SIPROTEC –
Synonym for the world’s leading protection technology

More than 1.6 Mill. devices installed therein >500,000 with IEC 61850

- First use of electro-magnetic relays
- The digital age begins for protection relays
- Siemens is honored by Frost & Sullivan for the implementation of IEC 61850
- More than one million SIPROTEC devices in operation
- SIPROTEC 5 integrated End-to-End Cyber Security
- SIPROTEC 5 IoT connectivity to MindSphere
- First digital application in Wuerzburg, Germany
- SIPROTEC 4 multi-functional relay series
- SIPROTEC Compact – compact and outstanding functionality
- SIPROTEC 5 benchmark for protection, automation and monitoring
- SIPROTEC 5 process bus and digital substation
- Cloud based applications for SIPROTEC

SIPROTEC 5 –
The benchmark for protection, automation and monitoring

SIPROTEC 5 –
A flexible generation of intelligent, digital field devices with a high degree of modularity

Individually configurable devices –
Save money over the entire life cycle

Trendsetting system architecture –
Flexibility and safety for all kind of grids

Multi-layered integrated safety mechanism –
Highest possible level of safety and availability

Consistent system and device engineering –
Efficient operating concepts, flexible engineering
SIPROTEC 5 – Proven solutions for all applications

- 7SJ8  Overcurrent and feeder protection
- 7SA8  Distance protection
- 7SD8  Line differential protection
- 7SL8  Combined line differential & distance protection
- 7UT8  Transformer differential protection
- 7VE8  Paralleling device
- 7SS85 Busbar protection
- 7SK8  Motor protection
- 7VK8  Breaker management
- 7UM85 Generator protection
- 6MD8  Bay controller
- 7KE85 Fault recorder
- 6MU85 Merging unit

Easy engineering and evaluation – DIGSI and SIGRA
Highlights V7.9 and V8.0

- **SIPROTEC DigitalTwin**
  - Compatibility of SIPROTEC 4 and SIPROTEC 5 for 87L and 21
  - IEC 61850-9-2 Process bus for digital substations (Server/Client)
  - SIPROTEC 6MU85 Merging Unit
  - Time synchronization with IEEE 1588 for High Precision applications
  - SIPROTEC 7SS85 distributed busbar protection based on process bus
  - Point-on-wave switching
  - Conformal coating of SIPROTEC 5 devices as standard
- Cyber Security
- ATEX certification for 7SK85 and 7UM85
- New overcurrent and feeder protection SIPROTEC 7SJ81
- Web Browser
- Further functions
SIPROTEC DigitalTwin

Application Scenarios

Control Center

Integration in SICAM Systems

Station Level

Communication

Firewall

SICAM Substation Automation

SICAM SCC Human Machine Interface

SICAM POS Power Quality Analysis

DIGSI 5 Online Testing DIGSI

Station bus

Field Level

GOOSE Testing

Process Simulation Device Testing Device Training

Remote Substation

Testing of protection interface

Process Level
Saves time, increases quality throughout the entire lifecycle of your system

Pre-sales and Design
- Information and Presentations
- Application concept and testing
- Design Specification
- Approvals

Implementation
- Planning
- Algorithm
- Settings
- Pre-testing

Commissioning
- FAT
- SAT, Field test
- Fault analysis

Operation
- Device handling
- COMTRADE replay

Training
- Device handling
- Operators
- Customer specific
- Flexible at any place

Maintenance and Service
- Fault analysis
- COMTRADE replay
- Upgrade scenarios
Saves time, increases quality throughout the entire lifecycle of your system

**Maintenance and Service**
- Fault analysis
- COMTRADE replay
- Upgrade scenarios

**Pre-sales and Design**
- Information and Presentations
- Application concept and testing
- Design Specification
- Approvals

**Implementation**
- Planning
- Algorithm
- Settings
- Pre-testing

**Commissioning**
- FAT
- SAT, Field test
- Fault analysis

**Operation**
- Device handling
- COMTRADE replay

**Training**
- Device handling
- Operators
- Customer specific
- Flexible at any place

**Maintenance and Service**
- Fault analysis
- COMTRADE replay
- Upgrade scenarios
Benefits – The customer value proposition

Testing of the energy automation system within minutes, without hardware and without additional effort

- Simulation and validation of product properties
- Faster energization of new systems thanks to shorter project lifetimes
  - Increase engineering quality
  - Virtual testing before start of commissioning
  - Shortest commissioning times
- Reduced OPEX with shorter outages for higher availability thanks to better pre-testing
- Efficient, scalable trainings on the job
- Fast and realistic fault analysis by easily reproducing the behavior of products and systems
Access your SIPROTEC DigitalTwin in 5 Steps

1. Open DIGSI 5 project
2. Export SIM file
3. Connection to the Cloud
4. Import SIM
5. SIPROTEC DigitalTwin
Highlights V7.9 and V8.0

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Interoperability of SIPROTEC 4 and SIPROTEC 5
Line protection – Profile

**Requirement**
- Replacement of protection devices after end of live
- New devices to be added to the protection topology
- Stepwise replacement or retrofit of SIPROTEC 4 protection devices

**Solution**
- Direct interoperable connection of SIPROTEC 5 and SIPROTEC 4 protection interfaces
- 2 – 6 line end differential protection
- Distance protection: PUTT or POTT teleprotection
- Transformer within protection zone

PUTT: Permissive Underreaching Transfer Trip
POTT: Permissive Overreaching Transfer Trip

**Function**
- Modules changeable and upgradeable
- Range extension via additional repeater
- Monitoring of protection interface transfer quality
- Remote commands and signals via protection interface

**Benefits**
- Mixed operation SIPROTEC 4 and SIPROTEC 5
- Step-by-step replacement and expansion of individual substations
- Line differential protection of other systems remains in operation
- Short switch-off time during conversion
- Use of existing communication links
Interoperability of SIPROTEC 4 and SIPROTEC 5
Communication infrastructure

- **Customer requirement**
  - USART-AD1FO / USART-AE2FO
  - Distances up to 60 km
  - FO17-18

- **Customer requirement**
  - USART-AD1FO / USART-AE2FO
  - Distances up to 100 km
  - FO19

- **Customer requirement**
  - USART-AD1FO / USART-AE2FO
  - Distances of more than 100 km
  - FO5

  All media between communication converters 7XV5662, e.g., pilot wire, G703, X21
  - FO5
Interoperability of SIPROTEC 4 and SIPROTEC 5
Example 1 – stepwise retrofit of protection relays

Station 1

Device logoff

Device logon

Station 2

Station 3

Station 4
Interoperability of SIPROTEC 4 and SIPROTEC 5
Example 1 – stepwise retrofit of protection relays
Interoperability of SIPROTEC 4 and SIPROTEC 5
Example 1 – stepwise retrofit of protection relays
Interoperability of SIPROTEC 4 and SIPROTEC 5
Example 1 – stepwise retrofit of protection relays
Interoperability of SIPROTEC 4 and SIPROTEC 5
Example 2 – extension of tapped line

Station 1

Device logoff

Station 2

Device logoff
Interoperability of SIPROTEC 4 and SIPROTEC 5

Example 2 – extension of tapped line
Highlights V7.9 and V8.0

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- Further functions
Digital Substation 4.0

Benefits

- Flexible solutions for different level of digitalization
- Process bus closes the gap to a fully digitalized system
- Agile for future requirements
- Digitalization of all primary data close to the process
- Data for optimizing grid control and monitoring
- Remote engineering and testing
Digital Substation 4.0

Process Bus Overview

Protocol on ETH-BD-2FO

<table>
<thead>
<tr>
<th>Protocol on ETH-BD-2FO</th>
<th>MU</th>
<th>PB Client</th>
<th>PTP (1 µs acc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7SA86, 7SA87</td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>7SD86, 7SD87</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>7SL86, 7SL87</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>7VK87</td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>7UT85, 7UT86, 7UT87</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>7SK85</td>
<td></td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>7UM85</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>7VE85</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>7SS85</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>7SJ85, 7SJ86</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>6MD85, 6MD86</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>6MU85</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>7KE85</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>7SJ81, 7Sx82 (non modular)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>7ST85, 6MD89</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>
SIPROTEC Merging Unit
One base module adapts to all sensor types

Principle of a Process Bus

- Stand-Alone merging unit
- Copper wires via short distances
- Digital interface for instrument transformers IEC 61869-9

- Merging unit as part of switchgear
- Low power stand alone current, voltage and combined sensors
- IEC 61869-10 and 11

* In preparation

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Sasho Martinovski / Energy Automation Products
Highlights V7.9 and V8.0

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- Web Browser
- Further functions
SIPROTEC 5 Merging Unit – Perfectly tailored fit to your requirements (examples shown)

**Perfectly tailored fit**

- Adaptable to multiple CT, VT, LPIT inputs
- Scalable BI and BO
- Direct “high speed” tripping of circuit breaker < 1 ms
- Collection of additional data (temperature, pressure, tap changer positions, …)
- Redundant power supply*
- Expandable by a 2nd row

* in preparation

<table>
<thead>
<tr>
<th>Aux-PS</th>
<th>CT</th>
<th>VT</th>
<th>BI</th>
<th>BO-STD</th>
<th>BO-HS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td></td>
<td>4 C divider</td>
<td>19</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Redundant*</td>
<td>12 PCIT</td>
<td>4 MCIT</td>
<td>4 CIT</td>
<td>111</td>
<td>8 4 … 20 mA 4</td>
</tr>
<tr>
<td>Redundant*</td>
<td>8 PCIT</td>
<td>4 CIT</td>
<td>35</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>Single</td>
<td>8 optical*</td>
<td>8 CIT</td>
<td>11</td>
<td>7</td>
<td>12</td>
</tr>
</tbody>
</table>

PCIT … Protection CIT, MCIT … Measurement CIT

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Sasho Martinovski / Energy Automation Products
SIPROTEC 5
Merging Unit functionality

- Ethernet communication module **ETH-BD-2FO** for process bus functionality required
- One Sampled Measured Value (SMV) stream per ETH-BD-2FO Ethernet module
  - up to 32 analog values in any combination of CT and VT
  - or 4x CT, 4x VT (IEC 61850-9-2LE)

- Up to 4 **ETH-BD-2FO** modules supported

- IEC 61869-9, IEC 61869-13 compliant
- IEC 61850-8-1 GOOSE, MMS and Merging Unit protocol on the same Ethernet module

- Sample synchronization via IEEE 1588v2/PTP

- Engineering with DIGSI 5 and IEC 61850 System Configurator

<table>
<thead>
<tr>
<th>MU</th>
</tr>
</thead>
<tbody>
<tr>
<td>7SA86, 7SA87</td>
</tr>
<tr>
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</tr>
<tr>
<td>7SL86, 7SL87</td>
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<tr>
<td>7VK87</td>
</tr>
<tr>
<td>7UT85, 7UT86, 7UT87</td>
</tr>
<tr>
<td>7SK85</td>
</tr>
<tr>
<td>7UM85</td>
</tr>
<tr>
<td>7VE85</td>
</tr>
<tr>
<td>7SS85</td>
</tr>
<tr>
<td>7SJ85, 7SJ86</td>
</tr>
<tr>
<td>6MD85, 6MD86</td>
</tr>
<tr>
<td>6MU85</td>
</tr>
<tr>
<td>7KE85</td>
</tr>
<tr>
<td>7SJ81, 7Sx82 (non modular)</td>
</tr>
<tr>
<td>7ST85, 6MD89</td>
</tr>
</tbody>
</table>

Example:
- Maximum configuration of four SMV streams, publishing to two physically separated networks (four networks possible)
- Minimum configuration of SMV streams

Availability of Merging Unit functionality (server)
SIPROTEC 5
Process Bus Client

- Ethernet communication module **ETH-BD-2FO** necessary
- Up to 32 analog values per ETH-BD-2FO (up to 80\(^1\)) using 3x ETH-BD-2FO

- Support of IEC 61850-9-2LE streams
- Support of IEC 61869 flexible streams
- IEC 61850-8-1 GOOSE, MMS and Process Bus Client protocol on the same module

- Supported protection functions 87B, 87L, 87T, 21, 67/67N, 50/50N, 51/51N, … \(^2\)
- Test- and Simulation Bit support
- Sample synchronization for mixed configurations of direct connected instrument transformers and sampled measured values via IEEE 1588v2/PTP
- Interoperability with multivendor merging units \(^3\)

- Engineering with DIGSI 5 and IEC 61850 system configurator

---

1) Limitations: network bandwidth of 100Mbit/s, limitation of 40 analog values per SIPROTEC 5 device (except 7SS85 limit of 80 values)
2) 87L supports two terminals
3) Interoperability is regulated in IEC 61850-9-2 Edition 2.1 (not published at this time), use of 3rd party MU must be coordinated with DG SA&P headquarter

---

**Availability of Process Bus Client functionality**

<table>
<thead>
<tr>
<th>PB Client</th>
<th>7SA86, 7SA87</th>
<th>✓</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td>7SL86, 7SL87</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>7VK87</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>7UT85, 7UT86, 7UT87</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>7SK85</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>7UM85</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>7VE85</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>7SS85</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>7SJ85, 7SJ86</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>6MD85, 6MD86</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>6MU85</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>7KE85</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>7SJ81, 7Sx82 (non modular)</td>
<td>✗</td>
</tr>
<tr>
<td></td>
<td>7ST85, 6MD89</td>
<td>✗</td>
</tr>
</tbody>
</table>
**SIPROTEC 5 Process bus example**

**Physically network segregation example**

**Simplify complexity**

Use of more than one redundant process bus network reduces the network engineering.

Increase the bandwidth with additional Ethernet interfaces.

Efficient use of network bandwidth with customization of the analog values per SMV streams (not only IEC 61850-9-2LE data set).
Central Protection for small substations

Process Bus (PRP)

IEEE 1588v2 / PTP GMC

Sample synchronisation

Central Protection with 7SS85

FG VI 01 3ph 1
50 67
51 21

FG VI 02 3ph 1
50 67
51 21

FG VI 10 3ph 1
50 67
51 21

FG Circuit Breaker 1
50BF CTRL

FG Circuit Breaker 2
50BF CTRL

FG Bus 87S8

FG Circuit Breaker 10
50BF CTRL
Central Protection for small substations and Line Protection

Central Protection with 7UT87

- PI
- FG Line
- FG Transf. side 1
- FG Transf. side 2
- FG Transf.
- FG Circuit Breaker 1
- FG Circuit Breaker 2
- FG Circuit Breaker 3
- FG Circuit Breaker 4

Sample synchronization

IEEE 1588v2 / PTP GMC

Process Bus (PRP)

6MU85

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SIPROTEC 5
New Ethernet module – ETH-BD-2FO

Communication module for the transmission of Ethernet protocols via 2 optical interfaces

Supports modular SIPROTEC 5 devices 7xx85/86/87*

Available protocols (DIGSI 5 V7.90)
- PRP
- Line Mode
- IEC 61850-8-1 GOOSE, MMS
- COMFEDE support via MMS file transfer
- IEEE 1588v2/PTP (1µs accuracy) ordinary slave clock for radial networks (PRP and Line Mode)
- DIGSI 5 protocol
- DCP, DHCP
- Homepage
- WebUI
- SysLog
- RADIUS

Additional protocols (DIGSI 5 V8.00)
- Process Bus Client
- Merging Unit

<table>
<thead>
<tr>
<th>Transmit Power</th>
<th>Minimum</th>
<th>Typical</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 µm/125 µm, NA1 = 0.2</td>
<td>-24.0 dBm</td>
<td>-21.0 dBm</td>
<td>-17.0 dBm</td>
</tr>
<tr>
<td>62.5 µm/125 µm, NA1 = 0.275</td>
<td>-20.0 dBm</td>
<td>-17.0 dBm</td>
<td>-14.0 dBm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Receiver sensitivity</th>
<th>Maximum -12.0 dBm</th>
<th>Minimum -31.0 dBm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical budget</td>
<td>Minimum 7.0 dB for 50 µm/125 µm, NA1 = 0.2</td>
<td>Minimum 11.0 dB for 62.5 µm/125 µm, NA1 = 0.275</td>
</tr>
<tr>
<td>Interface design</td>
<td>Correlates to IEEE 802.3, 100Base-FX</td>
<td></td>
</tr>
<tr>
<td>Laser class 1 as per EN 60825-1/-2</td>
<td>With the use of 62.5 µm/125 µm and 50 µm/125 µm optical fibers</td>
<td></td>
</tr>
</tbody>
</table>

Comment: 1 numerical aperture (NA = sin θ (launch angle))
# Time and Sample synchronization

**Precision Time Protocol – IEEE 1588v2/PTP**

<table>
<thead>
<tr>
<th>Communication Plug-In Module</th>
<th>NEW ETH-BD-2FO</th>
<th>ETH-BA-2EL ETH-BB-2FO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol</td>
<td>IEEE 1588v2-2008</td>
<td>IEEE 1588v2-2008</td>
</tr>
<tr>
<td>Type of implementation</td>
<td>Hardware / FPGA</td>
<td>Software</td>
</tr>
<tr>
<td>Accuracy</td>
<td>1µs</td>
<td>1 ms</td>
</tr>
<tr>
<td>Supported devices</td>
<td>modular SIPROTEC 5 devices 7xx85/86/87 (except 7ST85, 6MD89)</td>
<td>All SIPROTEC 5 devices</td>
</tr>
<tr>
<td>Supported Redundancy</td>
<td>PRP Line Mode</td>
<td>PRP (symmetrical) Line Mode</td>
</tr>
<tr>
<td>Supported Profiles</td>
<td>IEC 61850-9-3</td>
<td></td>
</tr>
<tr>
<td>Clock Type</td>
<td>Ordinary Slave Clock (OSC)</td>
<td>Ordinary Slave Clock (OSC)</td>
</tr>
<tr>
<td>Applications</td>
<td>Date and Time synchronization, Sample Synchronization for Process Bus, PMU data synchronization, 87L stabilization for asymmetrical PI networks</td>
<td>Date and Time synchronization</td>
</tr>
</tbody>
</table>
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Busbar Protection SIPROTEC 7SS85

Universal protection device for both centralized and distributed busbar protection solutions

Fully-compatible, IEC 61850 distributed busbar protection
Universal protection device for centralized and distributed busbar protection solutions

- Optional connection of the process data directly to the central unit or in the field to the merging unit
- Acquisition of measured values in the field at the merging unit and transmission compliant to IEC 61850-9-2 and/or via central IO module in SIPROTEC 7SS85
- Acquisition of binary input signals (e.g. isolator and circuit breaker positions, LS failure protection messages) in the field at the merging unit and transmission compliant with IEC 61850 GOOSE and/or via central IO module in the SIPROTEC 7SS85
- Output of binary signals (e.g. protection trips, transfer trip, bay out of service) in the field via the merging unit compliant with IEC 61850 GOOSE and/or via central IO module in the SIPROTEC 7SS85
- New hardware standard variant V4 (1/3 housing, 19 BI, 11 BA, 0 CT, 0 VT) as preferred version for distributed busbar protection solutions

<table>
<thead>
<tr>
<th>Hardware Variant</th>
<th>Binary Inputs</th>
<th>Binary Outputs</th>
<th>CTs</th>
<th>ETH-BD-2FO Module</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>15</td>
<td>13 (2S, 10F, 1 Life)</td>
<td>12</td>
<td>0</td>
<td>Standard variant for significant feature 9 (centralized)</td>
</tr>
<tr>
<td>V2</td>
<td>11</td>
<td>11 (2S, 8F, 1 Life)</td>
<td>16</td>
<td>0</td>
<td>Standard variant for significant feature B (centralized)</td>
</tr>
<tr>
<td>V3</td>
<td>15</td>
<td>15 (2S, 12F, 1 Life)</td>
<td>24</td>
<td>0</td>
<td>Standard variant for significant feature C, D, E (centralized)</td>
</tr>
<tr>
<td>V4</td>
<td>19</td>
<td>11 (10S, 0F, 1 Life)</td>
<td>0</td>
<td>1</td>
<td>Standard variant for all significant features (distributed)</td>
</tr>
</tbody>
</table>
Fully compatible IEC 61850
distributed busbar protection

SIPROTEC 7SS85 as a process bus client

Merging Unit (Process bus Server) can be:

• SIPROTEC 6MU85
• Any modular SIPROTEC 5 device with a process bus communication module ETH-BD-2FO
• IEC 61850 compatible third-party Merging Unit

Analog and binary process information

• Acquisition of measured values in the field at the merging unit and transmission compliant with IEC 61850-9-2
• Acquisition of binary input signals (e.g. isolator and circuit breaker positions, LS failure protection messages) in the field at the merging unit and transmission compliant with IEC 61850 GOOSE
• Output of binary signals (e.g. protection trips, transfer trip, bay out of service) in the field via the merging unit compliant with IEC 61850 GOOSE

Engineering

• Standard IEC 61850 Configuration Tools (e.g. IEC 61850 System Configurator)
• DIGSI 5
Distributed busbar protection
SIPROTEC 7SS85

Smart transition of energy systems
• Inter-operable IEC 61850 busbar protection solution
• Distributed process data acquisition:
  • Merging Unit SIPROTEC
  • Every modular SIPROTEC 5 device
  • Third party merging unit
• Simple expansion of existing SIPROTEC 5 systems with distributed busbar protection
• Open engineering through standard IEC 61850 configuration tools and DIGSI 5
Busbar protection SIPROTEC 7SS85 as centralized protection

- Busbar protection (87B) for up to 20 bays
- Impedance protection (21T) for up to 10 bays
- Directional time-overcurrent protection phase/ground (67/67N) for up to 10 bays
  - Non-directional time-overcurrent protection phase/ground (50/51N) for up to 20 bays
  - Circuit-breaker failure protection (50BF) for up to 20 bays
  - End fault protection (50EF) for up to 20 bays
- Voltage protection for up to 4 voltage measurements
Highlights V7.9 and V8.0

- SIPROTEC DigitalTwin
- Compatibility of SIPROTEC 4 and SIPROTEC 5 for 87L and 21
- IEC 61850-9-2 Process bus for digital substations (Server/Client)
- SIPROTEC 6MU85 Merging Unit
- Time synchronization with IEEE 1588 for High Precision applications
- SIPROTEC 7SS85 distributed busbar protection based on process bus

**Point-on-wave switching**
- Conformal coating of SIPROTEC 5 devices as standard
- Cyber Security
- ATEX certification for 7SK85 and 7UM85
- New overcurrent and feeder protection SIPROTEC 7SJ81
- Web Browser
- Further functions
Point-on-Wave Switching with SIPROTEC 5 (V7.90)

- Minimization of electro-dynamic and dielectric stress on equipment as a result of switching operations
- Longer service life of equipment and reduced aging
- Increased system reliability (via reduced voltage fluctuations and lower harmonic stress)

**Requirement**

- 6MD86 as „stand alone“ PoW device
- 6MD86 as Bay Controller + PoW functionality
- Protection device (7UT8, 7SJ85, LineProt 7xx87) + BCU + PoW functionality

**Solution**

Necessary Hardware:
- 2x IO209 with high-speed outputs for controlled single-phase CB opening
- 1x IO212 with 8x fast transducer inputs

**Benefits**

- Reduced aging and increase system reliability
- Low invest: One device for control, protection and PoW function
- One device for all type of loads
- Integration into substation automation system with standard protocols like IEC 61850
- Easy engineering
Point-on-Wave Switching with SIPROTEC 5

Why „Point-on-Wave“ Switching?

- “Point-on-Wave“ Switching minimizes electro-dynamic and dielectric stress for operational equipment as a consequence of switching (control) operations.
- Therefore, aging of operational equipment can be reduced and life time extended.

Switching a capacitive load
1) Closing time **not** optimized
2) Closing time optimized
## Point-on-Wave Switching with SIPROTEC 5

### Applications

<table>
<thead>
<tr>
<th>Type of load / operational equip.</th>
<th>Operation</th>
<th>Avoided stress / Reduction of</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inductive:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Transformer</td>
<td>Opening</td>
<td>Re-striking, overvoltage</td>
</tr>
<tr>
<td>• Shunt reactor (coil)</td>
<td>Closing</td>
<td>In-rush current</td>
</tr>
<tr>
<td><strong>Capacitive:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Capacitor bank</td>
<td>Opening</td>
<td>Re-striking, overvoltage</td>
</tr>
<tr>
<td>• Filter bank</td>
<td>Closing</td>
<td>Overvoltage, In-rush current</td>
</tr>
<tr>
<td>• Transmission line</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Cable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reduction of In-rush currents:**

- minimizes electro-dynamical and dielectric stress → Longer service life

**Minimization of overvoltage:**

- minimizes dielectric stress → Increased system reliability
Point-on-Wave Switching Function with SIPROTEC 5

How does Point-on-Wave Switching work? (simplified)

- PoW function operates the CB pole-selectively and determines the optimal switching instance for each phase / pole individually, with an IED accuracy of ~ 50µs

→ PoW switching can only be applied on circuit breakers that support phase-selective switching

- Example: Switching a “shunt reactor”
- Switching shall take place in the voltage maximum to avoid inrush currents

Switching sequence: C → B → A
Point on Wave Switching SIPROTEC 5
Device configuration

- **IO202**: 4xI, 4xV: & voltage measurement:
  - for reference voltage
  - for switching monitoring / recording

- **2x IO209**: overall 8 x high-speed outputs (< 50µs switching accuracy)
  - for controlled CB-opening and CB-closing

- **1x IO212**: 8 x fast transducer inputs (0..20 mA)
  - 3 inputs for Siemens-CB reference contacts
  - 2 inputs for CB-open / close control voltage
  - 1 input for temperature

- Optional: one plug-in module with 4 additional normal-speed transducer inputs:
  - 3 inputs for hydraulic CB pressure

**Remarks:**
- All transducer inputs are passive and require external 24 VDC supply
- CB control voltage must be externally transduced into 4..20 mA
Point-on-Wave switching device with SIPROTEC 5
Possible Device Types

PoW switching will be a platform functionality. This allows this functionality to be applied in different device application options:

1. Stand alone PoW-switching device: 6MD86
2. Bay Control and PoW-switching in one physical device: 6MD86
3. Protection, Bay Controller and PoW-switching in one physical device: e.g. 7SJ85
   (7SJ85 = Capacitor bank protection functionality)

The “PoW” function is available for configuration as a new function in the DIGSI device-function library:
Highlights V7.9 and V8.0

- SIPROTEC DigitalTwin
- Compatibility of SIPROTEC 4 and SIPROTEC 5 for 87L and 21
- IEC 61850-9-2 Process bus for digital substations (Server/Client)
- SIPROTEC 6MU85 Merging Unit
- Time synchronization with IEEE 1588 for High Precision applications
- SIPROTEC 7SS85 distributed busbar protection based on process bus
- Point-on-wave switching

**Conformal coating of SIPROTEC 5 devices as standard**

- Cyber Security
- ATEX certification for 7SK85 and 7UM85
- New overcurrent and feeder protection SIPROTEC 7SJ81
- Web Browser
- Further functions
Conformal Coating as standard SIPROTEC 5 devices

Conformal Coating:
• Double-sided coating of electronic modules, as standard
• As standard, at no additional charge, for all new orders of SIPROTEC 5 and SIPROTEC Compact devices

Customer Benefit:
• Highest lifetime and availability of SIPROTEC devices even under extreme environmental conditions:
• Increased protection against harmful environmental influences such as corrosive gases, salts, and moisture
• Additional mechanical protection against dust and abrasion
• Highest coating quality due to qualified production process
Highlights V7.9 and V8.0

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**Cyber Security**

- ATEX certification for 7SK85 and 7UM85
- New overcurrent and feeder protection SIPROTEC 7SJ81
- Web Browser
- Further functions
Security News in SIPROTEC 5

Cyber Security

Customer-authorized DIGSI 5 Instances (V7.90)
• Use customer-issued client certificates in DIGSI 5 instances so that only these instances (and not any standard DIGSI 5 installation) can communicate with the customer’s SIPROTEC 5 IEDs

Role-based Views In DIGSI 5 (V7.90)
• Users can only view or operate those functionalities in DIGSI 5 that are permitted for their assigned roles

Authenticated network access for COM-Modules (V8.00)
• COM-modules authenticate themselves using IEEE 802.1X und customer certificates against the switch in order to gain network access

…and other improvements in RBAC, security logging and HTTPS functionalities
Customer-authorized DIGSI 5 Instances (V7.90)

3. Mutually-authenticated and encrypted communication between DIGSI 5 and the SIPROTEC 5 device

NEW: Only DIGSI 5 installations that connect using certificates signed by customer’s CA are permitted

Device-side support for role-based access control including central user management and emergency access

Recording of security-relevant events and alarms over Syslog and in non-volatile security log in device

Confirmation codes for safety-critical operations

- AS BEFORE -

SIPROTEC 5

1. Install customer-issued client certificate in the Windows User account (Client authorization)

2. Install in the device the customer CA that is used to sign the DIGSI 5 client certificates

NEW: Only DIGSI 5 installations that connect using certificates signed by customer’s CA are permitted

Customer CA and Certificates can be issued using SICAM GridPass
Role-based Views in DIGSI 5 (V7.90)

Role-based Views with central user management in DIGSI 5 – also when not connected to the device

- Users can only view or operate those functionalities in DIGSI 5, that are permitted for their assigned roles.
- Usage of (existing) central user administration for role-based DIGSI 5 experience.
- Works with existing Microsoft Active Directory (AD) installations.
- Roles and rights correspond to standards and guidelines e.g. IEC 62351, IEEE 1686, BDEW Whitepaper.
- Works hand-in-hand with the RBAC feature in SIPROTEC 5 devices.
- The role-based views are also available for Windows user accounts that are not centrally managed in AD.

NEW in V7.90: DIGSI 5 automatically determines the user's roles from his Windows session.

| Access Control | Roles Mapping | Operation A | Operation B | Operation C | Operation ...
|----------------|---------------|-------------|-------------|-------------|---------------
| Role 1         | x             | x           | x           |             |               |
| Role 2         |               | x           |             | x           |               |
| ...            |               |             |             |             |               |

1. User requests access to IED with username and password
2. Authentication request with username, password via RADIUS
3. Authentication & Authorization (Role) response from RADIUS
4. Success/Fail Response from device to user
5. Role-based user session initiated/denied

All user logon attempts are logged as security events inside the device and via the Syslog protocol.
Authenticated Network Access for COM-Modules using IEEE 802.1X (V8.0)

1. Install customer-issued IEEE 802.1X Client certificates for COM modules (for network client authentication)

2. During bootup, the device’s COM module presents client certificate for authentication to the switch using IEEE 802.1X

3. RADIUS Server authenticates the device using its certificate and the switch grants or denies network access to the COM module

Customer CA und certificates can be created and managed with SICAM GridPass

IEEE 802.1x capable Switch

RADIUS Server

Other products without customer-issued IEEE 802.1x client certificates
Highlights V7.9 and V8.0

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- New overcurrent and feeder protection SIPROTEC 7SJ81
- Web Browser
- Further functions
ATEX-Certification for SIPROTEC 7SK85 and 7UM85

**Application**

- Use of Motor Protection and Machine Protection in potentially explosive atmospheres (e.g. Chemical-Industry)

**Solution**

- Certification of Hardware and Firmware by an independent and accredited institution: PTB = Physikalisch-Technische Bundesanstalt

**Advantage**

- SIPROTEC protection devices are applicable directly and without customer approvals in potentially explosive atmospheres
Highlights V7.9 and V8.0

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- **New overcurrent and feeder protection SIPROTEC 7SJ81**
- Web Browser
- Further functions
Overcurrent protection SIPROTEC 5 7SJ81

Profile

• Your start with SIPROTEC 5 – device family
• Good price value
• Optimized functionality for feeder protection
• based on the successful SIPROTEC 7SJ82, with limited functionality
Overcurrent protection SIPROTEC 5 7SJ81
Profile

- Feeder protection
- All network types, medium voltage level

- 4 CT, with 11 BI, 9 BO or 18 BI, 14 BO
- 4 CT, 4 VT with 11 BI, 9 BO or 16 BI, 11 BO
- Up to 1 plug-in module
- 12 programmable LEDs
- Non-expandable via 1/6 modules
- Standard and large graphical display

Suitable device 7SJ81

- Dir. & Non-Dir. OC protection with basic functionality
- Ground fault protection for comp./isolated networks
- V, f, P/Q protection functions
- AR, Sync function
- IEC 61850 (Edition 1 and 2)
- Cyber security
- Redundant communication
- SIPROTEC 5 standard functions for control and monitoring
Highlights V7.9 and V8.0

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- **Web Browser**
- Further functions
SIPROTEC 5

Web Browser - Extensions

Simple, fast and secure access to device data

Recording:
- Download, Delete and Trigger of Fault Records

Parameterization:
- Change of settings within an active setting-group

Display all signal state:
- Indication of all information
- Centralized view on warnings, alarms and inactive functions
Highlights V7.9 and V8.0

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- Web Browser
- **Further functions**
SIPROTEC 5
Further functions

Fault Locator Plus

- Accurate fault location by measuring at both ends of a 2-ended line with communication link via protection interface (Accuracy of 99%)
- Separate line sections with individual line data for non-homogeneous lines, e.g. for overhead line/cable sections
- Section specific auto-reclosure (AR) on overhead line sections
SIPROTEC 5
Further functions

Phasor Measurement Unit (PMU) – Improvement

- Up to 40 channels supported (20 channels in V7.8)
- Applications with pure CT connections possible
- Additional information in configuration frame 3 (according to IEEE C37.118) available, e.g. GPS-Data, Global PMU ID, Configuration Change counter
- Longer names possible in Config Frame 3 for phasor names and channel names as well as for PMU-station name
SIPROTEC 5
Further functions

Positive-sequence overcurrent protection function (ANSI 50/51) – New function

Positive-sequence overcurrent protection function detects short circuits in electric equipment and is applied when the zero-sequence current or negative-sequence current should not influence the tripping, for example, on the tertiary delta winding of an auto transformer.

Frequency protection in function group Voltage/current 1-phase – New application

Over-frequency protection (ANSI 81O) and underfrequency protection (ANSI 81U) functions are now available in the 1-phase voltage/current function group.
Contact information

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