

A photograph of two men in a server room. The man on the left, wearing a pink shirt, is smiling and looking towards the man on the right. The man on the right, wearing a light blue shirt, is looking down at a Siemens SWT 3000 Teleprotection device he is holding. The device is a rack-mounted unit with a grey front panel and a blue top section. The background shows server racks with various components and cables.

SIEMENS

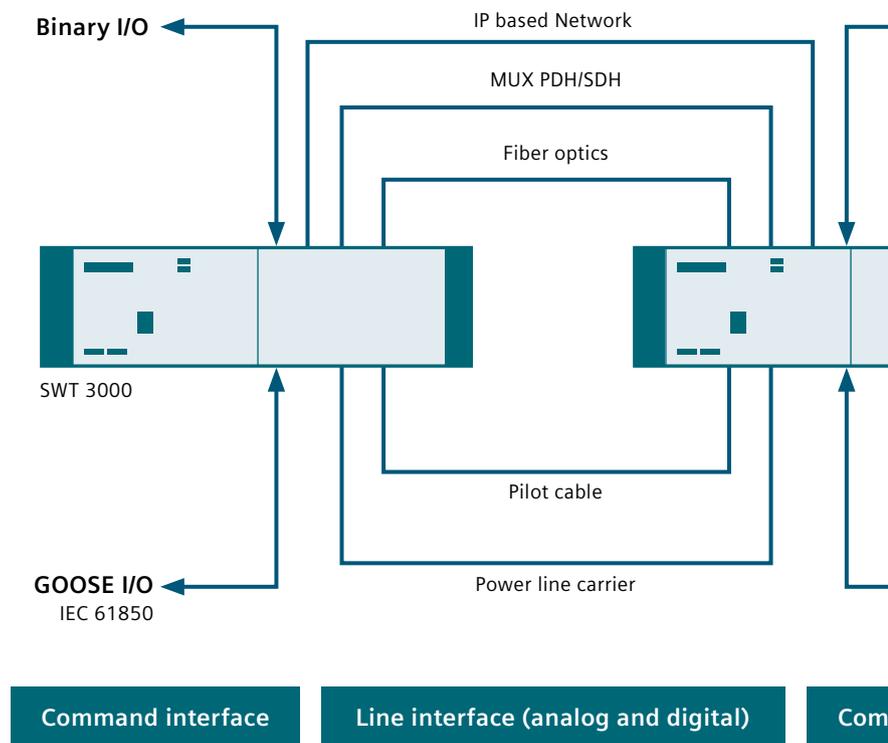
Ingenuity for life

Power network telecommunication

SWT 3000 Teleprotection

[siemens.com](https://www.siemens.com)

The best protection against high-voltage grid failures...



When it comes to managing power networks, the operators rely on Siemens. This has earned them the good reputation of supplying power to consumers with total reliability. That's because our SWT 3000 gives them the security that they'll be able to maintain grid operations even when circumstances indicate otherwise.

The SWT 3000 Teleprotection system is the highly developed solution worldwide for clearly and immediately identifying faults and isolating them extremely quickly in the high-voltage grid. It is combined with existing distance protection relays, allowing operators to reduce downtime to an absolute minimum. The current stage of development is based on 50 years of practical experience and adaptation to changing challenges. A proven technology that is continuously being refined to meet future needs.

Advantages at a glance:

- One device for all communication technologies
- High level of system stability
- Reliable signal transmission
- High security 1-P_{uc} and dependability 1-P_{mc}
- IEC 61850 substation communication interface
- Integrated path protection
- Future-proof technology
- IP based network communication line interface

Binary I/O



SWT 3000

GOOSE I/O
IEC 61850

Command interface

Existing modes with IEC 61850 interfaces:

- GOOSE mode only – without binary I/O
- Interchange mode – substation A has IEC 61850 interface and substation B has binary I/O
- Mixed mode – GOOSE and parallel binary I/O in coexistence

Operation features with binary interfaces:

- Four I/O ports per module
- Up to four modules per device
- Selectable input voltage range
- Individual timer setting for input/output limitation, extension, and pulse suppression
- Interface modules for high load and high speed
- Configurable output allocation
- Ethernet line communication

... the technology for the greatest security

High degree of flexibility – sustainable innovation protection

The SWT 3000 protection signaling system is extremely versatile. For example, it can be used as a common solution for analog and digital networks. At the same time, it's ideal for establishing substation-to-substation communication via IEC 61850. Many options have been combined in a single device, reducing investment costs and boosting system availability.

A closer look at the migration of existing substations

The SWT 3000 also demonstrates its high degree of flexibility when existing substations are migrated to protection devices via the IEC 61850 communications standard. The SWT 3000 has all necessary command interfaces – both as binary interfaces and as GOOSE. This always keeps investment costs economically manageable, because the substations can be updated step by step for a new network age.

SWT 3000 as a binary command interface

The Siemens SWT 3000 with bidirectional individual channels for direct, permissive or blocking applications offers the connection of traditional distance protection devices based on binary input and output commands.

SWT 3000 for IEC 61850 (GOOSE)

When distance protection is already operating with IEC 61850 interfaces, GOOSE commands can be transmitted via SWT 3000 from substation to substation via electrical or optical ports. In such case, the classical narrowband teleprotection lines, e.g. via PLC, are applicable for the conversion of an IEC 61850 standard GOOSE message into a binary value including transmission through the line side. Subsequently the reception at the far end is followed by the reconversion from binary to the GOOSE telegram stage.

Protection signaling in all networks

Reliability, security and low transmission time are the definitive criteria for the quality of protection signaling equipment. The SWT 3000 offers grid operators another decisive advantage: it is flexible and, as a communications interface, can use a variety of different transmission paths. Redundancy has a high priority. The greatest security is achieved when grid operators fully exploit the possibilities of the SWT 3000 and isolate the analog and digital transmission components from one another. If one communications channel should fail, there is always a second channel that keeps the teleprotection flowing.

Interfaces for integration into telecommunication networks:

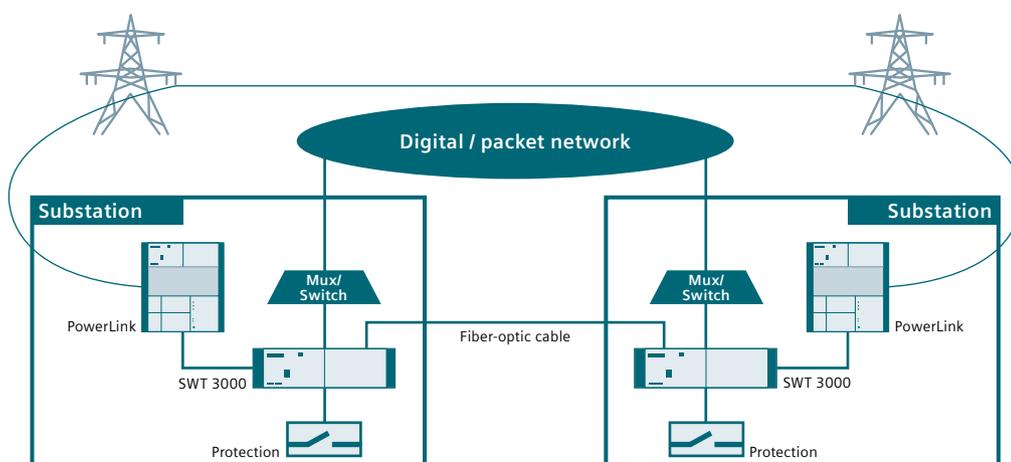
- Digital fiber-optic interface (direct connection)
- Digital electrical interface (PDH, SDH)
- Digital fiber-optic interface (IEEE C37.94)
- Analog interface for pilot cables
- Analog via power line carrier system PowerLink
- Ethernet line interface (MPLS-TP)

Interfaces for connecting distance protection devices:

- IEC 61850 interface (GOOSE)
- Binary command I/O interface

Combinations of path protection for alternative transmission routes

In case uninterrupted reliability is a primary goal, 1+1 path redundancy is absolutely essential. With SWT 3000 digital lines, fiber-optic lines, Ethernet lines or analog lines can be issued for path protection in several combinations.



SWT 3000 –
transmission routes

Features	Digital line	Analog line
Number of independent commands	up to 16	up to 4
Command interface		
Binary I/O	■	■
Digital I/O electrical or fiber-optic for GOOSE (IEC 61850)	■	■
Binary output for signaling	■	■
Digital line interface		
64 kbps (X.21 or G703.1)	■	
2 Mbps (G703.6)	■	
Ethernet line interface¹⁾		
100 Base-TX (electrical)	■	
100 Base-FX (optical, short-range; 1,310 nm)	■	
Fiber-optic interface		
Long-range (single-mode; 1,550 nm)	■	
Short-range (single-mode; 1,310 nm)	■	
Short-range (multi-mode; 850 nm)	■	
Analog line interface		
4-wire		■
2-wire		■
Transmission paths		
Connection to SDH multiplexer	■	
Connection to PDH multiplexer	■	
Connection to IP based network (Ethernet)	■	
Fiber-optic cable	■	
Fiber-optic connection to multiplexer (C37.94)	■	
Fiber-optic connection to power line carrier		■
Power line carrier		■
Pilot cable		■
Integrated path protection (1+1)	■	■
Integration into power line carrier system PowerLink	■	■
General		
Bidirectional channels for direct, permissive, or blocking applications	■	■
Redundant power supply (hot standby)	■	■
Addressing for increased security	■	
Configuration and software upgrade via service PC	■	■
Freely programmable output allocation	■	■
Remote access to SWT 3000 devices via TCP/IP interface or inband channel	■	■
Real-time clock, internal or external synchronization sources (including sync pulse, IRIG-B, NTP), and via the transmission link	■	■
Event recorder (date- and time-stamped, nonvolatile)	■	■
Remote readout of the event recorder	■	■
Easy upgrade from analog to digital		■
SNMP agent for NMS integration	■	■

¹⁾ Not applicable in combination with IEC 61850 GOOSE interface or for integration into the power line carrier system PowerLink



Digital networks with SWT 3000

Digital data transmission is the sustainable, future-proof method among the communications technologies. Its advantages: it provides the fastest transmission time and highest level of reliability – and the maximum security standards.

Advantages in detail:

- Each of SWT 3000's two disposable digital interfaces can be configured for X.21, G703.1 (64 kbps), or according to G703.6 (2 Mbps).
- Two fiber-optic modules can be allocated as an option, providing short- or long-range connections.
- In case legacy infrastructures based on SDH/PDH are being migrated to packet-based networks an Ethernet line interface can provide the interconnection of SWT 3000 (e.g. MPLS-TP) between substations. The Ethernet line interface is compliant to IEC 60834 standards for digital transmission. Quality of Service technology (DSCP, ToS, IEEE 802.1Q / VLAN) is used to ensure minimum delay.
- Up to sixteen commands can be digitally transmitted to the far end, where they are allocated to signal outputs in the required combination. The high-voltage power circuit breaker can be operated either in conjunction with selective relays or directly.

Applications in detail:

- **Direct fiber connection between SWT 3000**
SWT 3000 protection signaling incorporates an internal fiber-optic modem for short- or long-distance transmission up to 150 kilometers.
- **Fiber-optic connection to a multiplexer**
A fiber-optic connection of up to two kilometers between the SWT 3000 and a multiplexer can be realized via an integrated modem according to the IEEE C37.94 standard.
- **Addressing for high security**
Devices are identified via addresses when digital communications interfaces are in use. This can prevent the unintended connection of two devices following a digital network reconfiguration.
- **Ethernet line interface between SWT 3000**
The optional Ethernet line interface transmits in case of no trip a guard command packet on a predefined interval. An active trip command sends multiple trip command packets at short intervals. Message authentication is implemented to ensure Cyber Security. SWT 3000 provides the ability to supervise the performance for the Ethernet transmission (packet loss/delay, throughput).

Power line carrier – PowerLink devices with integrated SWT 3000

Two SWT 3000 systems are supported by the Siemens PLC PowerLink system – with a maximum of four commands per integrated teleprotection system. For optimized customer utilization, the teleprotection command transmission is available in a variety of modes.

Applications in detail:

- **Single-purpose mode**

In this mode, the PLC terminal PowerLink is used exclusively for the transmission of protection signals. This achieves the greatest transmission ranges combined with the highest security against impulse noise and the shortest transmission time.



SWT 3000 integrated in PowerLink

- **Simultaneous multipurpose mode**

In this mode, speech or data is transmitted along with the protection signals on a PowerLink device sharing the available frequency band.

- **Alternate multipurpose mode**

In this mode, the digital data band or analog voice band is used for the transmission of the protection commands. The pilot frequency of the PowerLink system is used as guard signal. When a protection command needs to be transmitted, voice or data transmission are briefly interrupted for the duration of protection command transmission.

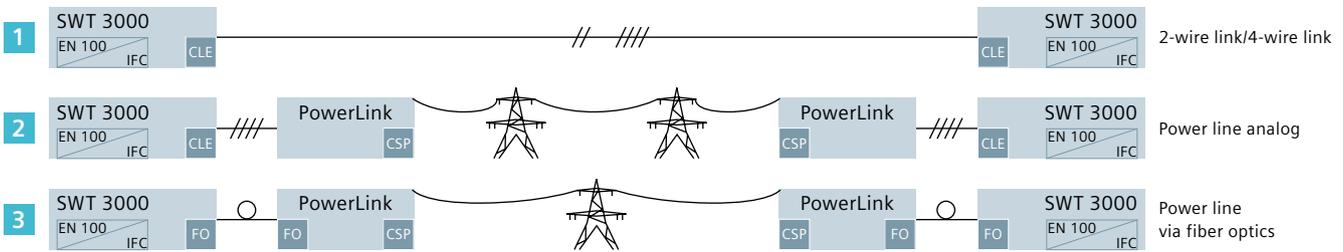
- **Multicommand mode (MCM)**

The MCM function extends the command transmission capabilities of the SWT 3000 system and can be integrated into Siemens' power line carrier system PowerLink. Up to 24 MCM commands can be transmitted for protection and emergency automation in a serial sequence by priority.

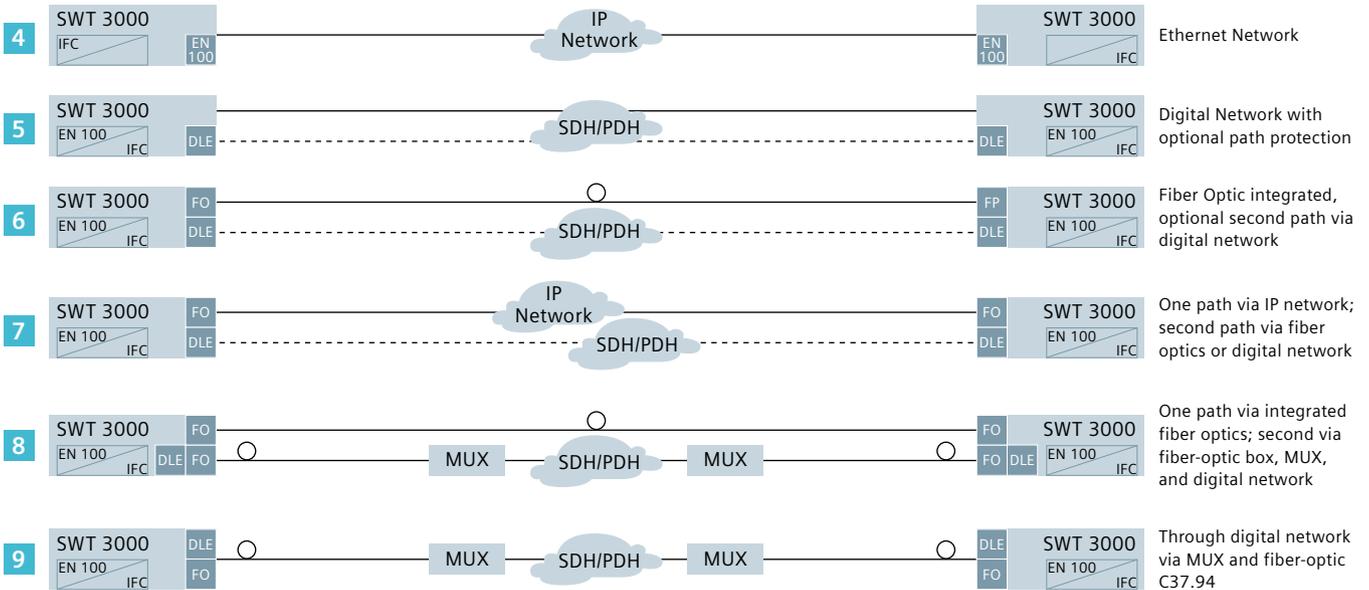


SWT 3000 for digital transmission

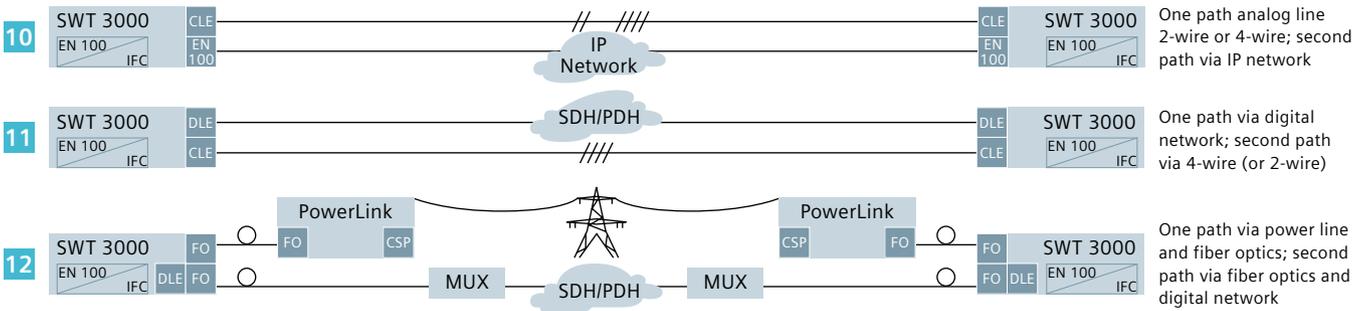
Analog transmission



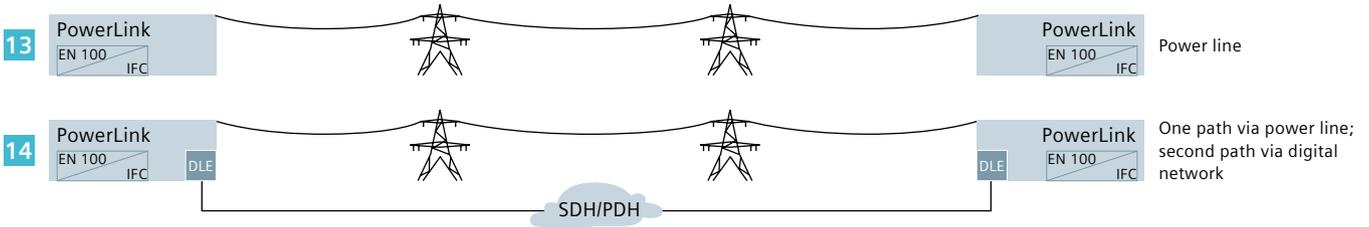
Digital transmission



Analog & digital transmission



Integrated into PowerLink



PowerLink Power Line Carrier System
IFC Interface Command Binary
DLE Digital Line Equipment
CLE Copper Line Equipment
PDH Plesiochronous Digital Hierarchy

EN 100 Interface IEC 61850 / Ethernet line
SDH Synchronous Digital Hierarchy
FO Fiber-optic Module
MUX Multiplexer

Transmission paths

1 Pilot cable connections

For operation via pilot cable, two SWT 3000 devices can be linked directly through the analog interfaces (CLE).

2 Power line carrier connections

The analog link (CLE) between two SWT 3000 devices can also be a PLC link. Depending on device configuration, SWT 3000 can be used with PowerLink in alternate multipurpose, simultaneous multipurpose, or single-purpose mode.

3 12 Fiber-optic connections between SWT 3000 and PowerLink

A short-distance connection between an SWT 3000 and Siemens' PowerLink PLC terminal can be realized via an integrated fiber-optic modem. In this case, an SWT 3000 stand-alone system provides the same advanced functionality as the version integrated into PowerLink. Each PowerLink can be connected to two SWT 3000 devices via fiber optics.

5 6 SWT 3000 digital connections

7 9 11 The digital interface (DLE) permits protection signals to be transmitted over a PDH or SDH network.

4 7 SWT 3000 Ethernet connections

10 The ETH line interface (EN 100) supports transmission via packet based networks.

6 5 Alternative transmission routes

7 8 10 11 12 14 SWT 3000 enables transmission of protection signals via two different routes. Both routes are constantly transmitting. In the event that one route fails, the second route still bears the signal.

6 8 Direct fiber-optic connection without repeater

SWT 3000 protection signaling incorporates an internal fiber-optic modem for long-distance transmission. The maximum distance between two SWT 3000 devices is 150 kilometers.

8 9 Fiber-optic connection between SWT 3000 and a multiplexer

12 A short-distance connection of up to two kilometers between SWT 3000 and a multiplexer can be realized via the integrated fiber-optic modem according to IEEE C37.94.

13 14 SWT 3000 integration into the PowerLink – PLC system

The SWT 3000 system can be integrated into the PowerLink equipment. Either the analog interface or a combination of the analog and the digital interfaces can be used.



SWT 3000 for fiber-optic networks

Analog networks with SWT 3000

Analog transmission of protection signals is still necessary in two cases: when a telecommunication line with four- or two-wire connections or a power line carrier connection is the best solution. The SWT 3000 is specifically adapted to the respective requirements.

Applications in detail:

- **Coded modulation/coded tripping CT**

In this mode, two frequencies are sent at the same time for transmission. This protects the system against unwanted interference from single frequencies and increases security. The transmission time (T0) for coded signals remains the same as for noncoded signals. With each command and each combination of commands assigned to a pair of frequencies, four independent commands are available.

- **Noncoded modulation/F6 modulation**

In this mode, one out of the possible frequencies is transmitted at a time that permits the use of full transmission power for a single frequency. Three independent protection commands can be sent, and at the receiver end, each protection frequency can be assigned to one or more command outputs (1 to 4).

- **Narrowband signals (F6 modulation)**

The narrowband version is used for pilot cables or PLC equipment and operates on voice frequency (VF) channels. Within one ITU-T voice band (0.3 kHz to 3.4 kHz), up to three narrowband systems can be operated in parallel. The narrowband version also supports two-wire cable links.

- **Fiber-optic connection to power line carrier**

A connection between the SWT 3000 and the Siemens PowerLink PLC equipment can be realized using the integrated fiber-optic modem. These stand-alone systems provide the same advanced functionality as integrated into PowerLink.

Administration of the SWT 3000



Commissioning of the SWT 3000





Element manager and network management

An Ethernet interface allows the use of the customer's LAN for remote monitoring and maintenance. Expensive travel time is virtually eliminated, because the SWT 3000 can be monitored and controlled remotely over the IP network. With authorized access, users are able to perform local and remote maintenance, read the event recorder from any location, and monitor the network.

Applications in detail:

- **Element manager – PowerSys**

This application supports local and remote access on three different user levels. Depending on the user class, provisions for read-only up to full access are granted. Remote access is available via the LAN, USB or the RS 232 interface and service channel. The remote monitoring RM in-band channel can be used to transmit device data between terminals on one or more transmission links through daisy-chaining.

- **Network management integration**

For SNMP-based network administration via LAN interface inventory management, performance management, and fault management data is available. The SNMP compatibility allows simple integration into the customer's network management system (NMS).

- **Supervision and alarming facilities**

SWT 3000 offers a great deal of intelligent plausibility verification, testing, and diagnostic functions for high investment security:

- Transmission capability is checked via continuous supervision of the system in both directions
- Operation voltage is monitored
- Receive alarm in case no valid guard signal is present
- Test loop for extended test purposes (local and remote)
- Programmable output blocking caused by low S/N ratio
- Transmit signal level monitoring on the amplifier stage
- Integrated time-stamped event recorder with 1 ms resolution and internal or external clock synchronization source
- Resettable trip counter for each command input and output
- Alarm contacts available for the general, pre-, and receive alarm
- External event recording contacts for I/O ports

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