

# SIPROTEC 5 Devices and Fields of Application

## Line Differential Protection – SIPROTEC 7SD86

### Description

The SIPROTEC 7SD86 line differential 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 7SD86 device offers future-oriented solutions for protection, control, automation, monitoring, and Power Quality – Basic.

Main function	Differential protection Interoperability of SIPROTEC 4 and SIPROTEC 5 line protection devices
Tripping	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 White-paper requirements
- Highest availability even under extreme environmental conditions by standard coating of the modules

### 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
- Main protection function is differential protection with adaptive algorithm for maximum sensitivity and stability even with the most different transformer errors, current-transformer saturation, and capacitive charging currents
- 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: 3IO>, VO>, transient ground fault,  $\cos \varphi$ ,  $\sin \varphi$ , dir. detection of intermittent ground faults, harmonic detection, and admittance measurement
- Ground-fault detection using the pulse detection method
- Detection of current-transformer saturation
- Fault locator plus for accurate fault location with inhomogeneous line sections and targeted automatic overhead-line section reclosing (AREC)
- Arc protection
- 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



[SIP5\_GD\_SS\_W3, 2, --, --]

Figure 2.7/3 SIPROTEC 5 Device with Expansion Module

- 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
- 3-pole automatic reclosing function
- 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
- 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

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- 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

### Applications

- Line protection for all voltage levels with 3-pole tripping
- Phase-selective protection of overhead lines and cables with single-ended and multi-ended infeed of all lengths with up to 6 line ends
- Also used in switchgear with breaker-and-a-half layout
- Transformers and compensating coils in the protection zone
- Detection of ground faults in isolated or arc-suppression-coil-ground power 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

- 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 all basic configurations and default settings.

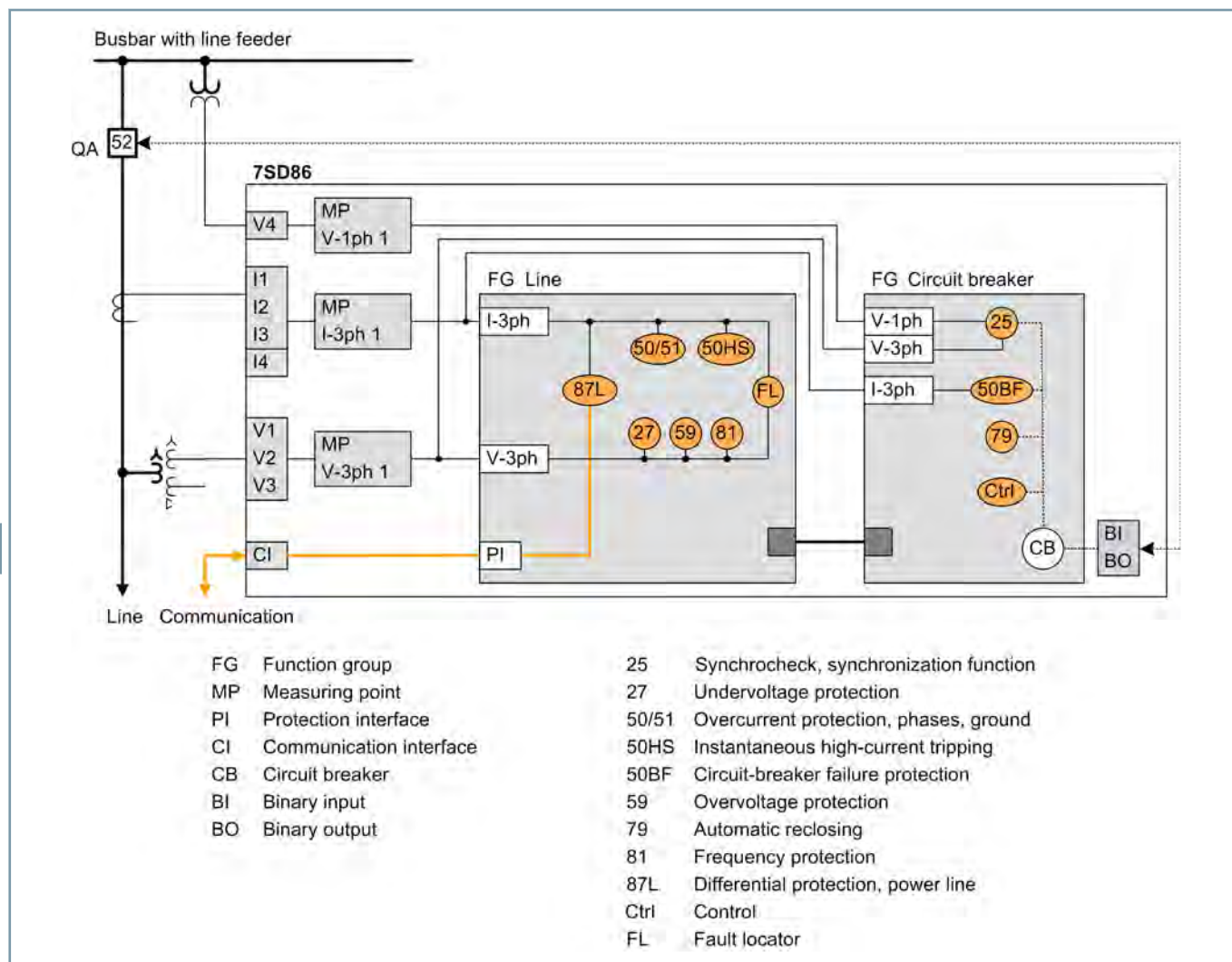
The following application templates are available:

- Differential protection basis
- Differential protection for overhead line
- Differential protection for overhead line with transformer in the protection range
- Differential protection for overhead line, for applications with breaker-and-a-half layout

# SIPROTEC 5 Devices and Fields of Application

## Line Differential Protection – SIPROTEC 7SD86

### Application Examples

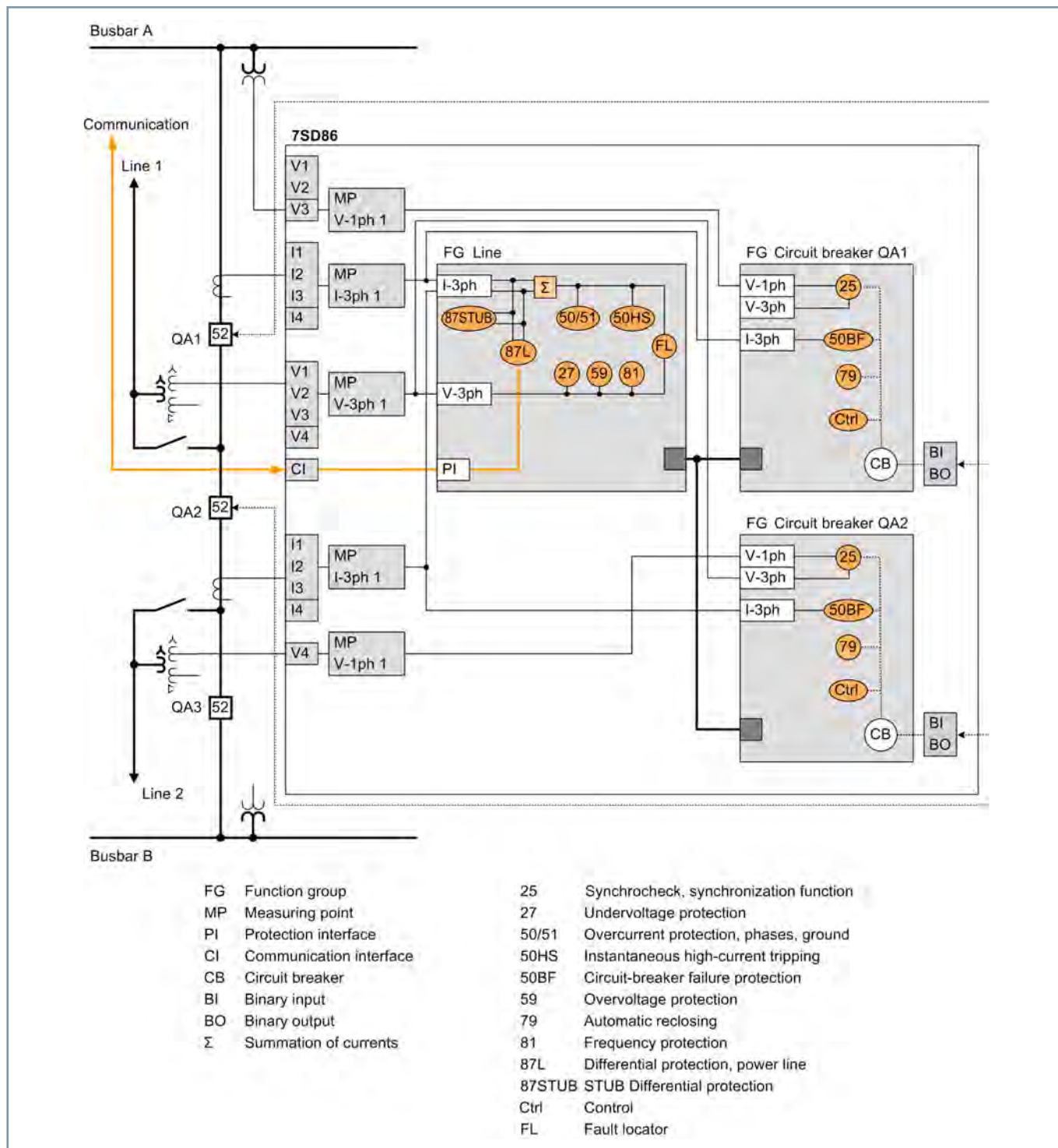


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Figure 2.7/4 Application Example: Line Differential Protection for Overhead Line

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[dw\_7SD86\_1-5LS, 1, en\_US]

Figure 2.7/5 Application Example: Line Differential Protection for Overhead Line with Breaker-and-a-Half Layout

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# SIPROTEC 5 Devices and Fields of Application

## Line Differential Protection – SIPROTEC 7SD86

ANSI	Function	Abbr.	Available	Application Templates			
				1	2	3	4
	Protection functions for 3-pole tripping	3-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	■				
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, 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>	■				
67	Directional overcurrent protection, phases	I>, ∠(V, I)	■				
67N	Directional ground-fault protection in grounded power systems	IN>, ∠(V, I)	■				

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ANSI	Function	Abbr.	Available	Application Templates			
				1	2	3	4
67 Ns	Sensitive ground-fault detection for grounded arc suppression coils and isolated power systems including a) $3I_0 >$ , b) $V_0 >$ , c) $\cos/\sin \Phi$ , 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"	$\angle(V_0h, I_0h)$	■				
	Directional Intermittent Ground-Fault Protection	IIEdir>	■				
74TC	Trip-circuit supervision		■				
74CC	Single circuit monitoring (from V7.9)		■				
79	Automatic reclosing, 3-pole	AREC	■		■	■	■
81	Frequency protection: "f>" or "f<" or "df/dt"	f<>; df/dt<>	■				
81U	Underfrequency load shedding	f<(ULS)	■				
	Vector-jump protection	$\Delta\varphi >$	■				
86	Lockout		■				
87N T	Restricted ground-fault protection	$\Delta I_N$	■				
87L	Line differential protection for 2 line ends	$\Delta I$	■	■	■	■	■
87L	Line differential protection for 3 to 6 line ends (dependent on significant properties)	$\Delta I$	■	■	■	■	■
87L/ 87T	Option for line differential protection with Transformer in the Protection Range	$\Delta I$	■			■	
	Option for line differential protection with charging-current compensation	$\Delta I$	■				
	Broken-wire detection for differential protection		■				
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)		■				
	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)		■	■	■	■	■

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ANSI	Function	Abbr.	Available	Application Templates			
				1	2	3	4
	CFC arithmetic		■				
	Circuit-breaker wear monitoring	$\Sigma I_x, I^2t, 2P$	■				
	Switching sequence function		■				
	Inrush-current detection		■				
	External trip initiation		■	■	■	■	■
	Control		■	■	■	■	■
	Circuit breaker		■	■	■	■	■
	Disconnectors/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	150	250	300
The configuration and function point class for your application can be determined in the SIPROTEC 5 order configurator at <a href="http://www.siemens.com/siprotec">www.siemens.com/siprotec</a> .							

**Table 2.7/2** SIPROTEC 7SD86 – Functions, Application Templates

- (1) Basic
- (2) DIFF Overhead Line
- (3) DIFF Overhead Line with Transformer
- (4) DIFF Overhead Line, breaker-and-a-half layout