

Description

The SIPROTEC 6MD86 bay controller is a general-purpose control and automation device with protection function. It is designed for use in all voltage levels from distribution to transmission. As part of the SIPROTEC 5 family, it enables a wealth of protection functions from the SIPROTEC library. The modular hardware permits integration of the I/Os depending on the application. Adapt the hardware precisely to your requirements and rely on the future-oriented solutions for protection, control, automation, monitoring, and Power Quality – Basic.

Main function	Bay controller for medium and high to extra-high voltage switchgear with integrated operation and comprehensive protection functions; performance automation, simple configuration with DIGSI 5
Inputs and outputs	7 predefined standard variants with 8 current transformers, 8 voltage transformers, 11 to 75 binary inputs, 9 to 41 binary outputs
Hardware flexibility	Flexibly adjustable and expandable I/O quantity structure within the scope of the SIPROTEC 5 modular system. If high requirements are placed on the quantity structure, the device can be extended in the 2nd row. For example, 240 (and more) binary inputs are possible with the IO230 (see Hardware section).
Housing width	1/3 × 19 inches to 2/1 × 19 inches

Benefits

- Safe and reliable automation and control of your plants
- Purposeful and simple operation of the devices and software thanks to 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 populated printed circuit boards

Functions

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

- Integrated bay controller with versatile protection function from medium to extra-high voltage
- Control of switching devices
- Point-on-wave switching
- Synchrocheck, switchgear interlocking protection and switch-related protection functions, such as circuit-breaker failure protection and automatic reclosing
- Fixed integrated electrical Ethernet RJ45 interface for DIGSI 5 and IEC 61850 (reporting and GOOSE)
- Up to 4 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)



[SIP5_GD_SS_W3, 2, --, --]

Figure 2.16/4 SIPROTEC 6MD86 (1/3 Device with 1/6 Expansion Module with Key Switch Operation Panel)

- 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
- Arc protection
- Graphical logic editor to create powerful automation functions in the device
- Optional overcurrent protection with 3-pole tripping
- Also used in switchgear with breaker-and-a-half layout
- Overcurrent protection also configurable as emergency function
- Secure serial protection communication, also over great distances and all available physical media (optical fiber, two-wire connections and communication networks)
- PQ – Basic: Voltage unbalance; voltage changes: overvoltage, dip, interruption; TDD, THD, and harmonics
- Capturing operational measured variables and protection function measured values to evaluate the plant state, to support commissioning, and to analyze faults
- Synchrophasor measured values with the IEEE C37.118 protocol integrated (PMU)
- Powerful fault recording (buffer for a max. record time of 80 sec. at 8 kHz and 320 sec. at 2 kHz)
- Point-on-wave switching (PoW)
- Auxiliary functions for simple tests and commissioning
- Flexibly adjustable I/O quantity structure within the scope of the SIPROTEC 5 modular system

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SIPROTEC 5 Devices and Fields of Application

Bay Controllers – SIPROTEC 6MD86

Applications

The SIPROTEC 6MD86 bay controller is a general-purpose control and automation device with a protection function on the basis of the SIPROTEC 5 system. The standard variants of the SIPROTEC 6MD86 device are delivered with instrument transformers. Furthermore, protection-class current transformers are also possible in SIPROTEC 6MD86 devices, allowing protection functions to be used. Due to its high flexibility, the device is suitable as selective protection equipment for overhead lines and cables with single-ended and multi-ended infeeds when protection communication is used. The device supports all SIPROTEC 5 system characteristics as well as detection and recording of power-quality data in the medium-voltage and subordinate low-voltage power system.

Application Templates

The following application templates are available:

- SIPROTEC 6MD86 standard double busbar
 - Double busbar feeder with switchgear interlocking protection
 - Synchrocheck for circuit breaker
 - Switching sequence for automatic busbar switchover preconfigured (triggered by function key)
- SIPROTEC 6MD86 breaker-and-a-half type 1
 - Control of a breaker-and-a-half layout (3 circuit breakers, 14 disconnectors)
 - Synchrocheck for the 3 circuit breakers with dynamic measuring-point switchover
- SIPROTEC 6MD86 breaker-and-a-half type 2
 - Control of a part of a breaker-and-a-half layout
 - Supports concepts with multiple bay controllers per bay
 - Circuit-breaker failure protection and automatic reclosing

SIPROTEC 6MD86 point-on-wave switching

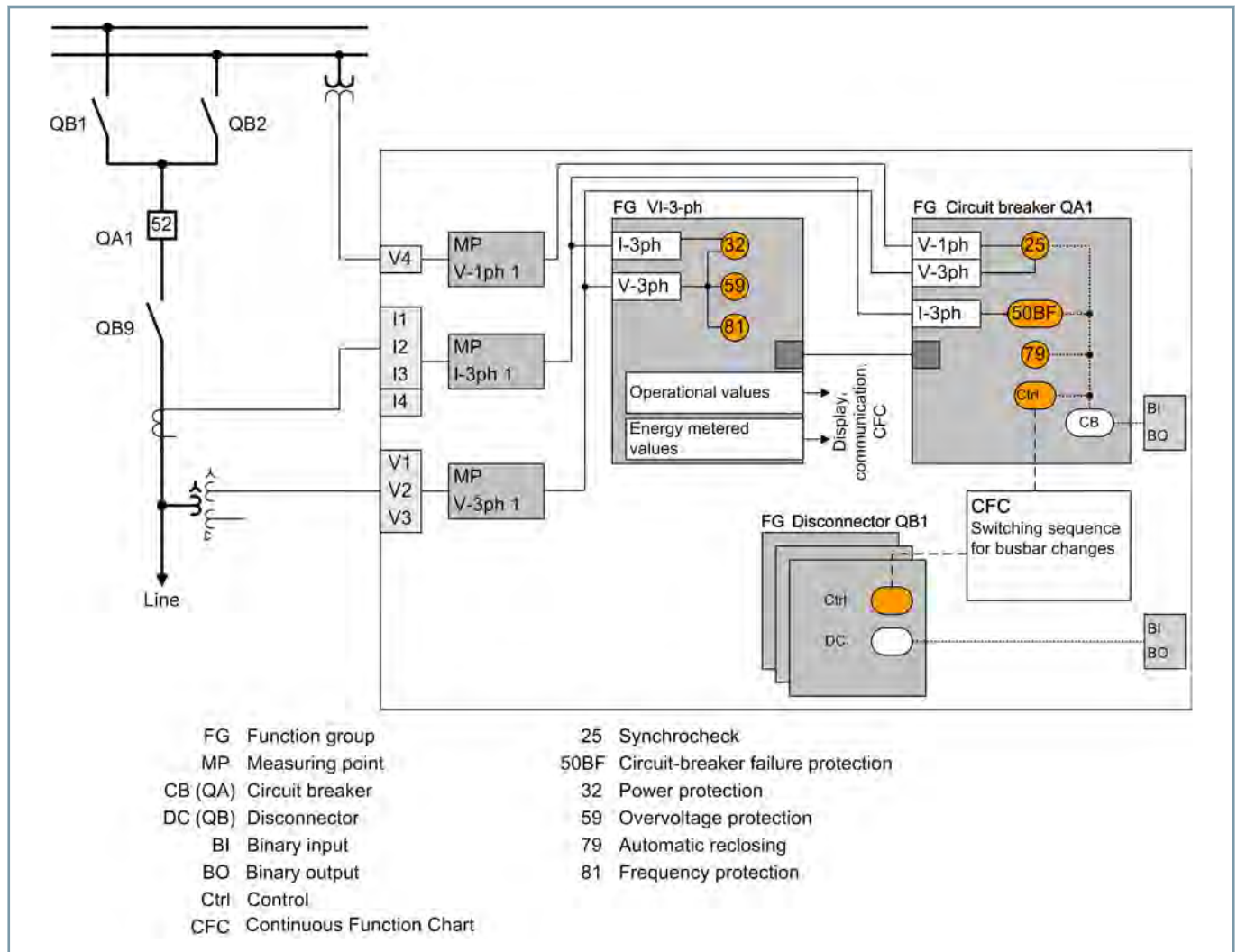
- Controlled switching (Point-on-Wave (PoW)) for precise activation of the 3 individual phases of a switch to minimize the load placed on the equipment.

Application Examples

Double Busbar with Protection Functions

In [Figure 2.16/5](#) the double busbar feeder is controlled and also protected by a 6MD86. For this purpose, circuit-breaker failure protection and the automatic reclosing are activated in the **Circuit breaker** function group. The **VI 3ph** function group

includes the protection functions overvoltage protection, frequency protection, and power protection. In contrast to [Figure 2.16/3](#), it is therefore connected to the circuit breaker so that the resulting trip signals have a destination. Such linkages can be created quickly and flexibly in the DIGSI 5 Editor **Function-group connections** ([Figure 2.16/6](#)).



[dw_6MD8-Bsp-Application-2, 3, en_US]

Figure 2.16/5 Bay Controller 6MD86 for Double Busbar with Protection Functions

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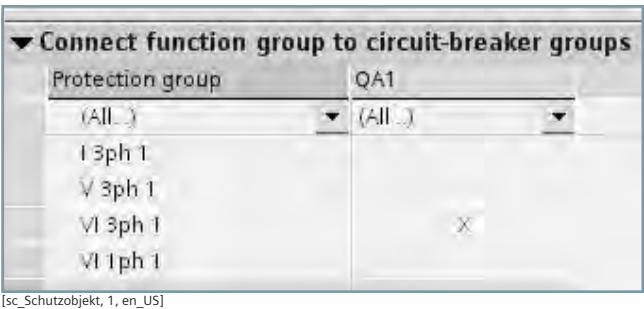
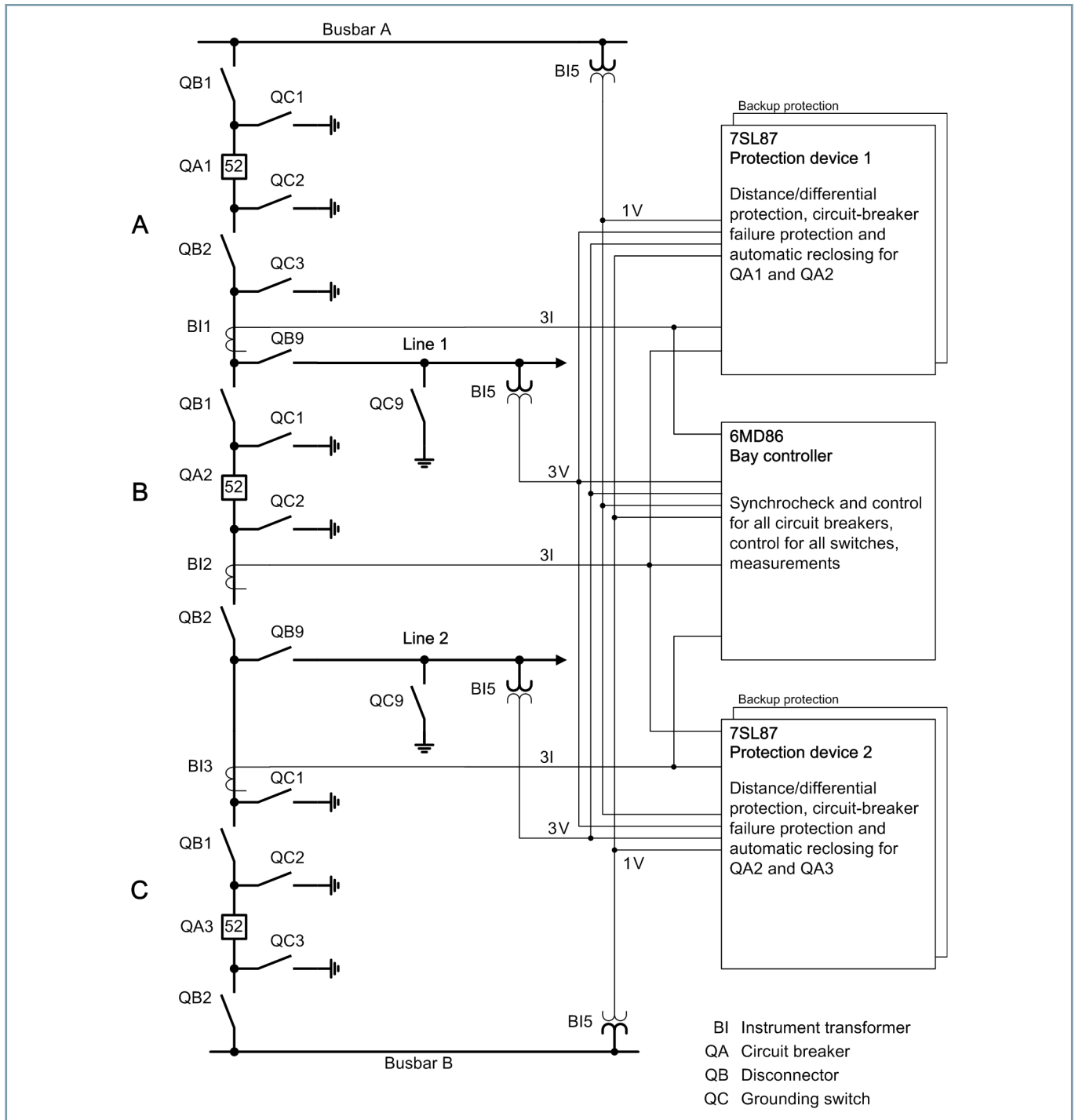


Figure 2.16/6 Assignment of the Function Group with Protection Functions to the Switch (Protected Object)

Breaker-and-a-Half Scheme with Protection and Systems Control

[Figure 2.16/7](#) shows a breaker-and-a-half scheme with protection and systems control. The protection is achieved by 2 SIPROTEC 7SL87 line protection devices which also assume circuit-breaker failure protection and the automatic reclosing of the 3 circuit breakers. The control of all switches and the synchrocheck of the circuit breakers is assumed by the SIPROTEC 6MD86 bay controller. [Figure 2.16/8](#) provides an insight view of the functions of the SIPROTEC 6MD86.



[dw_1-5_CB-Feldleit., 2, en_US]

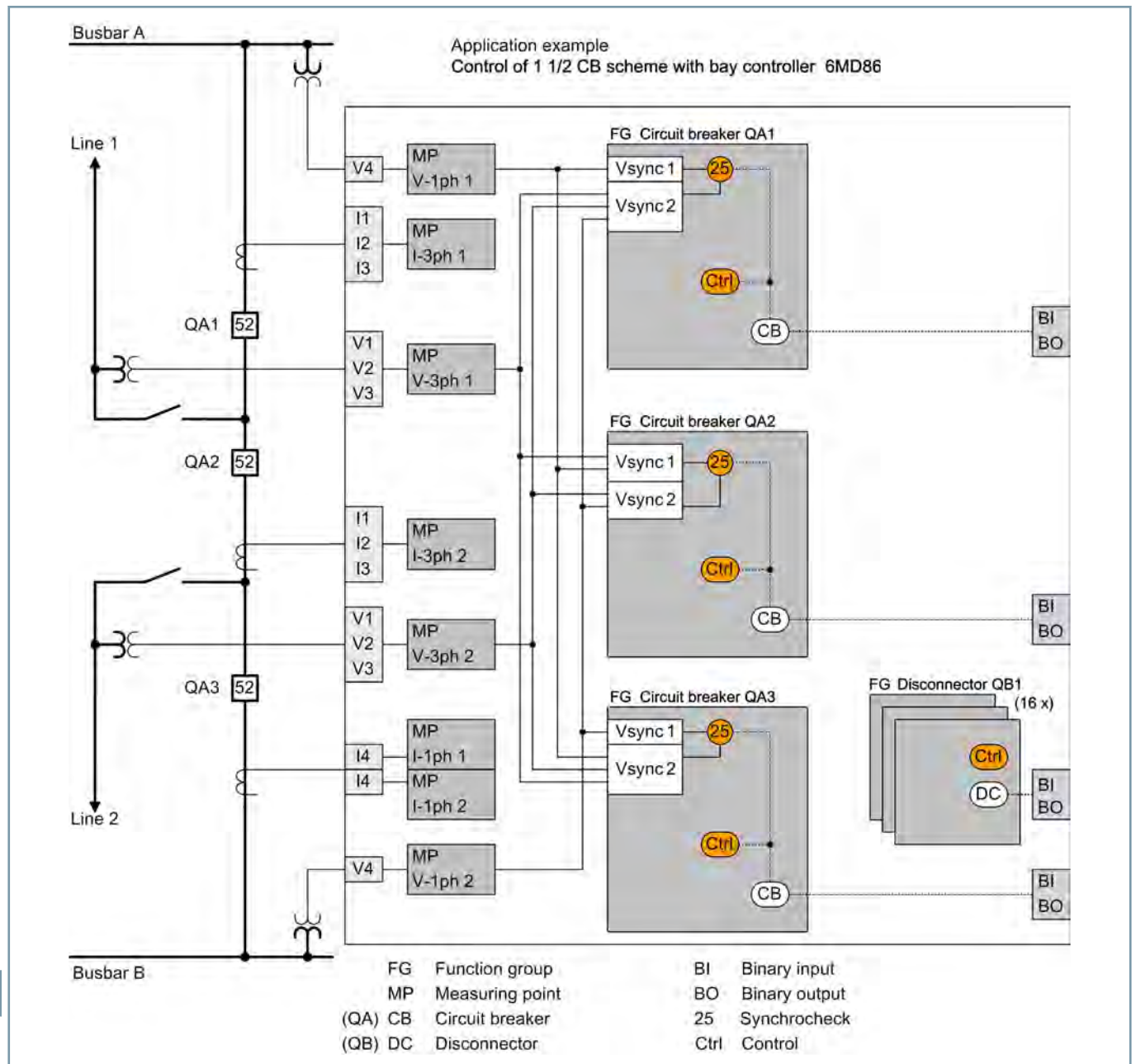
Figure 2.16/7 Breaker-and-a-Half Layout with a Bay Controller and 2 Line Protection Devices (Overview)

Figure 2.16/8 shows the principle of the dynamic switchover of the voltage measurements for the synchrocheck functions of the 3 circuit breakers in the SIPROTEC 6MD86 bay controller. Each synchrocheck function (ANSI number 25) requires both voltages V_{sync1} and V_{sync2} (feeder voltage and reference voltage). With the middle QA2 circuit breaker, there are 2 possi-

bilities for each of the 2 voltages depending on the position of the disconnector and circuit breaker. For the 2 outer QA1 and QA3 circuit breakers, there is 1 possibility for a voltage (that is, the neighboring busbar), while the other voltage is connected by means of 1 of 3 possibilities (likewise depending on the switch position).

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Bay Controllers – SIPROTEC 6MD86



[dw_6MD8-Bsp-Application-3, 1, en_US]

Figure 2.16/8 Breaker-and-a-Half Layout with 1 Bay Controller and 2 Line Protection Devices (Detail for Bay Controller)

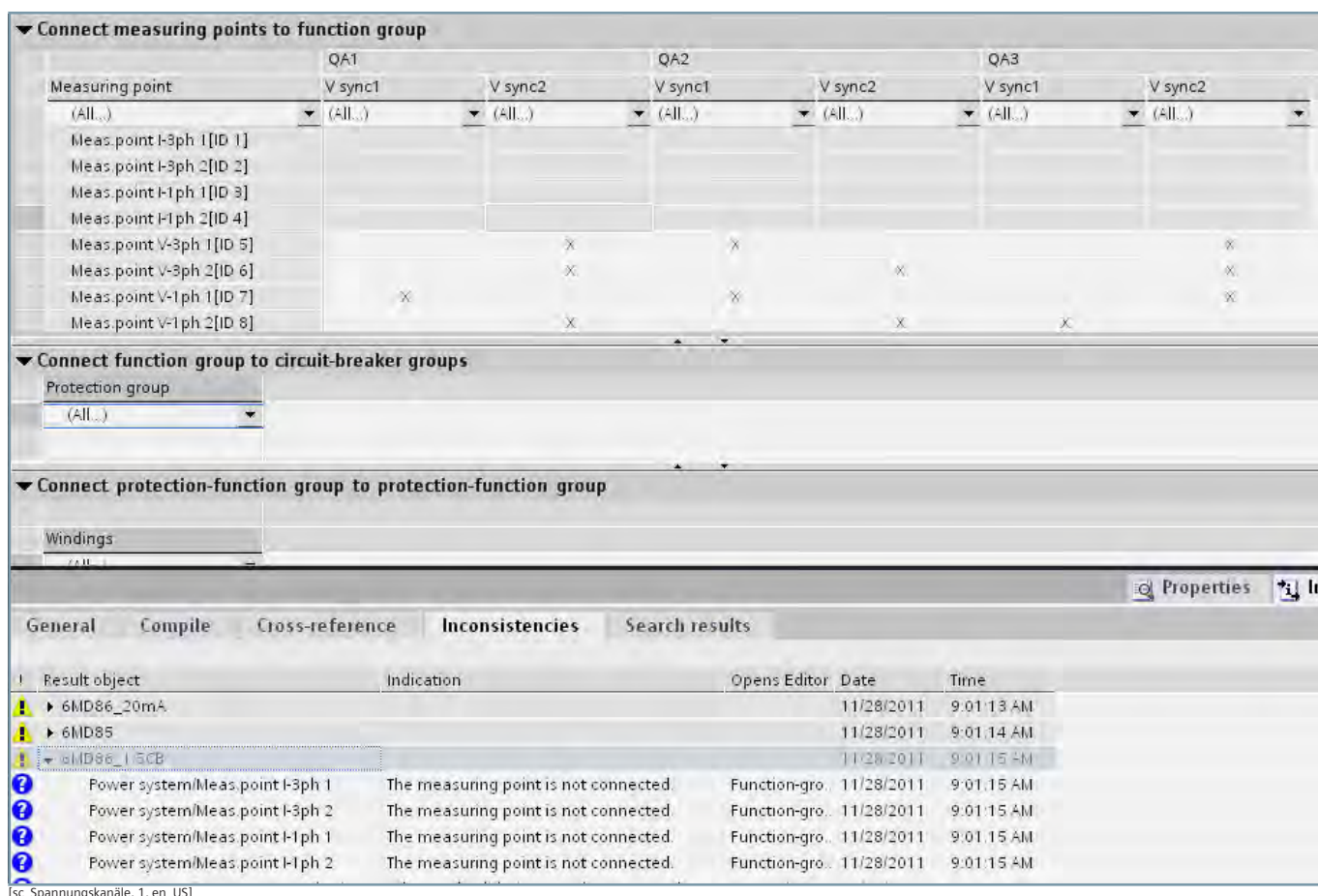


Figure 2.16/9 Routing of the Possible Voltage Terminals to the 3 Circuit-Breaker Function Groups

Figure 2.16/9 shows the routing in the **Function Group Connections** editor. All voltages which are considered as a feeder or reference voltage for the synchrocheck are assigned to the Vsync1 or Vsync2 inputs.

The ID number of the measured values is used to select the voltages which are currently operationally attached in a CFC chart (Figure 2.16/10).

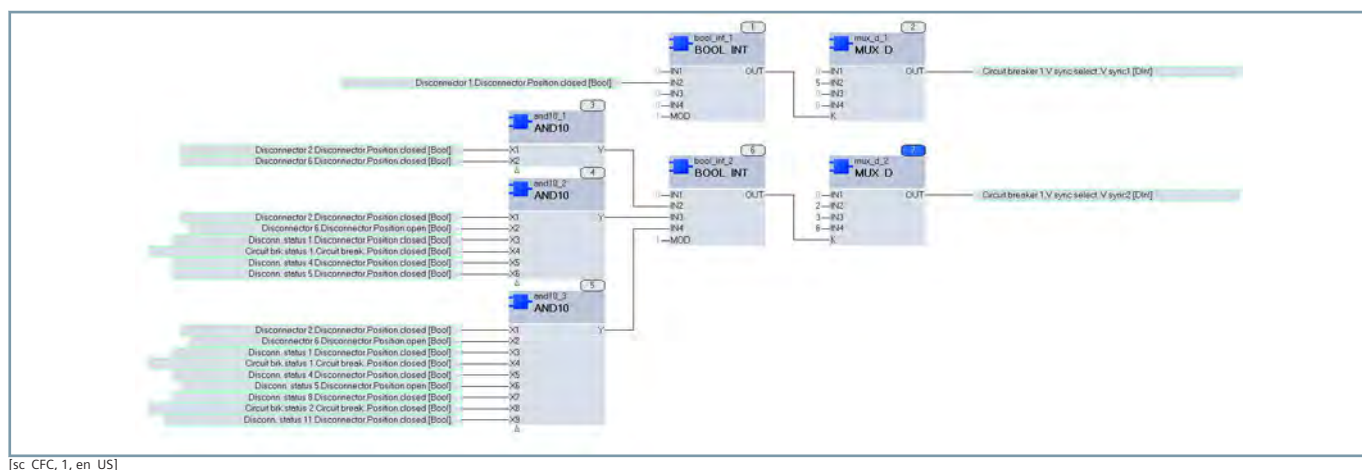


Figure 2.16/10 CFC Chart to Select the Synchrocheck Reference Voltages

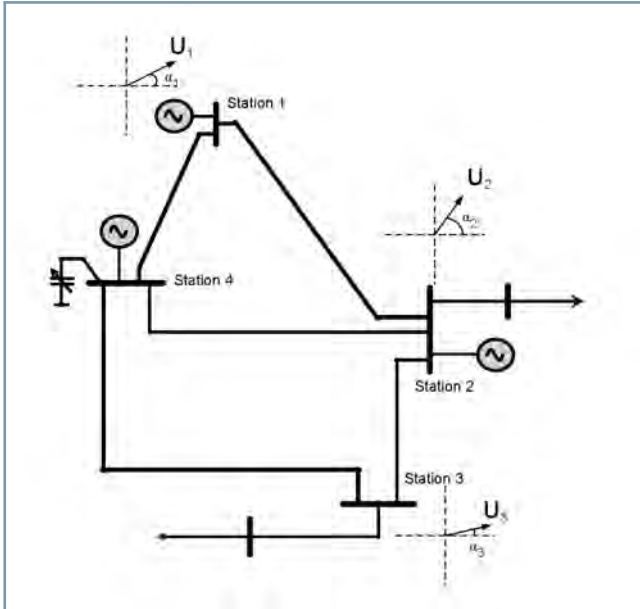
SIPROTEC 5 Devices and Fields of Application

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Use as a Phasor Measurement Unit

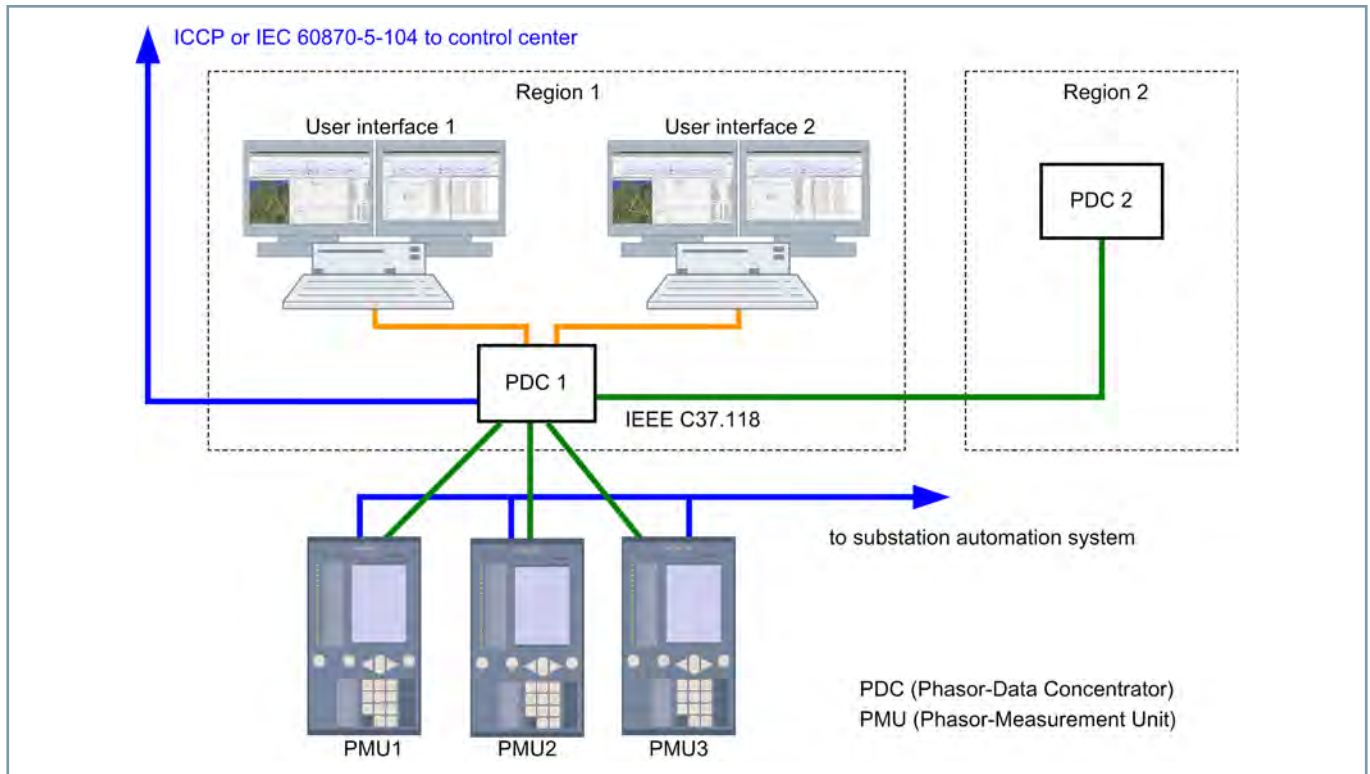
At selected stations of the transmission system, a measurement of current and voltage for absolute value and phase is carried out using PMUs. Due to the high-precision time synchronization (via GPS), the measured values from different substations that are far away from each other are compared, and conclusions about the system state and dynamic events, such as power fluctuations, are drawn from the phase angles and dynamic curves.

If you select the **Phasor Measurement Unit** option, the devices determine current and voltage phasors, add high-precision time stamps, and send these together with other measured values (frequency, rate of change of frequency) to an evaluation station via the communication protocol IEEE C37.118, see [Figure 2.16/12](#). With the aid of the synchrophasor and a suitable analysis program (for example, SIGUARD PDP), it is possible to detect power swings and trip alarms automatically which are sent to the network control center, for example.



[Zeigermessung (PMU), 1, ~, -]

Figure 2.16/11 Principle of the Distributed Phasor Measurement



[dw_struct_WAM, 1, en_US]

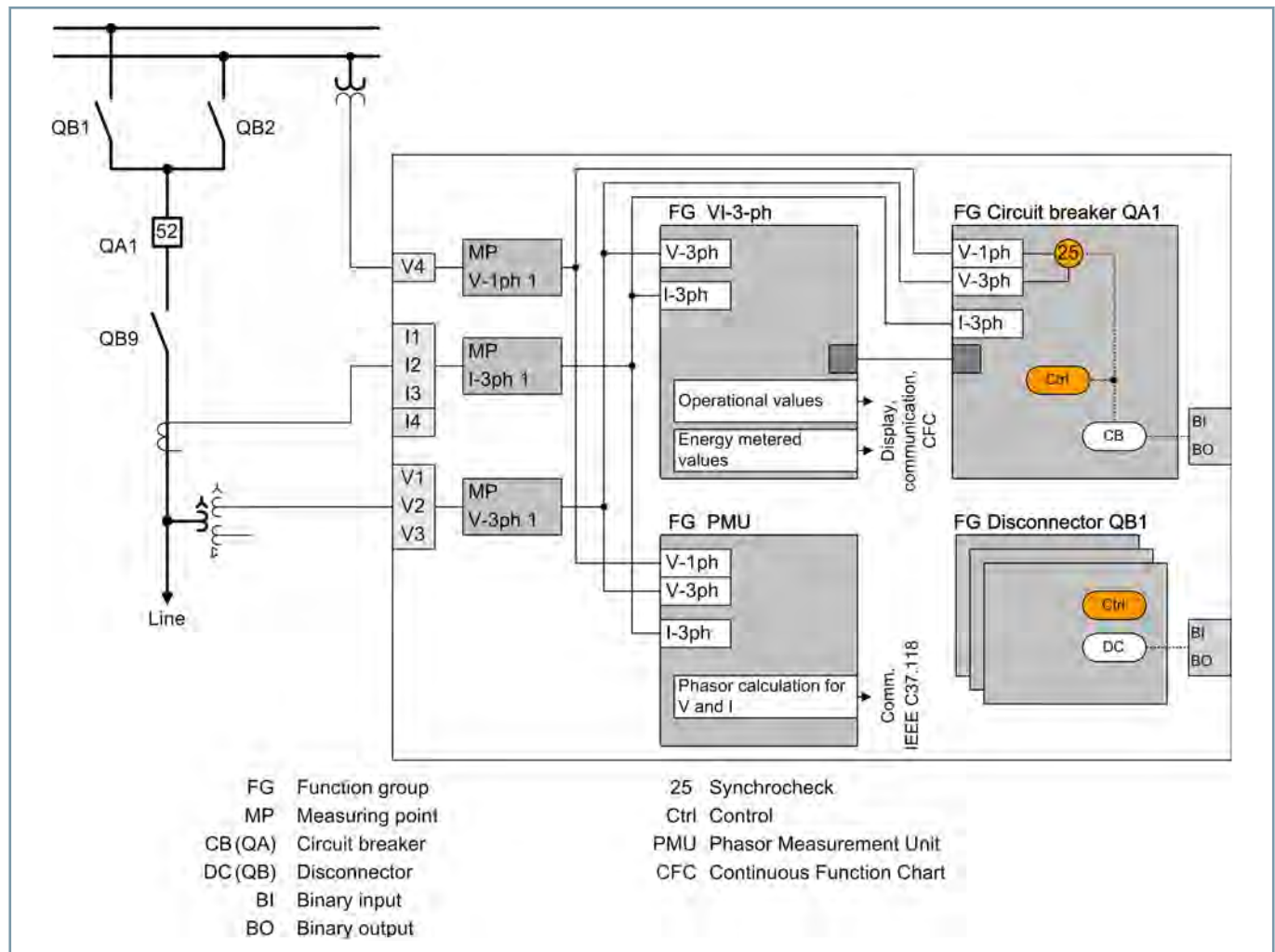
Figure 2.16/12 Connecting 3 Phasor Measurement Units with 2 Phasor Data Concentrators (PDCs) SIGUARD PDP

When the PMU function is used, a **FG PMU** function group is created in the device. This function group calculates the phasor and analog values, add time stamps, and transmits the data to

the selected Ethernet interface via the protocol IEEE C37.118. There, they can be received, saved, and processed by one or more clients. Up to 3 IP addresses from clients can be assigned in the device.

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[dw_6MD8-Bsp-Application-4, 3, en_US]

Figure 2.16/13 Application Example: Double Busbar with SIPROTEC 6MD86 Used as a Bay Controller and Phasor Measurement Unit (PMU)

SIPROTEC 5 Devices and Fields of Application

Bay Controllers – SIPROTEC 6MD86

ANSI	Function	Abbr.	Available	Application Templates				
				1	2	3	4	5
	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 "universal Vx"	V<	■					
27R, 59R	Voltage change protection (starting with V8.30)	dV/dt	■					
32, 37	Power protection active/reactive power	P<>, Q<>	■					
38	Temperature supervision	θ>	■					
46	Negative-sequence system overcurrent protection	I2>	■					
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>>>	■					
50N/ 51N TD	Overcurrent protection, ground	IN>	■					
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)		■					
51V	Voltage-controlled overcurrent protection	t=f(I, V)	■					
59	Overvoltage protection: "3-phase" or "positive-sequence system V1" or "universal Vx"	V>	■					
67	Directional overcurrent protection, phases	I>, ∠(V, I)	■					
67N	Directional overcurrent protection, ground	IN>, ∠(V, I)	■					
74TC	Trip-circuit supervision		■					
74CC	Single circuit monitoring (from V7.9)		■					
79	Automatic reclosing, 1-pole/3-pole	AREC	■				■	
81	Frequency protection: "f>" or "f<" or "df/dt"	f<>; df/dt<>	■					
81U	Underfrequency load shedding	f<(ULS)	■					
86	Lockout		■					
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		■					
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		■		■	■	■	

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ANSI	Function	Abbr.	Available	Application Templates				
				1	2	3	4	5
	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)		■		■	■	■	
	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		■		■	■	■	■
	Disconnect/grounding conductor		■		■	■	■	
	Fault recording of analog and binary signals		■		■	■	■	
	Monitoring		■		■	■	■	
	Protection interface, serial		■					
	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	0	0	75	200
The configuration and function point class for your application can be determined in the SIPROTEC 5 order configurator at www.siemens.com/siprotec .								

Table 2.16/4 SIPROTEC 6MD86 – Functions, Application Templates

- (1) Not preconfigured
- (2) Breaker-and-a-half type 1
- (3) Double busbar
- (4) Breaker-and-a-half type 2
- (5) Point-on-wave switching

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Standard Variants for SIPROTEC 6MD86

The standard variants of the 6MD86 also include an Ethernet communication module, a large display, and key switch (starting with type K2)

K1	1/3, 11 BI, 9BO, 4 I, 4 V	
	Housing width 1/3 x 19" 1 electrical Ethernet module ETH-BA-2EL 11 binary inputs 9 binary outputs (1 life contact, 2 standard, 6 fast) 4 sensitive current-transformer inputs 4 voltage-transformer inputs Contains the following modules: base module with PS201 and IO202	
K2	1/2, 27 BI, 17 BO, 4 I, 4 V	
	Housing width 1/2 x 19" 1 electrical Ethernet module ETH-BA-2EL 27 binary inputs 17 binary outputs (1 life contact, 10 standard, 6 fast) 4 sensitive current-transformer inputs 4 voltage-transformer inputs Contains the following modules: base module with PS201 and IO202 Expansion module IO207	
K4	2/3, 43 BI, 25 BO, 4 I, 4 V	
	Housing width 2/3 x 19" 1 electrical Ethernet module ETH-BA-2EL 43 binary inputs 25 binary outputs (1 life contact, 18 standard, 6 fast) 4 sensitive current-transformer inputs 4 voltage-transformer inputs Contains the following modules: base module with PS201 and IO202 Expansion modules 2 x IO207	
K5	5/6, 59 BI, 33 BO, 4 I, 4 V	
	Housing width 5/6 x 19" 1 electrical Ethernet module ETH-BA-2EL 59 binary inputs 33 binary outputs (1 life contact, 26 standard, 6 fast) 4 sensitive current-transformer inputs, 4 voltage-transformer inputs Contains the following modules: base module with PS201 and IO202 Expansion modules 3 x IO207	
K7	1/1, 75 BI, 41 BO, 4 I, 4 V	
	Housing width 1/1 x 19" 1 electrical Ethernet module ETH-BA-2EL 75 binary inputs 41 binary outputs (1 life contact, 34 standard, 6 fast) 4 sensitive current-transformer inputs 4 voltage-transformer inputs Contains the following modules: base module with PS201 and IO202 Expansion modules 4 x IO207	

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K8	1/1, 67 BI, 39 BO, 8 I, 8 V	
	Housing width 1/1 x 19" 1 electrical Ethernet module ETH-BA-2EL 67 binary inputs 39 binary outputs (1 life contact, 26 standard, 12 fast) 8 sensitive current-transformer inputs 8 voltage-transformer inputs Contains the following modules: base module with PS201 and IO202 Expansion modules IO202, 3 x IO207	
K9	5/6, 35BI, 17BO(8HS), 4I, 4V, 8 MT-F	
	Housing width 5/6 x 19" 35 binary inputs 17 binary outputs (1 life contact, 2 standard, 6 fast, 8 high-speed relays with semiconductor acceleration) 4 current transformers (protection) 4 voltage transformers 8 fast measuring-transducer inputs for current (20 mA) or voltage (10 V)	

Table 2.16/5 Standard Variants for Bay Controllers SIPROTEC 6MD86

You can find the technical data of the devices in the manual

www.siemens.com/siprotec