

SIPROTEC 5 Devices and Fields of Application

Line Differential and Distance Protection – SIPROTEC 7SL87

Description

The combined SIPROTEC 7SL87 differential and distance protection has specifically been designed for the protection of lines. With its modular structure, flexibility and the powerful DIGSI 5 engineering tool, the SIPROTEC 7SL87 device offers future-oriented solutions for protection, control, automation, monitoring, and Power Quality – Basic.

Main function	Differential and 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 powerful 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
- Several distance-protection functions selectable as backup protection or secondary main protection: Classic, reactance method (RMD), impedance protection for transformers
- Directional backup protection and various additional functions
- Adaptive power-swing blocking, out-of-step protection
- 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 , harmonic, dir. detection of intermittent ground faults, harmonic detection, and admittance measurement
- Ground-fault detection using the pulse detection method
- Detection of current-transformer saturation for fast tripping with high accuracy
- Fault locator plus for accurate fault location with inhomogeneous line sections and targeted automatic overhead-line section reclosing (AREC)
- Arc protection



[SIP5_GD_SS_W3, 2, --, --]

Figure 2.8/6 SIPROTEC 5 Device with Expansion Module

- Automatic frequency relief for underfrequency load shedding, taking changed infeed conditions due to decentralized power generation into consideration
- 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)
- Point-on-wave switching
- Control, synchrocheck, and switchgear interlocking protection
- Graphical logic editor to create powerful 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

2.8

SIPROTEC 5 Devices and Fields of Application

Line Differential and Distance Protection – SIPROTEC 7SL87

- 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
- Powerful 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

- Line protection for all voltage levels with 1-pole and 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.

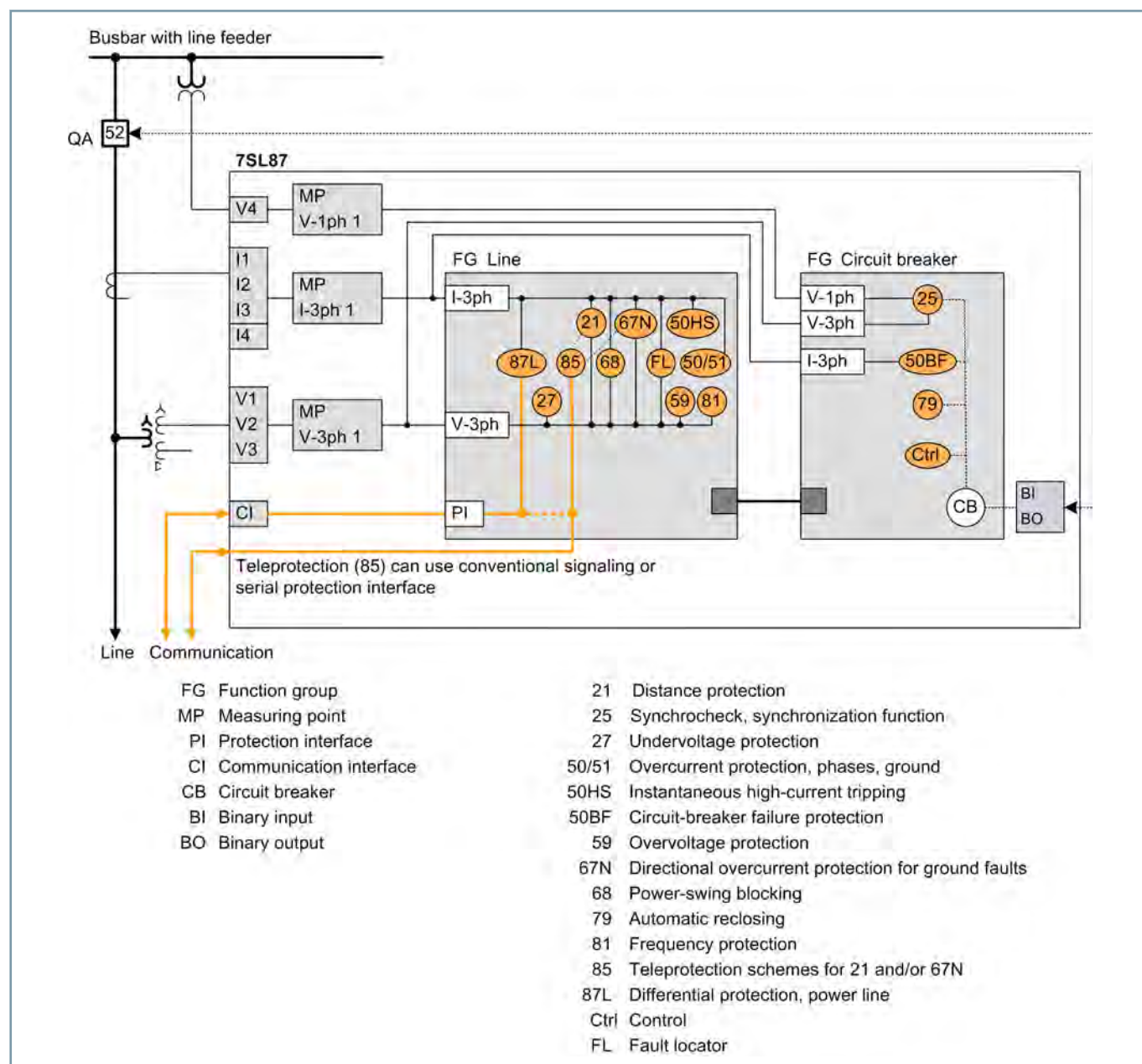
The following application templates are available:

- Basic differential and distance protection
- Differential protection and distance protection with reactance method for overhead lines in grounded electrical power systems
- Differential protection and distance protection with reactance method for overhead lines in grounded electrical power systems and applications with breaker-and-a-half layout

SIPROTEC 5 Devices and Fields of Application

Line Differential and Distance Protection – SIPROTEC 7SL87

Application Examples

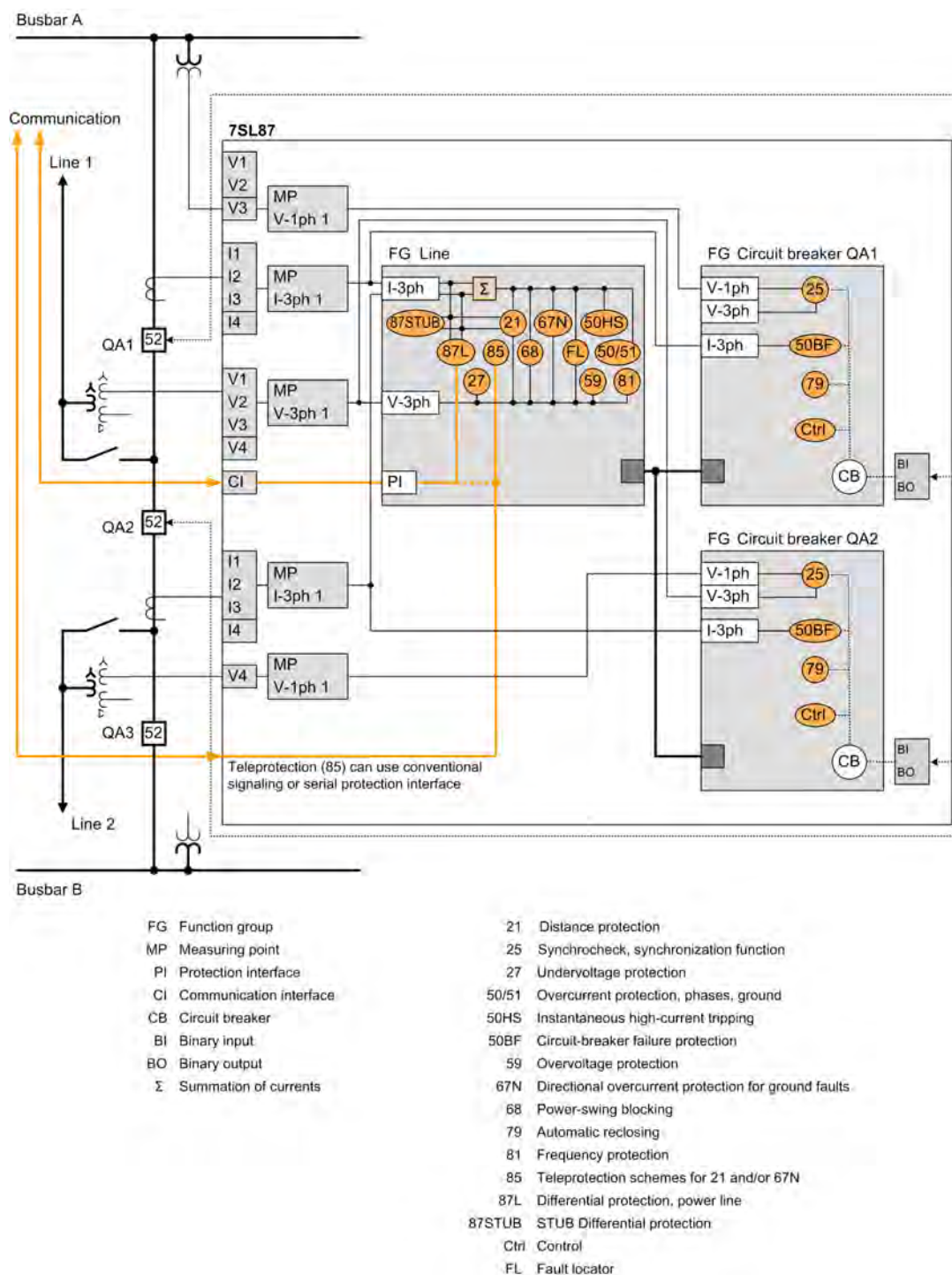


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Figure 2.8/7 Application Example: Combined Line Differential and Distance Protection for Overhead Line

SIPROTEC 5 Devices and Fields of Application

Line Differential and Distance Protection – SIPROTEC 7SL87



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Figure 2.8/8 Application Example: Combined Line Differential and Distance Protection for Overhead Line with Breaker-and-a-Half Layout

SIPROTEC 5 Devices and Fields of Application

Line Differential and Distance Protection – SIPROTEC 7SL87

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	$Z<, V< I>/\angle(V, I)$	■	■	■	■
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	$\theta>$	■			
46	Negative-sequence system overcurrent protection	$I2>$	■			
46	Negative-sequence system and overcurrent protection with direction	$I2>, \angle(V2, I2)$	■			
47	Overvoltage protection, negative-sequence system	$V2>$	■			
49	Thermal overload protection	θ, I^2t	■		■	■
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"	$V>$	■			

2.8

SIPROTEC 5 Devices and Fields of Application

Line Differential and Distance Protection – SIPROTEC 7SL87

ANSI	Function	Abbr.	Available	Application Templates		
				1	2	3
60	Voltage-comparison supervision	$\Delta V >$	■			
67	Directional overcurrent protection, phases	$I >, \angle(V, I)$	■			
67N	Directional ground-fault protection in grounded power systems	$IN >, \angle(V, I)$	■		■	■
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"	$\angle(V0h, I0h)$	■			
	Directional Intermittent Ground-Fault Protection	IIEdir>	■			
68	Power-swing blocking	$\Delta Z/\Delta t$	■		■	■
74TC	Trip-circuit supervision		■			
78	Out-of-step protection	$\Delta Z/\Delta t$	■			
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	$\Delta \varphi >$	■			
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	■			
87L	Line differential protection for 2 line ends	ΔI	■	■	■	■
87L	Line differential protection for 3 to 6 line ends (dependent on significant properties)	ΔI	■	■	■	■
87L/ 87T	Option for line differential protection with Transformer in the Protection Range	ΔI	■			
	Option for line differential protection with charging-current compensation	ΔI	■			
	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 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)		■			

2.8

SIPROTEC 5 Devices and Fields of Application

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				1	2	3
	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)		■	■	■	■
	CFC arithmetic		■			
	Circuit-breaker wear monitoring	ΣI_x , I^2t , 2P	■			
	Switching sequence function		■			
	Inrush-current detection		■			
	External trip initiation		■	■	■	■
	Control		■	■	■	■
PoW	Point-on-wave switching (starting with V7.90)	PoW	■			
	Circuit breaker		■	■	■	■
	Disconnect/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 .						

2.8

Table 2.8/3 SIPROTEC 7SL87 – Functions, Application Templates

(1) Basic

(2) DIFF/DIS RMD Overhead Line, grounded power systems

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