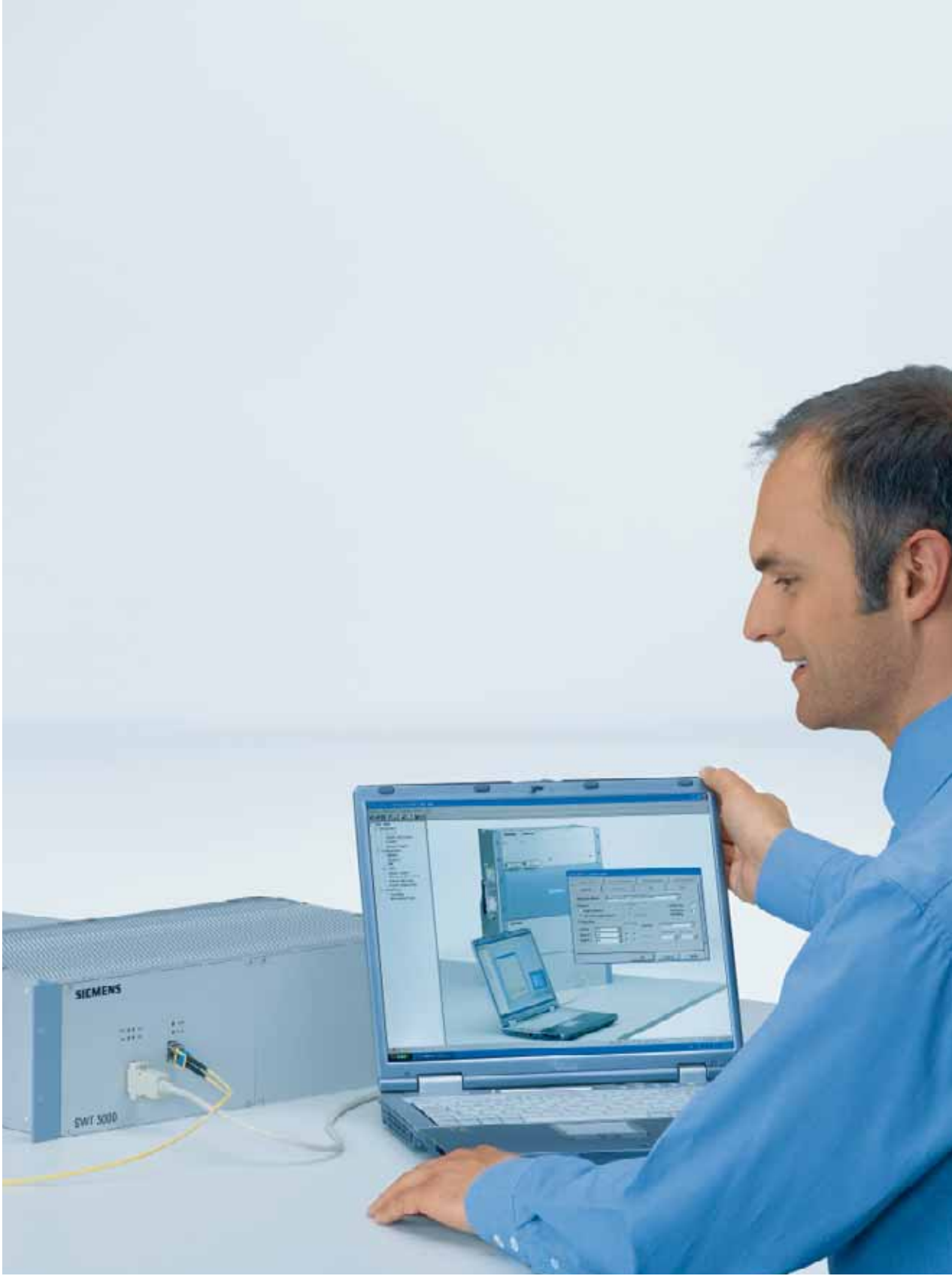


Power Network Telecommunication

SWT 3000 protection signaling equipment

Answers for energy.

SIEMENS

Sophisticated teleprotection facilities for power networks

Our customers have built their reputations on their ability to provide a constant, secure source of electric power under all conditions. That's why they depend on Siemens to provide the best possible solutions for controlling their power transmission networks. To meet the demanding needs of power companies worldwide, we have developed a world-class solution that helps them assure their own customers of an uninterrupted supply of electricity at all times. By combining our advanced SWT 3000 protection signaling system with your protection relays, we provide you with the ability to quickly identify, isolate and resolve problems in your high voltage network. SWT 3000 delivers a high degree of safety, keeping network downtime to an absolute minimum.

Designed for today's rapidly changing energy markets

In today's energy environment, it is more important than ever to have systems in place that can accommodate the increasingly complex financial and technical requirements of energy providers. Siemens is meeting the needs of today's rapidly changing markets with advanced solutions that provide:

- Exceptional security
- 100 % availability
- Increased investment security
- Cost-effectiveness over the equipment's total lifecycle

Fig. 1: SWT 3000 for
- analog
- digital or
- fiber optic transmission

Performance that's in a class by itself

By combining analog and digital capabilities within a single device, we have put the SWT 3000 in a class by itself.

SWT 3000's features include:

Two types of transmission capabilities in a single device
The SWT 3000 system's ability to transmit via analog and digital paths makes it possible for customers to upgrade their transmission networks to full digital performance while protecting their current technology investments. Using the SWT 3000, analog and digital transmission paths can co-exist on the same network. As an additional feature, both the analog and digital communication ports can be equipped with fiber optic interfaces, even after equipment has been installed.

Two different transmission routes for increased reliability
If uninterrupted reliability is your primary goal, system redundancy is absolutely essential. The SWT 3000 is the only commercially available protection signaling system that provides this extra safety and redundancy by using an independent alternate transmission path for analog and digital signals. Digital and analog system components are isolated from each other, significantly increasing system security and reliability.

Two independent power supplies for continuous operation
A second, hot standby power supply can easily be added to SWT 3000, providing safety and redundancy. If the primary power supply fails, the secondary power supply immediately takes over, ensuring continuous and unaffected operation. Even more, the redundant power supply units can be fed by different primary sources (for example, 230 V AC and 110 V DC).

Advanced features that improve total system performance

Security, dependability and transmission time are essential characteristics of an effective protection signaling system. The Siemens SWT 3000 improves all three.

Security
probability of unwanted commands
Dependability
probability of missing commands
Transmission time
time between activating the command input at the transmitter and activating the command output at the receiver

Advanced features that improve total system performance
The SWT 3000 uses a variety of innovative new features to improve total system performance. Siemens performance breakthroughs include:

- Impulse Noise Compression (INC) technology was developed by Siemens to ensure that impulse noise, the most serious disturbance in analog systems, can't be misinterpreted as a command by the system and accidentally actuate protection relays
- Device addressing to prevent unwanted interconnections between two equipments due to routing errors in digital networks and ensure that protection signals are received at the correct destination
- Alternate transmission routes that provide fully redundant signaling capabilities
- Redundant power supply with hot standby
- Various direct fiber optic connections between two SWT 3000 devices, fiber optic to a multiplexer or to a PLC terminal
- Coded tripping mode for four independent commands via analog transmission lines

All these advanced features are reinforced by the SWT 3000's extremely fast transmission speed. Depending on customer needs, transmission times can be less than 10 ms when using analog transmission paths and less than 3 ms when using digital transmission paths.

A cost-effective solution for today's power companies

The SWT 3000 was designed to help customers to control costs and to increase their profits under a wide variety of network conditions.

System's innovations include:

Built-in digital and analog communication capabilities
The revolutionary design concept of the SWT 3000 is unique to protection signaling systems. By combining analog and digital transmission capabilities within a single device, we give our customers the freedom they need to use new technologies and adapt to changing market conditions.

Lower inventory requirements
Customers using both analog and digital transmission paths can use the SWT 3000 for either, providing greater economies of scale with lower equipment inventory requirements.

Easy to learn
Our user-friendly configuration tool is identical for analog and digital teleprotection. Technicians have to learn only one system, making maintenance and monitoring easier.

Remote monitoring and maintenance capabilities
Our control interface allows to use your organization's LAN for remote monitoring and maintenance. Expensive travel time is virtually eliminated, since the SWT 3000 can be monitored and controlled remotely over your IP network.

Possible ways of using the SWT 3000
The SWT 3000 teleprotection system is available as a stand-alone device for analog, digital and fiber optic operation. Alternatively SWT 3000 can be easily integrated into Siemens' Power Line carrier system PowerLink.

Investment protection
Converting a communication network from analog to digital no longer requires new protection signaling equipment. The SWT 3000 makes it easy for customers to make the transition from analog to digital transmission paths without the need of expensive upgrades, and respectively to use it in mixed networks with both digital and analog transmission paths.

Coded tripping for the highest level of security
Coded tripping uses two frequencies for the transmission of a protection command. This increases the security of the SWT 3000 (the number of unwanted commands tends to zero) while the command transmission time is as fast as using non-coded transmission. Coded tripping thus raises the level of security against discrete frequencies to unprecedented levels.

Features at a glance

Feature	Digital	Analog
Number of commands	8	4
Digital line interface		
64 kbit/s (X.21 or G703.1)	■	□
2 Mbit/s (G703.6)	■	□
Analog line interface		
4-wire	□	■
2-wire	□	■
Fiber optic interface		
Long-range (single mode, 1550 nm)	■	■
Short-range (single mode, 1310 nm)	■	■
Short-range (multi mode, 850 nm)	■	■
Transmission paths		
Digital network		
Direct connection to SDH multiplexer	■	□
Direct connection to PDH multiplexer	■	□
Fiber optic cable	■	■
Power Line carrier	□	■
Pilot cable	□	■
Integrated path protection (1 + 1)	■	■
Integration into Power Line carrier system PowerLink	■	■
Redundant power supply (Hot standby)	■	■
Addressing for increased security	■	□
INC (Impulse Noise Compression)	□	■
Configuration of SWT 3000 with a service PC (intuitive Windows-based user interface)	■	■
Software-upgrade via service PC (download)	■	■
Free programmable output allocation	■	■
Remote access to SWT 3000 devices via TCP/IP link	■	■
Remote access to SWT 3000 devices via in band channel (SC)	■	□
Real-time clock integrated and synchronizable from external sources (e.g. GPS, IRIGB, NTP) and via the transmission link	■	■
Event recorder (date- and time-stamped) with guaranteed data storage when the power supply is switched off	■	■
Remote readout of the event recorder	■	■
Easy upgrade from analog to digital (and vice versa)	■	■
SNMP agent for NMS integration	■	■
Coded tripping for up to four independent commands	□	■

■ available
□ not available

SWT 3000 for digital networks

Each of the two digital interfaces of SWT 3000 can be configured for X.21 or G703.1 (64 kbps) or for G703.6 (HDB3 2 Mbps). Integrated path protection (1 + 1) is built-in.

Addressing for high security
Devices are identified via addresses when digital communication interfaces are used. This can prevent the unintended connection of two devices following digital network reconfiguration.

Use for digital transmission
Up to eight commands can be digitally transmitted transparently to the far end, where they can be cross-connected to signal outputs in any required combination.

Commands can be transmitted for the protection of two three-phase systems or for one three-phase system with individual phase protection.

The high-voltage power circuit breaker can be operated either in conjunction with selective relays or directly.

Fig. 2: SWT 3000 for digital and fiber optic networks

SWT 3000 for fiber optic networks

With SWT 3000 fiber optic connections highest possible level of security, dependability and fastest transmission times are provided. A variety of fiber optic applications (single mode, multi mode, short range, long range) is supported by SWT 3000.

Direct fiber optic connection between two SWT 3000
SWT 3000 protection signaling incorporates an internal fiber optic modem for long-distance transmission. The maximum distance between two SWT 3000 is 150 km. Two optical fibers are used, each for one direction.

Fiber optic connection between the SWT 3000 and a multiplexer
A short-distance connection of up to 3 km between the SWT 3000 and a multiplexer can be realized via an integrated fiber optic modem.
The multiplexer is connected to the SWT 3000 via FOBox, which converts the optical signal back to an electrical signal for PDH/SDH networks.

Fiber optic connections between SWT 3000 and a PLC
A short-distance connection of up to 3 km between an SWT 3000 and Siemens' PowerLink PLC equipment can be installed using an integrated fiber optic modem. Two optical fibers are used, one in each direction. SWT 3000 standalone system provides the same advanced functionality as one integrated into PowerLink – retaining all analog transmission features. Each PowerLink can be connected to two standalone SWT 3000 systems via fiber optics.

Alternative transmission routes
SWT 3000 enables transmission of protection signals via two different routes. The addition of the fiber optic transmission options enlarges the spectrum of combinations remarkably.

Fig. 3: SWT 3000 fiber optic interface

Fig. 4: FOBox for connection of an SWT 3000 to a remote multiplexer

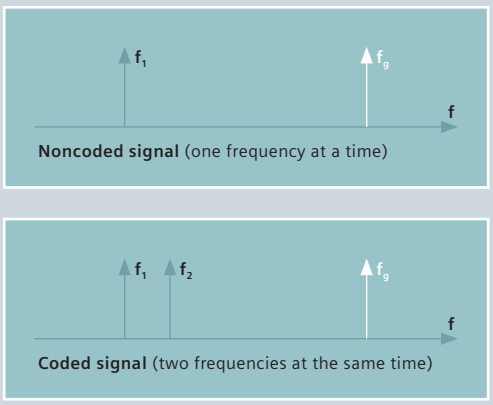
SWT 3000 for analog networks

Broadband or narrowband modes are available depending on the purpose for which they are used. Integrated path protection (1 + 1) is possible when these devices are combined with a digital interface.

Noncoded signals / F6 modulation
The SWT 3000 uses F6 modulation. In this mode only one out of the possible frequencies is transmitted at a time. This allows to use all the available transmission power for one single frequency providing the largest transmission ranges for the protection signal.

Coded signals / Coded tripping CT
Two frequencies are sent at the same time to transmit one signal (coding). Acceptance of the signal by the receiver depends on the proper detection of both frequencies at the same time. This protects the system against unwanted interference from single frequencies and increases security. The transmission time (T_0) for coded signals remains the same as for noncoded signals, reducing the transmission range in comparison to F6 modulation.

Fig. 5: Frequency scheme



f_1, f_2: trip frequencies
f_g: guard

Broadband mode

This mode is intended for operation via any form of telecommunications transmission path (4-wire connections) but preferably via PLC links. It offers a high level of security against impulse noise (INC) and interference voltages.
When combined with PLC transmission, one frequency slot is required in the 2.5-kHz or 4-kHz frequency grid. In the case of microwave links and cable links, one ITU-T voice band at 0.3 – 3.4 kHz is occupied for each direction. Simultaneous multipurpose or alternate multipurpose operation in conjunction with PLC transmission is possible.

Applications

- **Three independent protection commands (F6)**
  Three command inputs are available in this mode of operation. At the transmitter end, one protection frequency is assigned to each possible command input combination. At the receiver end, each protection frequency can be assigned to one or more command outputs (1 to 4).
  Commands can be transmitted for the protection of two three-phase systems, or for one three-phase system with individual phase protection.

- **Four commands with priority (F6)**
  This operating mode is particularly suited to the secure and reliable transmission of switching commands. The transmission time depends on device configuration and the number of commands to be transmitted.
  In this mode, several commands can be active at the same time. They are arranged in order of priority (input 1, 2, 3, 4) and transmitted one after another.

- **Four independent protection commands (CT)**
  Each command, and each combination of commands, is assigned to a pair of frequencies. The use of multiple frequencies ensures the highest possible level of security. The use of four independent commands also permits combinations, for example, 2 + 2. This operating mode is particularly suitable for the transmission of protection commands for different protection systems, where two commands are transmitted coded and two commands noncoded.

- **Multicommand Mode (MCM)**
  The MCM function extends the command transmission capabilities of the SWT 3000 system for the version integrated into Siemens' PowerLink Power Line carrier system.
  Up to 24 MCM commands can be transmitted for protection and emergency automation.

- **Device combinations**
  SWT 3000 systems can be positioned separately, with a VF or fiber optic interface either for direct connection to the transmission path or for connection to PowerLink, or integrated into PowerLink.

Narrowband mode

The narrowband mode version is used for pilot cables and operates on voice frequency (VF) channels. The trip frequencies are closer together in this version. Within one ITU-T voice band (0.3 – 3.4 kHz) up to three narrowband systems can be operated in parallel.

Applications

- **Two-wire links**
  The narrowband versions of the SWT 3000 also support the implementation of two-wire cable links.
  Since only one wire pair is available for the transmit and receive directions, different frequencies must be used. To achieve this, frequency variants comprising combinations of narrowband channels 1–3 can be used.

- **Four commands with priority**
  This operating mode is particularly suitable to the secure and reliable transmission of switching commands. The transmission time depends on the device configuration and the number of commands to be transmitted.
  In this mode, several commands can be active at the same time. They are arranged in order of priority (input 1, 2, 3, 4) and transmitted one after another.

- **Device combinations**
  SWT 3000 systems can be positioned separately, connected via pilot cable or fiber optic to the remote terminal or to PowerLink, or integrated into PowerLink.

- **Three independent protection commands**
  Three command inputs are available in this mode of operation. At the transmitter end, one protection frequency is assigned to each possible command input combination. At the receiver end, each protection frequency can be assigned to one or more command outputs (1 to 4). Commands can be transmitted for the protection of two three-phase systems, or for one three-phase system with individual phase protection.

Fig. 6: SWT 3000 for analog, digital or fiber optic networks

Possible ways of using the SWT 3000

Operating modes with Power Line carrier devices

Single-purpose mode
In this mode, the PLC terminal 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.

Simultaneous multipurpose mode
In this mode, speech or data is transmitted in addition to the protection signals on a PowerLink device sharing the available frequency band.

Alternate multipurpose mode
In this mode, the voice band (or digital data 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 transmission and, depending on the parameterization, possibly data transmission, are briefly interrupted for the duration of protection command transmission.

Protection signaling in the superimposed data band
Narrowband of SWT 3000 is transmitted in the data band of PowerLink.

1 2 **Pilot cable connections**
For operation via pilot cable, two SWT 3000 devices can be linked directly through the analog interfaces (CLE).

3 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.

4 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 standalone 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 7 11 **SWT 3000 digital connections**
The digital interface (DLE) permits protection signals to be transmitted over a PDH or SDH network.

6 7 9 11 12 14 **Alternative transmission routes**
SWT 3000 enables transmission of protection signals via two different routes. Both routes are constantly used. In the event that one route fails, the second route immediately takes over without any loss of time.

7 8 9 **Direct fiber optic connection between two SWT 3000 devices**
SWT 3000 protection signaling incorporates an internal fiber optic modem for long distance transmission. The maximum distance between two SWT 3000 devices is 150 km.

9 10 12 **Fiber optic connection between an SWT 3000 and a MUX**
A short distance connection of up to 3 km between an SWT 3000 and a multiplexer can be realized via an integrated fiber optic modem.
The multiplexer is connected with the SWT 3000's FOBox, converting the optical signal to an electrical signal.

13 14 **SWT 3000 integration into the PowerLink PLC system**
An SWT 3000 system can be integrated into the PowerLink equipment. Either the analog interface or the digital interface, or a combination of the analog and the digital interfaces, can be used.

PowerLink	Power Line carrier system	PU3	Processing Unit
IFC	Interface Command	SDH	Synchronous Digital Hierarchy
DLE	Digital Line Equipment	FOBox	Fiber optic box
CLE	Copper Line Equipment	FO	Fiber optic module
PDH	Plesiochronous Digital Hierarchy	MUX	Multiplexer

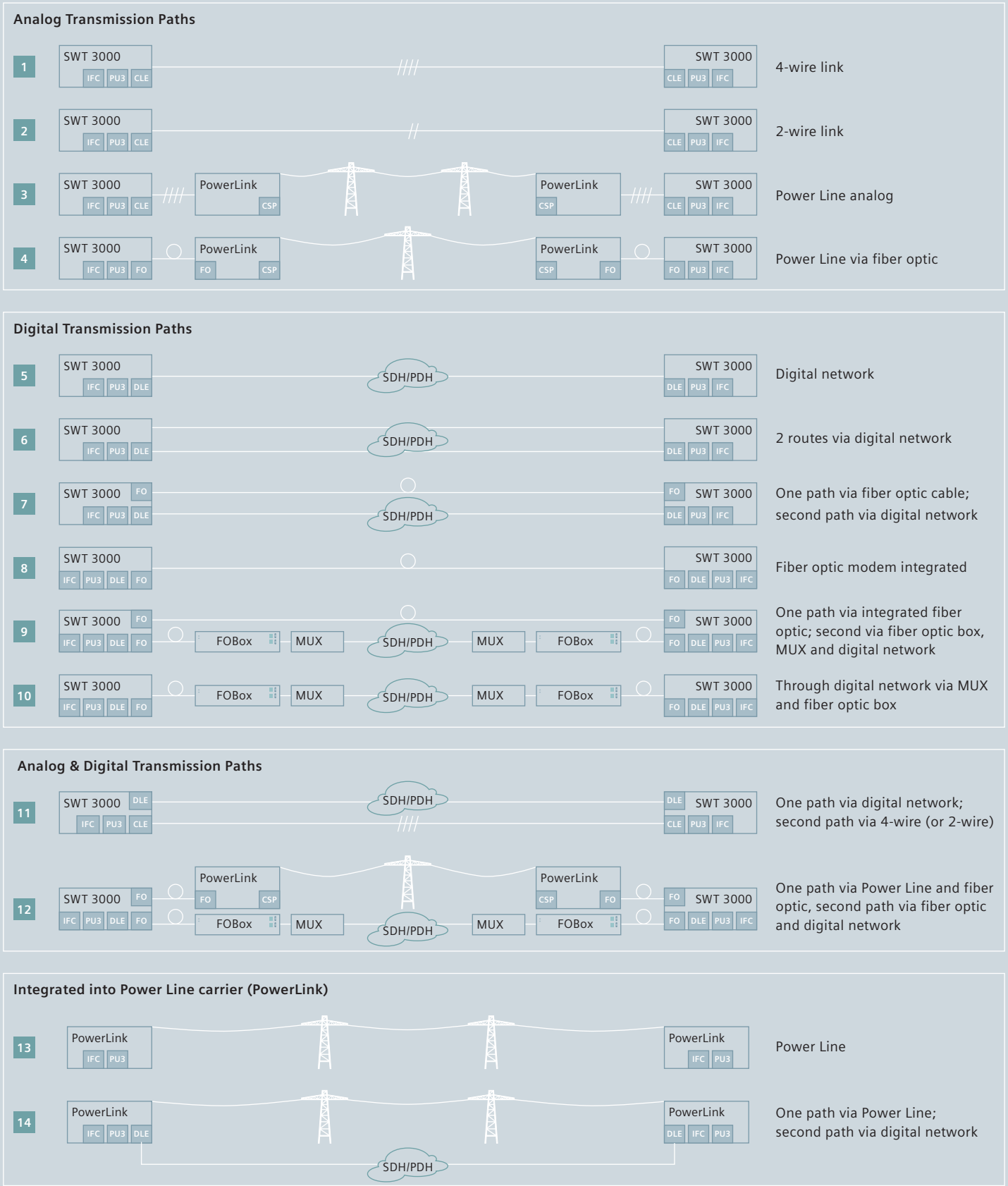


Fig. 7: Examples of using SWT 3000

The IP network – your gateway to SWT 3000

The SWT 3000 takes advantage of the latest technology to simplify operation and improve reliability. Using standard TCP/IP network protocols, administrators can easily access each SWT 3000 device from anywhere inside your organization's intranet. Access is also available remotely using a modem. The system can interface with your own network security system and firewall, providing you with the exact level of security your company requires. With easy authorized access to the SWT 3000 from just about anywhere, users can now:

- Perform remote maintenance operations
- Read the event recorder from any location
- Monitor the network in real time with SNMP

Our Windows-based PowerSys software is both intuitive and easy to learn, running on all standard computers. To make things even more simple for users, the same PowerSys that runs the SWT 3000 is also used to administer and maintain our companion Power Line carrier system PowerLink.

Power utilities increasingly rely on the real-time, comprehensive management capabilities of their networks to ensure optimum performance and data communication. Based on the SNMP standard (Simple Network Management Protocol), Siemens Power Line carrier and Teleprotection devices can be smoothly integrated to replace proprietary solutions or unmanaged components.

A selection of device data is available for SNMP network management administration:

- Inventory management (hardware data, configuration data)
- Performance management (event recorder)
- Configuration management (reset command)
- Alarm management (local alarms)

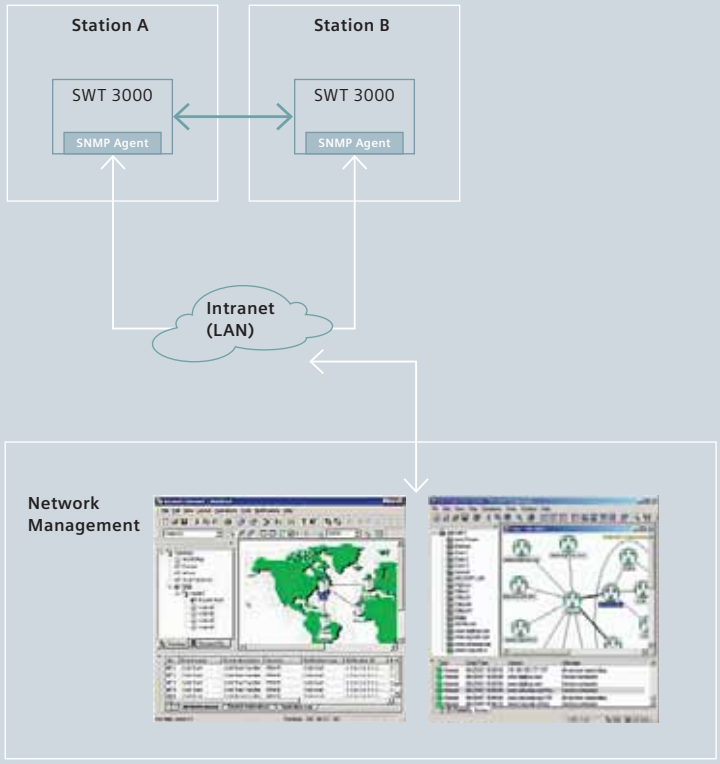


Fig. 8: SWT 3000 Integration in a Network Management System

SWT 3000 remote monitoring

Remote monitoring for digital networks

Remote access via a TCP/IP network (LAN)

- Example 1 (Fig. 9)
  Here, stations A and B are linked to the office via LAN. The SWT 3000 devices in these stations can be reached via the Intranet. The device in station C can also be accessed via the inband service channel (SC).

Remote access via the service channel

- Example 2 (Fig. 9)
  The service channel is a transparent data channel (9600 bps, 8 data bits, 1 start bit, 1 stop bit, no parity), which is available in case a digital transmission path is used.

Remote monitoring via RM function

- Example 3 (Fig. 10)
  RM can be used to transmit device data between terminal devices on one or more transmission links. Communication via a number of transmission links is also possible, using a link between two devices through the rear RM interface (SSB).

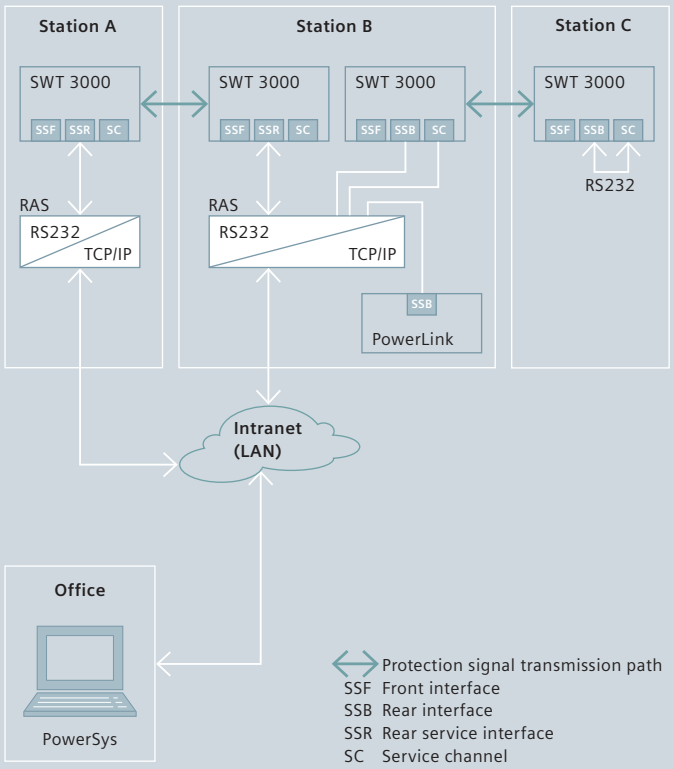


Fig. 9: Access to SWT 3000 devices via LAN

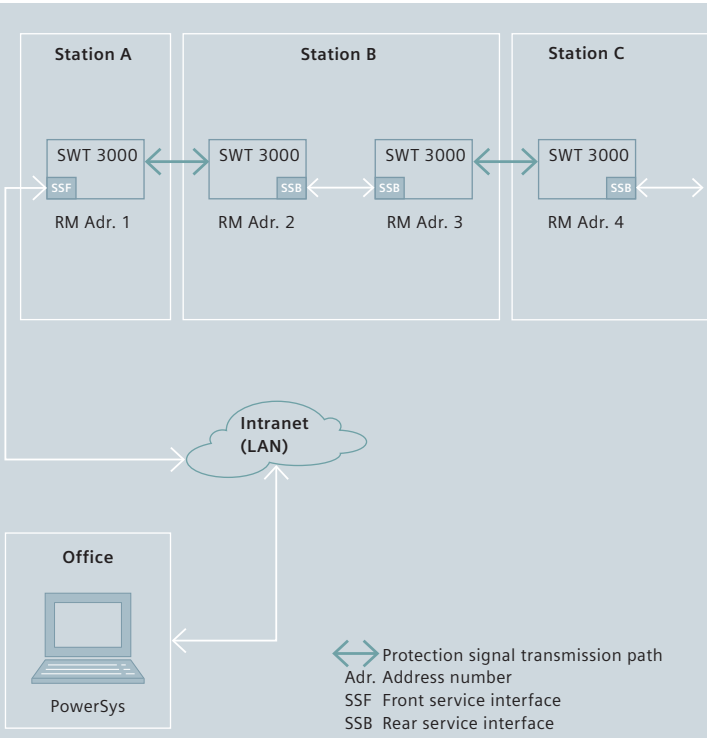


Fig. 10: Establishment of an RM link via a number of transmission links

Technical data

Command input/output

Command input IFC-P/IFC-D	
Nominal input voltage	24 V – 250 V DC (–20 % to +15 %)
Threshold	70 % of nominal input voltage
Polarity independence	yes
Pulse suppression	1 ms (up to 100 ms pro-grammable in steps of 1 ms)

Command output IFC-P	
Contact type	NO
Switching power max.	250 VA
Switching voltage max.	350 V AC/DC
Switching current	1.5 A (5 A for 2.5 ms)
Insulation withstand voltage	2.5 kVrms

Command output IFC-D	
Contact type	NO, heavy duty
Switching power AC DC	 1250 VA 150 W
Switching voltage max.	380 V AC, 220 V DC
Switching current continuous	5 A
Current < 0.5 s	30 A
Insulation withstand voltage	2.5 kVrms

Signaling output IFC-S
See IFC-D

Transmission via digital networks

Digital interfaces	
64 kbps	X.21 synchronous or G703.1
2 Mbps	G703.6 sym. 120 Ω G703.6 asym. 75 Ω
Transmission time: [1]	< 3 ms (2 Mbps) < 5 ms (64 kbps)

Security and dependability	
Security	$< 10^{-8}$
Dependability	$< 10^{-4}$ at BER of 10^{-6}

Transmission via fiber optic SWT 3000 fiber optic module FOM

FOL1 Long-range single mode	
Optical module	SFP-Transceiver
Connector	Industry standard duplex LC connector
Wavelength class	1550 nm
Optical budget at 64 kbps at 2 Mbps	 43 dB 33 dB
Range [km] **Depending on the fiber*** at 64 kbps at 2 Mbps * attenuation for range calculation	 154 km 118 km 0.28 db/km

FOS1 Short-range single mode	
Optical module	SFP-Transceiver
Connector	Industry standard duplex LC connector
Wavelength class	1310 nm
Optical budget at 64 kbps at 2 Mbps to PowerLink	 33 dB 17 dB 13 dB
Range [km] **Depending on the fiber*** at 64 kbps at 2 Mbps to PowerLink * attenuation for range calculation	 87 km 45 km 34 km 0.38 db/km

FOS2 Short-range multi mode	
Optical module	SFP-Transceiver
Connector	Industry standard duplex LC connector
Wavelength class	850 nm
Optical budget at 64 kbps at 2 Mbps to PowerLink	 7 dB 7 dB 7 dB
Range [km] **Depending on the fiber*** at 64 kbps at 2 Mbps to PowerLink * attenuation for range calculation	 2 km 2 km 2 km 3.50 db/km

1) Values are given for the IFC-P module. If the interface module IFC-D is used for increased contact load, all specified signal transmission times are prolonged by about 4 ms.

Transmission via fiber optic
SWT 3000 fiber optic box

Power supply	
Input voltage	20 – 72 V DC / 22 – 60 V AC
Power consumption max.	3.5 W

Alarm output	
Contact type	Changeover contact
Switching power max.	1000 VA / 150 W
Switching voltage max.	380 V AC / 220 V DC
Continuous current	5 A AC/DC

Mechanical design	
Dimensions approx. (mounting onto DIN rail)	230 x 110 x 60 mm

Insulation withstand voltage	
Power supply	2.5 kVrms
Alarm outputs	2.5 kVrms
Digital input/output G703.6 sym.	500 Vrms

Fiber optic modules	
For the FOBox, different SFP modules can be selected.	Optical budget and range are identical to FOM (FOL1, FOS1, FOS2) specification.

Transmission via analog networks

Modulation type	F6 modulation (frequency shift keying or coded tripping)

Broadband modulation	
Trip frequencies	0.3 to 2.03 kHz
Guard	2.61 or 3.81 kHz

Narrowband modulation	
Channel 1	0.63 to 1.26 kHz
Channel 2	1.64 to 2.27 kHz
Channel 3	2.65 to 3.28 kHz
Channel 4	3.16 to 3.79 kHz

Transmission time (SWT 3000 standalone) [1]	
Broadband modulation	
Single-purpose	< 10 ms (F6, CT)
Alternate multipurpose	< 15 ms (F6,CT)
Narrowband modulation	< 15 ms (F6)

Transmission time (SWT 3000 Integrated into PowerLink) [1]	
Broadband modulation	
Single-purpose	< 10 ms (F6, CT)
Alternate multipurpose (F2 + AMP)	< 15 ms (F6, CT)
Alternate multipurpose (DP + AMP)	< 19 ms (F6, CT)
Simultaneous multipurpose	< 10 ms (F6, CT)
Narrowband modulation	
Using service F6	< 15 ms (F6)

Security and dependability	
Security (improved by INC)	< 10^{-6}
Dependability (improved by INC)	< 10^{-4} at SNR of 6 dB

Voice frequency interface CLE	
Transmitter	
Impedance	600 Ω
Level max.	+15 dBm
Receiver	
Impedance	600 Ω or 5 kΩ
Level range	–40 dB to +4 dB

Power supply

Input voltage	24/48/60 V DC (–20 % to +15 %) 110 V/220 V/250 V DC (–20 % to +15 %) or 115/230 V AC (–15 % to +10 %) 47 Hz – 63 Hz
Power consumption	approx. 22 W/VA

Alarm outputs

Contact type	Changeover contact
Switching power max.	1000 VA/300 W
Switching voltage max.	250 V AC/DC
Continuous current	5 A DC

Clock synchronization

Analog input USYNC	24 V – 250 V DC (–20 % to +15 %)
Digital input IRIG-B	5 V – 250 V DC
Ethernet	NTP, Network Time Protocol

Service PC

Interface	9.6 kbps RS 232/Sub-D 9

1) Values are given for the IFC-P module. If the interface module IFC-D is used for increased contact load, all specified signal transmission times are prolonged by about 4 ms.

Network management

SNMP v2 on Ethernet interface	10/100 BaseT

Electromagnetic compatibility (EMC)

Immunity	
Electrostatic discharge	8 kV (contact discharge)
Electromagnetic fields (RF fields)	10 V/m (80 MHz – 2 GHz)
Conducted disturbances	10 V_{rms} (150 kHz – 80 MHz)
Bursts	
Power supply	4 kV
Data lines	4 kV
Surges	
Common mode (line-to-line)	4 kV
Differential mode (line-to-ground)	2 kV
Direct coupling into shield (communication cable)	2 kV
Damped oscillatory waves	
Common mode (line-to-line)	2.5 kV
Differential mode (line-to-ground)	2.5 kV
Direct coupling into shield (communication cable)	2.5 kV

Emission	
RF disturbance emission (30 – 1000 MHz)	Limit Class B (EN 50081-2)

Insulation withstand voltage

VF input/output	500 V_{rms}
Power supply	2.5 kV_{rms}
Command input/output	2.5 kV_{rms}
Alarm outputs	2.5 kV_{rms}
Digital input/output	
G703.1	500 V_{rms}
G703.6 sym	500 V_{rms}

Impulse withstand level 1.2/50 µs

VF input/output	1 kV
Digital input/output	1 kV
Power supply	5 kV
Command input/output	5 kV
Alarm outputs	5 kV

Climatic conditions

During operation	–5 °C to +55 °C
During storage and transport	–40 °C to +70 °C
Relative humidity	5 % – 95 %
Max. abs. humidity (no condensation)	29 g/m^3

Mechanical conditions

Degree of protection	IP 20
Vibration	5 – 9 Hz: 1.5 mm amplitude 9 – 200 Hz: 0.5 g acceleration
Shock	10 g acceleration

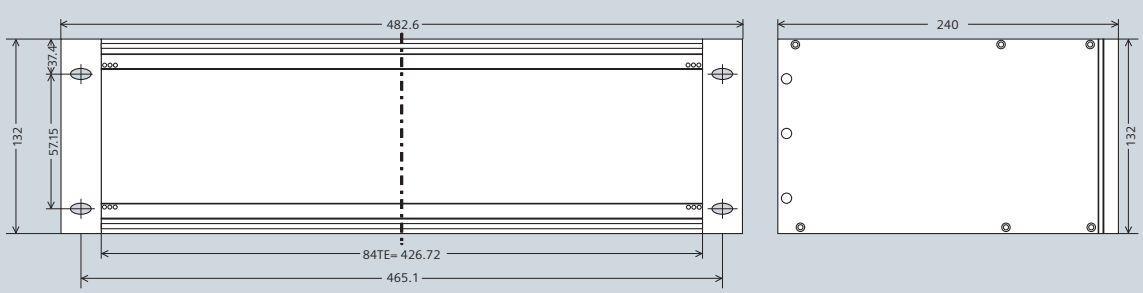
International standards

Performance and testing of teleprotection equipment of power systems	IEC 60834-1 second edition 1999-10
Power supply and electromagnetic compatibility	IEC 60870-2-1
Environmental conditions	IEC 60870-2-2
Product safety	EN 60950

Mechanical design

Dimensions	ES 902 C (19" inch)
Weight	approx. 5 kg

Fig. 11: Mechanical design



Security and alarming

Monitoring the operating voltage
Command transmission and receiver output are inhibited if the operating voltage exceeds its tolerance range.

Redundant power supply
Either one or two power supply units can be used. These are decoupled by means of diodes on the rear circuit board. The output voltages of PS-1 and PS-2 are monitored in order to detect the failure of either power supply.

Integrated path protection (1 + 1)
Switchover to a standby path is possible if either two digital interfaces or one digital and one analog interface are available. The service PC can be used to define the main and standby path. If a transmission link fails, switchover is performed fully automatically and without loss of data.

Operating state
The actual operating state for the device is shown by colored LEDs on the front panel.

Guard alarm
If no valid guard signal is present, a guard alarm is triggered.

Continuous supervision
The system's transmission capability is checked via continuous supervision of the SWT 3000 in both directions by transmitting the guard signal (telegram via the digital transmission path and guard frequency via the analog transmission path). This "round-the-clock" check ensures that all components of the SWT 3000 are supervised continuously and that any failure will result in an alarm. For extended test purposes a loop can be configured via remote maintenance in the remote station. Each command could be manually sent and looped back from the remote terminal.

S/N ratio
Fast and reliable S/N ratio supervision increases system security and reliability. In case of a low S/N ratio, output blocking can be programmed.

Transmit signal level monitoring
The level of the transmit amplifier output is monitored.

Integrated event recorder
Up to 2048 events are stored. Each event is saved with date and time (1 ms resolution). External synchronization is possible via GPS, IRIG-B or NTP. Even in the absence of external synchronization, the transmit and receive terminals can be synchronized via the signal transmission path to prevent time shifts between the RTCs of SWT 3000.

Integrated trip counter
For each command input and output, trip counters are realized and can be read out or reset by software.

Alarm contacts
Floating change-over contacts are available for the following signals:
- General alarm
- Pre-alarm
- Receive alarm

External event recording
Contacts for external event recording are available with the optional IFC-S interface module. Each input and output event is reported via auxiliary contact.

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