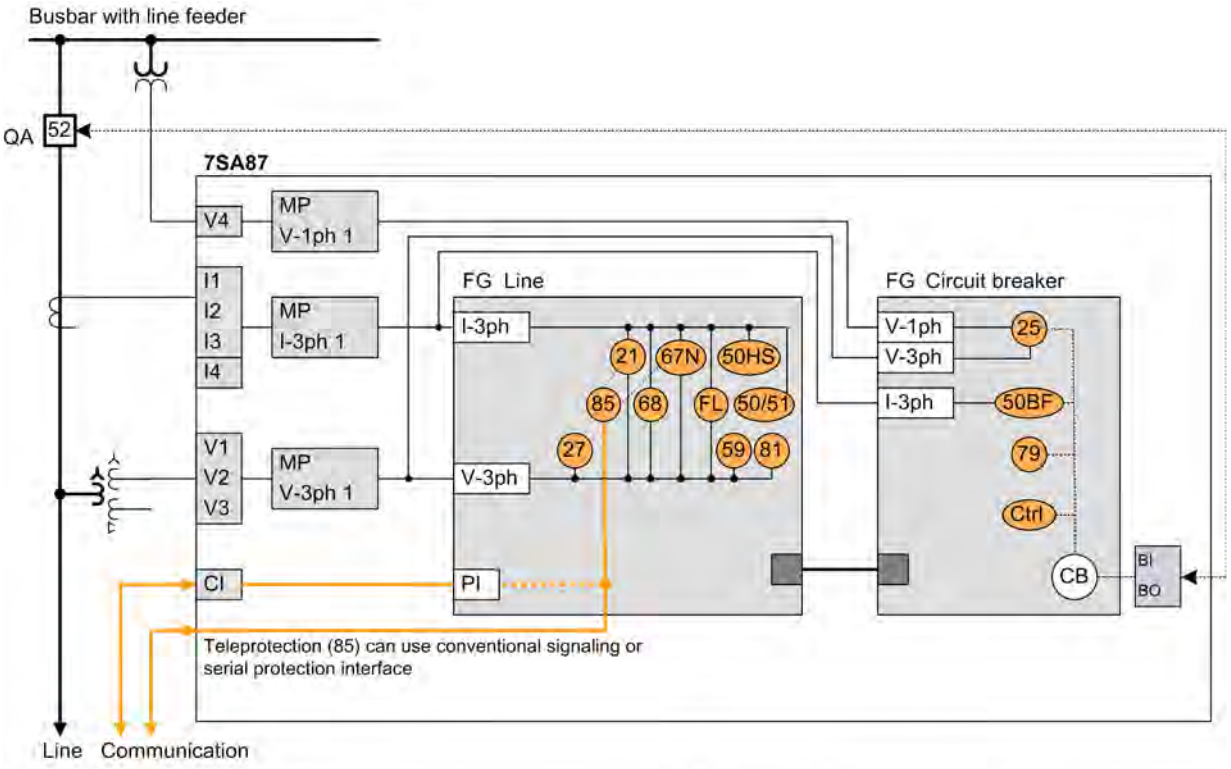
Application Templates

DIGSI 5 provides application templates for standard applications. They include basic configurations and default settings.

The following application templates are available:

- Distance protection basis
- Distance protection with reactance method for overhead lines in grounded electrical power systems
- Distance protection with reactance method for overhead lines in grounded electrical power systems and applications with breaker-and-a-half layout

Application Examples



FG	Function group
MP	Measuring point
PI	Protection interface
CI	Communication interface
CB	Circuit breaker
BI	Binary input
BO	Binary output

21	Distance protection
25	Synchrocheck, synchronization function
27	Undervoltage protection
50/51	Overcurrent protection, phases, ground
50HS	Instantaneous high-current tripping
50BF	Circuit-breaker failure protection
59	Overvoltage protection
67N	Directional overcurrent protection for ground faults
68	Power-swing blocking
79	Automatic reclosing
81	Frequency protection
85	Teleprotection schemes for 21 and/or 67N
Ctrl	Control
FL	Fault locator

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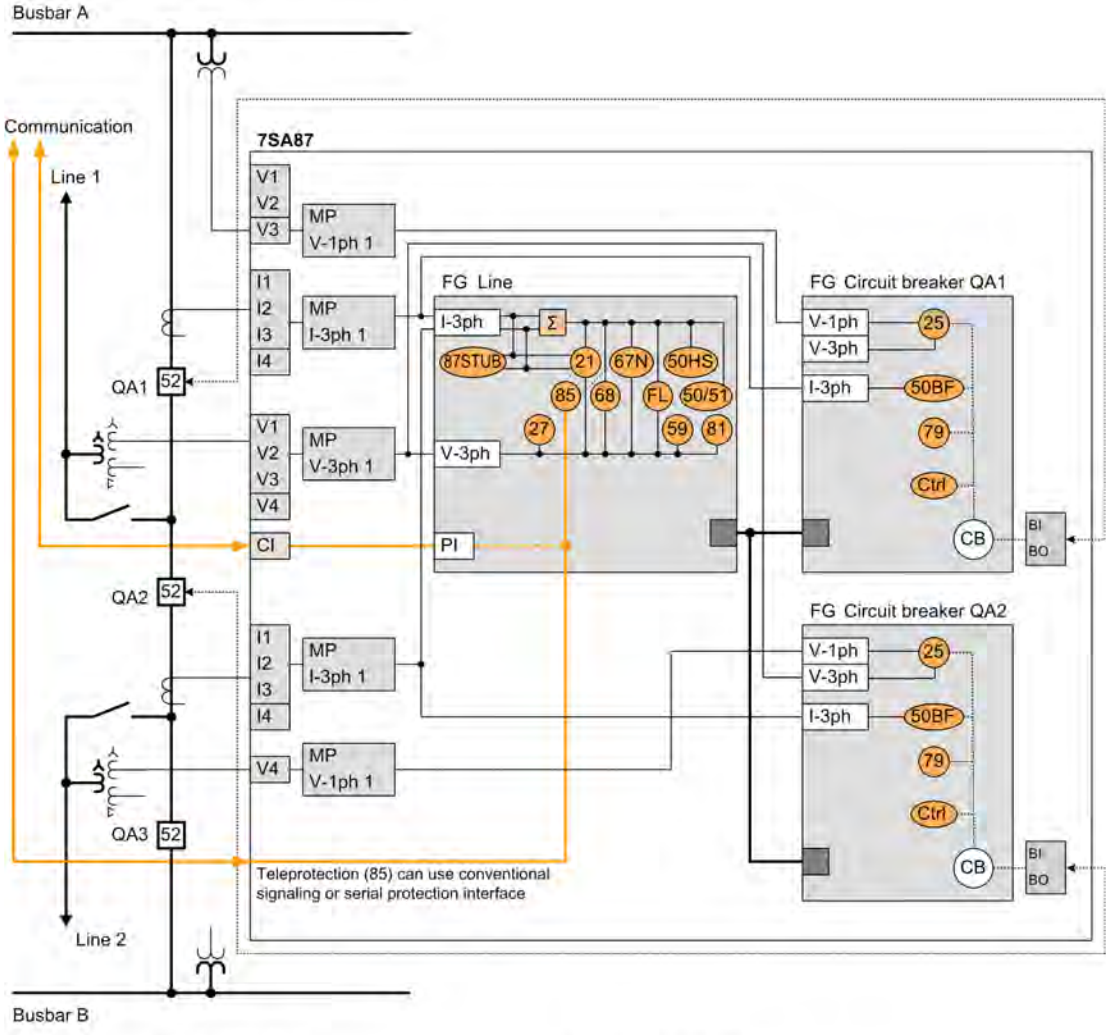
Figure 2.6/7 Application Example: Distance Protection for Overhead Line



FG	Function group
MP	Measuring point
PI	Protection interface
CI	Communication interface
CB	Circuit breaker
BI	Binary input
BO	Binary output
Σ	Summation of currents

21	Distance protection
25	Synchrocheck, synchronization function
27	Undervoltage protection
50/51	Overcurrent protection, phases, ground
50HS	Instantaneous high-current tripping
50BF	Circuit-breaker failure protection
59	Overvoltage protection
67N	Directional overcurrent protection for ground faults
68	Power-swing blocking
79	Automatic reclosing
81	Frequency protection
85	Teleprotection schemes for 21 and/or 67N
87STUB	STUB Differential protection
Ctrl	Control
FL	Fault locator

[dw_7SA87_1-5LS, 1, en_US]

Figure 2.6/8 Application Example: Distance Protection for Overhead Line with Breaker-and-a-Half Layout

Distance Protection – SIPROTEC 7SA87

ANSI	Function	Abbr.	Available	Application Templates		
				1	2	3
	Protection functions for 3-pole tripping	3-pole	■	■	■	■
	Protection functions for 1-pole tripping	1-pole	■	■	■	■
	Expandable hardware quantity structure	I/O	■	■	■	■
	Process bus client protocol (hint: PB client requires a separate ETH-BD-2FO plug-in module, from V8.0)	PB client	■			
	IEC61850-9-2 Merging Unit Stream (hint: Each stream requires a separate ETH-BD-2FO plug-in module, from V8.0)	MU	■			
	IEC61850-9-2 Merging Unit Stream 7SS85 CU (hint: Only for communication with a 7SS85 CU. A separate ETH-BD-2FO plug-in module is required starting with V8.40)	MU	■			
21/21N	Distance Protection	Z<, V< /I>/∠(V, I)	■	■	■	■
21T	Impedance protection for transformers	Z<	■			
25	Synchrocheck, synchronization function	Sync	■		■	■
27	Undervoltage protection: "3-phase" or "positive-sequence system V1" or "universal Vx"	V<	■			
27R, 59R	Voltage change protection (starting with V8.30)	dV/dt	■			
	Undervoltage-controlled reactive power protection	Q>/V<	■			
32, 37	Power protection active/reactive power	P<>, Q<>	■			
37	Undercurrent	I<	■			
38	Temperature supervision	θ>	■			
46	Negative-sequence system and overcurrent protection with direction	I2>, ∠(V2, I2)	■			
47	Overvoltage protection, negative-sequence system	V2>	■			
49	Thermal overload protection	θ, I²t	■		■	■
50/51 TD	Overcurrent protection, phases	I>	■	■	■	■
	Instantaneous tripping at switch onto fault	SOTF	■			
50HS	Instantaneous high-current tripping	I>>>	■	■	■	■
50/51 TD	Overcurrent protection with positive-sequence current I1 (from V7.9)	I1>	■			
50N/ 51N TD	Overcurrent protection, ground	IN>	■	■	■	■
50N/ 51N TD	Overcurrent protection, 1-phase	IN>	■			
50 Ns/ 51Ns	Sensitive ground-fault detection for grounded arc suppression coils and isolated power systems including a) 3I0> b) admittance Y0>, c) 3I0-harm> (from V7.8)	INs>	■			
	Sensitive ground-fault detection via pulse detection; hint: this stage also requires the function 50Ns/51Ns or 67Ns "sensitive ground-fault detection for grounded arc suppression coils and isolated power systems"	IN pulse	■			
	Intermittent ground-fault protection	IIE>	■			
50BF	Circuit-breaker failure protection 1-pole/3-pole	CBFP	■		■	■
50EF	End-fault protection (hint: For use only in decentralized busbar protection with a 7SS85 CU starting with V8.40)		■			
50RS	Circuit breaker restrike monitoring	CBRM	■			
51V	Voltage-controlled overcurrent protection	t=f(I, V)	■			
59, 59N	Overvoltage protection: "3-phase" or "zero-sequence system V0" or "positive-sequence system V1" or "universal Vx"	V>	■			
60	Voltage-comparison supervision	ΔV>	■			

ANSI	Function	Abbr.	Available	Application Templates		
				1	2	3
67	Directional overcurrent protection, phases	I>, ∠(V, I)	■			
67N	Directional ground-fault protection in grounded power systems	IN>, ∠(V, I)	■		■	■
67 Ns	Sensitive ground-fault detection for grounded arc suppression coils and isolated power systems including a) 3I0> b) V0>, c) cos/sine Phi, d) transient ground fault, e) Phi(V, I), f) admittance		■			
	Directional tripping stage with one harmonic; hint: this stage also requires the function "67Ns sensitive ground-fault detection for grounded arc suppression coils and isolated power systems"	∠(V0h,I0h)	■			
	Directional Intermittent Ground-Fault Protection	IIEdir>	■			
68	Power-swing blocking	ΔZ/Δt	■		■	■
74TC	Trip-circuit supervision		■			
78	Out-of-step protection	ΔZ/Δt	■			
79	Automatic reclosing, 1-pole/3-pole	AREC	■		■	■
SAD	Secondary arc detection (SAD) in 1-pole automatic reclosing cycles starting with V8.30; note: SAD also requires the function points for "79 automatic reclosing, pole/3-pole"	SAD	■			
81	Frequency protection: "f>" or "f<" or "df/dt"	f<>; df/dt<>	■			
81U	Underfrequency load shedding	f<(ULS)	■			
	Vector-jump protection	Δφ>	■			
85/21	Teleprotection scheme for distance protection		■	■	■	■
85/27	Weak or no infeed: Echo and tripping		■	■	■	■
85/67N	Teleprotection scheme for directional ground-fault protection		■	■	■	■
86	Lockout		■			
87N T	Restricted ground-fault protection	ΔIN	■			
87 STUB	Stub fault differential protection (for breaker-and-a-half layouts)		■			■
90 V	Voltage controller for two-winding transformer		■			
90 V	Voltage controller for two-winding transformer with parallel control		■			
	Number of two-winding transformers with parallel control (hint: only together with the function "voltage controller for two-winding transformer with parallel control")		■			
90 V	Voltage controller for three-winding transformer		■			
90 V	Voltage controller for grid coupling transformer		■			
FL	Fault Locator, single-side	FL-one	■	■	■	■
FL	Fault Locator Plus (from V7.9)	FL plus	■			
PMU	Synchrophasor measurement	PMU	■			
AFD	Arc protection (only with plug-in module ARC-CD-3FO)		■			
	Measured values, standard		■	■	■	■
	Measured values, extended: Min, max, average		■			
	Switching statistics counter		■	■	■	■
	PQ – Basic measured values: THD (Total Harmonic Distortion) and harmonic component (starting with V8.01) and THD voltage average values (starting with V8.40)		■			
	PQ – Basic measured values: Voltage unbalance (starting with V8.40)		■			

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ANSI	Function	Abbr.	Available	Application Templates		
				1	2	3
	PQ – Basic measured values: Voltage changes – monitoring of voltage dips, overvoltages and voltage interruptions (starting with V8.40)		■			
	PQ – Basic measured values: TDD - Total Demand Distortion (starting with V8.40)		■			
	CFC (standard, control)		■	■	■	■
	CFC arithmetic		■			
	Circuit-breaker wear monitoring	ΣIx, I²t, 2P	■			
	Switching sequence function		■			
	Inrush-current detection		■			
	External trip initiation		■	■	■	■
	Control		■	■	■	■
PoW	Point-on-wave switching (starting with V7.90)	PoW	■			
	Circuit breaker		■	■	■	■
	Disconnector/grounding conductor		■			■
	Fault recording of analog and binary signals		■	■	■	■
	Monitoring		■	■	■	■
	Protection interface, serial		■	■	■	■
	Region, France: Overload protection for 'PSL-PSC' lines		■			
	Region, France: 'MAXI-L' overcurrent protection		■			
	Region, France: 'PDA' system decoupling protection		■			
	Region, France: Overload protection for transformers		■			
	Frequency group tracking (from V7.8)		■			
	Cyber security: Role-Based Access Control (from V7.8)		■			
	Temperature recording via communication protocol		■			
	Cyber security: Authenticated network access using IEEE 802.1X (starting from V8.3)		■			
Function point class:				0	225	400
The configuration and function point class for your application can be determined in the SIPROTEC 5 order configurator at www.siemens.com/siprotec.						

Table 2.6/3 SIPROTEC 7SA87 – Functions, Application Templates

(1) Basic

(2) DIS RMD Overhead Line, grounded power systems

(3) DIS RMD Overhead Line, grounded power systems, 1.5 CB