SIEMENS

Telecommunication Products

PowerLink IP

V4.19 and higher

Equipment Manual

C53000-H6040-C254-D

NOTE

For your own safety, observe the warnings and safety instructions contained in this document, if available.

Disclaimer of Liability

Subject to changes and errors. The information given in this document only contains general descriptions and/or performance features which may not always specifically reflect those described, or which may undergo modification in the course of further development of the products. The requested performance features are binding only when they are expressly agreed upon in the concluded contract.

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Version of the product described: V4.19 and higher

Preface

Purpose of the Manual

This manual describes the control and monitoring functions for Smart Communications.

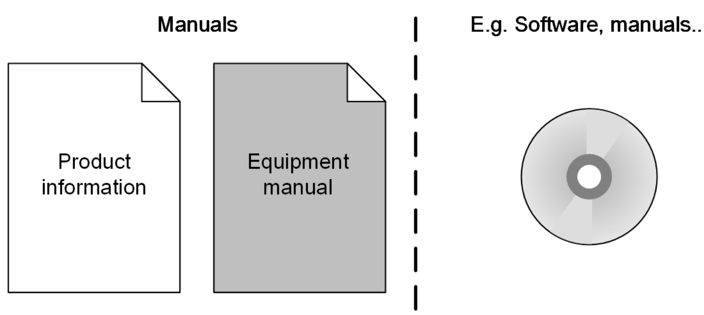
Target Audience

Smart Communications engineers, protection system engineers, commissioning engineers, persons entrusted with the setting, testing and maintenance of automation, selective protection and control equipment, and operating personnel in electrical installation and power plants.

Scope

This manual is valid for the PowerLink device family.

Further Documentation



[dw_Product-overview_SWT3000_Equipment-manual, 2, en_US]

- Product Information
  The **Product Information** includes general information about device installation, technical data, limit values for input and output modules, and conditions when preparing for operation. This document is delivered with each device.
- Equipment Manual
  The **Equipment Manual** describes the functions and applications of a specific PowerLink device.

Additional Support

For questions about the system, contact your Siemens sales partner.

Customer Support Center

Our Customer Support Center provides a 24-hour service.

Siemens AG
Smart Infrastructure – Protection Automation
Customer Support Center

Tel.: +49 911 2155 4466
E-Mail: *energy.automation@siemens.com*

Notes on Safety

This document is not a complete index of all safety measures required for operation of the equipment (module or device). However, it comprises important information that must be followed for personal safety, as well as to avoid material damage. Information is highlighted and illustrated as follows according to the degree of danger:

DANGER

DANGER means that death or severe injury **will** result if the measures specified are not taken.

✧ Comply with all instructions, in order to avoid death or severe injuries.

WARNING

WARNING means that death or severe injury **may** result if the measures specified are not taken.

✧ Comply with all instructions, in order to avoid death or severe injuries.

CAUTION

CAUTION means that medium-severe or slight injuries **can** occur if the specified measures are not taken.

✧ Comply with all instructions, in order to avoid moderate or minor injuries.

CAUTION

ESD (Electrostatic sensitive devices) means that a device or component **can** be damaged by common static charges built up on people, tools, and other non-conductors or semiconductors.

✧ Comply with all instructions, in order to avoid moderate or minor injuries.

NOTICE

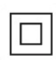
NOTICE means that property damage **can** result if the measures specified are not taken.

✧ Comply with all instructions, in order to avoid property damage.

NOTE

Important information about the product, product handling or a certain section of the documentation which must be given attention.

Selection of Used Symbols on the Device

No.	Symbol	Description
1		Direct current, IEC 60417, 5031
2		Alternating current, IEC 60417, 5032
3		Direct and alternating current, IEC 60417, 5033
4		Earth (ground) terminal, IEC 60417, 5017
5		Protective conductor terminal, IEC 60417, 5019
6		Caution, risk of electric shock
7		Caution, risk of danger, ISO 7000, 0434
8		Protective insulation, IEC 60417, 5172, safety class II devices
9		Guideline 2002/96/EC for electrical and electronic devices
10		Guideline for the Eurasian market
11		Mandatory conformity mark for electronics and electrotechnical products in Morocco
12		Extra low voltage (ELV), IEC 60417, 5180, Safety Class III devices

OpenSSL

This product includes software developed by the OpenSSL Project for use in OpenSSL Toolkit (*http://www.openssl.org/*).

This product includes software written by Tim Hudson (*tjh@cryptsoft.com*).

This product includes cryptographic software written by Eric Young (*eay@cryptsoft.com*).

Table of Contents

1 Safety and Installation Instructions

1.1 Scope of Delivery

The equipment is delivered with:

- The **Product Information** with a system description and instructions for installation, commissioning and operation, decommissioning and disposal.
- The corresponding software package (formerly delivered on DVD) is available for download on *SIOS* (Siemens Industry Online Support) platform free of charge, a registration is required.
- Test protocols are available for download under *Energy Automation Testreports*
  Enter BF code of device to view the requested test protocol in pdf format. The installed firmware package version loaded into the device can be seen in the protocol.

For further details, see the information that can be found in the manual.

1.2 Notes on Safety

PowerLink devices use the high-voltage line between transformer substations as a communication path for data and protection signals.

Notes on Safety must be adhered to ensure personal safety and to avoid damage to property during commissioning and use.

	Danger of severe personal injury or substantial damage to property Hazardous voltages may occur in devices and modules during operation. Always observe the instructions given in "Qualified Electrical Engineering Personnel" below.
	Qualified Electrical Engineering Personnel Qualified electrical engineering personnel must have up to date technical qualifications as electrical technicians. Only these persons may commission, use, maintain, decommission and dispose of the device according to the state of the art standards of engineering in the high voltage power line environment.
	Use as Prescribed The device may only be used for such applications as set out in the user instructions, and only in combination with equipment recommended and approved by Siemens. Correct and safe operation of the product requires adequate transportation, storage, installation and mounting in a control cabinet, as well as appropriate use and maintenance. During operation of the equipment, it is unavoidable that certain parts will carry dangerous voltages. Severe injury or damage to property can occur if the appropriate measures during use are not taken:
	Danger Make sure, that the equipment is properly connected to ground at all times and mechanically fixed in the rack. The device is connected through a coupling unit to the HV line. A permanent ground connection is an essential precondition to safeguard the user against any high voltages from the HV line.
	Danger This equipment can be supplied by and connected to different independent energy sources. Before any maintenance work, disconnect the equipment from all energy sources to ensure that no dangerous voltage is present. Even after the power supply has been disconnected, hazardous voltages can still be present within the device (capacitor storage).
	Danger To prevent the risk of possible over voltages the cable shield of the communication cable between Line Matching Unit (LMU, AKE) and the power line carrier communication devices (PowerLink) must be grounded on both ends. The grounding of the cable shield must be carried out on the LMU side itself and once again before entering the station building or a ground connection within the building in which the PowerLink devices or any other powerline carrier communication device are installed. The grounding must be carried out using a connection that cannot be detached without tools. The grounding of the cable shields must not be removed until it is ensured that by closing the short circuit switch on the LMU and attaching an additional grounding rod to the HV input, the LMU is voltage-free and safely grounded.
	Before making any connections, ground the equipment and the grounding terminal

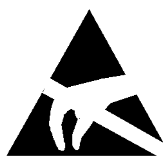
	Note This is a Class A device. It is intended to be operated in an industrial environment only. It may cause harmful interference if operated in residential/light industry environment.
	Note IP20: Device may only be operated in a dry location within a temperature range of -10 to +55 degree Celsius
	Note The limit values indicated in the manual must not be exceeded; that also applies to testing and commissioning

1.3 Electrostatic Sensitive Devices

NOTE

This Manual is written for **service and operation personnel** in the high voltage power line environment. All existing safety instructions in the **environment of the user** must be observed and **only trained and instructed** personnel shall be allowed to work with the equipment.

CAUTION



Electrostatic sensitive devices are protected against destruction by electrostatic charge with protective structures at the inputs and outputs. In unfavorable cases, however, plastic floor coverings, non-conductive work surfaces, or clothing containing artificial fibers can result in such high charges.

These charges can damage or even destroy the electrostatic sensitive devices despite the protective networks mentioned. If a device is damaged, its reliability decreases drastically although the effects of the damage are noticeable a long time before.

✧ In order to ensure that electrostatic charges are completely eliminated when working on the system, comply with the following instructions in order to avoid moderate or minor damage:

✧ - Before carrying out any work on the system, ground yourself with a wrist strap.

✧ - When working on modules, always place them on a grounded conductive surface.

✧ - Transport modules only in suitable protective bags.

The following instruction must also be observed during **installation**:

- Connect the grounding wire to the device.
- Reduce charge of persons that handles the device (e.g. ESD shoes, shoe grounding strips or wrist strap.)

1.4 Environmental Conditions

- The device may only be operated in a dry and weather protected location.
- The temperature in the room must not exceed the temperatures specified in the operating rules.
- The device can be damaged if it is not operated in accordance with the specified environmental conditions.
- Provide sufficient cooling or heating (for operation conditions out of the specified limits).

1.5 Transport, Package and Storage

1.5.1 Unpacking the Device

NOTE

Devices are tested prior to delivery. The verification certificate is part of the device.

- Check the package for external transport damage. A damaged packing may indicate that the device inside is also damaged
- Unpack the device carefully.
- Visually check the devices to ensure that they are in perfect mechanical condition.
- Keep the packing in case the devices must be stored or transported elsewhere.
- Return a damaged device to the manufacturer or dispose it correctly. A defect device may not either be used or repaired by the user

1.5.2 Storing the Device

- The device must be stored in rooms, which are clean, dry, and dust-free. Devices or associated spare parts must be stored at a temperature between –40° C and +70° C.
- The relative humidity must be at a level where condense water and ice are prevented from forming.
- If the device has been in storage for more than 2 years, connect it to the primary voltage source, and operate it for 1 to 2 days. This will cause the electrolytic capacitors to form on the printed circuit board assemblies again.
- When the device is reshipped ensure that the transport requirements for the selected means of transport are met. The outer package alone is not adequate for transport purposes.

1.6 Installation

1.6.1 Checking Rated Voltage

- Check the rated voltage and the electrical operating conditions using the complete order designation/the product code. This manual contains all technical data and a description of the functions.
- Check the information provided on the name plate too.
- Make sure that the rated voltage of the device properly matches the installation conditions. You can find the necessary information in the Technical Data chapter.

1.6.2 Laser Radiation Emission Warning

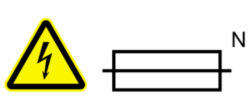
The device may be equipped with a class 1 hazard level laser radiation source.
All laser sources have the potential to harm eyes.
The following safety instructions must be observed during commissioning and operation:

- Do not look directly into the optical fiber terminals of the active optical plug-in modules.
- **Do not expose users of telescopic optics.**
- Do not stare into the laser beam using any optical device.
- De-energize the device before fiber optic cables are plugged/unplugged
- Do not remove any protection plug from any fiber adaptor during operation of the device.
- In case that fiber cables or protection plugs are removed unintentionally:
  Do not look into the fiber adaptor - stray radiation may occur.
  Switch OFF device immediately.

NOTE

Laser class 1, product is in compliance with EN 60825-1 and EN 60825-2, in the case of ≤ 62.5 µm/125 µm optical fibers are used.

1.6.3 Fuse



[dwfusesa-191211-01.tif, 1, en_US]

NOTE

CAUTION

The power supply PSPA2 is equipped with a fuse.
After operation of the fuse, parts of the equipment that remain energized might represent a hazard during servicing.
The user may not under any conditions replace the fuse.

1.7 Commissioning

DANGER

- All safety notes as described must be observed.

DANGER

- The cross section of the ground wire and the laying of the wire must comply with the regulations applicable for the place of installation.

- Connect the device with a solid low-resistance to earth. Observe local installation conditions
- Connection of the Supply Voltage: The AC supply voltage is connected to the terminals PE-N-L1 (Protective Earth, Neutral, Line). In case of DC voltage the (-) is connected to the N and (+) to the L1 terminal. The terminals are covered. The supply voltage connected must be within the specified limit values (see technical data). These values indicated in the manual must not be exceeded in any case.
- Make sure that all front and back covers of the device are remounted upon completion of the installation.
- Turn on the Supply Voltage: switch S1 located on DMB board enables/disables the secondary voltages of the power supply.

  Down position: Off mode; LED "i" (red) lights up on the PSPA2 power supply unit(s).

  Up position: On mode; LEDs +48V/-48V (green) lights up on the PSPA2 power supply unit(s).

  After system startup the LEDs on DMB board will light up green.

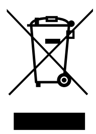
1.8 Replacement of Modules

- ✧ Before any maintenance work, disconnect the equipment from all energy sources to ensure that no dangerous voltage is present.
- ✧ Install plug-in modules on the electrically deactivated device only.
- ✧ De-energize the device.
- ✧ Remove the front plate from the device.
- ✧ Carefully pull out the plug-in module.
- ✧ Configure the jumper settings prior to installation.
- ✧ Push in the new plug-in module on the inner guide as far as it is possible.
- ✧ Connect the leads to the terminals.
- ✧ Then check for secure attachment of the connectors.
- ✧ Mount and fasten the front plate on the device.
- ✧ The device shall recognize the new plug-in module.
- ✧ In case you installed a new module, configure the settings of the new module in Web UI.
- ✧ Only qualified electrical engineering personnel is authorized to reset the hardware parameters.

1.9 Environmental Protection Hints

Disposal of Old Equipment and Batteries (Applicable only for European Union and Countries with a Recycling System)

The disposal of our products and possible recycling of their components after decommissioning has to be carried out by an accredited recycling company, or the products/components must be taken to applicable collection points. Such disposal activities must comply with all local laws, guidelines and environmental specifications of the country in which the disposal is done. For the European Union the sustainable disposal of electronic scrap is defined in the respective regulation for "waste electrical and electronic equipment" (WEEE).



The crossed-out wheelie bin on the products, packaging and/or accompanying documents means that used electrical and electronic products and batteries must not be mixed with normal household waste.

According to national legislation, penalties may be charged for incorrect disposal of such waste.

By disposing of these products correctly you will help to save valuable resources and prevent any potential negative effects on human health and the environment.

NOTE

Our products and batteries must not be disposed of as household waste. For disposing batteries it is necessary to observe the local national/international directives.

Disposal of Mobile Storage Devices (e.g. USB Sticks and Memory Cards)

When disposing of/transferring mobile storage devices, using the **format** or **delete** functions only changes the file management information and does not completely delete the data from your mobile storage device. When disposing of or transferring a mobile storage device, Siemens strongly recommends physically destroying it or completely deleting data from the mobile storage device by using a commercially available computer data erasing software.

REACH/RoHS Declaration

You can find our current **REACH/RoHS** declarations at:

https://www.siemens.com/global/en/home/products/energy/ecotransparency/ecotransparency-downloads.html

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NOTE

You can find more information about activities and programs to protect the climate at the EcoTransparency website:

https://www.siemens.com/global/en/home/products/energy/ecotransparency.html

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2 Functional Description

2.1 System Overview

2.1.1 PowerLink IP

[ph_PLIP_SWT_CIB, 1, --_--]

PowerLink IP uses the high-voltage line between substations as a communication path for data, protection signals and voice. This technology has two main application areas:

- as a communications link between substations where a fiber-optic connection does not exist or would not be economically viable and
- as a backup system for transmitting protection signals parallel to an installed fiber-optic link.

Siemens power line carrier technology has been applied over decades, ensures extremely high standards of transmission reliability in network protection (such as protection signals), safeguards the transmission quality, and can easily be integrated into a wide range of communication networks. PowerLink IP has been designed for the Ethernet / IP environments of the new digital high voltage substations and makes PLC systems today more attractive and efficient than ever before.

Advantages at a glance

Proven PLC technology for the extended bandwith requirements of digital highvoltage substations

- Adaptable data rata of up to 1.5 Mbps per direction
- Smart frequency management including efficient bandwith utilization up to 256 kHz bandwidth
- Frequency grooming for use of non-contiguous frequency bands (notching)
- High availability with fast synchronization and automatic levelling
- Integrated TCP/IP interface optimized for Ethernet-LAN / IP traffic
- Cross-functional management system for all integrated services and functions based on state-of-the-art WebUI
- Integrated or external (via fiber-optic module) teleprotection system (optional)
- Seamless integration into existing PLC infrastructure

High performance

PowerLink IP offers a transmission capacity up to 1.5 Mbit/s in each transmission direction. Integrated TCP/IP interfaces allow Ethernet-capable terminals to use the power line communication network as communication medium.

Easy to manage

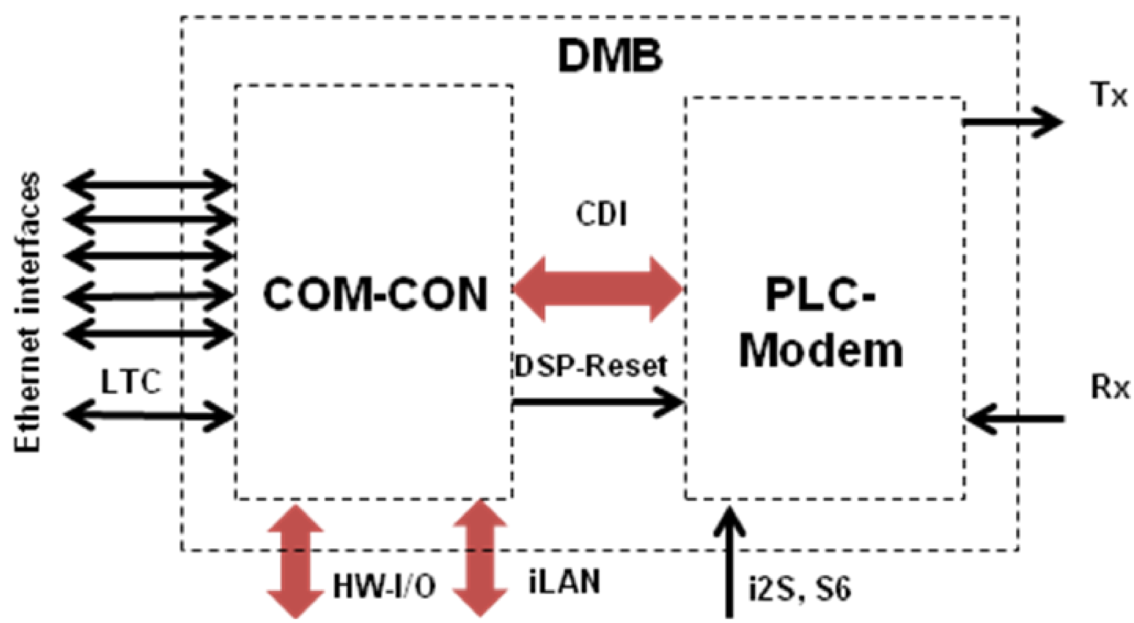
PowerLink IP not only simplifies communications, it also makes communications more cost effective. PowerLink IP's integrated applications can be locally accessed and administered via local craft terminal and state-of-the-art WebUI interface. This ensures higher operating security while keeping training time and costs to a minimum.

2.1.2 DMB

2.1.2.1 Overview

The DMB (Data Modulation Board) module is the central component of PowerLink IP and consists of the following sub-components:

- Communication controller (COMCON)
- PLC modem based on a digital signal processor (PLCDSP)
- Control and data interface (CDI)
- Data and I/O interfaces
- TX and RX interfaces to PLC Modem



[dmb_blockdiagram, 1, --_--]

2.1.2.2 COMCON Communication Controller

COMCON is the central controller in the device providing the following main functionalities:

- Ethernet / IP based communication
- Management of the device (parameter, log-books, alarming, component monitoring, firmware update, event recording, ...)

2.1.2.3 PLC Modem

The PLC Modem is used for following main functionalities:

- Transmission and reception of frames to/from the partner PowerLink IP device over HV power line
- FEC (forward error correction) to increase robustness of data transmission and to reduce the required SNR at the receiver
- Transmission and reception of MARC signals
- Spectrum analyses, TX filter test, test signal generation

2.1.2.4 User Interfaces DMB

Ethernet connectors

6 Ethernet connectors on front cover:

- 1 port 100TX electrical, LCT for configuration
- 3 ports 10/100TX electrical, one of them with PoE class3
- 2 ports 100FX optical with SFP cage

LEDs

4 LEDs at front cover indicating:

- Device Status COMCON (green/red)
- Device Status PLCDSP (green/red)
- Sync Status (green/red)
- Receive Alarm (red)

Reset button

Operable through a drill hole in the front panel

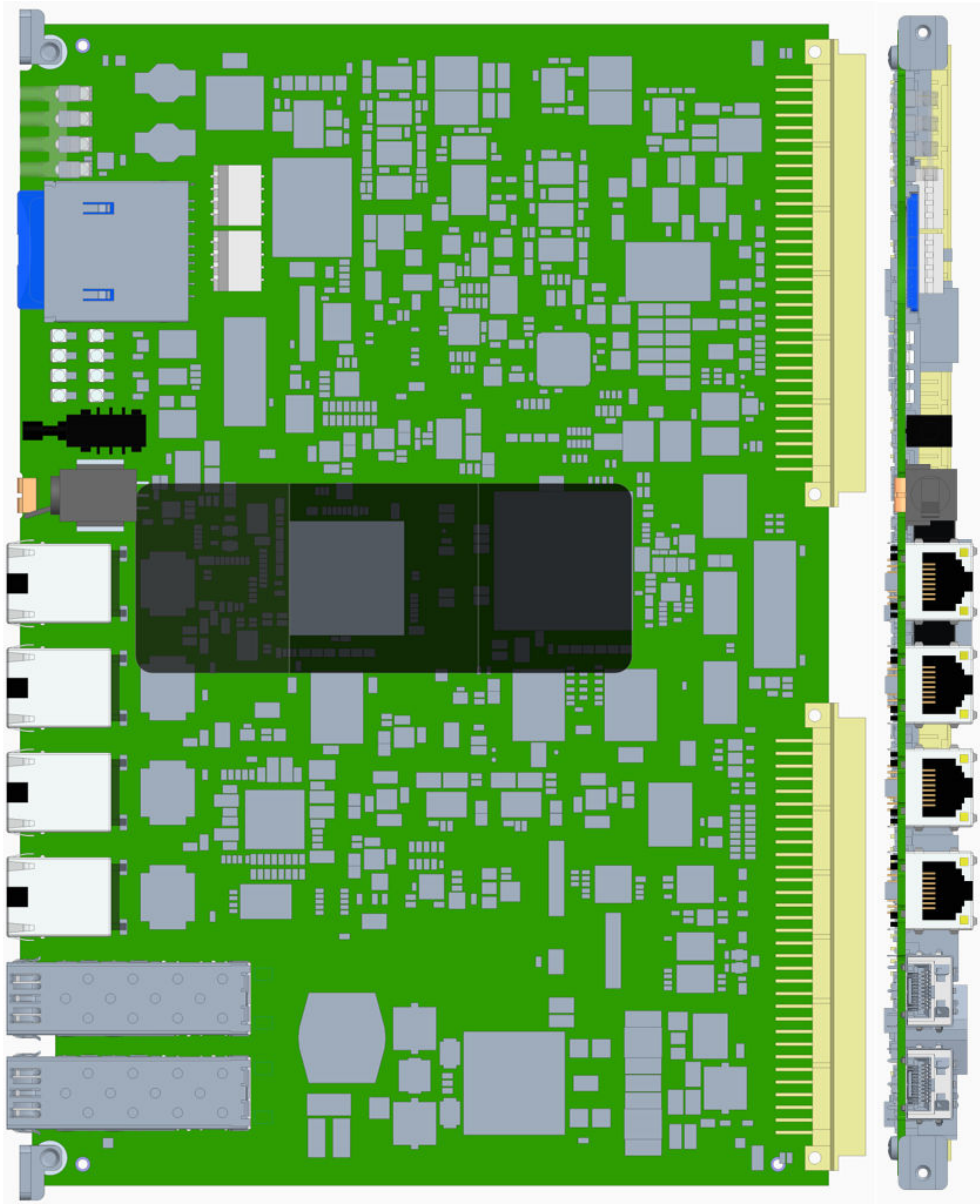
Power Inhibit (Switch S1)

Position	
Up	Power supply enabled
Down	Power supply disabled

DIP switch to set device to default IP address. (S5.2)

Set IP address of device.
Start with default service interface IP address (192.168.20.20) and default user interface IP address (192.168.30.20)

2.1.2.5 DMB Mechanical Design



[dmb_mechanical_design, 1, --_--]

2.1.3 TFLT

2.1.3.1 Overview

The TFLT (Transmit Filter and Line Termination) module consists of two boards. Both possible amplifiers share this common transmit filter.

Two variants are available:

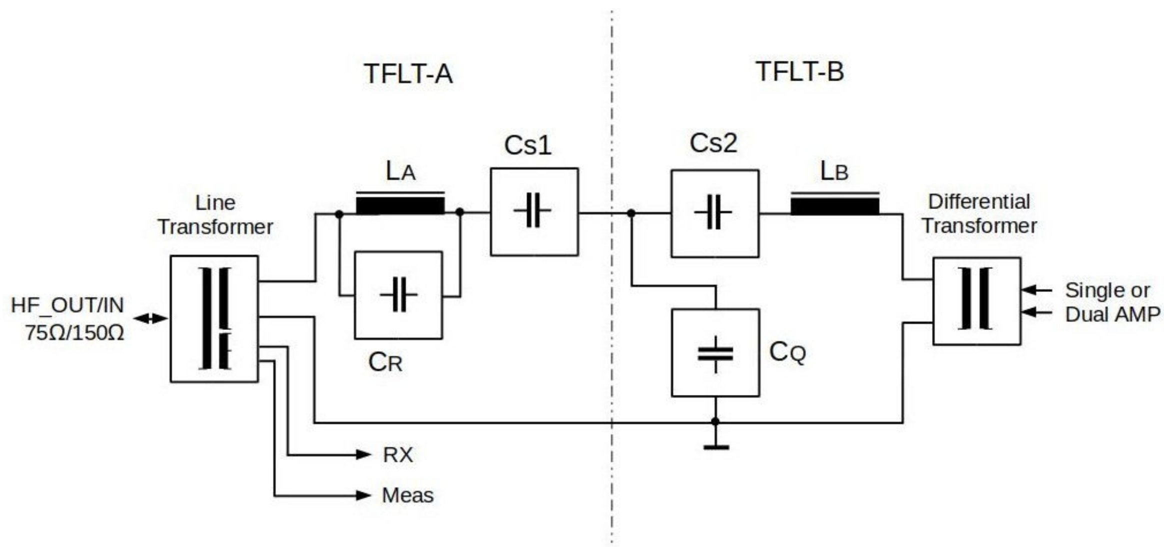
- TFLT-A + TFLT-B filter for transmit bandwidth 32 kHz up to 256 kHz
- TFLT-C + TFLT-D filter for transmit bandwidth 4/5/8/12/16 kHz

2.1.3.2 TX Filter

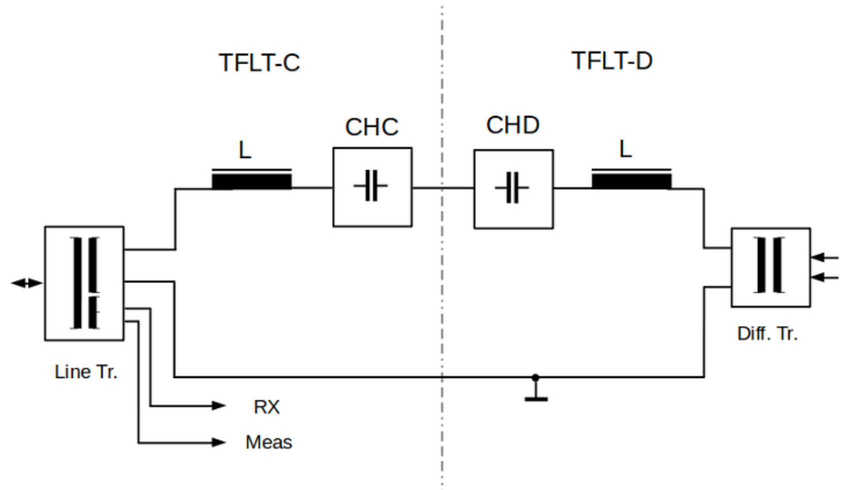
The TX filter serves the following purposes:

- Isolation of the power amplifier from other power amplifiers on the same line, i.e. providing high impedance in the stop bands
- Reduce energy content of transients (lightning, circuit breakers) from the HV line by reflecting out-of-band spectral components
- Improve suppression of power amplifier harmonics

Blockdiagram of TX filter



[TFLT_tx_filter_blockdiagram, 1, --_--]



[sc_TFLTCD_tx_filter_blockdiagram, 1, --_--]

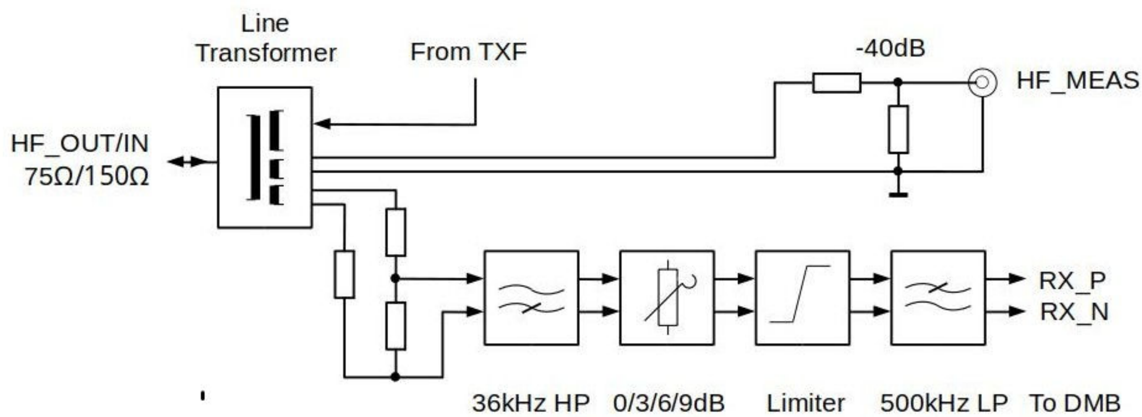
2.1.3.3 Line Transformer

The Line Transformer provides the interface between the HV Line (via coupling unit) and the internal signal paths (TX-filter, RX, and measurement output). The primary side´s impedance is configurable to 75 Ω ground-referenced or 150 Ω differential. A screen between the primary and secondary winding protects the internal circuitry from arc-over under severe fault conditions, common-mode interference and improves high frequency stop band attenuation.

2.1.3.4 RX and Measurement Path

The main constituent of the RX path is the line transformer, which provides isolation from common mode transients from the HV line. The RX-filter comprises of high-pass filter section, a variable attenuator, a limiter circuit and a low-pass filter section.

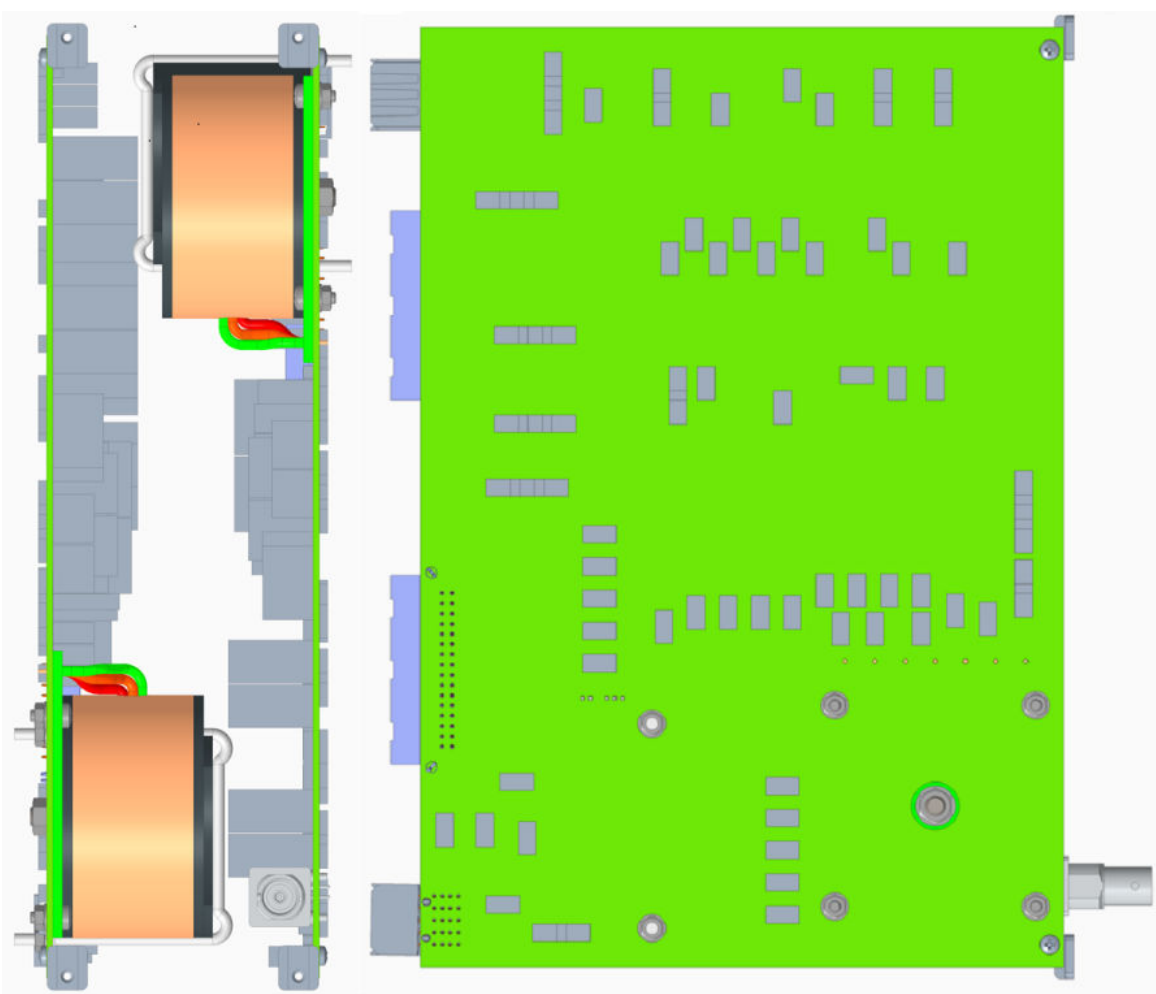
Block diagram of TFLT RX/Meas



[TFLT_rx_meas_blockdiagram, 1, --_--]

The RX-Filter needs not to be adjusted, it has fixed cut-off frequencies of 36 kHz and 500 kHz respectively.

2.1.3.5 TFLT Mechanical Design

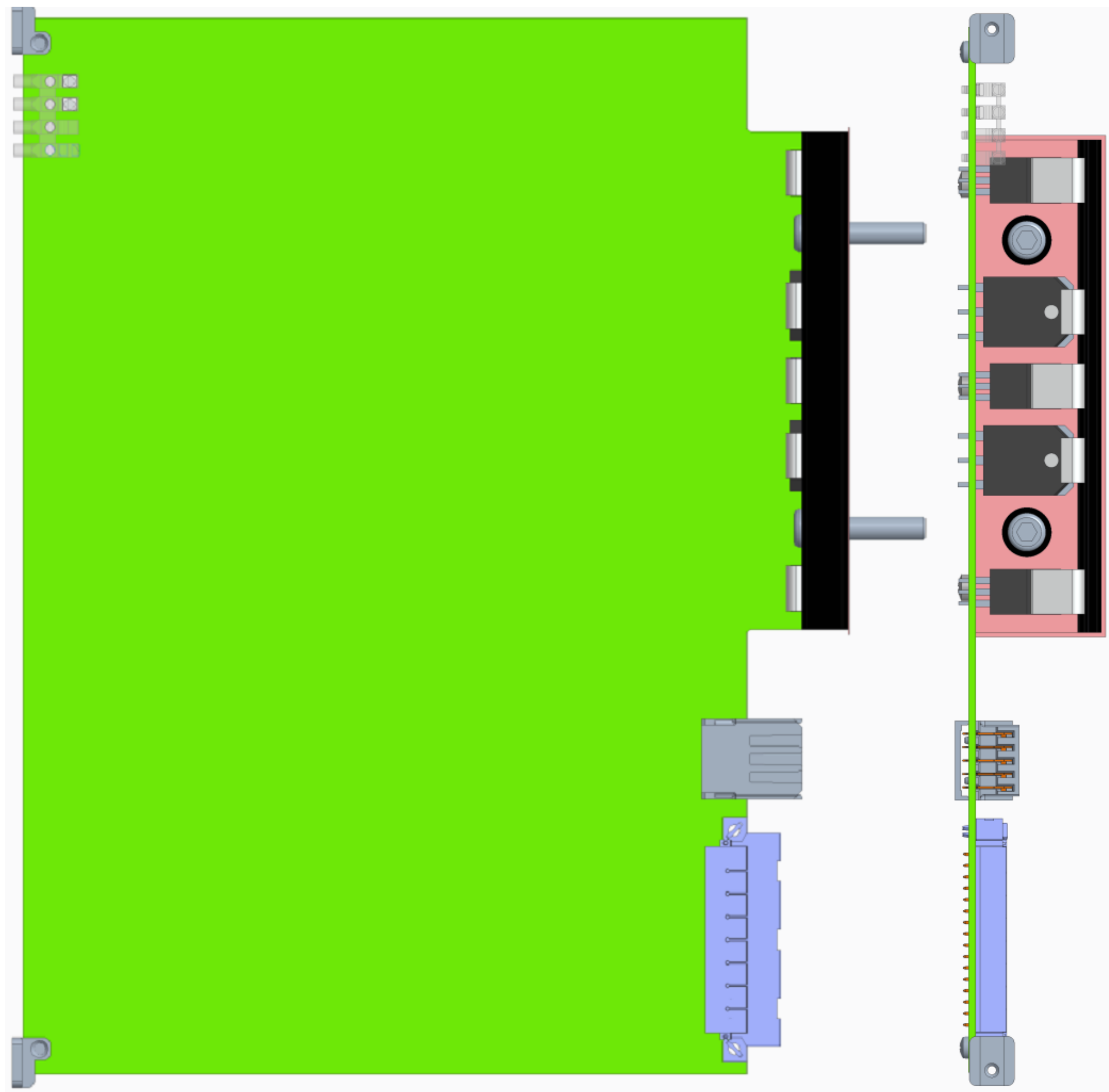


[TFLT_mechanical_design, 1, --_--]

2.1.4 AMP

2.1.4.1 Function of Amplifier

The AMP (Power Amplifier) module amplifies the TX signal generated by the DMB. Nominal output power is 50W sine at the PowerLink IP connector (HF_OUT/IN).



[dw_AMP_mechanical_design, 1, --_--]

Dynamic Control

Switching operations in the high-voltage network, in addition to climatic conditions, may cause changes of the impedance of the high-voltage line, which affects the output current and the output voltage of the amplifier adapted to the line. Significant deviations from the nominal impedance will overload the amplifier and the resulting signal distortion would impair system performance. The dynamic control circuit monitors the AMP's load and reduces output power if necessary. This condition is signaled to the DMB and also indicated by the red alarm LED on the front.

Temperature Control

A temperature supervisor module continuously measures the temperature on the DMB. Also the temperatures of the amplifiers are supervised, if the temperature rises above ~80°C, output power is reduced gradually up to ~92°C, where the AMP will be disconnected by the failsafe relay.

Failsafe Relay

Whenever the temperature limit of 92°C is exceeded, power supplies fail, or if commanded by the DMB, the AMP's output will be disconnected and the TX filter will be terminated by an equivalent resistor instead. Other PLC-devices on the same coupling unit will therefore remain undisturbed. This error condition is signaled to the DMB and indicated by turning off the green LED.

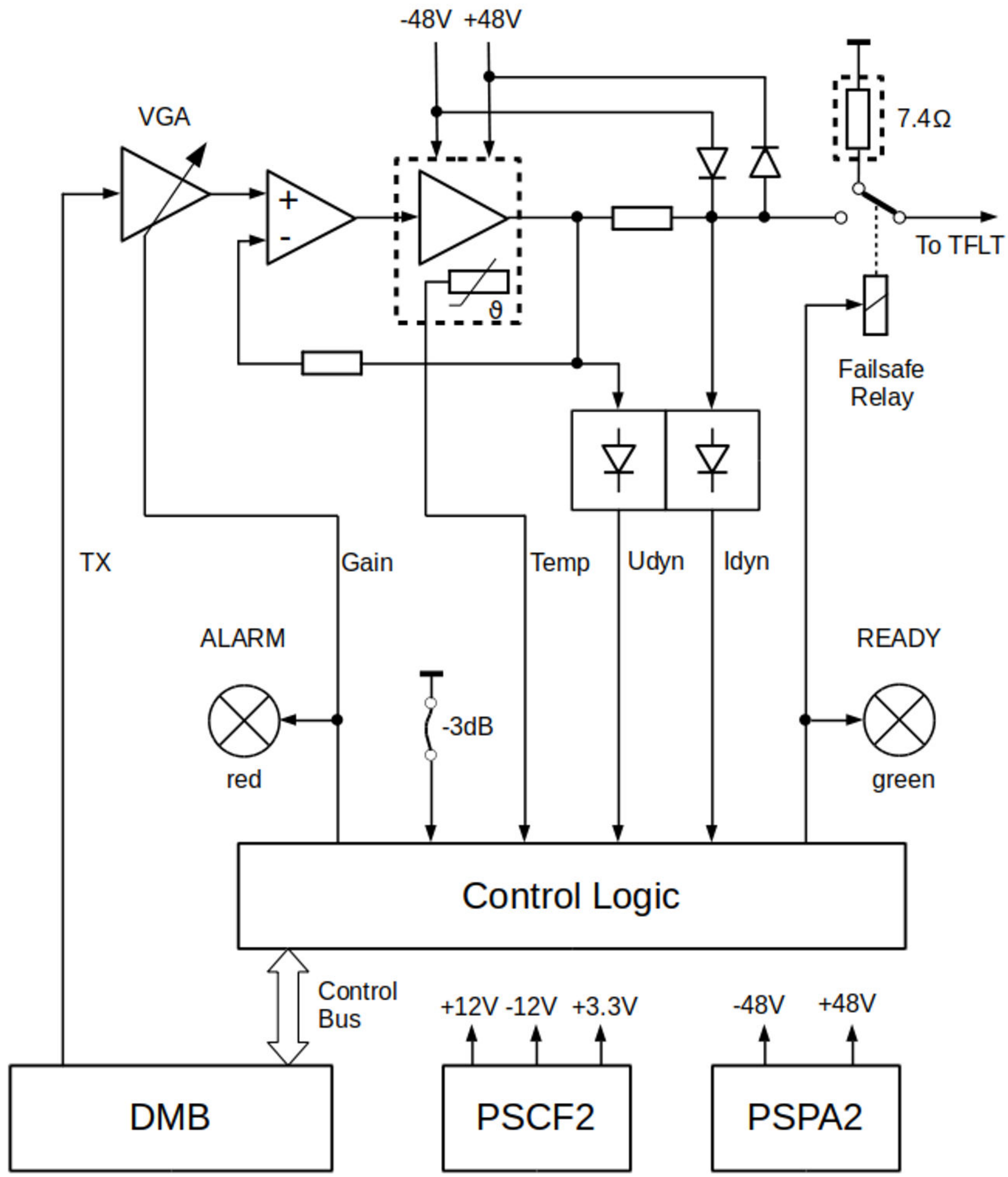
Dual AMP (100 W)

For 100 W configuration, the output of a second AMP is added to the first AMP by means of the differential transformer at the TFLT's input.

25 W/50 W

A reduced power mode (25 W, resp. 50 W for dual AMPs) is selectable by jumper. Overvoltage/overcurrent limits are decreased by 3 dB to improve the dynamic headroom for counter e.m.f. due to excessive HV line noise or other high-powered PLC devices on the same coupling unit. Both AMPs must be jumpered to the same mode.

Block diagram of AMP



[dw_AMP_blockdiagram, 1, --_--]

2.1.5 Power Supply

2.1.5.1 The Power Supply PSPA2

The power supply PSPA2 is available in DC and AC versions.

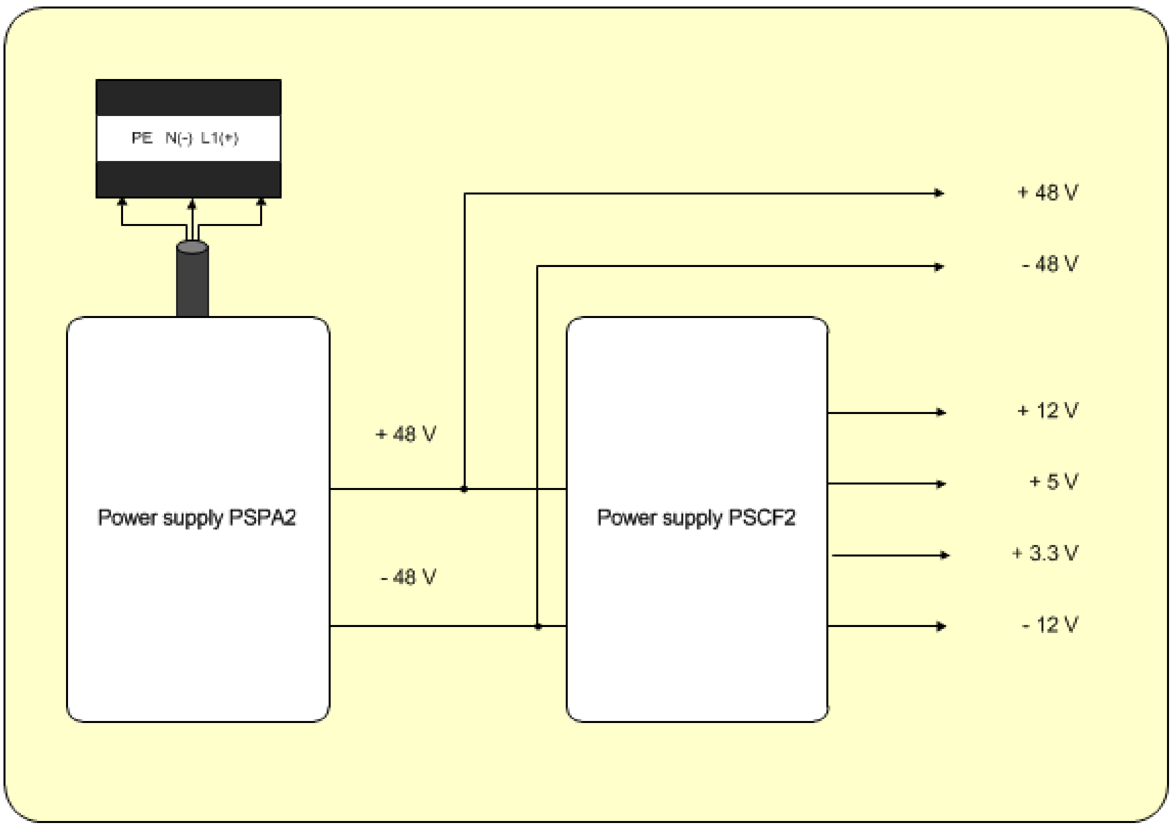
Table 2-1 PSPA2 versions

PSPA2 version	Input voltage
PSPA2-DC	DC 38 V to 72 V
PSPA2-AC	AC 93 V to 264 V (47 Hz to 63 Hz) DC 88 V to 264 V

Each power amplifier has its own power supply.

Interconnection of the Power Supplies

The principle of the voltage distribution in the system is shown in the figure below.



[dw_powersupply, 1, --_--]

Figure 2-1 Interconnection of the power supplies in the PowerLink system

Enable/disable of the power supply is carried out with the switch S1 on the DMB module. The switch is behind the front cover and controls the PSPA2 via an inhibit conductor.

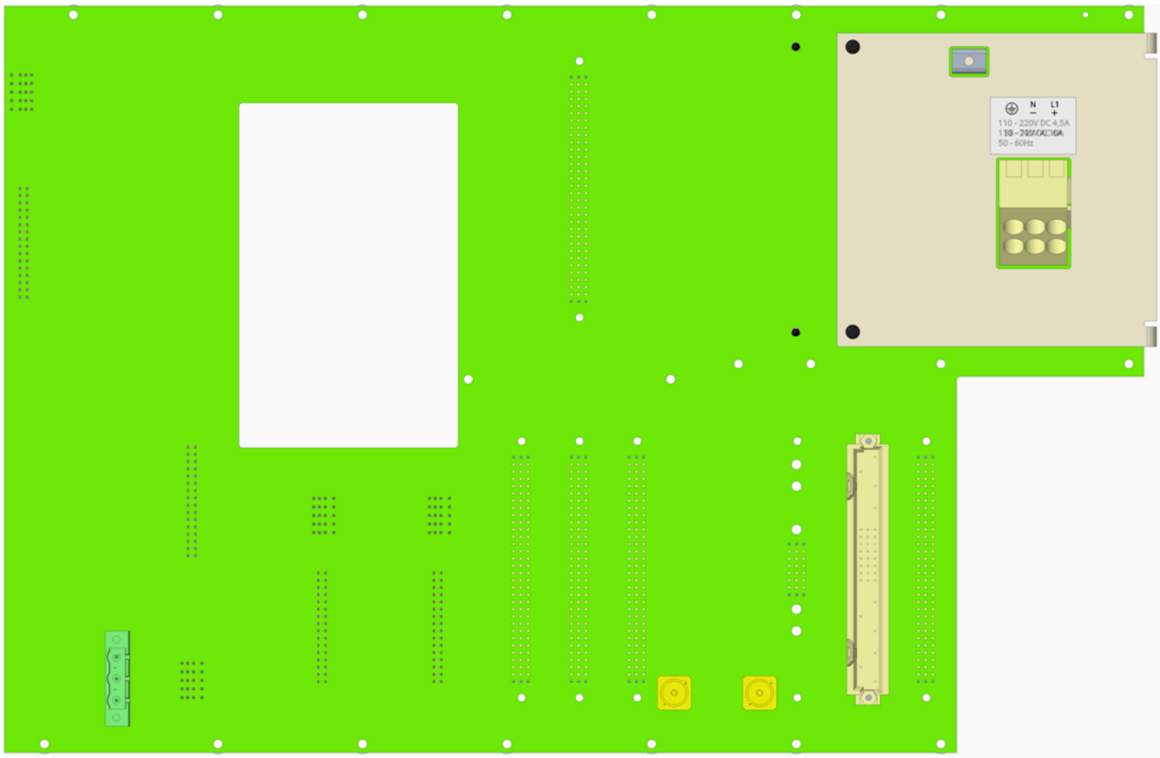
2.1.6 Backplane

2.1.6.1 Overview

Main functions of the backplane:

- Interfacing the submodules
- Provide rear side connectors for
  - high frequency interface output HF_OUT/IN
  - TX_IN/TX_OUT (BNC jacks) for amplifier tests

2.1.6.2 Mechanical Design



[dw_backplane_rearside, 1, --_--]

2.1.7 ALR

The ALR module is required for the output of alarms to the Alarm Interface connector and for the signal processing of the IRIG-B clock synchronization input. The allocation of the system alarms to the relays of the ALR modules is user selectable and can be defined in WEB UI.

Additional Adjustments

Additionally a common delay time **for all relays** can be adjusted in the range from 1 up to 15 sec.

Binary Inputs

The module ALR provides 2 electrically isolated inputs BI1 and BI2 with selectable input voltage levels. As the circuits for the binary inputs comprise rectification, differential DC input signals of either polarity can be connected. The output signals of the circuits have TTL level. Binary input BI1 is alternatively configurable as an input for entering IRIG-B signals.

BI2 is for future use.

Pin assignment of the alarm interface connector

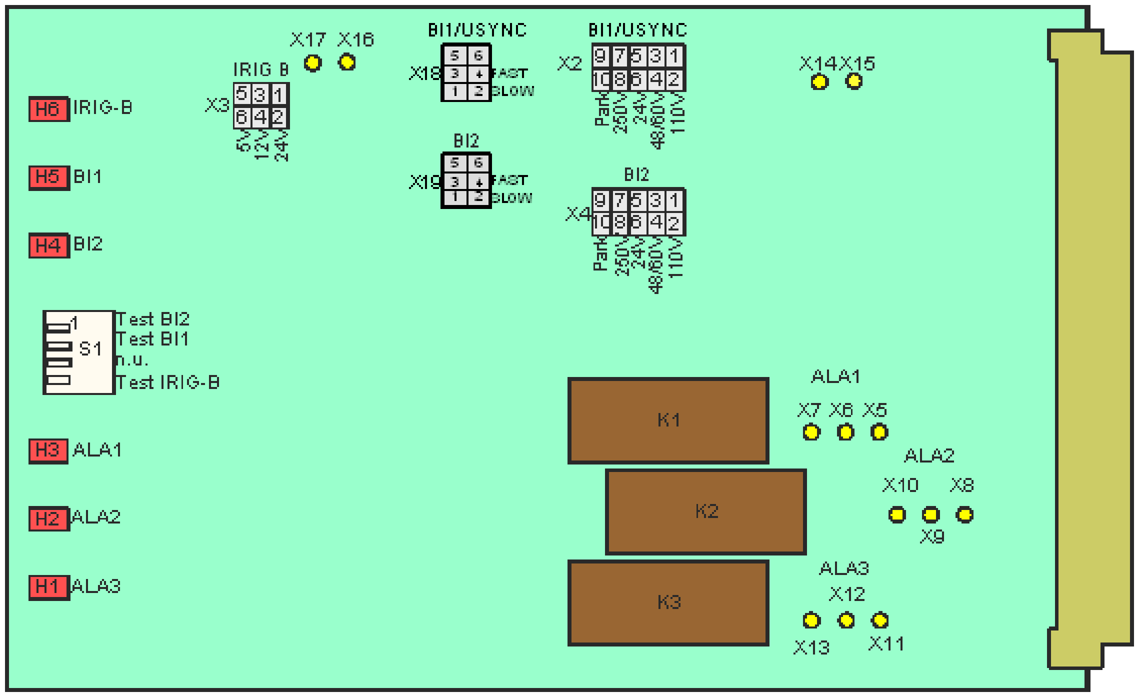
Table 2-2 Pinout of the ALR Module

PIN	Signal Name	PIN	Signal Name	PIN	Signal Name
A1	BI1_A	B1		C1	
A2		B2		C2	
A3		B3		C3	BI1_B
A4		B4		C4	

PIN	Signal Name	PIN	Signal Name	PIN	Signal Name
A5	BI2_A	B5		C5	
A6		B6		C6	
A7		B7		C7	
A8	BI2_B	B8		C8	
A9		B9		C9	
A10		B10		C10	
A11		B11		C11	
A12	FGND	B12	FGND	C12	FGND
A13		B13		C13	ALA1_OUT_L
A14	BI1_IN_L	B14		C14	ALA2_OUT_L
A15	BI2_IN_L	B15		C15	ALA3_OUT_L
A16	P5V (+5 V)	B16	P5V (+5 V)	C16	P5V (+5 V)
A17	GND	B17	GND	C17	GND
A18	P12V (+12 V)	B18	P12V (+12 V)	C18	P12V (+12 V)
A19		B19		C19	
A20		B20		C20	
A21	ALA1_A	B21		C21	
A22		B22		C22	
A23		B23		C23	ALA1_B
A24		B24		C24	
A25	ALA2_B	B25		C25	
A26		B26		C26	
A27		B27		C27	
A28	ALA2_A	B28		C28	
A29		B29		C29	
A30		B30		C30	ALA3_B
A31		B31		C31	
A32	ALA3_A	B32		C32	

Relay Outputs

The alarm module comprises as well 3 alarm outputs, switched by relay (K1 – K3). The 3 relays provide change over contacts. In the standard setup the break contacts (NC) are used.



[tddsteam-120813-01.tif, 1, en_US]

Figure 2-2 Display and setting elements on the ALR module

2.1.8 CIB

2.1.8.1 Classic Interface Board

The CIB is a classic interface board to compress voice speech, process serial data service and transmit them via PLC. The integration of these capabilities makes external voice or serial port converters obsolete.

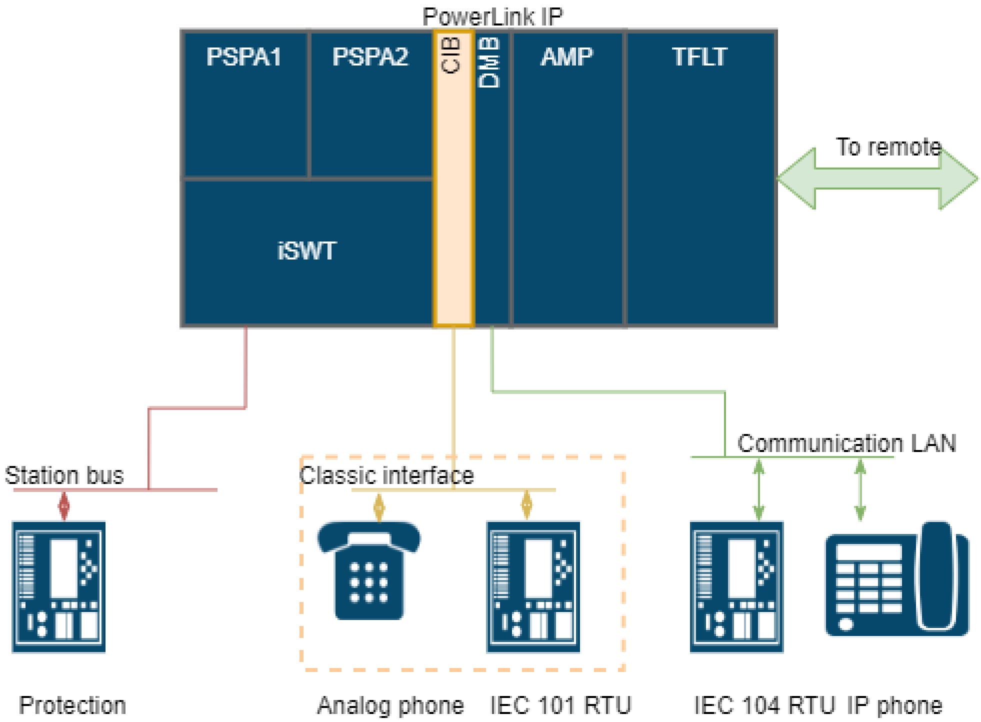


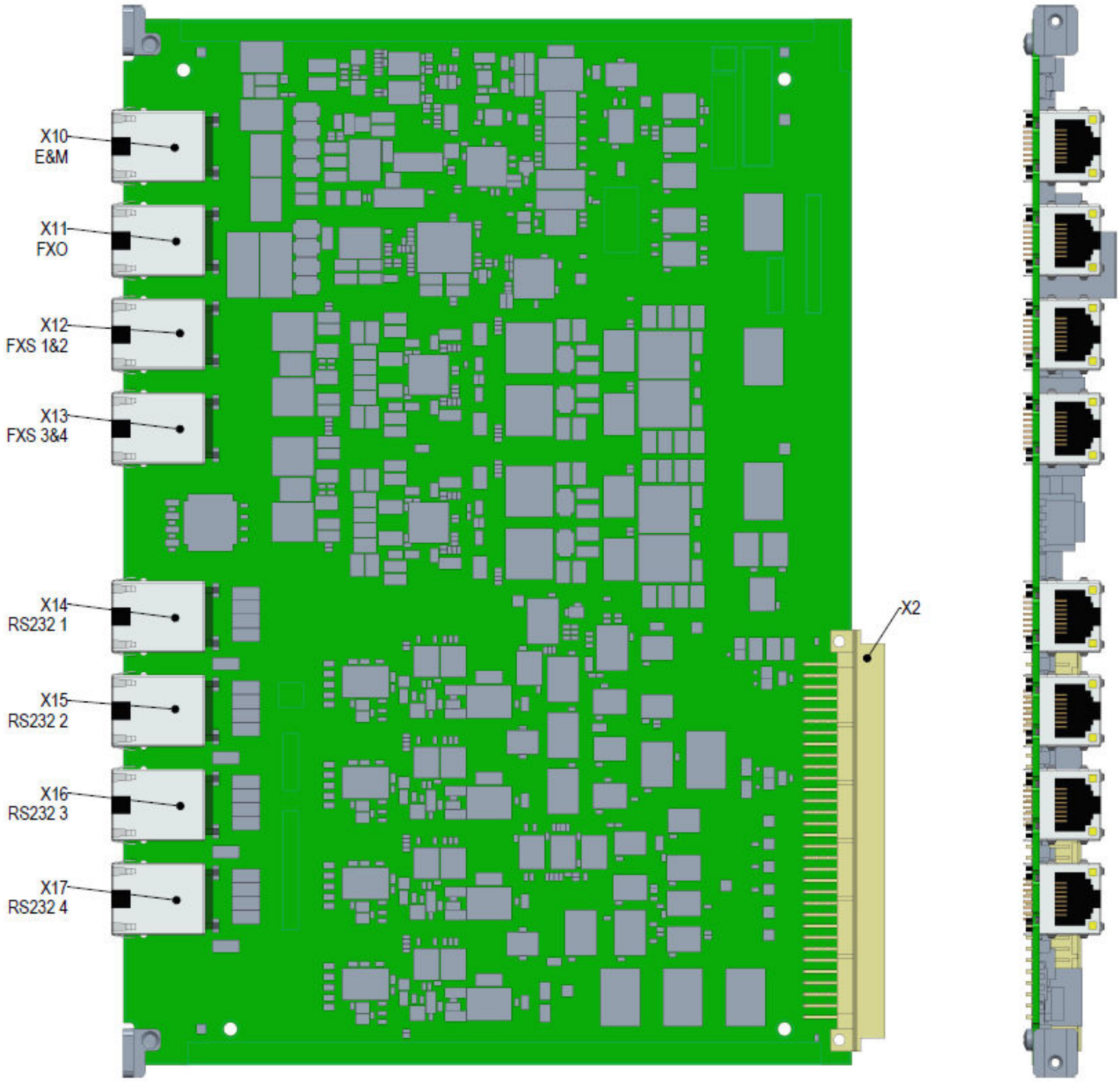
Figure 2-3 Classic interface

The standard SIP protocol is used in the device for initiating, maintaining, and terminating the voice communication session over IP-based protocol. The device acts as a SIP User Agent that sends or receives SIP messages and manages SIP sessions. The two SIP endpoints located at local and remote device can communicate without an external SIP server. A SIP user agent client (UAC) sends SIP request to the remote peer and the remote user agent server (UAS) receives the request and returns a SIP response. For each voice port (FXS, FXO or E&M) the SIP account is assigned by the device.

The supported features of CIB including:

- 1 * E&M (Ear and Mouth) interface for connection with PBX
- 1 * FXO (Foreign Exchange Office) interface for connection with PB
- 4 * FXS (Foreign Exchange Subscriber) interfaces for connection with telephone subscriber
- 4 * RS-232 interfaces with up to 115.2 Kbps for connection with RTU
- Low data rate voice codec (~10 Kbps) for utilization available transmission bandwidth
- Dialing mode (DTMF / Dial pulse) selection for FXO port
- 2 / 4 wires mode for E&M port
- Voice line echo cancelation (LEC)
- Voice activity detection (VAD)
- DTMF transmission in RFC 2833 message
- RS-232 splitter for RTU polling mode
- RS-232 serial over IP for peer to peer transmission or polling by SCADA systems

2.1.8.2 CIB Mechanical Design



[sc_cib_mechanical_design, 1, --_--]

Figure 2-4 CIB Mechanical Design

Pin assignment of E&M connector

Table 2-3 Signal wiring of E&M connector

Pin	Signal at RJ45	Description
1	S2INA	input of S2-current-detector
2	S2INB	input of S2-current-detector
3	W4IA	positive phase of voice signal, input in 4-wire-mode / unused in 2-wire-mode
4	W24IOA	positive phase of voice signal, output in 4-wire-mode/ bidirectional in 2-wire-mode

Pin	Signal at RJ45	Description
5	W24IOB	negative phase of voice signal, output in 4-wire-mode/bidirectional in 2-wire-mode
6	W4IB	negative phase of voice signal, input in 4-wire-mode / unused in 2-wire-mode
7	S2OUTA	output of S2-switch
8	S2OUTB	output of S2-switch

Pin assignment of FXO connector

Table 2-4 Signal wiring of FXO connector

Pin	Signal at RJ45
1	n.c.
2	n.c.
3	n.c.
4	RING
5	TIP
6	n.c.
7	n.c.
8	n.c.

Pin assignment of FXS connector

Table 2-5 Signal wiring of FXS connector

Pin	Signal at RJ45
1	n.c.
2	n.c.
3	RING2
4	RING1
5	TIP1
6	TIP2
7	n.c.
8	n.c.

Pin assignment RS-232 connector

Table 2-6 Signal wiring of RS-232 connector (Data Communication Equipment naming convention)

Pin	Signal at RJ45
1	CTS (out)
2	GND
3	RxD (out)
4	GND
5	TxD (in)
6	GND
7	RTR (RTS) (in)
8	GND

Table 2-7 Recommended length of cable at specifical data rate

Data rate [kBd]	Length [m]
≤2.4	900
4.8	300
9.6	152
19.2	15
57.6	5
115.2	< 2

2.2 PLC Modem Mode

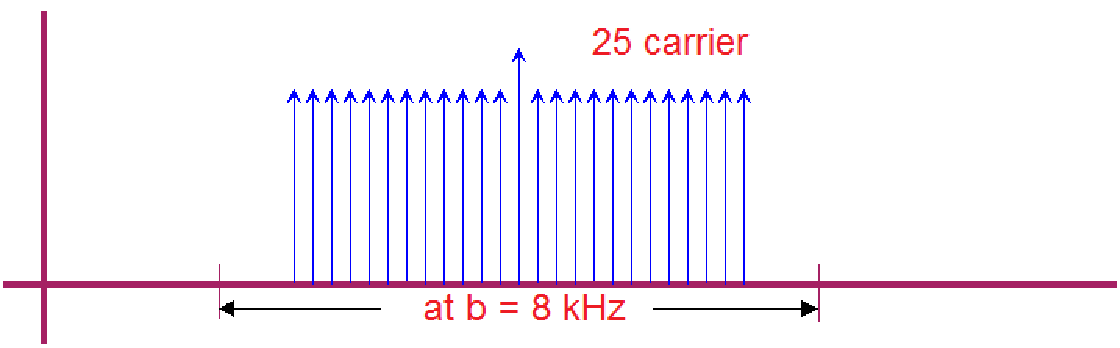
2.2.1 Overview

The PLC Modem allows a fast and transparent Ethernet data transmission and is used for following main functionalities:

- transmission and reception of frames to/from the partner PowerLink IP device over HV power line
- transmission and reception of MARC signals
- spectrum analysis, TX filter tests, test signal generation

2.2.2 Modulation Method

Modulation in PowerLink IP is based on windowed OFDM. The information which has to be transmitted is divided in blocks. Then the information of 1 block is distributed to many single carriers. Each carrier is QAM modulated. The modulation scheme ranges from QAM 4 to QAM 16,384 and is dynamically adjusted depending on the current SNR.

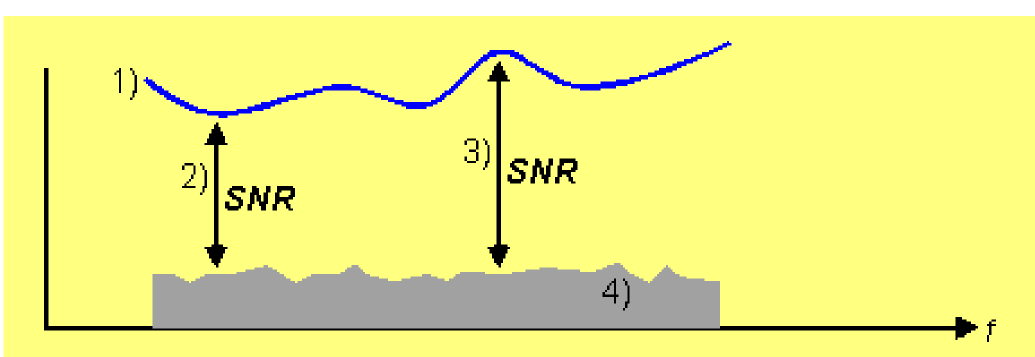


[dw_modulation_principle_of_plcmodem, 1, --_--]

Figure 2-5 The modulation principle of the PLC Modem

Fast adaption

The characteristics of the transmission channel like signal/noise ratio and frequency response is not constant with the frequency. The multicarrier method makes it possible to transmit more information at frequencies with a high signal/noise ratio, and less (or no) information at frequencies with low signal/noise ratio.



[dw_frequency_response_transmission_channel, 1, --_--]

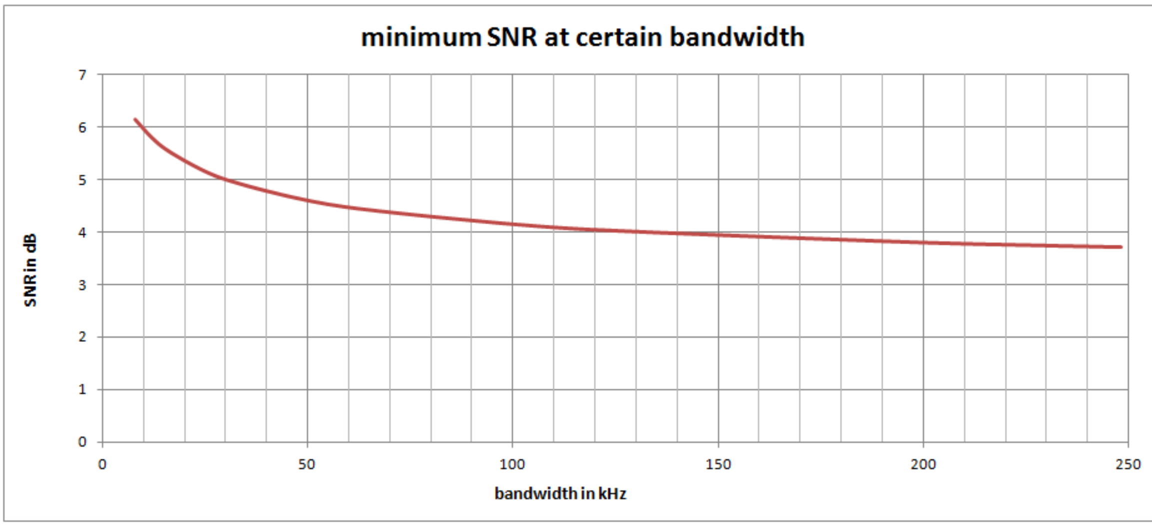
Figure 2-6 Frequency response from a transmission channel

(1) Frequency response of the line
(2) Carrier with low signal/noise ratio
(3) Carrier with high signal/noise ratio
(4) Noise level

2.2.3 Spectral Efficiency

The performance of a data transmission via power lines is defined as achievable bit rate versus bandwidth. The unit of measurement is bit/s/Hz.

For PowerLink IP the highest possible spectral efficiency is 10.2 bit/s/Hz.



[dw_minimum_SNR, 1, --_--]

[dw_spectral_efficiency, 2, --_--]

SNR	BW (kHz)	Spectral efficiency bit/s/Hz	Date rate (kbps)
50	4	10.2	40.8
51.7	8	9.68	309.8
52.5	16	9.12	145.9
50.8	32	7.92	63.4
49.4	256	6.4	1638.0

2.2.4 Relationship Bit Rate vs. SNR

The relation between bandwidth efficiency and signal-to-noise ratio is approximately linear. The bandwidth efficiency may be calculated as the transmission bit rate divided by the bandwidth effectively used for PLC transmission.The SNR at the input of a PLC receiver depends on many factors such as line attenuation, noise and disturbance level, weather conditions etc..

2.2.5 Supervision of the Transmission Line

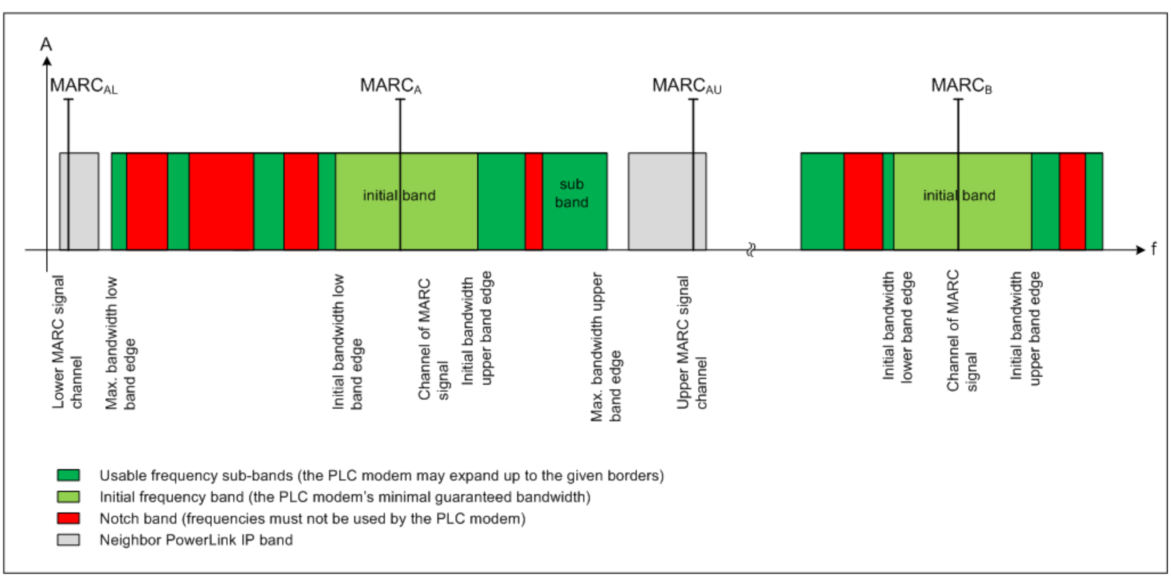
Each transmission error is recognized in the PLC modem as a block error. The block error rate is supervised continuously serving the criteria for restart with regard to a number of subsequent erroneous blocks. This is recognized as a loss of a correct communication signal reception in the channel and a restart is executed.

2.2.6 Medium Access Request Channels

The Medium Access Request Channel (MARC) signal is used to coordinate the frequency band utilization between a PLC link and its neighboring links.

The MARC in each PLC modem is used for a robust control frame transmission to its PLC link partner (in direction A to B) and to other PLC modems that are frequency-band-neighbors to the transmitting PLC link.

The cyclic control frame transmission via MARC is independent from the frame transmission in the modem’s data channel (DC). The MARC signal is implemented as a FSK modulated sine signal.



[dw_plcmodem_parameters, 2, --_--]

In a PowerLink IP communication system containing several PLC modem point-to-point connections, every single PLC modem is uniquely defined by the nominal frequency channel of its MARC and additionally by its transmitter identification number. Each PLC modem A is associated with a dedicated partner PLC modem B by means of the nominal frequency channel of $MARC_B$ and the transmitter B identification number expected by transmitter A. Both PLC modems form a functional entity called a PLC link.

A PLC modem (e.g. device A) contains the following MARC related functional blocks:

- three MARC receivers, that follow and decode up to 3 MARC signals at a time ($MARC_B$ Rx, $MARC_{AL}$ Rx, $MARC_{AU}$ Rx
- one MARC transmitter ($MARC_A$ Tx)
- one MARC controller ($MARC_A$ CTL)

$MARC_A$ CTL coordinates the use of the frequency resources between DC_{AL}, DC_{AU} and DC_A neighboring in the frequency domain by transmission of medium access request/release information.

2.2.7 Frequency bandwidth adaptation

A dynamic adaptation of the PLC channel bandwidth is performed automatically according to the available frequencies of the PLC frequency band.

The frequency band adaptation is carried out by $MARC_A$ CTL and $MARC_B$ CTL independently for the transmission directions A to B and B to A, respectively, as long as the used frequencies of the DC_A and DC_B are not adjacent.

To maximize frequency utilization, neigboring PowerLink IP systems adjust their bandwidth so that both systems achieve approximately the same efficiency, defined as ratio between currently possible data rate on the line and requested data rate as configured by the user. This method is called channel spreading.

The used method for spreading the DC’s spectrum inhibits an overlapping (= a contact) of the frequency bands used by the single DCs to avoid collisions in the frequency domain.

The MARC signals are situated in preconfigured frequency channels and serve as so called “anchor channels”. During adaption, these fixed MARC channels prevent an unlimited movement of the DCs in the frequency band used by the PLCs.

The single MARCs have to be configured inside the initial band used by the MARC’s corresponding DC. It is recommended to set the MARC’s frequency in the center of the DC’s initial band.

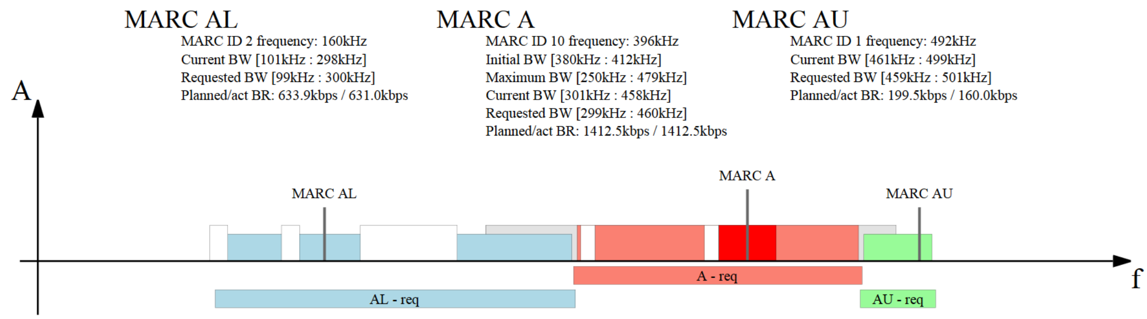
The PowerLink IP may be operated in parallel with traditional PowerLink devices or other PLC devices in the same substation. If other PLCs are operated in the frequency band of PowerLink IP, the reserved frequencies can be notched out.

In this case, the other PLC devices must not be connected to the same physical line (same phase between two line traps or AKEs) as the transmit filters still remain low impedance over the whole set bandwidth. Only in the notched band no signal will be sent or received.

It is recommended (but not required) to set up the initial DC_A band as a whole, i.e. without notches inside.

The initial band must have a contiguous "notch-free" bandwidth of minimum 4kHz.

To enable the MARC’s functionality the maximum DC_A bands of the neighboring PowerLink IP PLCs have to overlap but may not reach into the initial DC_A bands of their neighbors. The picture below shows a typical configuration where the MARC functionality is used. The dark red area depicts the DC_A initial band, the light grey area the DC_A maximum band and the light red area shows the actual used band. White areas are notched frequency bands.



[dw_MARC_frequency_bar, 1, --_--]

MARC control algorithm

The $MARC_A$ CTL implements the following rules to perform the DC's frequency adaption:

- If no lower ($MARC_{AL}$) and/or upper ($MARC_{AU}$) neighbor is configured then the lower and/or upper band edge immediately spreads to the configured maximum start/stop frequencies.
- If a neighbor MARC is configured but not received for a certain time (currently 100s), then the DC's start/stop frequency is increased/decreased to the halfway usable frequency between the $MARC_A$ and the configured but not received MARC ($MARC_{AL}$ or $MARC_{AU}$) or to the configured minimum/maximum band edge, whatever is higher/lower.
- If the neighboring MARC signals are correctly decoded the DC_A spreads up to the current maximum/ minimum band edges of its neighbors or to the configured minimum/maximum band edge, whatever is higher/lower.
- After completing the spreading phase the optimization phase starts. During this phase the Transmit bit rate to Desired transmit bit rate (configuration parameter) ratio of the DC_A compared to its neighbor's bit rate ratios determines whether the DC_A channel stays as it is or if it releases some bandwidth. E.g. if the DC_A's ratio is better than its lower neighbors ratio, then the DC_A releases some bandwidth on its lower band edge. Now the DC_{AL} is able to occupy the released frequency band and to improve its bit rate ratio. Whereas if the upper neighbors ratio is better than the DC_A's ratio, the DC_A waits until its upper neighbor releases some bandwidth. During the bandwidth spreading/reducing process the configured minimum/maximum and initial band edges are always maintained.

The whole process is designed to be quite slow to avoid frequent changes in the user data rates.

2.3 Measurement

2.3.1 Signal Generator

The signal generator offers the possibility to generate test signals (sine, sweep) to check the functionality of the HF TX and RX path within the device.

The spectral view allows measuring the spectrum of the signals present on the HV (high voltage) line.

Additional features are selectable windowing functions, zoom functions, averaging and peak-hold functions. Two graphical cursors aid in measuring signal frequencies and signal levels.

2.3.2 Spectrum Analyzer

The spectrum analyzer shows the measured spectrum as seen during the regular operation process. This view can be used to verify the configured frequency and level parameters and check for spectral collisions with other services present on the HV line.

2.4 Web UI

2.4.1 WEB User interface

For commissioning, maintenance, monitoring and diagnostics of the PowerLink IP device and an integrated SWT 3000 unit serves the web browser installed on a service device. The web browser shows secure HTML sites (HTTPS) provided by the device´s integrated webserver. The configuration of PowerLink IP respective the iSWT is performed online.

A role based user management and a role based access control supervises the access to the device settings.

There are four main sections in the WEB User interface:

- Device Information
  e.g. installed firmware versions, logs, diagnostics
- Commissioning
  e.g. PLC modem settings, time synchronization, user and service interface
- Measurement
  e.g. signal generator, spectrum analyzer
- User Management
  e.g. administration of users, change password

2.5 Monitoring

In the Web UI you find the following items to monitor the operation of a PowerLink IP device:

Device Information

Device Information offers all device identifying information at a glance. All version numbers of assembled hardware parts are listed as well as the version numbers of the loaded firmwares.

iSWT Event Log

The iSWT offers a non volatile event log for up to 8184 entries. All log entries are marked with date and time information. It is possible to export the log to a file and to clear the log.

Event Log

A non volatile DMB event log is part of PowerLink IP. Up to 9999 logs marked with date and time information can be displayed or saved to a file. It is possible to export and to clear the log.

Secure Log

Secure logs are secure trails, e.g. user log in and log off, user management etc.

Alarms

Active alarms are displayed in the head bar of Web UI and can be viewed in the alarm log.
Alarm raise and clear event is recorded in the event log.
Four status alarm LEDs are located on the front cover (DMB board) of the PowerLink IP device.
Four alarm LEDs are located on front cover (iSWT) of device to indicate iSWT alarm.

Diagnostics Information

In the diagnostics part of Web UI you can find information about

- PLC modem status
- Error statistics counter
- Ethernet status
- iSWT
  - Statistics counter
  - Service info
  - EN100 info

2.6 Integrated Protection Signal Transmission with integrated SWT 3000 (iSWT)

2.6.1 Overview

2.6.1.1 General Information

In the event of faults occurring in high-voltage systems the object of the high voltage network protection is to disconnect the faulty part of the system selectively as quickly as possible. As a consequence of higher power plant outputs and the increasingly close interconnection of high-voltage power systems, high demands are placed on network protection systems in terms of reliability and availability. Therefore, network protection systems with absolute selectivity need a reliable and fast transmission system for the transfer of information between the stations.

The iSWT for teleprotection signaling offers the required maximum security and reliability together with the shortest command transmission time. The iSWT device is integrated in the PowerLink IP system or connected via fiber optic module and can be equipped with up to two interface modules IFC.

Operation Modes

iSWT supports the following different protection operating modes:

Protection operating mode 3a (4 independent commands)

4 signal inputs are available in this operating mode. On the transmit side, every possible combination of signal input is assigned to a pair of protection frequencies. On the receive side, each pair of protection frequencies is assigned to one or more signal outputs. The commands are always transmitted coded with the application permissive or direct tripping (selectable per iSWT device). The command codes consist of two simultaneously transmitted trip frequencies (coded tripping).

Protection operating mode 3b (2 plus 2).

2 commands are transmitted in the fast permissive underreach transfer trip, the other 2 are transmitted in the direct trip application and using the coded tripping (CT) feature.

Mode 7a (8 Independent Commands, 8iC)

This operation mode is available for the transmission of eight independent commands. Commands are always transmitted coded with the application permissive or direct tripping (selectable per iSWT device).

Transmission Features

- Frequency generation and evalution by digital signal processor
- Burst interferences with even greater amplitudes than the desired signal are largely suppressed
- Noise analysis in the unused desired signaling circuits
- Non-volatile event memory for 8184 entries.

2.6.2 Alternate Multi Purpose Operation (AMP)

Normal operation:	PowerLink IP is working in normal operation as long as there is no protection case. During this idle state, i.e. the high-voltage system is operating properly, the signals of all services including the guard tone are transmitted simultaneously. The MARC of the PLC system is used as the guard tone in this operating mode.
Protection mode:	If a protection command has to be transmitted, the PLC modem mode is interrupted briefly while the protection command is being transmitted. The protection command can thus be transmitted with the full transmission power available.

2.6.3 Monitoring

The monitoring functions of the device are as follows:

- Operating voltage
  All outgoing information (TX and command outputs) are blocked as long as the operating voltages of the equipment are not within the specified ranges.
- Switching command duration
  If a switching command with a duration of > 500 ms is received, the command outputs are disabled and an alarm is triggered. The switching command duration can be configured.
- Guard tone failure alarm
  If there is no valid command frequency present, a guard tone failure alarm is triggered after about 10 ms.
- Transmit level monitoring
  The level of the transmit amplifier is monitored.
- Operating state
  The operating state of the device is displayed on the front panel with differently colored LED.
- Control contacts for external equipment
  A floating make contact or break contact (alarm contact) is available at the device terminals for signaling the following alarms:
  - Non-urgent alarm (NU-alarm, NUALR, or NDALR)
  - Receiver alarm (RXALR or EALR)
  - General alarm (GALR or GENALR)

  The alarms are routed to the COMCON ALRS
- A Signaling module IFC-S can be installed as an option. With the aid of this module, any operation of the local circuit can be signaled externally via an auxiliary contact.

NOTE

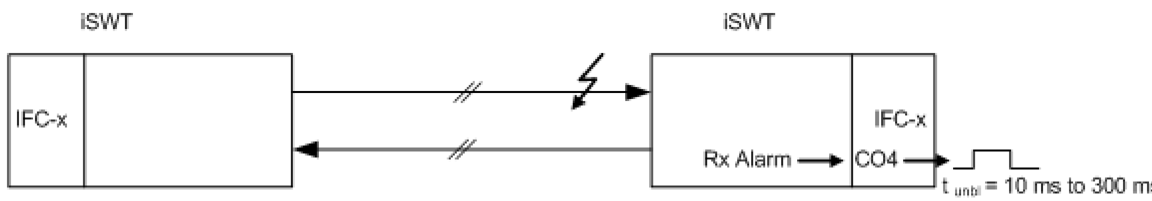
Only one IFC-S module can be installed in iSWT.

- Input pulse suppression
  In order to be accepted as an input signal, commands must be applied at the input for at least 1 ms. You can increase this minimum time to 100 ms in steps of 1 ms. The input pulse suppression can be configured.
- Minimum transmission duration
  Each command is transmitted for at least 20 ms. The minimum transmission time can be configured.

2.6.4 Unblocking Mode

The unblocking mode is a release procedure. Short circuits on overhead lines can cause a disturbance of PLC links. In this case, in order to warrant the release of the permissive protection device, the unblocking impulse ($t_{unbl.}$) is used.

If the signal to be transmitted does not reach the other line end, the receiver recognizes a fault and emits the unblocking impulse. The reason for the unreached signal is because a short circuit on the line causes excessive attenuation or reflection of the signal.



[dw_principle of unblocking mode, 1, --_--]

Figure 2-7 Principle of the Unblocking Mode

The unblocking function is activated when the time for the unblocking impulse is more than 0 ms ($t_{unbl.} > 0$ ms).

2.6.5 Protection Mode

Mode 3a (4 Independent Commands)

NOTE

This mode is always transmitted in the coded tripping function.

Table 2-8 Logic Scheme for the Mode 3a

Activated Input	Transmission Coded	Command Output in the Remote Station[1)] without unblocking	Command Output in the Remote Station with Unblocking[1] $T_{unbl.} > 0$[2)]
All off	fg	-	-
BI1	$f_s + f_4$	CO1	CO1
BI2	$f_1 + f_4$	CO2	CO2
BI3	$f_2 + f_4$	CO3	CO3
BI4	$f_3 + f_4$	CO4	CO4
BI1 + BI2	$f_s + f_5$	CO1 + CO2	CO1 + CO2
BI1 + BI3	$f_2 + f_5$	CO1 + CO3	CO1 + CO3
BI1 + BI4	$f_s + f_6$	CO1 + CO4	CO1 + CO4
BI2 + BI3	$f_1 + f_5$	CO2 + CO3	CO2 + CO3
BI2 + BI4	$f_3 + f_5$	CO2 + CO4	CO2 + CO4
BI3 + BI4	$f_2 + f_6$	CO3 + CO4	CO3 + CO4
BI1 + BI2 + BI3	$f_1 + f_6$	CO1 + CO2 + CO3	CO1 + CO2 + CO3
BI1 + BI2 + BI4	$f_3 + f_6$	CO1 + CO2 + CO4	CO1 + CO2 + CO4
BI1 + BI3 + BI4	$f_s + f_7$	CO1 + CO3 + CO4	CO1 + CO3 + CO4
BI2 + BI3 + BI4	$f_1 + f_7$	CO2 + CO3 + CO4	CO2 + CO3 + CO4
BI1 + BI2 + BI3 + BI4	$f_2 + f_7$	CO1 + CO2 + CO3 + CO4	CO1 + CO2 + CO3 + CO 4
USYNC	$f_3 + f_7$	-	-

Activated Input	Transmission Coded	Command Output in the Remote Station[1)] without unblocking	Command Output in the Remote Station with Unblocking[1] $T_{unbl.} > 0^{2)}$
-	-	Alarm signaling[3)]	Alarm signaling + unblocking impulse at RXALR[2]
[1)]If output allocation 1:1 is adjusted. [2)]If an invalid frequency or code is received, or in case of guard tone alarm: If $t_{unbl.} > 0$, output of the unblocking impulse ($t_{unbl.}$ = Duration of the unblocking impulse). The unblocking pulse is distributed via the RXALR output (ALR1-3 contact if activated in the ALR configuration). [3)]If an invalid frequency or code is received or in case of guard tone alarm.			

NOTE

In device configurations with EN100 and IFC (Mixed mode) the first input ports are always allocated to the pre-configured EN100 channels.

The remaining input ports (depending on the number of assigned EN100 channels) are allocated to the input ports of IFC module in ascending order, IFC-1/IN1, IFC-1/IN2, etc.

Mode 3b (2 plus 2)

The commands 1, 2 and 1+2 are permissive tripping commands, which are always transmitted uncoded. The commands 3, 4 and any combination with commands 3, 4 (e.g. 1+2+3+4) are direct tripping commands, which are always transmitted coded.

The uncoded frequency level is 6 dB higher than coded frequency, because full power is used for single frequency transmission.

The transmission time of direct tripping command is approx. 3 ms longer than permissive tripping command in order to increase transmission security.

The mode 3b has been enhanced with the setting for fast transmission of permissive commands.

Table 2-9 Logic Scheme for the Mode 3b

Activated Input	Transmission Uncoded	Transmission Coded	Command Output in the Remote Station without Unblocking	Command Output in the Remote Station with Unblocking $T_{unbl.} > 0^{1)}$
All off	f_g	-	-	-
BI1	f_1	-	CO1	CO1
BI2	f_2	-	CO2	CO2
BI1 + BI2	f_3	-	CO1 + CO2	CO1 + CO2
BI3	-	$f_s + f_4$	CO3	CO3
BI4	-	$f_s + f_5$	CO4	CO4
BI3 + BI4	-	$f_s + f_6$	CO3 + CO4	CO3 + CO4
BI1 + BI3	-	$f_1 + f_4$	CO1 + CO3	CO1 + CO3
BI1 + BI4	-	$f_1 + f_5$	CO1 + CO4	CO1 + CO4
BI1 + BI3 + BI4	-	$f_1 + f_6$	CO1 + CO3 + CO4	CO1 + CO3 + CO4
BI1 + BI2 + BI3	-	$f_1 + f_7$	CO1 + CO2 + CO3	CO1 + CO2 + CO3
BI2 + BI3	-	$f_2 + f_4$	CO2 + CO3	CO2 + CO3

Activated Input	Transmission Uncoded	Transmission Coded	Command Output in the Remote Station without Unblocking	Command Output in the Remote Station with Unblocking $T_{unbl.} > 0^{1)}$
BI2 + BI4	-	$f_2 + f_5$	CO2 + CO4	CO2 + CO4
BI2 + BI3 + BI4	-	$f_2 + f_6$	CO2 + CO3 + CO4	CO2 + CO3 + CO4
BI1 + BI2 + BI4	-	$f_3 + f_4$	CO1 + CO2 + CO4	CO1 + CO2 + CO4
BI1 + BI2 + BI3 + BI4	-	$f_3 + f_5$	CO1 + CO2 + CO3 + CO4	CO1 + CO2 + CO3 + CO4
USYNC	-	$f_s + f_7$	-	-
-	-	-	Alarm signaling[2)]	Alarm signaling + unblocking impulse at RXALR[1]
[1)]If an invalid frequency or code is received, or in case of guard tone alarm: If $t_{unbl.} > 0$, output of the unblocking impulse ($t_{unbl.}$ = Duration of the unblocking impulse). The unblocking impulse is distributed via the RXALR output of the ALR board. [2)]If an invalid frequency or code is received or in case of guard tone alarm.				

Mode 7a (8 Independent Commands, 8iC)

This operation mode is available for the transmission of eight independent commands. Commands are always transmitted coded with the application permissive or direct tripping (selectable). There are 255 command combinations. Every possible combination of signal input is assigned to a protection frequency and are defined as code number (Cxxx) in below table:

Table 2-10 Code number definition for all signal inputs

code no.	BI8	BI7	BI6	BI5	BI4	BI3	BI2	BI1
C1	-	-	-	-	-	-	-	X
C2	-	-	-	-	-	-	X	-
C3	-	-	-	-	-	-	X	X
C4	-	-	-	-	-	X	-	-
...	...	...	...	...	...	...	...	...
C254	X	X	X	X	X	X	X	-
C255	X	X	X	X	X	X	X	X
C256	USYNC							

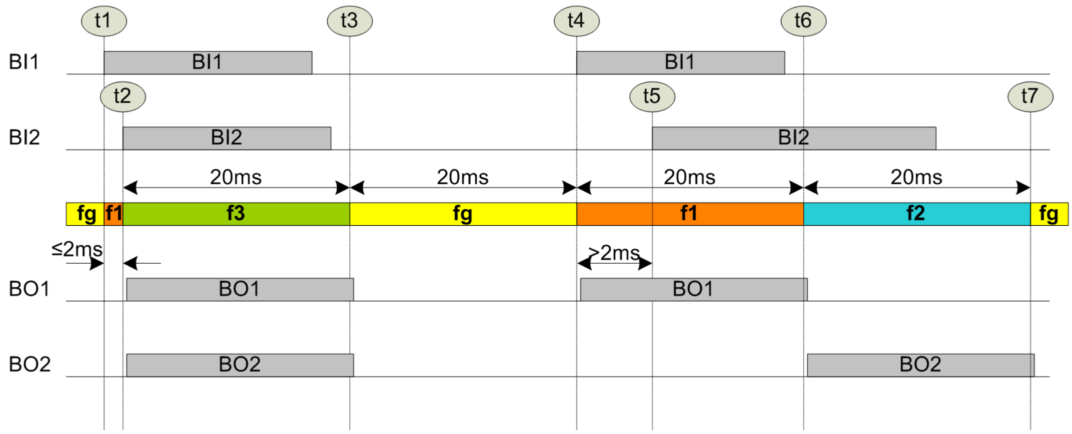
Required Frequency Bandwidth

mode	frequency range
mode3a/3b with VF1_CT_PL	365 Hz ~ 2615 Hz
mode7a with VF40_CT_PL	505 Hz ~ 3789 Hz

Command Duration

The single command applied at the device input is transmitted for at least 20 ms. The next command is then transmitted, or the same command is continuously transmitted if no other command input active.

If next command input is active at same time or within the time interval of 2 ms, the transmit signal is shifted to the frequency corresponding to this input combination. Otherwise, the next command will be transmitted after minimal transmission duration.



[DwpermComm-020215, 1, en_US]

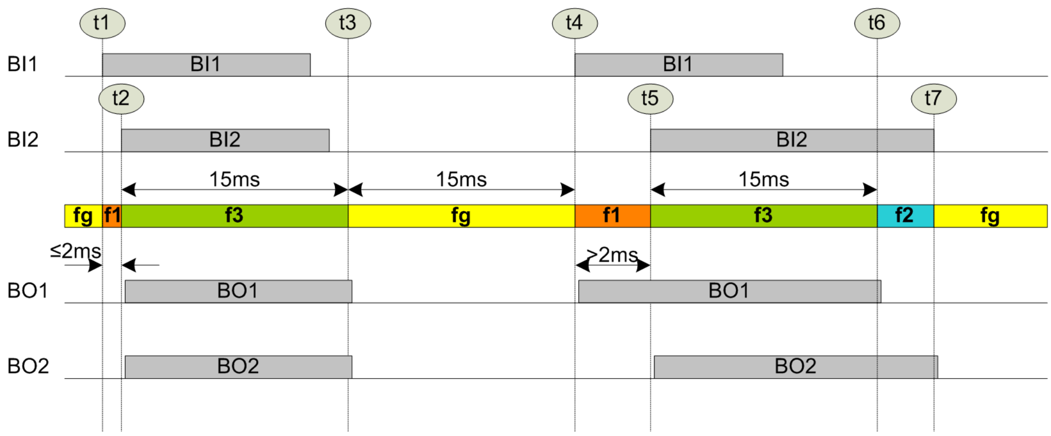
Figure 2-8 Permissive Command 1+2 Transmission

Table 2-11 Command Transmission Timeline Description

Timeline	Description
t1	BI1 active, start transmission of command 1.
t2	BI2 active within time interval 2 ms, switch to transmit command combination of 1+2, BO1+2 active after command transmission time.
t3	Transmission duration time-out, BO1+2 inactive after command transmission.
t4	BI1 active, start transmission of command 1.
t5	BI2 active after time interval 2 ms, continue transmission of command 1.
t6	Transmission duration time-out, switch to transmit command 2, BO1 inactive after command transmission.
t7	Transmission duration time-out, BO2 inactive after command transmission, switch to transmit guard command.

It is possible to enable fast transmission of permissive command for mode 3b with additional setting as below:

- "BI1+2 interrupt single command BI1 or BI2 without delay" is enabled. Permissive command 1 or 2 transmission can switch to input combination 1+2 without waiting for minimal transmission duration time-out.
- Transmission duration for permissive command is set to 15 ms. Permissive command is transmitted for at least 15 ms.
- Pulse suppression for permissive command is set to 0 ms. Permissive command input is accepted without additional delay by suppression timer.



[DwFastComm020215, 1, en_US]

Figure 2-9 Fast Transmission of Permissive Command 1+2

Table 2-12 Fast Command Transmission Timeline Description

Timeline	Description
t1	BI1 active, start transmission of command 1.
t2	BI2 active within time interval 2 ms, switch to transmit command combination of 1+2, BO1+2 active after command transmission time.
t3	Transmission duration time-out, BO1+2 inactive after command transmission.
t4	BI1 active, start transmission of command 1, BO1 active after command transmission.
t5	BI2 active after time interval 2 ms, switch to transmit command combination of 1+2, BO2 active after command transmission.
t6	Transmission duration time-out, switch to transmit command 2, BO1 inactive after command transmission.
t7	BI2 inactive, switch to transmit guard command, BO2 inactive after command transmission, switch to transmit guard command.

2.6.6 The PU4 Module

2.6.6.1 Overview

The Processing Unit PU4 is the central control module of the integrated SWT 3000 unit.

The protection commands are given to iSWT via an interface module IFC-D or IFC-P and/or an EN100 module.

At the transmit side, PU4 converts protection commands or commands at digital transmission lines given from the IFC-x or the EN100 interface into tones of a defined frequency.

If the PU4 and the IFC modules are integrated in the PowerLink IP unit, the frequencies are forwarded directly to the DMB module via the SSI interface without D/A - A/D conversion.

At the receive side, the incoming commands are received in the PU4 module.

These commands are converted into one of the following cases:

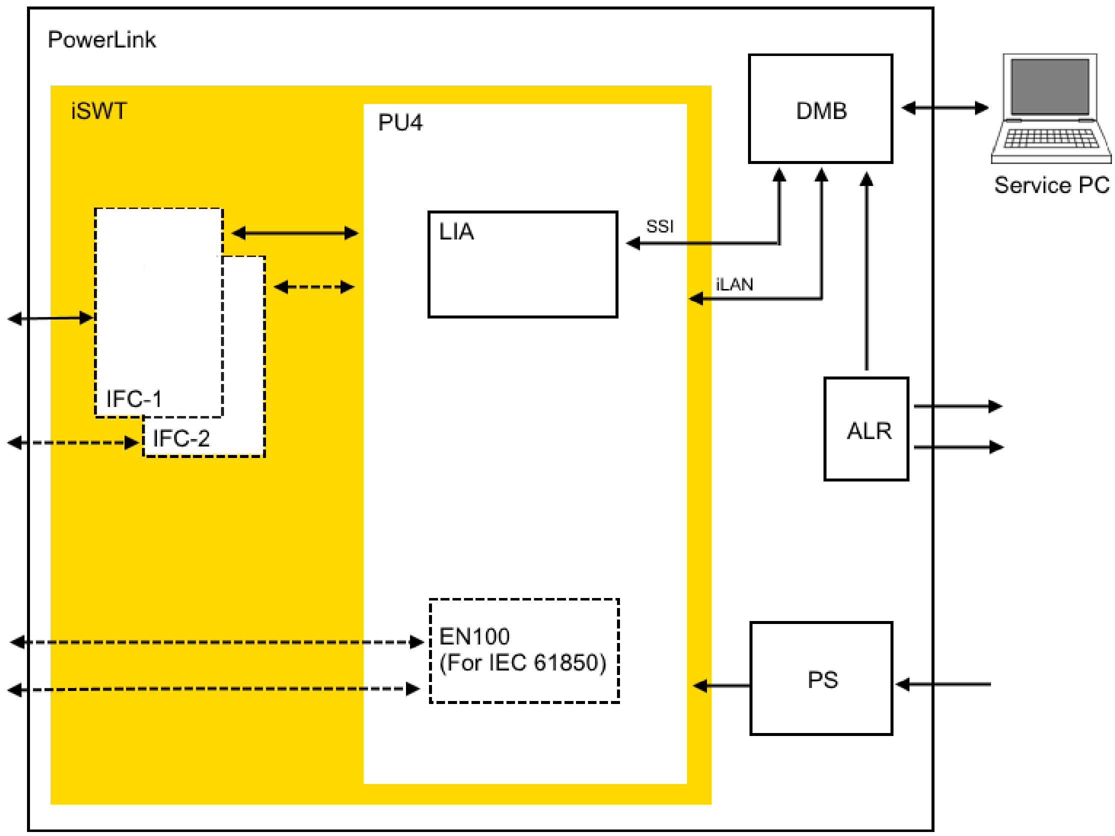
- Binary protection commands, and forwarded to the IFC-D/P module for command output.
- GOOSE command and forwarded to EN100 module for command output

Apart from coding and decoding of protection commands, the PU4 also performs various **monitoring functions**.

For example, the receive and transmit levels are fed via measuring points to the PU4 where they are compared with the permissible values. If these levels are not reached, the PU4 activates an alarm. In the normal working operation, that is, if there is no protection command transmitted, the MARC signal is sent to the remote station instead of the guard signal. The level of the guard signal from the PU4 is evaluated and causes an alarm, if the level decreases.

Loss of a wanted signal (command or guard tone) triggers a receive alarm at the receive side and causes the IFC relay outputs of iSWT to block. This alarm state can only be canceled by receiving the guard signal again.

When the unit is started, a self-test is carried out. A watchdog also monitors the functionality of the internal Digital Signal Processor (DSP). If there are failures, the transmitter output and the relay outputs of the unit are blocked. An overview of the functional units of the PU4 is shown in the following diagram:



[dw_signal_transmission_with_iSWT, 2, --_--]

2.6.6.2 Functional Units

The PU4 module consists of the following functional units:

- Internal power supply
- Controller
- Analog line interfaces with digital signal processor
- Ethernet EN100 module (optional)

2.6.6.3 Internal Power Supply

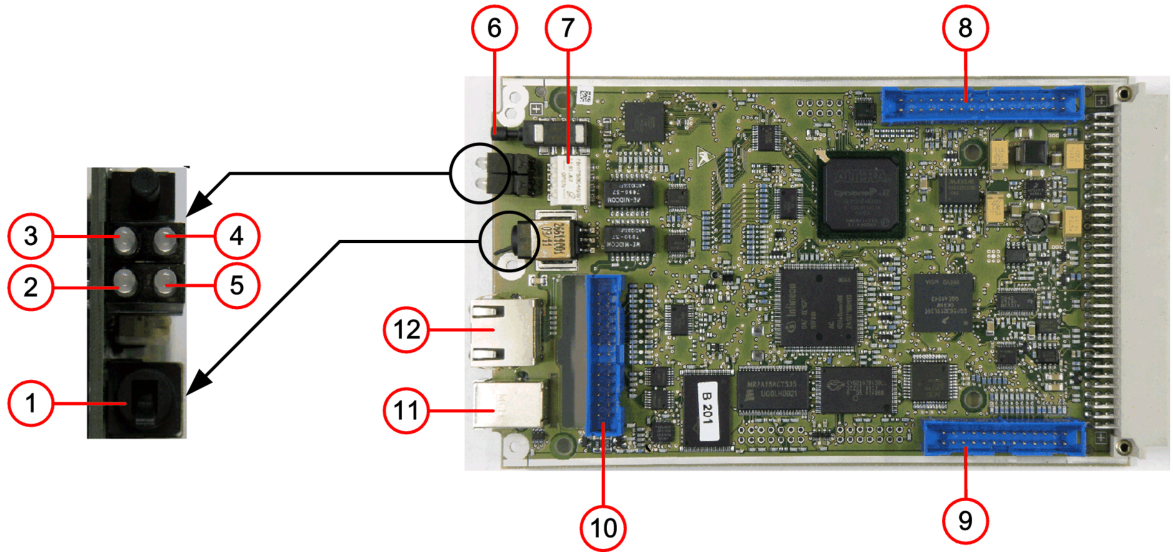
The internal power supply generates the voltages needed on the module that are not fed externally:

- Supply voltages for the analog line interface
- Switched 12 V supply voltage for the relays on the IFC modules

The 12 V operating voltage for the IFC modules can be switched from the controller and allows selective disabling of the output relays. The operating voltages on the module are monitored. Loss of a voltage generates a reset and an alarm on the module.

2.6.6.4 Control and Display Elements of the PU4 Module

Control and display elements are mounted on the module. The front panel covers some of them.



[le_pu4jum, 1, en_US]

Figure 2-10 Position of Jumpers, Input and Signaling Elements on the PU4 Module

1	S2: Power ON/OFF
2	LED OK/BGAL
3	LED Status Interface LID-2 (for PowerLink 100)
4	LED Status Interface LID-1 (for PowerLink 100)
5	LED Status Interface LIA
6	S1: Reset button
7	S3 (3.1 to 3.4)
8	DLE connector (for PowerLink 100)
9	DLE connector (for PowerLink 100)
10	IFC module connector
11	LCT: Service Interface (USB)
12	NMS: Ethernet Interface

- The 2-color LIA LED is needed for displaying the status of the LIA. The following states can be displayed:

Table 2-13 Significance of the LIA LED Displays

State	Significance
Off	LIA is not configured
Red static	LIA is not ready for operation (for example, primary path receiver alarm)
Red flashing	LIA is only operational to a limited extent
Green static	LIA is working correctly and used as main path.

The 2-color OK/BGAL LED is needed for displaying the PU4 module status. The following states can be displayed:

Table 2-14 Significance of the OK/BGAL LED Displays

State	Significance
Off	Power supply is disconnected or faulty
Red static	Module is not ready for operation
Red flashing	General alarm active. Module is only operational to a limited extent
Green static	Normal operation
Green slow flashing	Test operation
Green fast flashing	Ethernet port of PU4 is not ready for operation

2.6.6.5 Event Memory and Real-Time Clock

Protection commands and alarms are provided with time and date and a registration number before they are entered in the event memory. Up to 8184 entries with a time resolution of 1ms are possible. They are read out by the Web UI and this is also possible from the remote station by means of Remote Monitoring. The following events are entered:

- Incoming protection commands from IFC-D/P and EN100
- Outgoing protection commands to IFC-D/P and EN100
- Detected alarms
- Program restart
- Changing date and/or time
- Changing the configuration

In case of an overflow the oldest entry in the event memory is overwritten.

The **real-time clock** supplies the time marker for the particular entries. It is possible to synchronize the local time with an external signal (SYNC). The synchronizing pulse is fed into the iSWT unit via a surge-proof, floating signal input on the alarm module ALR. Synchronization can be configured in minute or hourly intervals with the positive or negative edge of the pulse.

The external SYNC pulse is recognized by the PU4 controller of the iSWT and processed. The evaluation of the rising or falling pulse edge can be parameterized.

The local sync pulse must be received within a one minute or a one hour interval via signal input USYNC. Clock synchronization can be done when:

- second > 35 (time is set to xx:xx:59.99) or
- second < 25 (time is set to xx:xx:00.00)

With the ALR module the clock synchronization is also possible with IRIG-B message.

The clock module is buffered so that no data is lost in the event of a power failure (data retained for about 2 hours without supply voltage).

2.6.7 The Interface Modules IFC

2.6.7.1 General Information

Overview

The interface module IFC is used for communication between protection equipment and the iSWT. The following versions are available:

- Module IFC-**D** Heavy duty version (**I**nter**f**ace **C**ommand **D**irect tripping)
- Module IFC-**P** Normal version (**I**nter**f**ace **C**ommand **P**ermissive tripping)
- Module IFC-**S** Signaling (**I**nter**f**ace **C**ommand **S**ignaling)

IFC Module Equipment in integrated SWT 3000 systems

For an integrated SWT 3000 unit in PowerLink you can insert up to 2 IFC-D or IFC-P modules into the module slots IFC-1 and IFC-2 of the PowerLink subrack. Slot IFC-2 alternatively can be equipped with an IFC-S module.

2.6.7.2 Description of Operation

Overview

IFC-D
The IFC-D module has 4 binary inputs for receiving contact information from the protection devices. Up to 4 circuit breaker coils can also be operated with this module. It is thus possible to implement the trigger commands **directly** from a distant station, for example, without a protection device. This module is preferably used for direct tripping mode but the use in protection systems with permissive tripping is also possible.

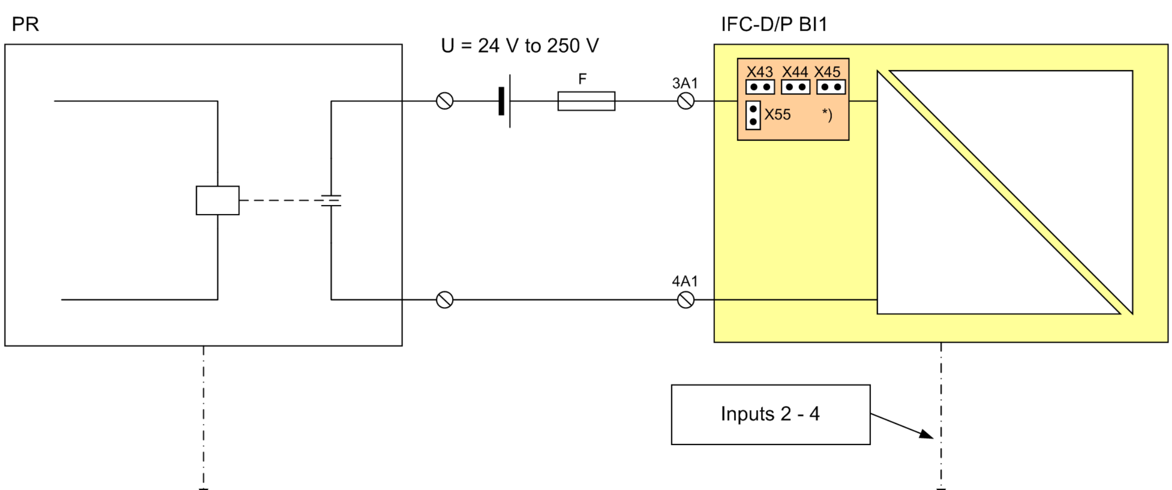
IFC-P
The IFC-P module is preferably used in protection systems with permissive tripping. When observing the maximum switching current of the relays, direct tripping of circuit breaker coils is also possible (refer to *Technical Data*). There are similarly 4 binary inputs and 4 command contact outputs available. The contact rating of the output relays is lower compared to the IFC-D module but operating times are shorter. IFC-D and IFC-P modules are pin-compatible.

IFC-S
The IFC-S is used for signaling. Each command input as well as each command output in the corresponding IFC-D/P is activating a relay on the IFC-S.

The IFC-S module is used for:

- Signaling commands that are entered (binary inputs)
- Signaling commands that are output (binary output)

Connection Principle



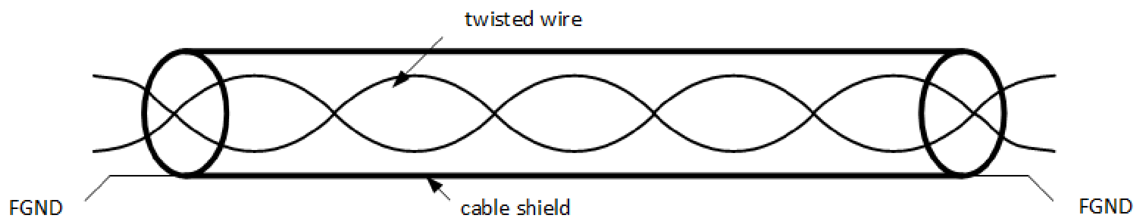
[dw_SWT_baseim, 1, en_US]

Figure 2-11 Basic Connection of IFC-D or IFC-P Modules

*)	Setting the rated DC voltage 24 V, 48 V/60 V, 110 V, 250 V
IFC-D/P BI 1	IFC Binary Input 1
PR	Protection Relay
3A1 - 4A1	Terminals Binary Input 1
F	Fuse

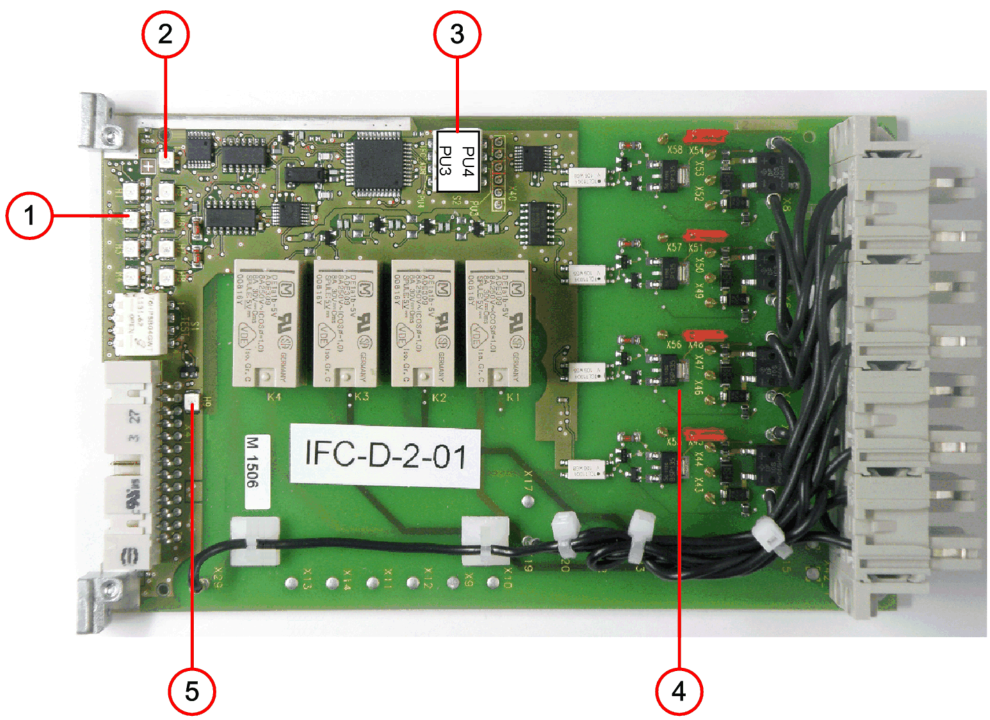
NOTE

Each interface needs its own shielded, twisted wire cable.
The binary Input cabeling shall not run in parallel with other power supply or heavy load cables.



[dw_binary_input_cable_shielded_twistedwire, 1, --_--]

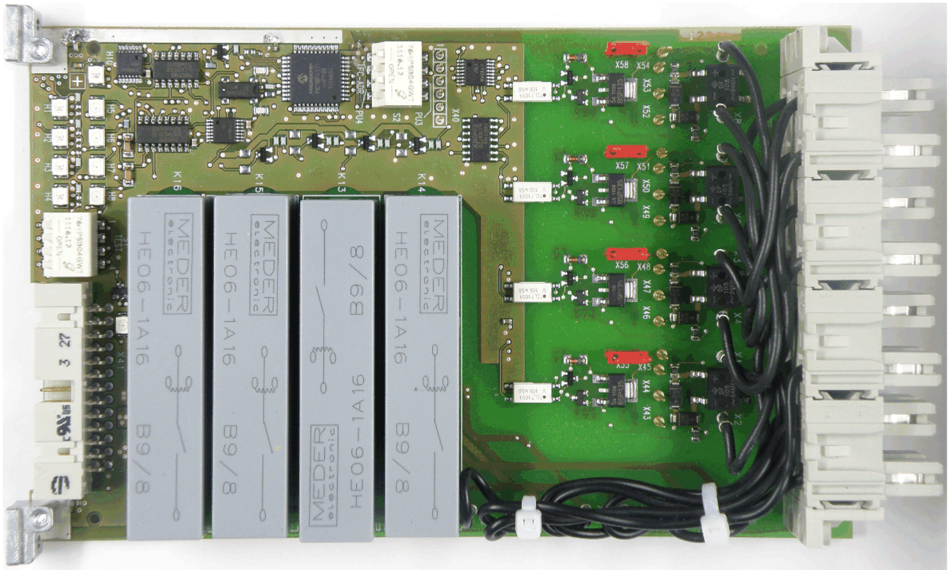
Figure 2-12 Shielded twisted wire cable



[scjumper-220513-01.tif, 2, en_US]

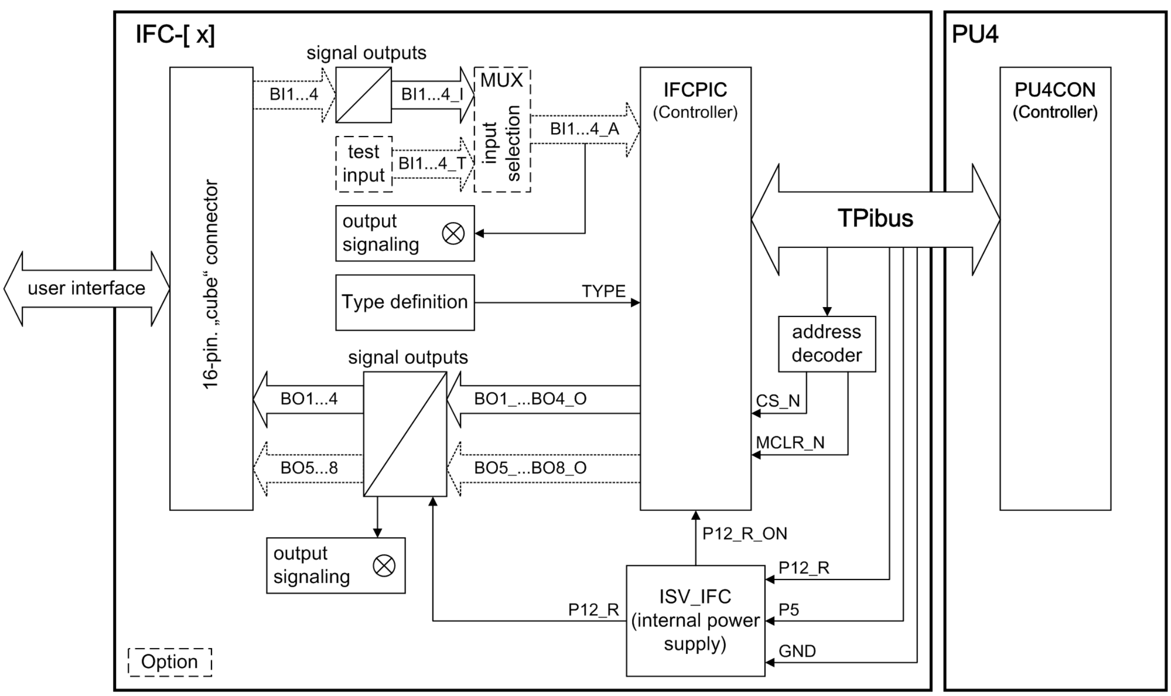
Figure 2-13 Signaling elements and DIL-switches of the IFC module, e.g. IFC-D

(1)	LED H1 to H4 (red): activated outputs LED H5 to H8 (green): activated inputs
(2)	Test Operation Display (H10)
(3)	S2: IFC Slot Address Selection (S2.1, S2.2) and PU3 / PU4 switch: S2.3: closed/down - PU3 S2.3: open/up - PU4
(4)	Jumpers X43 to X58
(5)	Operating LED (H9)



[scifcpju-300112-01.tif, 1, en_US]

Figure 2-14 IFC-P Module



[dwifcblc-051011-01.tif, 1, en_US]

Figure 2-15 Block Diagram of IFC Modules

TPi-Bus	Internal bus
MUX	Multiplexer
ISV_IFC	Internal power supply IFC
P12_R	12-V supply voltage for relays
P5	5-V supply voltage
P12_R_ON	12-V supply voltage available

2.6.7.3 Controller

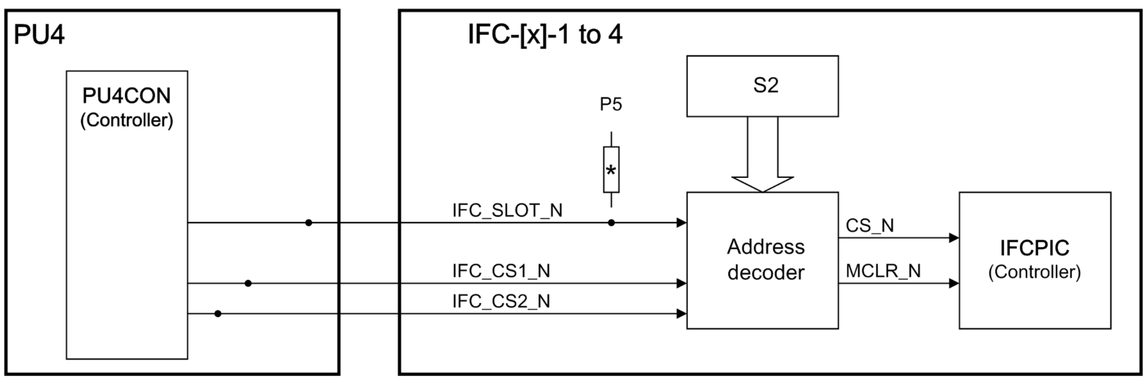
A controller is used on all IFC interface modules for the following functions:

- Control of the data traffic from/to the PU4
- Sampling the signal inputs 1 to 4 and triggering an interrupt at the PU4 in case of changes.
- Switching the command relays via the signal outputs.
- Supervision functions

The controller is connected to the PU4 controller via an internal bus.

2.6.7.4 Slot and Module Identifier

The new IFC modules can also communicate with the old TPi-Bus (PU3). For this purpose, no additional signal from PU4CON (PU4 controller) can be used for IFC addressing.
A DIP switch S2 is added to each IFC module to indicate its slot address.



[dwifcadd-051011-01.tif, 1, en_US]

Figure 2-16 IFC Addressing Used for SWT 3000

Table 2-15 Function of S2 Switch

Switch	Function
S2.1	IFC slot address selection
S2.2	IFC slot address selection
S2.3	PU3 or PU4 selection (only PU4 is supported in PowerLink IP)
S2.4	Not connected

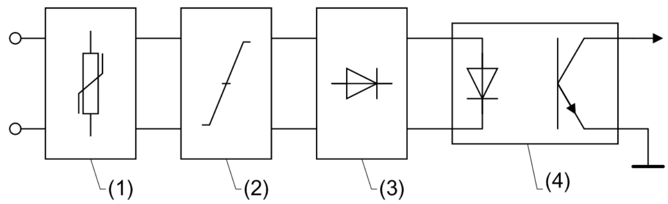
For PU4 the IFC slot address is configured by changing the state of DIL switches, and it is independent of the position where it is located. The 4 slot addresses are mapped into different switching states.

Table 2-16 IFC Slot Address

Selection	S2.1 Position	S2.2 Position
IFC-1	Open = up position = OFF	Open = up position = OFF
IFC-2	Close = down position = ON	Open = up position = OFF

2.6.7.5 Signal Acquisition via Binary Inputs

If the binary inputs (BI1 to BI4) of the module detect a signal, an interrupt request is sent to the PU4. The IFC module is connected to the PU4 via a ribbon cable via connector X3 at the front. If an interrupt is detected, PU4 can read the status of the binary inputs.
In order to suppress interference pulses, a signal must be applied to the binary input for at least 1 ms before the interrupt request is sent. The following figure shows the block diagram of a binary input:



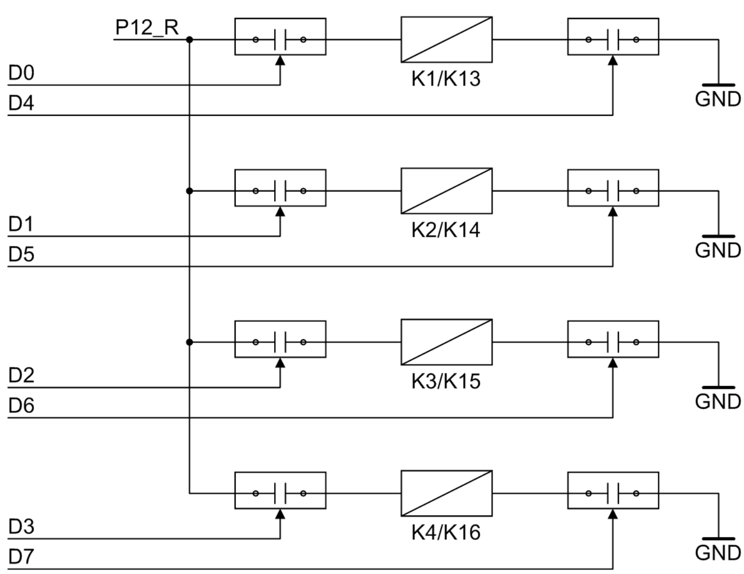
[dwcsem34-051011-01.tif, 1, en_US]

Figure 2-17 Binary Inputs of Modules IFC-D and IFC-P

(1)	Protective circuit The protective circuit provides the required security against destruction and interference.
(2)	Setting of the input rated voltage You can set the input rated voltage to the values DC 24 V, DC 48/60 V, DC 110 V and DC 250 V with the jumpers X43 to X58. The operating point is at 80 % of the selected voltage. Refer to Chapter *Jumper Settings for the IFC Modules* for more details
(3)	Rectifier Rectification ensures that the input signal is polarity-neutral.
(4)	Optocoupler The optocoupler isolates the input circuit electrically from the electronic system.

2.6.7.6 Signal Output from the IFC-D/P Module

If there is an IFC-D module, the commands from the remote station are distributed via the relays K1 to K4. If there is an IFC-P module, the commands from the remote station are distributed via the relays K13 to K16. Compared with the IFC-P module, the relays of the IFC-D module are slower but they can switch more power.



[dwcsem35-051011-01.tif, 1, en_US]

Figure 2-18 Block Diagram of the Output Circuit of IFC-D/P

K1 - K4	Output Relays of Module IFC-D
K13 - K16	Output Relays of Module IFC-P
D0 - D7	Operation of the IFCx Controller

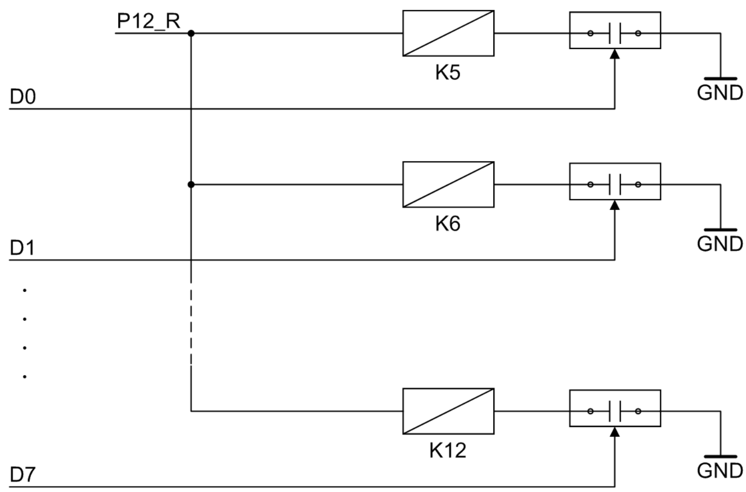
The following security systems are incorporated for sending commands without interference:

- PU4 must enable the supply voltage P12_R
- Relays are operated on a 2-pole basis

2.6.7.7 Signal Output from IFC-S Module

The messages are transmitted via the relays K5 to K12. These relays are identical with those relays on the IFC-D module. For 7 relays, one change-over contact per relay is brought out. The contact of relay K5 can be used as a make contact or break contact with jumper X42. All 8 signal relay contacts have a **common root (3A1)**.

The PU4 must enable the excitation voltage P12_R of the relay coils.

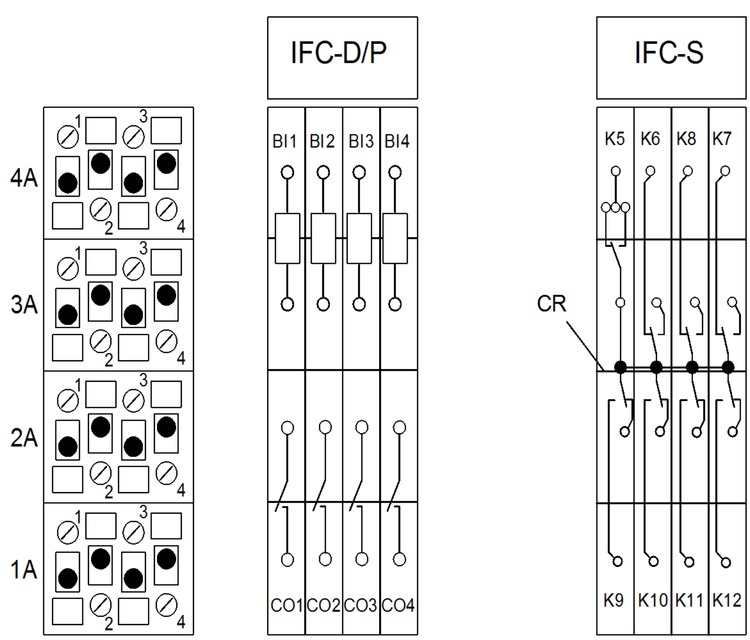


[dwcsem36-051011-01.tif, 1, en_US]

Figure 2-19 Block Diagram of the Output Circuit of IFC-S

2.6.7.8 Pinout of the IFC-x Module

The interface modules must be connected from the protective relay to the connector X1 (modular terminal block). The cable cross section must be up to 1.5 mm^2. **Minimum** 2 cables must be tied immediately at the terminals.



[dwpinifc-060711-01.tif, 1, en_US]

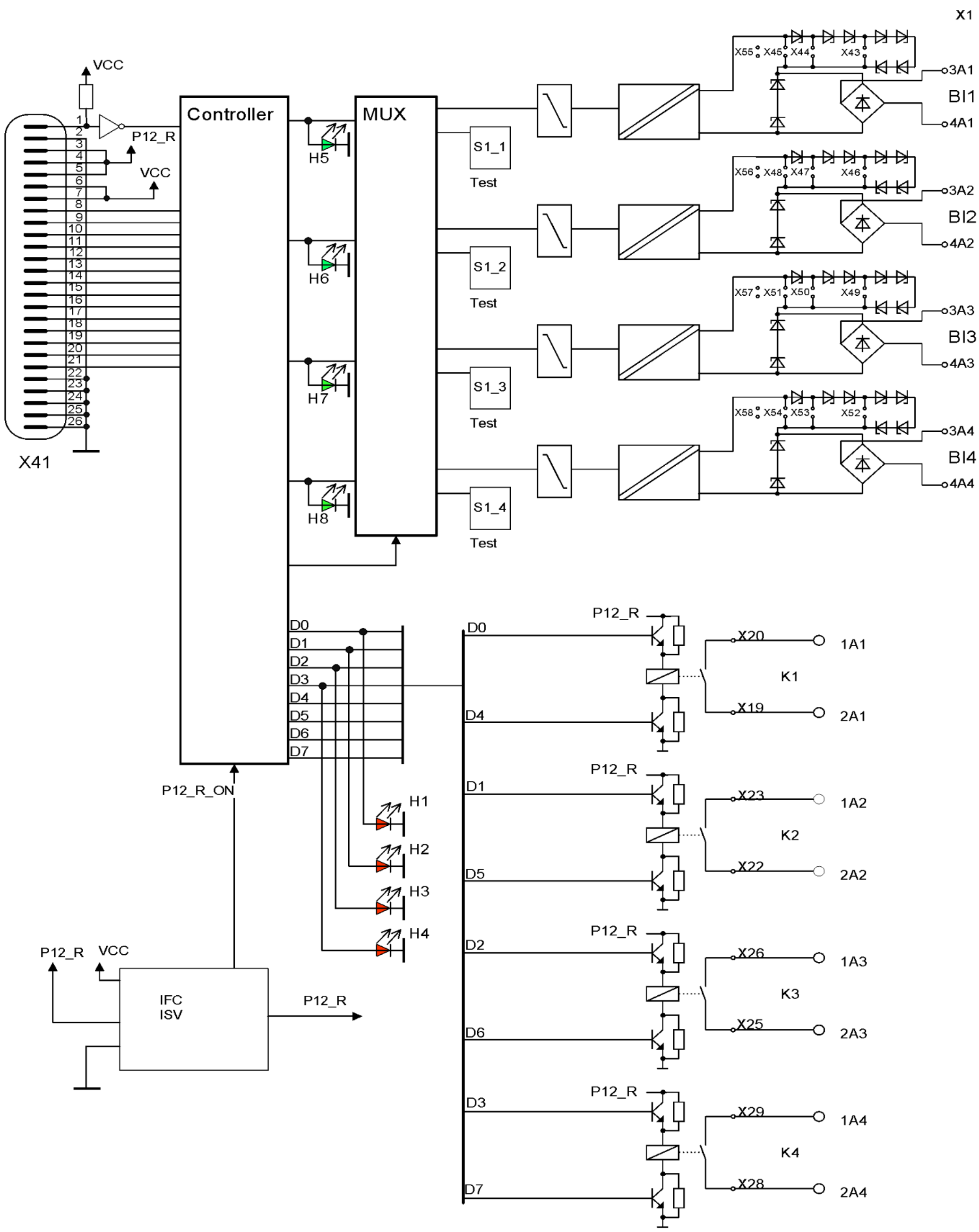
Figure 2-20 Pinout of the IFC-x Modules

IFC-D	Interface module direct tripping
IFC-P	Interface module permissive tripping

IFC-S	Interface module signaling
CR	Common root of relays K5 to K12
1A to 4A	Modular terminal block
BI1 to BI4	Binary inputs 1 to 4
CO1 to CO4	Command outputs 1 to 4
K5 to K8	Signaling of the binary inputs 1 to 4
K9 to K12	Signaling of the command outputs 1 to 4

2.6.7.9 Block Diagrams of IFC Modules

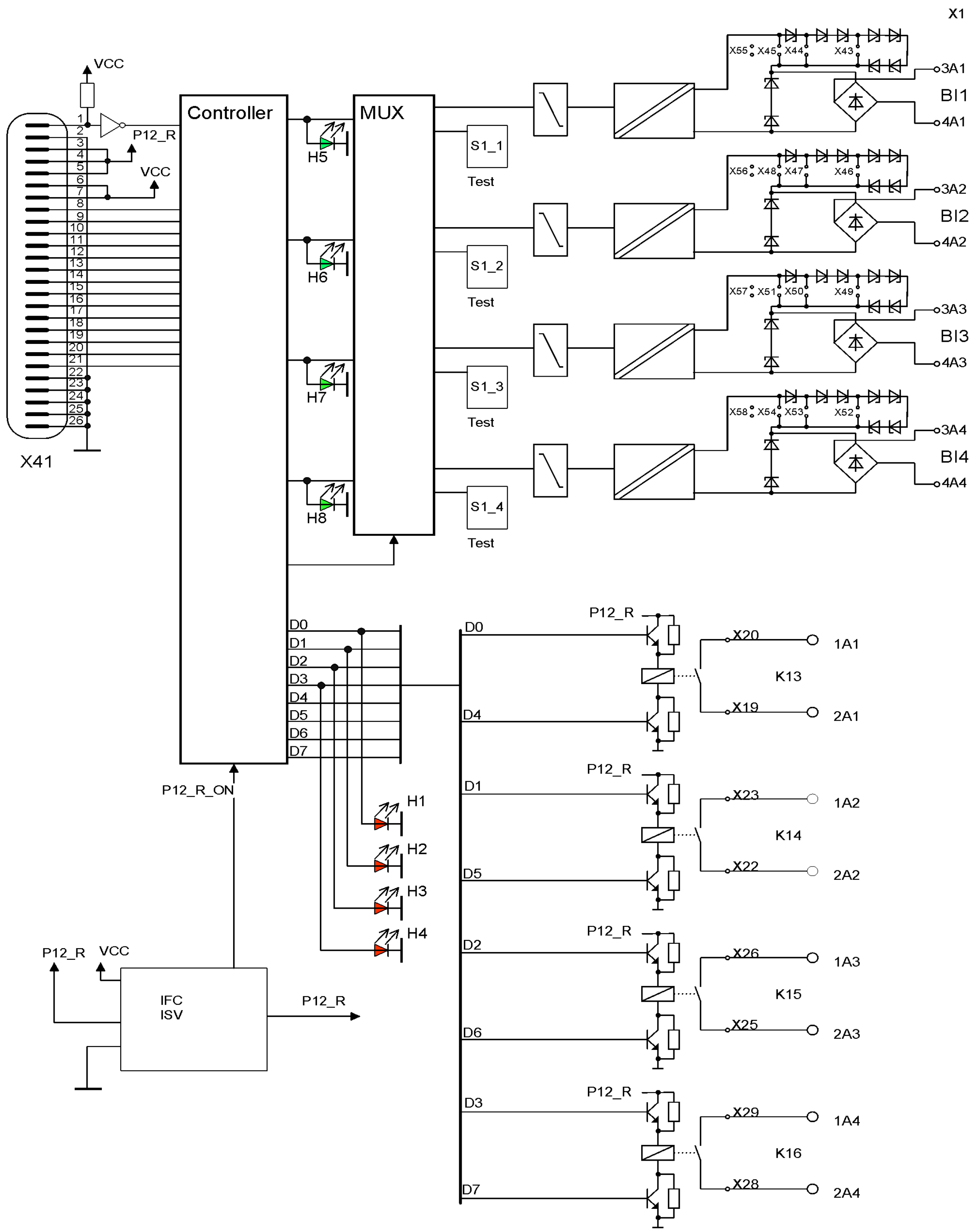
IFC-D Module



[dw_rgcsem01, 1, en_US]

Figure 2-21 Block Diagram of the IFC-D Module

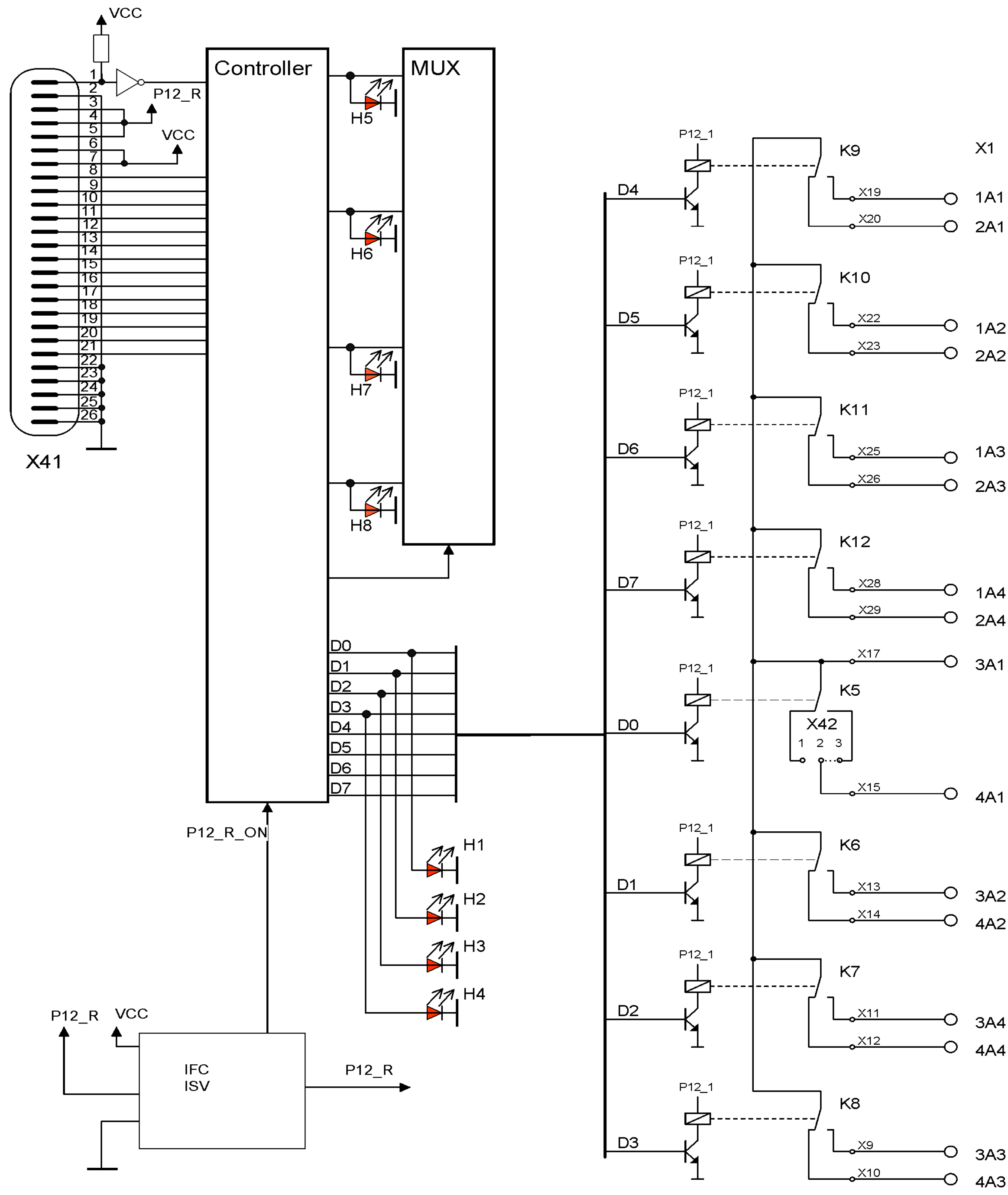
IFC-P Module



[dw_rgcsem02, 1, en_US]

Figure 2-22 Block Diagram of the IFC-P Module

IFC-S Module



[dw_rgcsem03, 1, en_US]

Figure 2-23 Block Diagram of the IFC-S Module

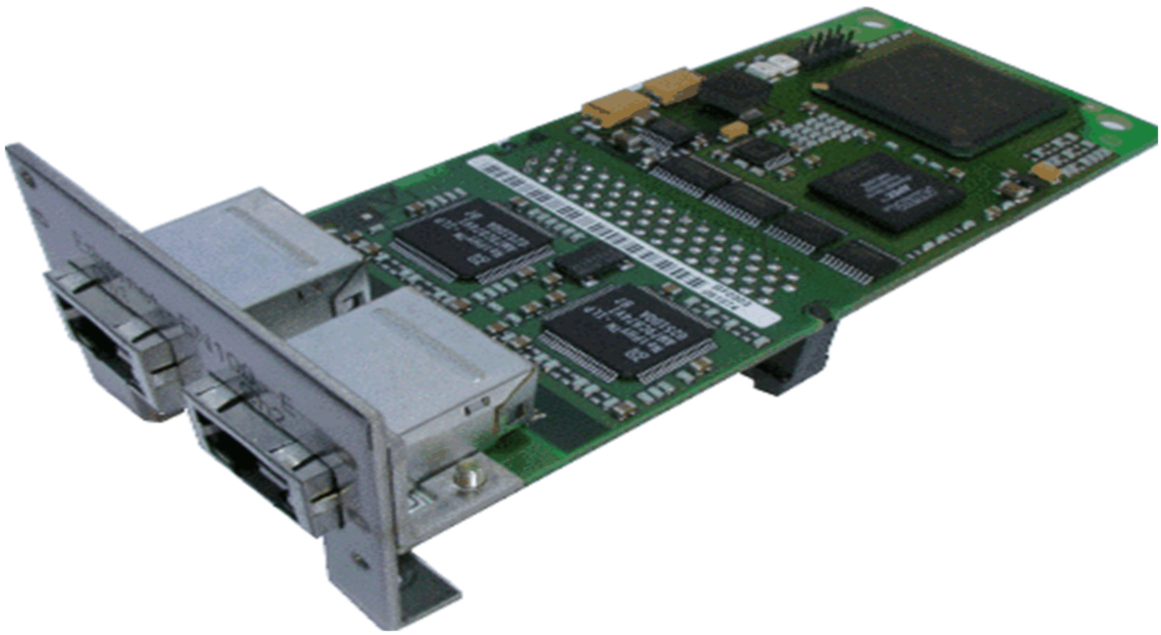
2.6.8 Ethernet EN100 Module

2.6.8.1 Ethernet EN100 Module Functionality

The **Ethernet EN100 module** enables the integration of SWT 3000 into 100-Mbit communication networks. These networks are used by process control, automation systems, and communications systems with the protocols according to IEC 61850 standard (**I**nternational **E**lectrotechnical **C**ommission). This standard permits uniform communication of the devices without gateways and protocol converters.

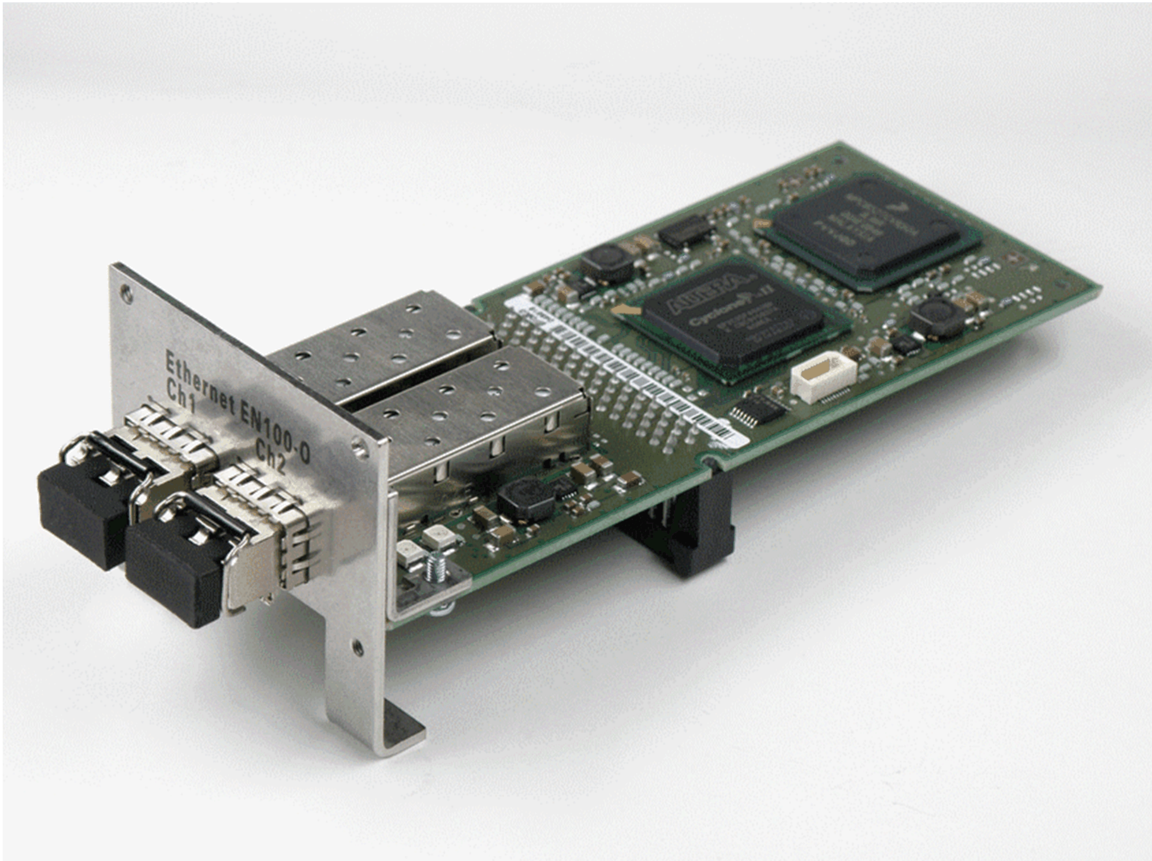
With 2 RJ45 connectors or with 2 Duplex-LC interfaces for a 1300-nm fiber-optic connection, 2 module types are available.

The following figures show the mechanical design of the EN100 module with electrical interfaces and fiber-optic interfaces for internal installation:



[scen100m-310111-01.tif, 1, en_US]

Figure 2-24 EN100 Module with Ethernet Interfaces (RJ45) for internal Installation



[scen1opt-210211-01.tif, 1, en_US]

Figure 2-25 EN100 Module with Duplex-LC Interfaces for internal Installation

The preceding modules can be used in the integrated SWT 3000 device and are mounted on the solder side of the PU4 module via connector. These modules are connected electrically to the PU4 module via a D-sub plug connection and screwed to the PU4 module and device front panel.

The physical interface is always duplicated to permit redundant structures. One of the 2 interfaces is always active while the other interface is monitored passively. If a fault occurs on the active interface, switchover to the other interface is performed in a matter of milliseconds.

Both Ethernet connectors of the module with RJ45 interfaces and also the fiber-optic module interfaces are accessible from the front of the device. The fiber-optic version of the module comprises the entire functionality of the module with the electrical interfaces.

2.6.8.2 IEC 61850 Application Mode for integrated SWT 3000

GGIO Mode

The binary command input and output of integrated SWT 3000 are mapped one-to-one onto the standard-compliant object GGIO LN in IEC 61850. The parameterization of IEC 61850 is performed using the System Configurator (e.g. DIGSI). After importing SWT 3000 ICD file into System Configurator, it is possible to establish a GOOSE command mapping between protection relay and iSWT device. iSWT is realized as IEC 61850 GGIO gateway, it exchanges up to 8 I/O points between substations. On transmitting side, iSWT receives GOOSE message from protection relay and re-codes to own special communication protocol. On the receiving side, iSWT recreates GOOSE message and sends to protection relay. The IEC 61850 protocol is implemented in Ethernet EN100 module.

In GGIO mode, the border of the IEC 61850 world is iSWT. That means no IEC 61850 related auxiliary data, like quality data, are transferred to the remote side. The GOOSE command is transmitted as long as the command input is active if the input command limit time is set to zero. For integrated SWT 3000 with alternative multi-purpose operation, the GOOSE command is only transferred for the input limit time.

iSWT in PowerLink IP offers EN100 and IFC interfaces in mode 3a for up to 4 commands, mode 3b for 2 plus 2 commands and mode 7a for 8 commands.

IEC 61850 Logical Nodes Parameters for integrated SWT 3000 Teleprotection with EN100 GOOSE Communication

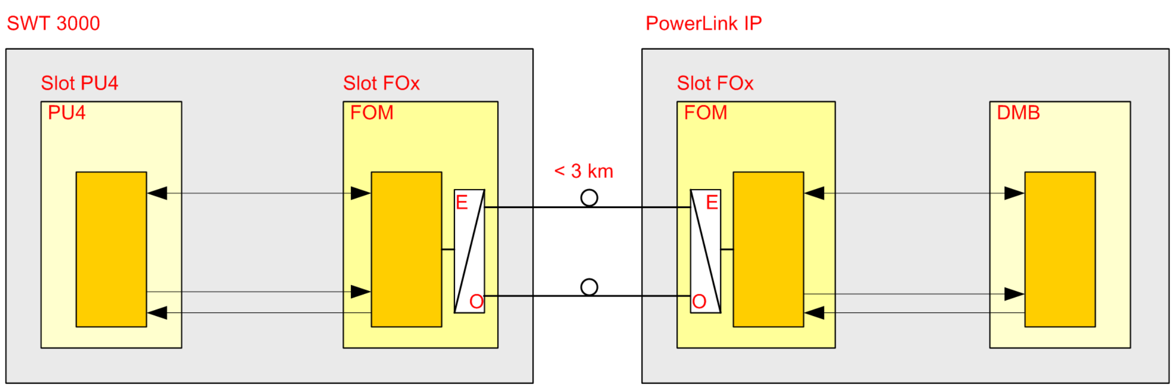
According to the IEC 61850 model logical nodes are the building blocks of an Intelligent Electronic device (IED). A Logical Node (LN) represents the function within a physical device; it performs some operations for that function and is object defined by its data and methods. The users view of the logical nodes is the ICD file of the iSWT. A fixed set of ICD files is provided for iSWT.

Since the iSWT related settings (communication interfaces, CMD timers) are configured via Web UI and thus 'outside' the IEC61850 world only a minimal set of Logical Node (LN) according to the IEC61850 model is used for the teleprotection signaling with EN100 GOOSE communication and for supervision.

2.6.9 Fiber Optic Connection

2.6.9.1 Overview

With the integrated Fiber Optic Module (FOM), it is possible to connect an external SWT 3000 to the Power-Link IP system via fiber-optic cables.



[dw_iSWTviaFOMconnection, 1, en_US]

Figure 2-26 SWT 3000

The SWT 3000 is connected via fiber-optic cables (for each transmission direction one fiber) to the PowerLink IP. The functionality of SWT 3000 is like an integrated SWT 3000 (iSWT). The programming and configuration of the SWT 3000 is in this case only possible via PowerLink IP Web UI. Only one SWT 3000 can be connected via fiber-optic cables (iSWT-1). The FOM in PowerLink IP is installed in the slot of the PU4.

The main transmission path of the SWT 3000 via fiber-optic cable is the PLC connection of the PowerLink IP via high-voltage line. You can connect a digital alternative path to the SWT 3000 as follows:

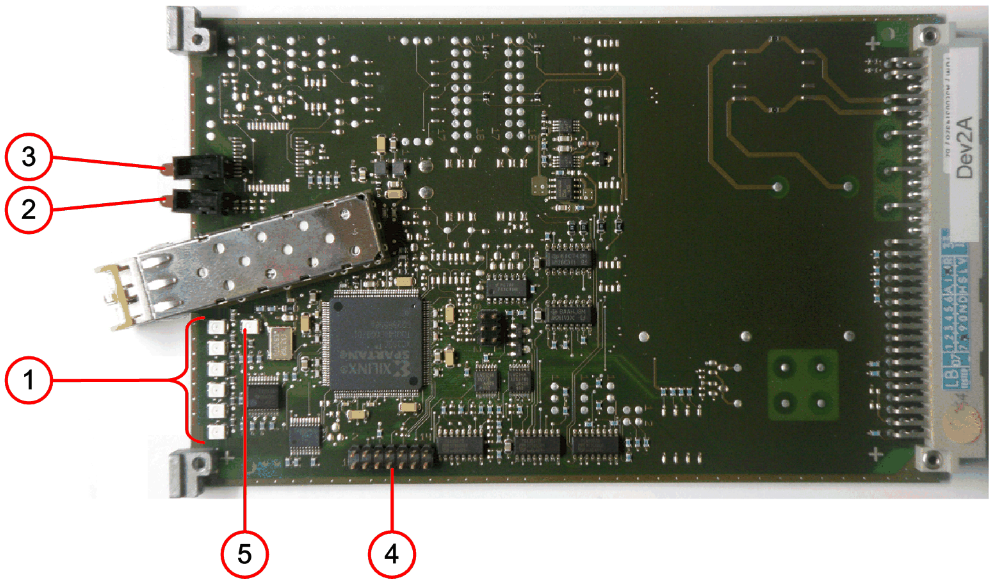
- Direct electrical connection to the remote SWT 3000 device
- Optical connection via a second FOM

The S6 pilot wire for the switchover in the Alternate Multi-Purpose (AMP) operation is transmitted from the FOM to PowerLink IP.

Fiber-optic module	Small Form-factor Pluggable (SFP) module
Fiber type	Multi-mode with modules using 850-nm wavelength, single-mode with modules using 1300-nm wavelength
Wavelength	850 nm or 1300 nm
Optical connector	LC-connector
Range	Up to 2 km at 850 nm (depending on the attenuation of the fiber) No minimum attenuation limit for 1300 nm
2 x LED	Tx-Alarm and Rx-Alarm (Rx + F6 Supervision-Alarm)

2.6.9.2 FOM

The FOM can be used for a connection of the stand-alone SWT 3000 to PowerLink IP or a digital FO transmission path between stand-alone SWT 3000 devices.
On the FOM, no jumper settings are required.



[scfomled-220513-01.tif, 1, en_US]

Figure 2-27 Position of the LEDs on the FOM

(1) LED H4 to H9: Diagnosis
(2) LED H3 Rx-Alarm
(3) LED H2 Tx-Alarm
(4) Programming Interface
(5) LED H1: FPGA Readiness

Table 2-17 Signification of the Alarm LEDs on the FOM

LED		LED Indication when Lighted
H1	red	FPGA not ready
H2	red	**Tx-Alarm** F6 supervisory alarm
H3	red	**Rx-Alarm**
H4	yellow	ILAN high
H5	yellow	BUF alarm Buffer overflow or under run Source: Supervisory circuit of FPGA
H6	yellow	MOD-alarm Modulation alarm, carrier frequency at the optical receiver not detected
H7	yellow	COM-alarm Communication alarm at the electrical interface
H8	yellow	SFP_LOS The received optical power is below the receiver sensitivity Loss of signal
H9	yellow	S6 asserted

2.7 IEC 61850

2.7.1 Overview

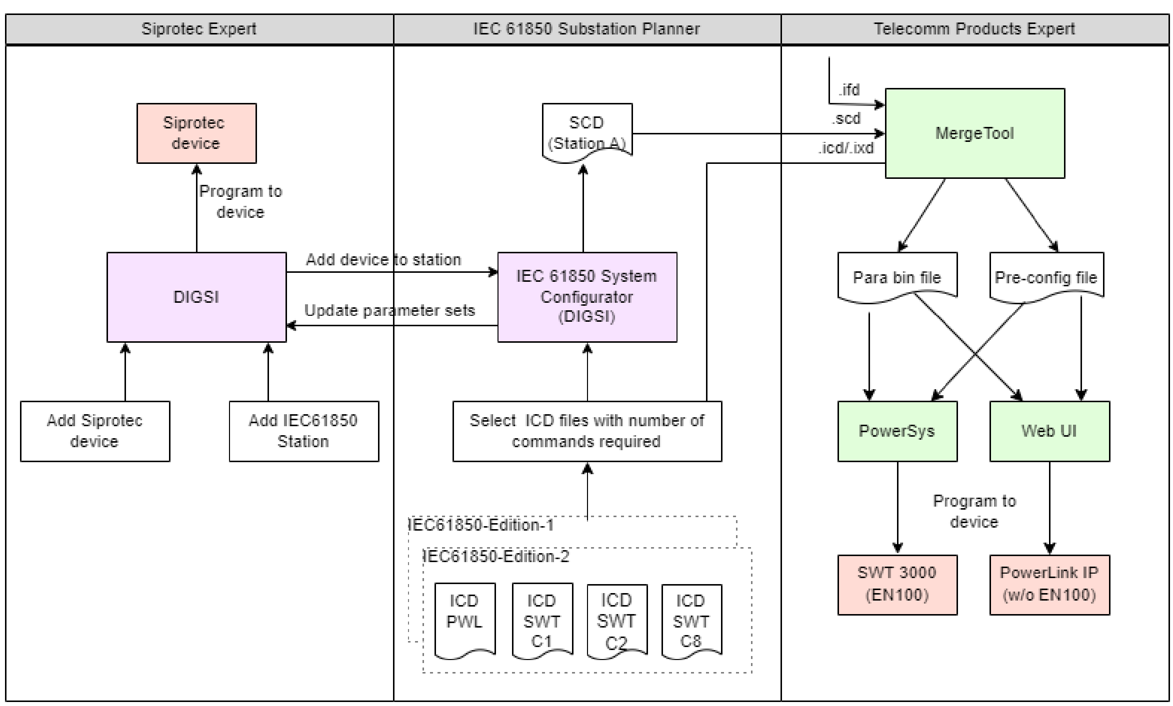
IEC 61850 defines the communication interfaces between intelligent electronic devices (IEDs) for receiving or sending data control from or to an external source, exchange information between IEDs in the substation via Ethernet communication.

Substation control center reads the inventory data or health status of running devices via MMS (Manufacturing Message Specification) communication protocol. The generic substation event (GOOSE) provides the peer-to-peer information exchange between input / output data values of IEDs. The protection commands are transmitted over GOOSE message between protection device and telecommunication (telecom) products.

IEC 61850-90-1 defines the standard for protection command exchange between substations. The telecom products are used as IEC 61850 gateway to transmit GOOSE commands to remote stations via different communication media (e.g., Power line carrier or SDH network).

In the IEC 61850 parameterization workflow following 3 roles are defined:

- **SIPROTEC Expert**
  Responsible for the parameterization of the SIPROTEC2 device using DIGSI software.
- **IEC 61850 Substation Planner**
  Responsible for the configuration of the IEC 61850 Station using IEC 61850 System Configurator. The tasks assigned are: Add IEC 61850 device, network setting, GOOSE mapping etc.
- **Telecomm Product Expert**
  Responsible for the parameterization of the telecom products device using PowerSys, MergeTool and device Web UI. The tasks assigned are: Generate BIN / CFG file, import BIN / CFG file and configure telecommunication devices.



[sc_IEC61850_Parameterization, 1, --_--]

The IEC 61850 function are supported in two modules:

- EN100 module
  If iSWT enabled, the IEC 61850 are provided by EN100 module and enabled in Web UI > iSWT 3000 > System.

- DMB module
  If iSWT not enabled, the IEC 61850 function are provided by DMB module and enabled in Web UI > Configuration > IEC 61850. Note: GOOSE command transmission and redundancy protocol (PRP, RSTP) are not supported in DMB module. Only MMS connection to substation control center is supported.

LN PWL ITPC - Communication Interface

Table 2-18 LN: PWL_ITPC - Communication Interface

ITPC class				
Data object Name	**Common data class**	**Explanation**	**T**	**M/O**
LNName		Name composed of the class name, the LN-Prefix and LN-Instance- ID according to IEC 61850-7-2		
Data objects				
EEHealth	ENS	External equipment health. It reflects the alarm status of the PowerLink IP device. Possible values: 1: Ok (Green) no alarms active 2: Warning (Yellow) only none urgent alarms active 3: Alarm (Red) at least one urgent alarm is active		O
Status information				
AlarmGen	SPS	Device general alarm TRUE: (Alarm is active)		O
AlarmNU	SPS	Device non-urgent alarm TRUE: (Alarm is active)		O
AlarmRx	SPS	Device receive alarm TRUE: (Alarm is active)		O
LosSig	SPS	Alarm situation: No signal received, indicates a channel problem of analog communication. Possible values: TRUE: RX alarm is active. FALSE: RX alarm is inactive.		O
LosSyn	SPS	Alarm situation: Loss of synchronism of PLC modem Indicates that there is no synchronization between the transmitter and the receiver, i.e., no communication is possible.		O
TxCmdCnt1	INS	For diagnostics: Transmitted command 1 counters.		O
TxCmdCnt2	INS	For diagnostics: Transmitted command 2 counters.		O
TxCmdCnt3	INS	For diagnostics: Transmitted command 3 counters.		O
TxCmdCnt4	INS	For diagnostics: Transmitted command 4 counters.		O
TxCmdCnt5	INS	For diagnostics: Transmitted command 5 counters.		O
TxCmdCnt6	INS	For diagnostics: Transmitted command 6 counters.		O
TxCmdCnt7	INS	For diagnostics: Transmitted command 7 counters.		O
TxCmdCnt8	INS	For diagnostics: Transmitted command 8 counters.		O
RxCmdCnt1	INS	For diagnostics: Received command 1 counters.		O
RxCmdCnt2	INS	For diagnostics: Received command 2 counters.		O
RxCmdCnt3	INS	For diagnostics: Received command 3 counters.		O
RxCmdCnt4	INS	For diagnostics: Received command 4 counters.		O
RxCmdCnt5	INS	For diagnostics: Received command 5 counters.		O
RxCmdCnt6	INS	For diagnostics: Received command 6 counters.		O
RxCmdCnt7	INS	For diagnostics: Received command 7 counters.		O
RxCmdCnt8	INS	For diagnostics: Received command 8 counters.		O
NumTxCmd	INS	Numbers of used transmit GOOSE commands. Possible values: 0...8		O

ITPC class				
NumRxCmd	INS	Numbers of used binary receive GOOSE commands. Possible values: 0...8		O
TpcTxMod	ENS	Teleprotection application mode in Transmit direction for each command. Possible values: 0: Direct tripping 1: Permissive tripping		O
TpcRxMod	ENS	Teleprotection application mode in Receive direction for each command. Possible values: 0: Direct tripping 1: Permissive tripping		O
Measured values				
FerCh	MV	Frame error rate of PLC modem communication channel.		O
CarLev	MV	Power of received signal (in dB) of PLC modem.		O
SigNsRat	MV	Signal to noise ratio (in dB) of PLC modem.		O

LN PWL RFLO - Fault Locator

The fault locator RFLO LN is used to report fault location and impedance for condition monitoring.

Table 2-19 LN: PWL_RFLO - Fault locator

RFLO class				
Data object Name	**Common data class**	**Explanation**	**T**	**M/O**
LNName		The name shall be composed of the class name, the LN-Prefix and LN- Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
FltAlarm	SPS	Line fault alarm is active (TRUE)		O
OpCntRs	INS	Detected line fault counter		O
Measured values				
FltDiskm	MV	Fault distance in km		M
FltZ	MV	Fault impedance in relative percentage		O
RefLevel	MV	Fault reflection level in dB		O

LN SWT ITPC – Communication Interface

Table 2-20 LN: SWT_ITPC - Communication Interface

ITPC class				
Data object Name	**Common data class**	**Explanation**	**T**	**M/O**
LNName		Name composed of the class name, the LN-Prefix and LN-Instance- ID according to IEC 61850-7-2		

ITPC class				
Data objects				
EEHealth	INS	External equipment health. It reflects the alarm status of the SWT device. Possible values: 1: Ok ("green") no alarms active 2: Warning ("yellow") only none urgent alarms active 3: Alarm ("red") at least one urgent alarm is active		O
Status information				
AlarmGen	SPS	SWT general alarm TRUE: (Alarm is active)		O
AlarmNU	SPS	SWT non-urgent alarm TRUE: (Alarm is active)		O
AlarmRx	SPS	SWT receive alarm TRUE: (Alarm is active)		O
LosSig	SPS	Alarm situation: No signal received, indicates a channel problem of analog communication. Possible values: TRUE: RXALR of PU4 LIA is active. FALSE: RXALR of PU4 LIA is inactive.		O
TxCmdCnt1	INS	For diagnostics: Transmitted command 1 counters.		O
TxCmdCnt2	INS	For diagnostics: Transmitted command 2 counters.		O
TxCmdCnt3	INS	For diagnostics: Transmitted command 3 counters.		O
TxCmdCnt4	INS	For diagnostics: Transmitted command 4 counters.		O
TxCmdCnt5	INS	For diagnostics: Transmitted command 5 counters.		O
TxCmdCnt6	INS	For diagnostics: Transmitted command 6 counters.		O
TxCmdCnt7	INS	For diagnostics: Transmitted command 7 counters.		O
TxCmdCnt8	INS	For diagnostics: Transmitted command 8 counters.		O
RxCmdCnt1	INS	For diagnostics: Received command 1 counters.		O
RxCmdCnt2	INS	For diagnostics: Received command 2 counters.		O
RxCmdCnt3	INS	For diagnostics: Received command 3 counters.		O
RxCmdCnt4	INS	For diagnostics: Received command 4 counters.		O
RxCmdCnt5	INS	For diagnostics: Received command 5 counters.		O
RxCmdCnt6	INS	For diagnostics: Received command 6 counters.		O
RxCmdCnt7	INS	For diagnostics: Received command 7 counters.		O
RxCmdCnt8	INS	For diagnostics: Received command 8 counters.		O
NumTxCmd	INS	Numbers of used binary transmit commands. Possible values: 0...8		O
NumRxCmd	INS	Numbers of used binary receive commands. Possible values: 0...8		O
TpcTxMod	INS	Teleprotection application mode in Transmit direction for each command. Possible values: 0: Direct tripping 1: Permissive tripping		O
TpcRxMod	INS	Teleprotection application mode in Receive direction for each command. Possible values: 0: Direct tripping 1: Permissive tripping		O

ITPC class				
Measured values				
FerCh1	MV	Frame Error Rate of the communication channel LID-1. Used in case of a digital communication channel. This attribute is mapped to BER of DLE.		O
FerCh2	MV	Frame Error Rate of the communication channel LID-2.		O
CarLev	MV	Power of received signal (in dB), used in case of an analogue communication channel.		O
SigNsRat	MV	Signal to noise ratio (in dB), used in case of analogue communication channel.		O

LN TXC GGIO - Transmit Command

Table 2-21 LN: TXC_GGIO - Transmit command

GGIO class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O**
LNName		Name composed of the class name, the LN-Prefix and LN-Instance- ID according to IEC 61850-7-2		
Data objects				
Common Logical Node Information				
Measured values				
Status Information				
Controls				
SPCSO1	SPC	Single point controllable status output. Command input 1, which acts as an input for the local SWT processing. Attribute ctlVal is assigned to the iSWT command input. The input status is not transferred transparent to the remote side! It depends on the actual iSWT-Mode, how a change of ctlVal influences the command outputs on the remote iSWT.		O
SPCSO2	SPC	Command input 2		O
SPCSO3	SPC	Command input 3		O
SPCSO4	SPC	Command input 4		O
SPCSO5	SPC	Command input 5		O
SPCSO6	SPC	Command input 6		O
SPCSO7	SPC	Command input 7		O
SPCSO8	SPC	Command input 8		O

LN RXC GGIO - Receive Command

Table 2-22 LN: RXC_GGIO - Receive command

GGIO class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O**
LNName		Name composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2		
Data objects				
Common Logical Node Information				
Measured values				
Status Information				
Controls				
SPCSO1	SPC	Single point controllable status output. Command input 1, which acts as an input for the local SWT processing. Attribute ctlVal is assigned to the SWT command input. The input status is not transferred transparent to the remote side! It depends on the actual SWT-Mode, how a change of ctlVal influences the command outputs on the remote SWT.		O
SPCSO2	SPC	Command output 2		O
SPCSO3	SPC	Command output 3		O
SPCSO4	SPC	Command output 4		O
SPCSO5	SPC	Command output 5		O
SPCSO6	SPC	Command output 6		O
SPCSO7	SPC	Command output 7		O
SPCSO8	SPC	Command output 8		O

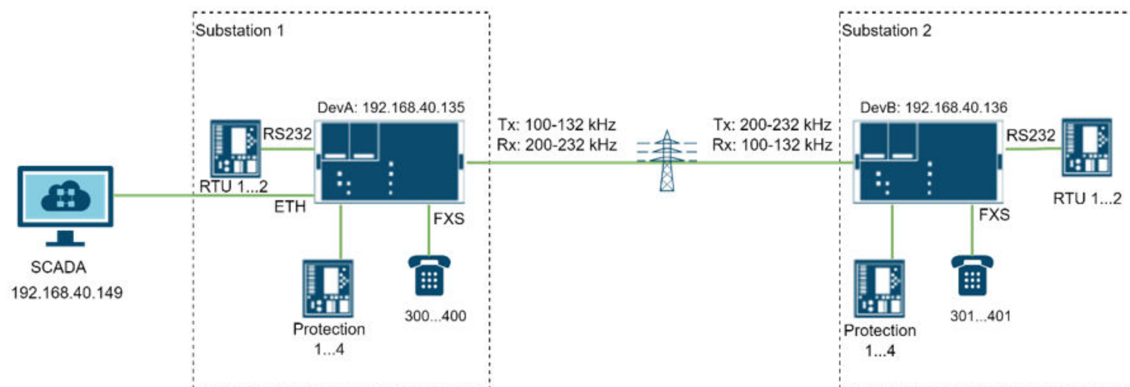
3 Device Configuration with Web UI

3.1 Quick Start

3.1.1 Overview

This quick start guide introduces the PowerLink IP commissioning procedure through step by step for below example configuration:

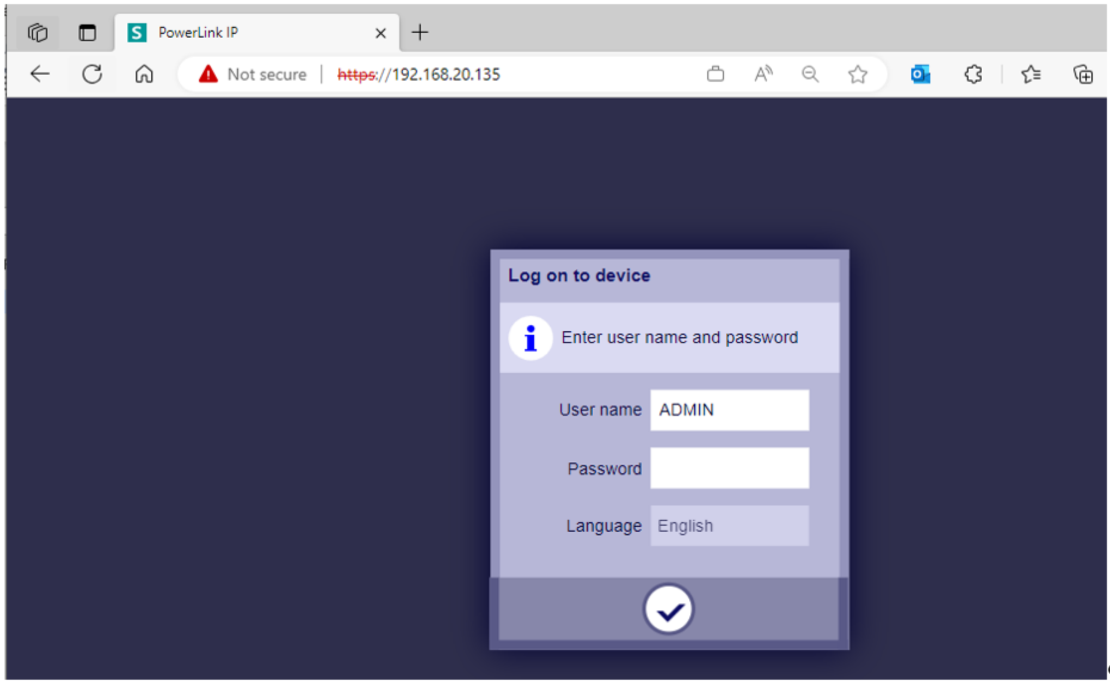
- 32 kHz bandwidth, 100 W
- 4 * tele-protection commands
- 2 * analog voice phones
- 1 * RS232 data channel for point to point between RTUs
- 1 * RS232 data channel for SCADA TCP master polling



[sc_quick_start_example, 1, --_--]

3.1.2 Web access

- Connect to device web home page via default IP address (https://192.168.20.20) with default username and password (ADMIN / admin)



[sc_logon_username_password_admin, 1, --_--]

- Change default ETH service and user port IP address

	Device A	Device B
Web UI > Configuration > Ethernet > Service interface		
IP address	192.168.20.135	192.168.20.136
Subnet mask	255.255.255.0	
Web UI > Configuration > Ethernet > User interface		
IP address	192.168.40.135	192.168.40.136
Subnet mask	255.255.255.0	
Web UI > Head bar > Apply settings		

- Change default user password after logon. Try to re-logon with changed user password.

	Device A	Device B
Web UI > User management		
ADMIN	***	
SECAUD	***	
ENGINEER	***	
VIEWER	***	
Web UI > Head bar > Main memu > Log off		

3.1.3 Time setting

- Adjust device time to have correct timestamp in event log

	Device A	Device B
Web UI > Time		
Set PC time to device		

3.1.4 Firmware update

- Check DMB release version and update latest AllInOne_DMB firmware if necessary
- Check iSWT release version and update latest AllInIne_PU4 firmware if necessary

	Device A	Device B
Web UI > Device		
Release version	xx.yy.zz	
PU4CON	xx.yy.zz	

3.1.5 HW configuration

- Change output power and line impedance to same as HW settings.
- Enable iSWT for tele-protection command transmission (Operation mode 3a for 4 independent commands from IFC-D/P enabled by default)
- Enable ALR board for alarm relay outout.
- Enable CIB board for RS232 and analog voice data transmission.
- Change HF frequency band to same as HW settings.

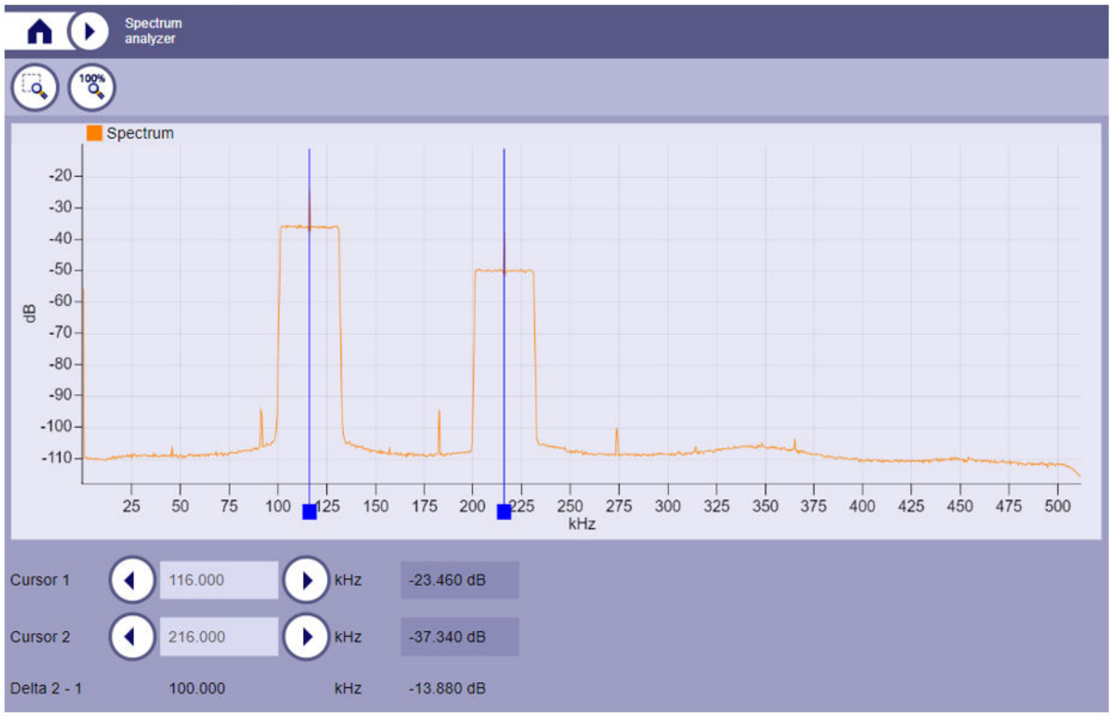
	Device A	Device B
Web UI > Hardware		
iSWT	via DMB	
CIB	Enabled	
ALR	Enabled	
HF	100-132 kHz	200-232 kHz

3.1.6 PLC modem

- Change initial transmit frequency band.
- Tx MARC signal (pilot) is set to middle of frequency band by default.
- Tx max frequency is set to same as initial frequency.
- Change receive frequency band and MARC signal channel to same as remote Tx frequency.
- PLC communication link shall be established after applying settings and restarting of device.

	Device A	Device B
Web UI > PLC modem > Inband MARC signal		
Initial Tx start / stop frequency	100-132 kHz	200-232 kHz
Initial Rx start / stop frequency	200-232 kHz	100-132 kHz
Web UI > Head bar > Apply settings		
Web UI > Main menu > Restart device		

- Verify Tx / Rx frequency band in integrated spectrum analyzer. Place two cursor at Tx and Rx MARC position to estimate the line attenuation. In this example, the line attenuation is about 13dB. It assumes Tx MARC signal level are same as remote device in symmetric configuration.



[sc_spectrumanalyzer_example_quickstart, 1, --_--]

3.1.7 Voice

- Enable FXS-1/2 ports for hotline phone call.
- Switch off unused voice ports to avoid unnecessary data rate consumption.

	Enabled	SIP account	Peer account	Peer address	Hotline
Device A > Web UI > Configuration > CIB > Voice					
E&M-1	☐	--	--	--	--
FXO-1	☐	--	--	--	--
FXS-1	☑	300	301	192.168.40.136	☑
FXS-2	☑	400	401	192.168.40.136	☑
FXS-3	☐	--	--	--	--
FXS-4	☐	--	--	--	--
Device A > Web UI > Configuration > CIB > Voice					
E&M-1	☐	--	--	--	--
FXO-1	☐	--	--	--	--
FXS-1	☑	301	300	192.168.40.135	☑
FXS-2	☑	401	400	192.168.40.135	☑
FXS-3	☐	--	--	--	--
FXS-4	☐	--	--	--	--

3.1.8 RS232

- Enable RS232-1 port for point to point between two devices.
- Enable RS232-2 port for SCADA TCP master polling.
- Switch off unused RS232 ports to avoid unnecessary data rate consumption

	En able	Data rate	Ser. mode	Ser. IP	Prot.	Master	Max conn	Port	Peer-address	Peer - addr. 2	Peer-port
Device A > Web UI > Configuration > CIB > RS232											
RS232-1	☑	9600	8N1	☑	TCP	☑	1	30201	192.168.40.136	0.0.0.0	30201
RS232-2	☑	9600	8N1	☑	TCP	☐	1	30202	192.168.40.149	0.0.0.0	0
RS232-3	☐	---	---	---	---	---	---	---	---	---	---
RS232-4	☐	---	---	---	---	---	---	---	---	---	---
Device B > Web UI > Configuration > CIB > RS232											
RS232-1	☑	9600	8N1	☑	TCP	☐	1	30201	192.168.40.135	0.0.0.0	30201
RS232-2	☑	9600	8N1	☑	TCP	☐	1	30202	192.168.40.149	0.0.0.0	0
RS232-3	☐	---	---	---	---	---	---	---	---	---	---
RS232-4	☐	---	---	---	---	---	---	---	---	---	---

3.1.9 Traffic control

- Traffic control enabled by default to ensure VoIP and Serial IP QoS under heavy Ethernet traffic load.
- Minimal 20 kbps for 2 parallel phone call at same time (each voice channel consumes about 10 kbps)
- Minimal 25 kbps reserved for serial IP.
- Sum of min data rate shall not exceed the 90% of max bit rate shown in Web UI > Diaglostics > PLC modem status > Transmit bit rate.

Protocol	Min. data rate (Kbps)	Max. data rate (Kbps)	Enabled
Web UI > Ethernet > QoS > Traffic control			
VoIP voice	20	0	☑
VoIP signaling	8	0	☑
Serial over IP	25	0	☑

3.1.10 Level adjustment

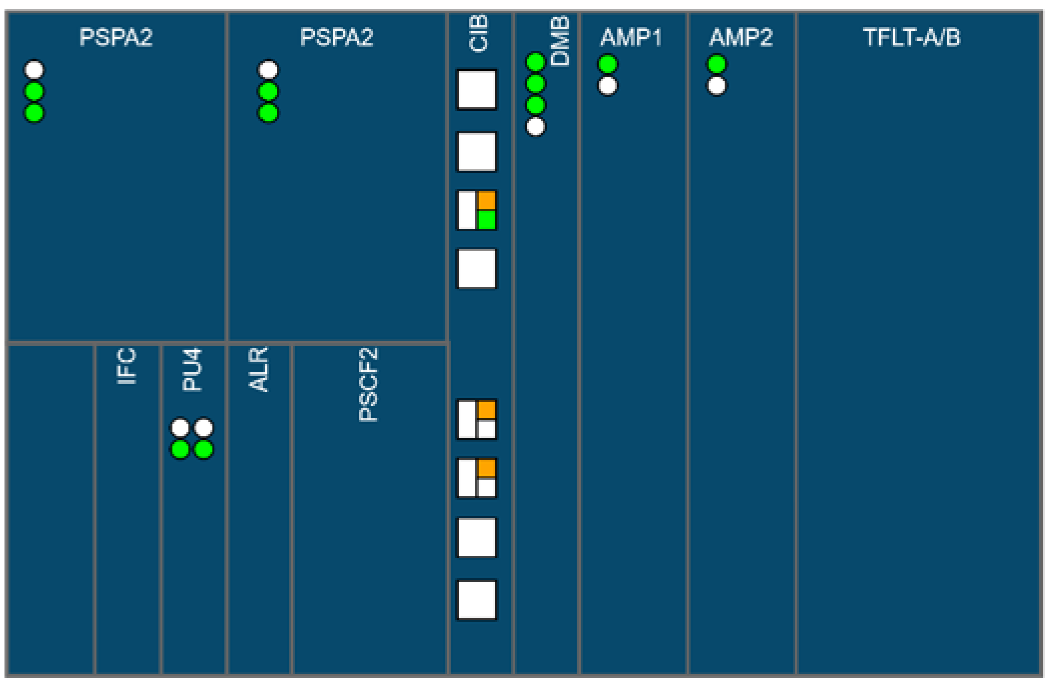
- Adjust iSWT Rx leveling, reload measured Rx level to until value reach in -9dB to -3dB range

	Device A	Device B
Web UI > Configuration > Leveling		
iSWT Rx level adjustment	0 ~ +48dB in step of 6dB	
iSWT Rx level measured	-9 ~ -3dB	

	Device A	Device B
Web UI > Head bar > Apply settings		
Web UI > Head bar > Reload		

3.1.11 LED indication

- After commissioning, no alarm displayed in Web UI alarm status bar.
- PSPA2 +/- 48V LED are green.
- AMP1/2 READY LED are green.
- DMB LED COMCON / PLCDSP / SYNC are green.
- CIB FXS-1/2 LED are amber
- CIB RS232-1/2 LED are amber.
- PU4 LIA / OK LED are green.



[sc_led_indication_quickstart, 1, --_--]

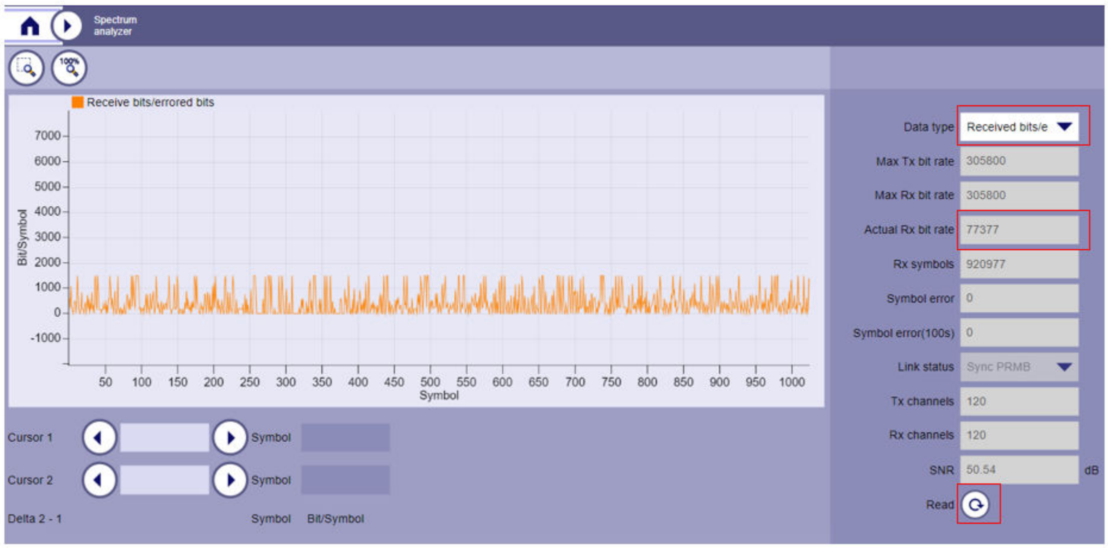
3.1.12 Test data transmission

- Enable IFC-Test mode to activate command input from switches S1.1 to S1.4 on the IFC module. Command will be outputted at remote device (IFC output LED H1...H4 is red).

	Device A	Device B
Web UI > iSWT 3000 > System		
Test mode	IFC-Test	

- Pickup phone 300 will direct call to remote phone 301 and phone 400 will call to 401.
- Send serial data with 9600 / 8N1@RS232-1 using serial terminal client tool (e.g., PuTTY). Serial data will be received at remote terminal.

- Send RTU polling request from SCADA tool (e.g., IEC-Test) via ETH user port. RTU response will be received.
- Open spectrum analyzer to measure actual used bit rate for all running services. The value shall be less than max Rx bit rate.



[sc_spectrumanalyzer_test_datatransmission, 1, --_--]

3.1.13 Clean up before normal operation

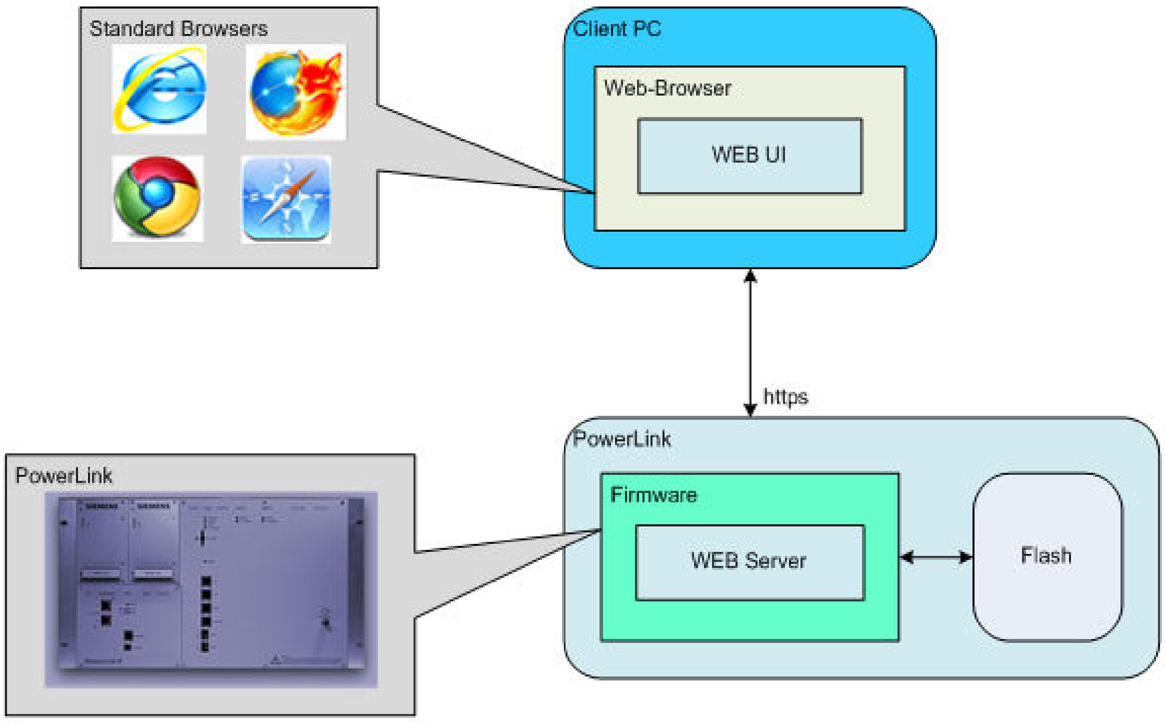
- Disable IFC-Test mode.
- Restart device.
- Clear event log, command counter.
- Create system log for customer care support in case of any problems.
- Log off device web home page.

	Device A	Device B
Web UI > Event log > Event log		
Web UI > Event log > iSWT 3000		
Web UI > Diagnostics > iSWT 3000 > Statistics counter		
Web UI > Main menu > Create system log		

3.2 Web UI

3.2.1 Overview

The web based configuration tool supports configuration, supervision and maintenance of the PowerLink IP system. The web server is running on the target device PowerLink IP. The Web UI running in a web browser installed on a service device connects to the web server via secure transmission protocol (HTTPS).



[dw_webUI_overview, 2, --_--]

Figure 3-1 Overview Web UI Description

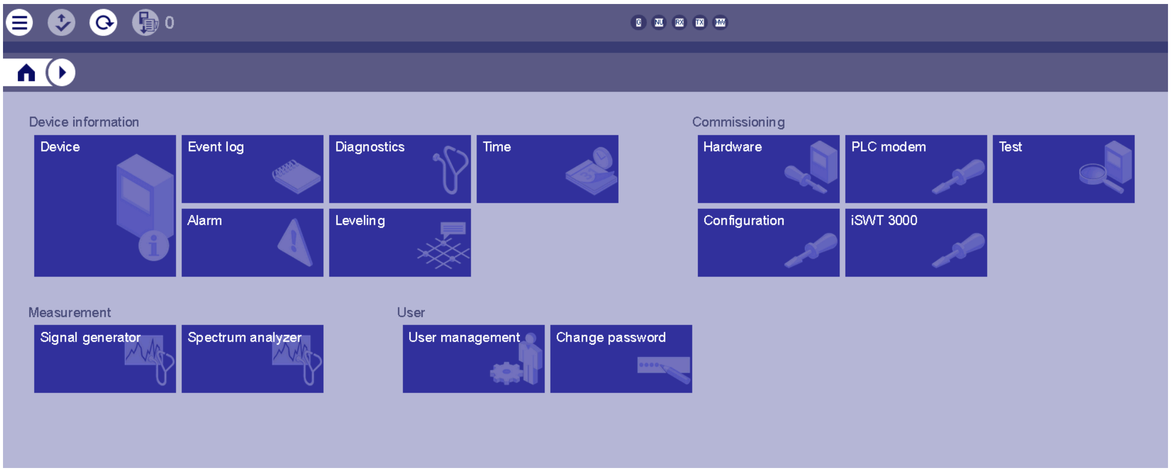
Depending on the login user and the defined user role(s), your dashboard varies.

NOTE

All images of Web UI description are dashboard views of a user with the role admin.

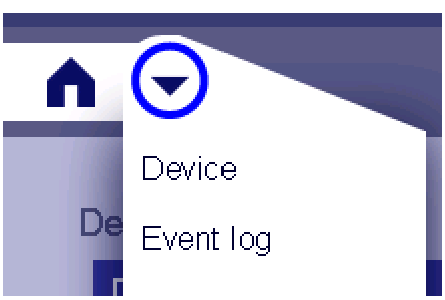
3.2.2 Structure of the device configuration in Web UI

The Web UI represented in the web browser is structured in three parts:



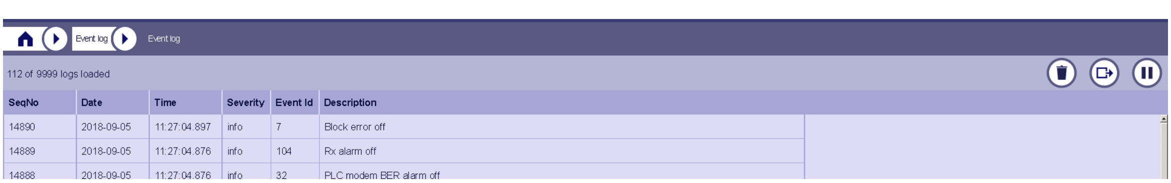
[sc_navigation_WEBUI, 2, --_--]

- Fixed head bar with four operation buttons
  - "Open Menu" for administrative functions, depending on the user this menu varies.
  - Apply changes for the transfer of changed parameters to the target system.
  - Reload data for this view to refresh the displayed view. (Already changed but not saved values are reset to the original values)
  - Show status log for the display of actions on the web server.
    Restart requirement notice appears below the head bar.
- The > button in the navigation bar opens the navigation menu for faster navigation and direct selection of the web pages as displayed in the image below. You can return to the dashboard by clicking on the "home" button in the navigation bar.



[sc_navigation_button_WEBUI, 2, --_--]

- Variable display of the dashboard depending on the role you log in with.
- Pages that receive log entries in real time have an extra bar below the navigation bar. This bar contains on the left side the number of entries loaded and the total number of entries as well as Delete, Export and Pause buttons on the right side.



[sc_structure_log_entries_WEBUI, 2, --_--]

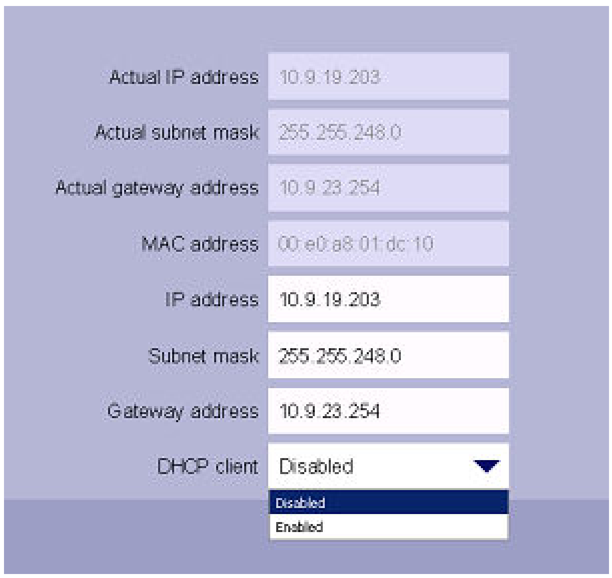
Logs (all entries) can be deleted by clicking the Delete button.
Log files can be exported by clicking on the Export button.

Clicking on the Pause button freezes the view, stopping the page from showing further new entries. When clicked the grey circle surrounding the button turns blue. To unfreeze the view click on the Pause button again, you will notice that the blue circle will turn back to grey.

3.2.3 Parameter Entry

The WEB user interface supports different ways of entries:

Selection of values or texts.



[sc_dropdown_WEBUI, 2, --_--]

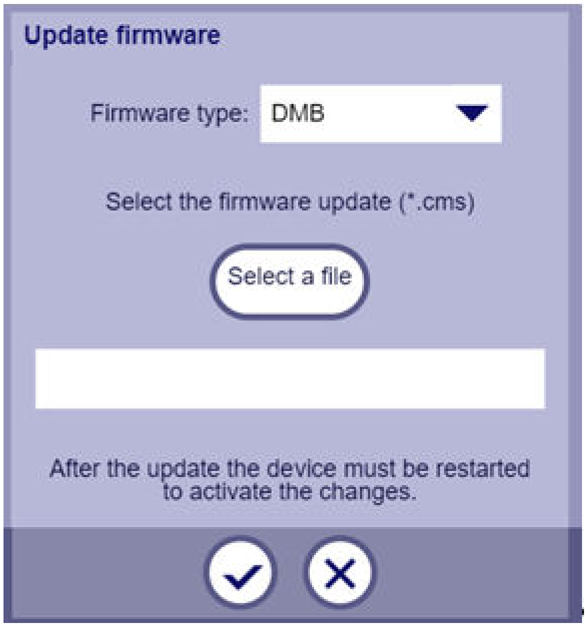
Entry of values or texts: The value/text can be written in a writable input field or may be selectable from a drop-down menu.

Errors are recorded in the diagnosis log.

NOTE

Changes of selected or entered values or text require a confirmation via the button Apply changes.

3.2.4 Update firmware or license



[sc_update_firmware, 3, --_--]

Setting	Comments
Firmware type: DMB	For DMB firmware updates an "All in one" image or an individual component image can be selected. The digital signature has been included in the image files. (*.cms or *.cmsx)
Firmware type: PU4	For PU4 firmware updates an "All in one" image or an individual component image can be selected: • Pu4BootFw_vxx_yy_zz.hex • Pu4MonFw_vxx_yy_zz.jnk • Pu4ConFw_vxx_yy_zz.jnk • Pu4DspCtFw_vxx_yy_zz.jnk • Pu4DspNuCtFw_vxx_yy_zz.jnk • Pu4Fpga_vxx_yy_zz.jnk • Pu4DleFpga_vxx_yy_zz.jnk
License	Upload license file

Firmware backup / restore

Do not power off the device or disconnect Ethernet cable while the firmware update is in progress. If the online DMB firmware update fails, the firmware will be rolled back to the previous version.

After successful firmware update, device must be restarted to activate the new firmare and backup the firmware to flash. If firmare image is damaged at next startup, the backup firmware will be restored.

Firmware signature

Starting with V4.19, the DMB FW images have a .cmsx extension are digitally signed to protect the integrity of the FW and extended flash memory space.

To upgrade firmware from V4.19 to higher version, the firmware file *.cmsx must be used. The higher release will not support uploading FW file format with .cms. To downgrade firmware from higher version to V4.19, the special sdcard image must be used with help from customer care.

NOTE

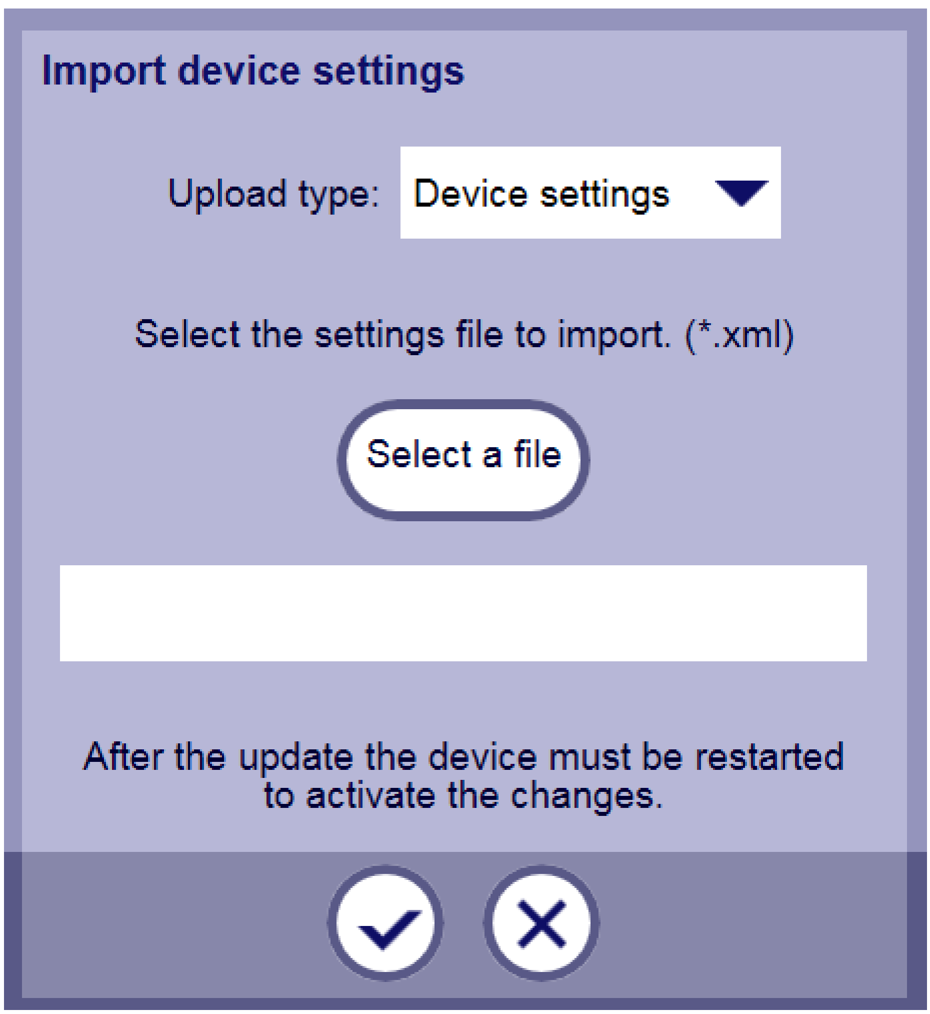
Manual change file extension name *.cms / *.cmsx could cause firmware programmed into wrong area and boot device failed.

NOTE

For a high data transmission rate during firmware update we recommend to connect the local PC to the service interface of the device.

3.2.5 Import settings

The exported file can be loaded into another device. After loading to the device, it is possible to make changes to some parameters (e.g. IP address) before applying the settings. If the stored file version is not the same as the actual device release version, some parameters might not be imported or may be converted to latest version.



[sc_import_device_settings, 1, --_--]

3.2.6 Export settings

The device settings can be exported into a file (.xml) on PC via Web UI > Menu > Export / Import. The following data will be included:

- Device settings
- Device information (e.g. alarm, counter, diagnostics info, leveling)

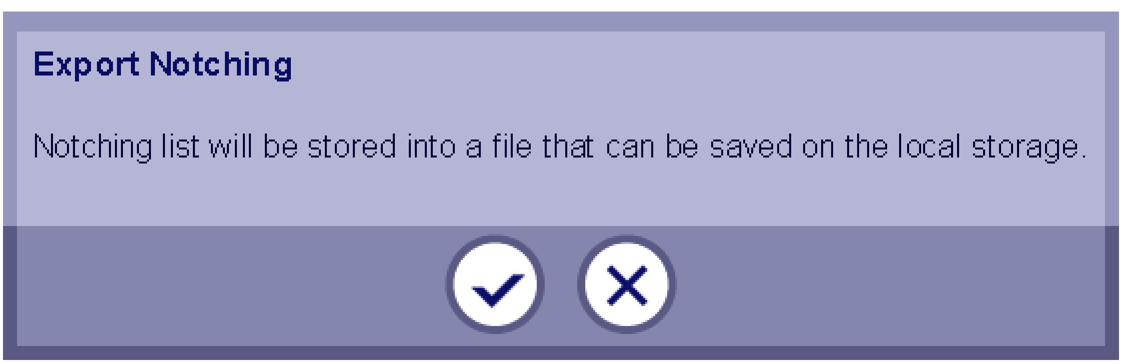
[sc_export_settings_info, 1, --_--]

Setting	Comments
File name format	setting_<BF number or IP address>_<date>.xml e.g. settings_192.168.20.60_20170601.xml

NOTE

If IEC 61850 is enabled in iSWT, EN100 CFG/BIN files have to be imported separately in Web UI.

3.2.7 Export notching

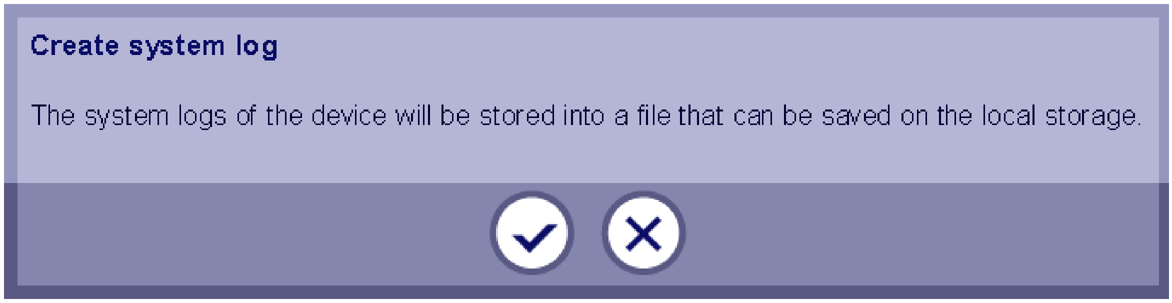


[sc_export_notching, 1, --_--]

The notching list can be exported and stored into local storage.
It is part of the device settings and it can be imported via menu item “Import settings”.

Setting	Comments
File name format	notching_<BF number or IP address>_<date>.zip e.g. notching_BF1701035161_20180104.zip

3.2.8 Create system log



[sc_create_system_log, 1, --_--]

A system log can be exported into a file (.zip) on PC via Web UI > Menu > Create system log. The following data will be included:

- device settings
- quality data
- DMB event log
- PU4 event log
- secure log
- diagnostic logs (kernel / SIP log)

Setting	Comments
File name format	syslog_<BF number or IP address>_<date>.zip e.g. syslog_BF1701035161_20180104.zip

The functionality is available in Web UI for user with the role admin, engineer or viewer.

3.2.9 Restart

If a changed parameter requires a restart for the activation, an indication appears below the head bar of the user interface. However, arbitrary additional parameters can be changed, until they are all together activated with a restart.
The indication is maintained with change of the menus. It disappears only after a restart of the device. To restart the device use the "Open menu"-button and select the option "Restart device".

[sc_webui_restart_requirement, 2, --_--]

3.3 User

3.3.1 User

User login

Start the web browser of your PC or tablet and enter the IP address of your target system into the address field and accept with the enter key. If the connection to the target system is established, the logon page is opened.

The access to the system (web server) is protected by means of an individual password. This must be changed after the initial login, in order to protect the engineering data against unauthorized access.

If the user name or the password is invalid or the user is disabled, the login fails and an appropriate message is displayed.

If RADIUS authentication is enabled, user management is performed in central RADIUS server.

Default users

The following predefined users are available at first login.

User	Password
ADMIN	admin
ENGINEER	engineer
SECAUD	secaud
VIEWER	viewer

User logoff

To quit the system properly, select the LOGOFF button. If at least 1 parameter has been changed and has not yet been transferred into the target system with the button Apply, a warning appears. After logoff, the login page is displayed.

Session management

After a login with correct user name and password, a session is created. If there is no user action within a configurable timeperiod (default 15 minutes) or the session exists for 12 hours, the session is deleted automatically and a re-login is required. After a device restart all existing sessions are expired and a re-logon is necessary.

Role based access control

Web UI offers a role based access control (RBAC).Four different roles for users are selectable.

- ADMIN
- SECAUD
- ENGINEER
- VIEWER

The user can have accumulative roles, e.g. the user can both change configurations and access secure trails if having both ENGINEER and SECAUD roles.

Access rights	Comments	ADMIN	SECAUD	ENGINEER	VIEWER
VIEW_DATA	View data, counters, event logs	Yes	No	Yes	Yes
VIEW_CONFIG	View configurations	Yes	No	Yes	Yes
CHANGE_CONFIG	Change config, debug commands	Yes	No	Yes	No

Access rights	Comments	ADMIN	SECAUD	ENGINEER	VIEWER
CHANGE_FIRM-WARE	Update firmware	Yes	No	No	No
CHANGE__SELF_PASSWORD	Change own password	Yes	Yes	Yes	Yes
DELETE_LOG	Delete event logs	Yes	No	No	No
MANAGE_RBAC	Manage users and roles	Yes	No	Yes	No
AUDIT_TRAIL	View and delete secure trails	Yes	Yes	No	No

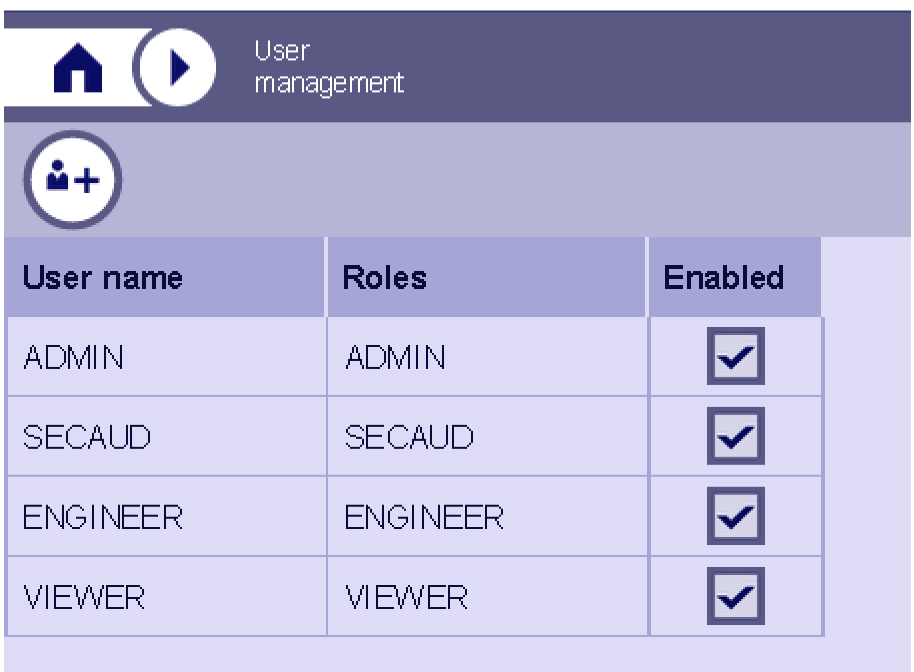
Role based user management

Users with the role ADMIN or ENGINEER have the permission to perform the following operations:

- Add/remove users
- Change user properties (e.g. change name, role)
- Reset user password

The number of local users is limited to 20.

User Management



[sc_user_management, 2, --_--]

In this menu item you find a list of all existing users and their roles. In a checkbox beside the user it is shown, if this user is enabled/allowed to login.

Add User

Setting	Comments
User name	Name of new user
New password	Password of user

Setting	Comments
Confirm password	Password confirmation
Roles	Select one or more roles.

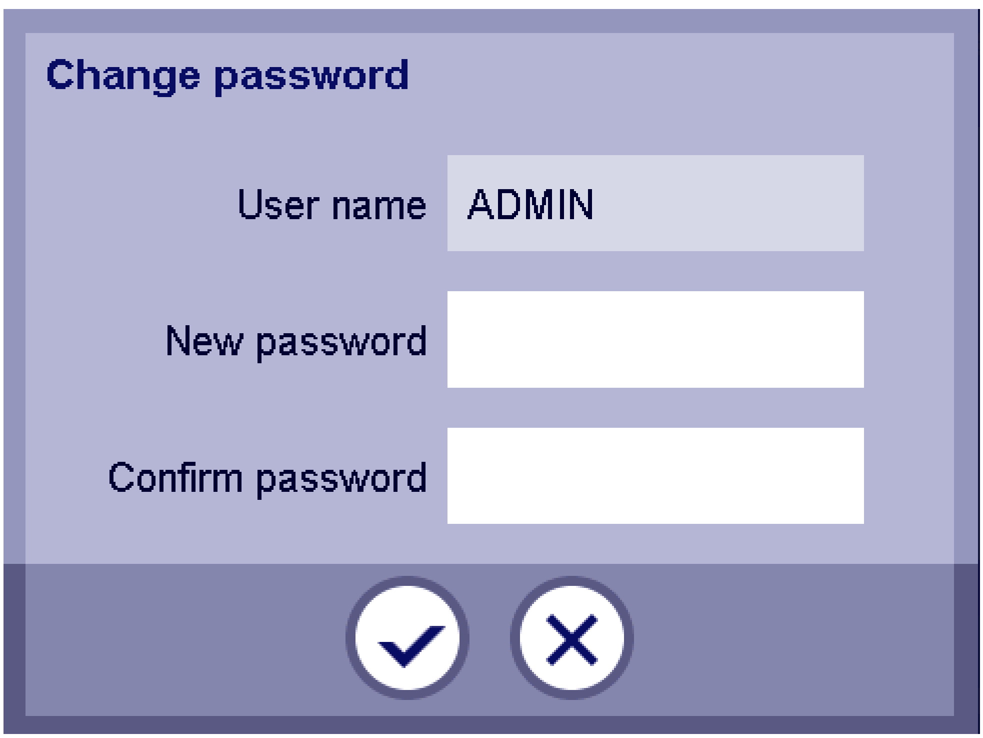
Delete user

Predefined users can be disabled, but not deleted. All other users can be deleted.

Change password

You can change passwords of users according to the configured password policy.
“Change password” is invisible for users on the RADIUS server, when RADIUS service is enabled.

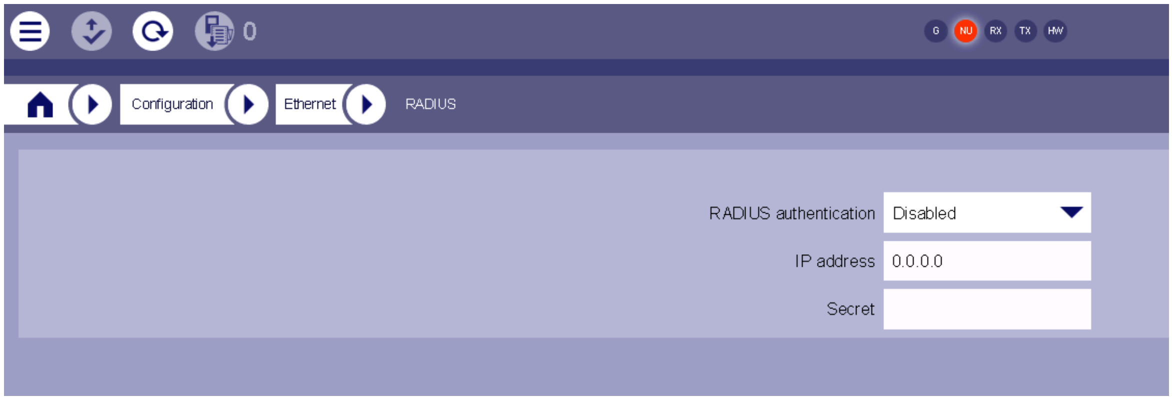
3.3.2 Change own Password



[sc_change_password, 1, --_--]

Setting	Comments
User name	Actual login username is shown.
New password	Define new password according to defined password policy.
Confirm password	Password confirmation

3.3.3 RADIUS



[sc_configuration_ethernet_radius, 1, --_--]

RADIUS (Remote Authentication of Dial In User Service) provides a service for user authentication.

When RADIUS is enabled, the user management and authentication are performed on the RADIUS server. Otherwise, it is performed on the local device.

If the RADIUS server is out of service, the local user still can be used as emergency account to login to the device successfully.

Setting	Comments
RADIUS authentication	Disabled: Only the users of the device can log on Enabled: User authentication by the remote server Default: Disabled
IP address	Default: 0.0.0.0 IP address of RADIUS server
Secret	String Default: empty Security for RADIUS connection. Secret has to have the same value as configured on RADIUS server. The secret key has to be definded by the customer during commissioning.

IEC 62351-8 standard roles defined in RADIUS are mapped to 4 roles in the device.

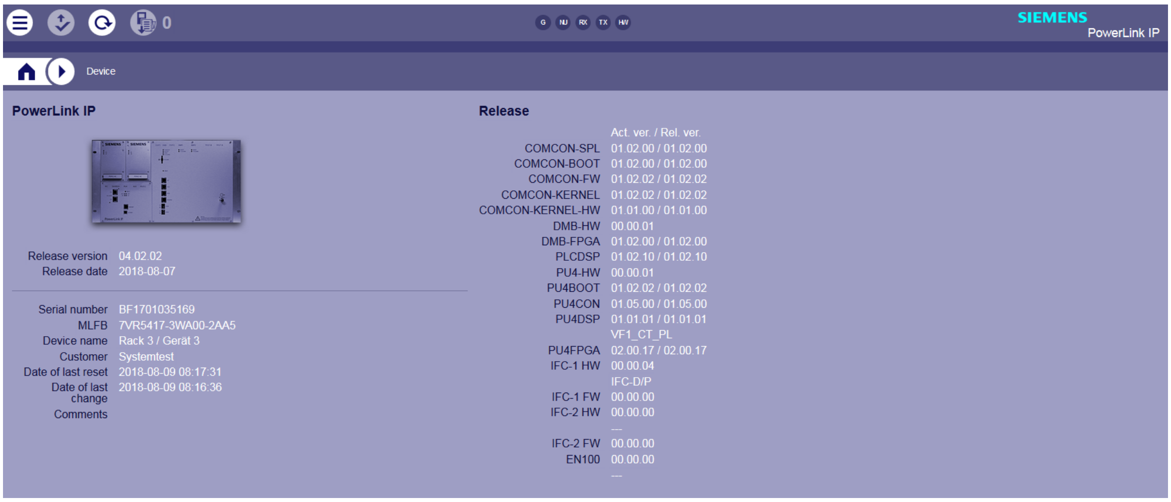
Roles on RADIUS server	Roles on Device
GUEST VIEWER	VIEWER
OPERATOR ENGINEER INSTALLER	ENGINEER
SECAUD SECADM	SECAUD
ADMIN RBACMNT	ADMIN

Multi-role is available. The user on the RADIUS server can be configured with several roles, and the device recognizes the role info and displays the accordant Web UI view.

3.4 Device Information

3.4.1 Device

PowerLink IP



[sc_device_information, 2, --_--]

Setting	Comments
Device photo	PowerLink IP device photo with or without iSWT, based on HW configuration
Release version / date	Release version and release date of connected PowerLink IP
Device name	Parameter is configured in Web UI > Configuration > System. Factory setting of device name is the DMB board number.
Customer	Parameter is configured in Web UI > Configuration > System. Factory setting of customer is the customer name.
Date of last reset	Date/time of last device reset.
Date of last change	Date/time of last applied configuration changes.
Comments	Parameter is configured in Web UI > Configuration > System. Factory setting of comments is the order number.
Release/Component version	Actual version and initial released version of components. If a component is updated, the actual version is higher than the initial version.This is marked with "(updated)", e.g. PLCDSP 01.00.26 / 01.00.30 (updated).

3.4.2 Event Log

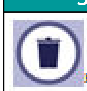
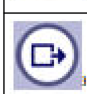
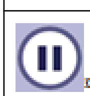
3.4.2.1 Event Log

[sc_event_log, 1, --_--]

Events of the PowerLink IP (without iSWT events, they are recorded in the iSWT log) are provided with date and time and a sequence number when they are entered in the event log. The following events are entered:

- Detected alarms
- Changing date and/or time
- Changing the configuration
- Session/User management
- Internal system messages

Up to 9999 entries with a time resolution of 1 ms are possible. In case of an overflow the oldest entry in the event log is overwritten. The event log can be exported to a file or deleted by a user with an appropriate role.

Setting	Comments
	Delete event log.
	Export log file to PC (.csv). Filename format: log_sys_<BF number | IP address>_<date>.csv
	Pause automatic event log reload.

Setting	Comments
SeqNo	Sequential number
Date	Date of event
Time	Time of event

Setting	Comments	
Severity / Event id	Info Warning Error Critical error	event ID 0 - 999 1000 - 1999 2000 - 2999 3000 - 3999
Description	Description of event	

3.4.2.2 iSWT log

General Information

Protection commands and alarms of the iSWT are provided with time and date and a sequence number before they are entered in the event log. The following events are entered:

- Incoming protection commands from IFC-D/P
- Outgoing protection commands to the IFC-D/P
- Detected alarms
- Program restart
- Changing date and/or time
- Changing the configuration

Up to 8184 non volatile event entries with a time resolution of 1 ms are possible. If there is an overflow, the oldest entry in the iSWT event log is overwritten. The iSWT event log can be exported to a file or deleted by a user with appropriate role.

SeqNo	Date	Time	Group	Event Id	Description
1	2017-10-24	14:21:50.000	1	1	program started
2	2017-10-24	14:14:02.001	3	20	clock synchronisation (local or remote) successfull
3	2017-10-16	15:06:24.341	3	25	device configuration programmed in FLASH
4	2017-10-24	14:21:52.551	3	90	active line from now on is LIA
2923	2017-10-24	14:29:17.693	4	71	general alarm off
2922	2017-10-24	14:29:17.692	4	75	receiver alarm off
2921	2017-10-24	14:29:17.692	4	73	non urgent alarm off
2920	2017-10-24	14:29:17.503	3	44	RXAL [PU4] going (on->off)
2919	2017-10-24	14:28:52.492	3	3	RXAL [PU4] coming (off->on)
2918	2017-10-24	14:28:52.492	4	70	general alarm on
2917	2017-10-24	14:28:52.492	4	74	receiver alarm on
2916	2017-10-24	14:28:52.492	4	72	non urgent alarm on
2915	2017-10-24	14:22:19.554	4	71	general alarm off

[sc_iswt3000_log, 1, --_--]

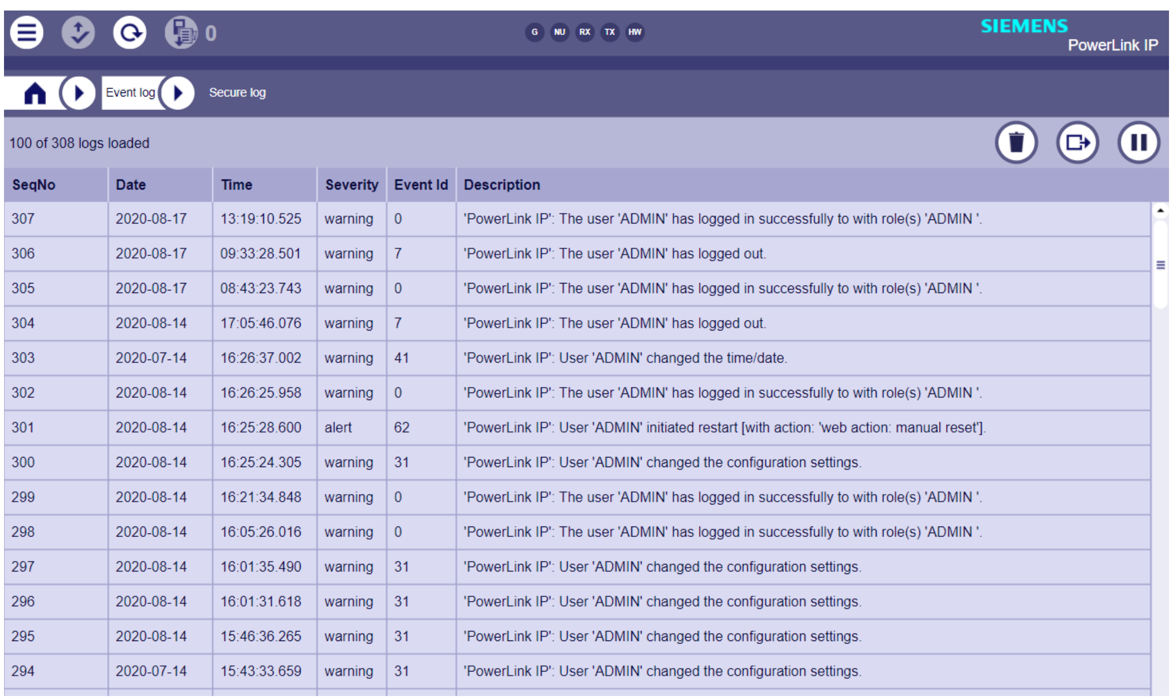
Setting	Comments
SeqNo	Sequential number
Date	Date of event
Time	Time of event

Setting	Comments	
Group	1	System control
	2	Tele protection commands
	3	Alarms
	4	Alarms
	128 - 255	Internal system messages
Event Id		
Description	Description of event	

Table 3-1 The first four lines in the iSWT event log are fixed lines:

SeqNo.	Group	Event Id	Description
1	1	1	Last start-up of the PU4 firmware
2	3	20	Last successful clock synchronization (if activated)
3	3	25	Device configuration programmed in FLASH
4		90	Active line from now on is LIA

3.4.2.3 Secure Log



[sc_secure_log, 2, --_--]

The Secure Log records the security relating actions of users.

Action
Log on (local)
Log on(RADIUS)
Log off
User blocked
Log on failed
Log off (timeout)
Add user

Action
User change role
Remove user
Change password
Enable user
Disable user
MAC addr whitelist changed
MAC addr whitelist enabled
MAC addr whitelist disabled
Firmware update
Web date/time changed
Device restarted
Firewall enabled
Firewall disabled
Firewall parameter changed
”Block user failure” enabled
”Block user failure” disabled
Web access parameter changed
Password policy enabled
Password policy disabled
Password policy parameter changed
SNMP enabled
SNMP disabled
SNMP ”Read-only community” changed
SNMP ”Read-write community” changed
SNMPV3 user added
SNMPV3 default user restore
SNMPV3 user enabled
SNMPV3 user disabled
SNMPV3 user deleted
SNMPV3 ”auth password” changed
SNMPV3 ”priv password” changed
Clear measurement data
Clear device settings
HW alarm
Configuration changed
Configuration change failed
Configuration change canceled
Update license

3.4.3 Diagnostics

3.4.3.1 PLC modem status

[sc_plc_modem_status, 3, --_--]

Setting	Comments
Link status	PLC modem link status 0 - **Startup**: No MARC signal transmission 1 - **NO Sync**: MARC signal is transmitted 2 - **Sync PRMB**: MARC signal and a synchronization preamble have been transmitted 3 - **TxDATA**: MARC signal and data are transmitted
Transmitted frames since the last sync	Number of transmitted frames since last syncronization
Transmit bit rate [bps]	Current transmit bit rate
Receive bit rate [bps]	Current receive bit rate
SNR [dB]	Current signal to noise ratio
Frame error probability [%]	Current frame error probability
Transmitted frames per second	Current transmitted frames per second
Error frames per second	Current error frames per second
Receive level of MARC B [dB]	Current receive level of MARC B

3.4.3.2 Error statistics counter

Statistic over the number of error occurence of every error since the last reset of the PowerLink IP device. The overview is divided in two parts:

- errors/warnings

Diagnostics > Error statistics counter

Error/Warning

Name	Value	Name	Value	Name	Value	Name	Value
GENALR	3	TXALR	0	RXALR	11	NUALR	1
SYNC	7	MARC	4	BER	10	PF	0
IP_DEF	0	CLOCK_SYNC	1	F6SV	1	NOTRDY	1
ISWT_GEN	3	ISWT_RX	2	ISWT_NU	1	SFP1_TXF	0
SFP2_TXF	0	PA1_DR	0	PA1_OFF	0	PA2_DR	0
PA2_OFF	0	TEMP_DMB	0	TEMP_AMP1	0	TEMP_AMP2	0
FOM1_MOD	0	FOM1_MISS	0	FOM1_LOS	0	FOM1_TXF	0
FOM1_COM	0	FOM1_BUF	0	FOM1_GEN	0	DEF_LIC	0
PARA	0	REMALR	0	BLKERR	10	AUTH_FAIL	0
SFP1_LOS	0	SFP1_MISS	1	SFP2_LOS	0	SFP2_MISS	1
PLC_DOWN	0	HW_TEST	0	FWDL	0	TEST	0
RST_REQ	0	TEMP_SET	0	APPLY	0	COMM_TO	0

[sc_error_statistics_counter_error_warning, 3, --_--]

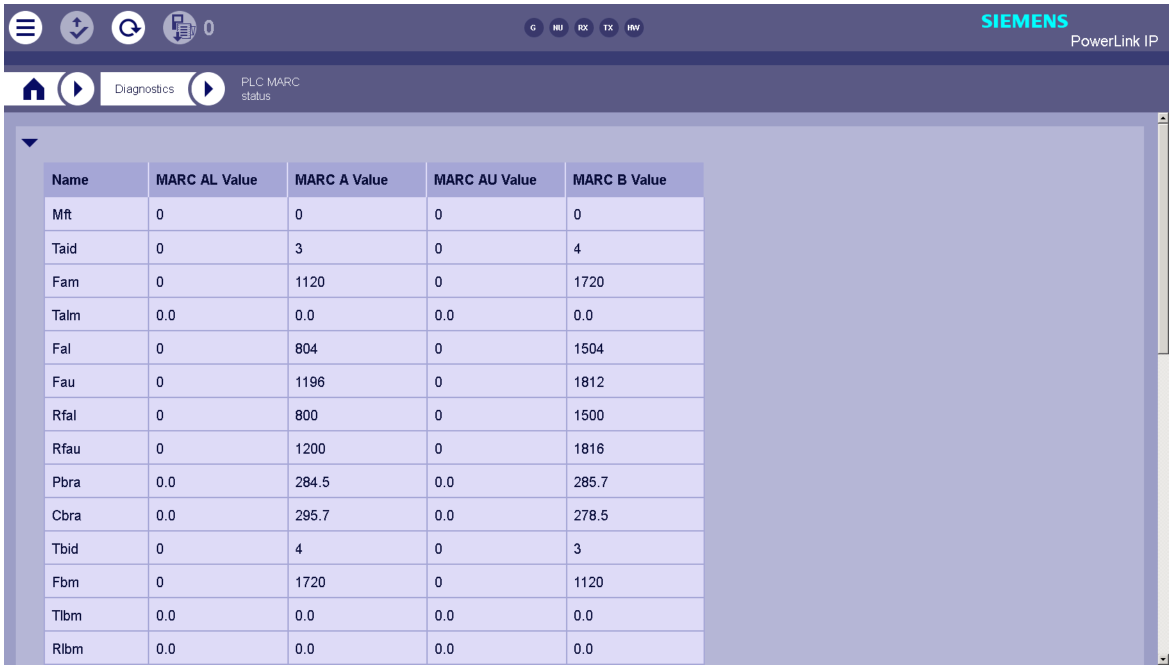
- critical errors

Critical error

Name	Value	Name	Value	Name	Value	Name	Value
BGAL	0	BGAL_SYS	0	TEMP_DEV	0	ISWT_ERR	0
ISWT_MISS	0	ISWT_ARES	0	ISWT_ADDR	0	ISWT_CFG	0
ISWT_TO	0	ALR_MISS	0	FW_UPDATE	0	PLC_ERR	0
HW	0	LICENSE	0	FOM1_FPGA	0	TEST_FAIL	0

[sc_error_statistics_counter_critical_error, 2, --_--]

3.4.3.3 PLC MARC status

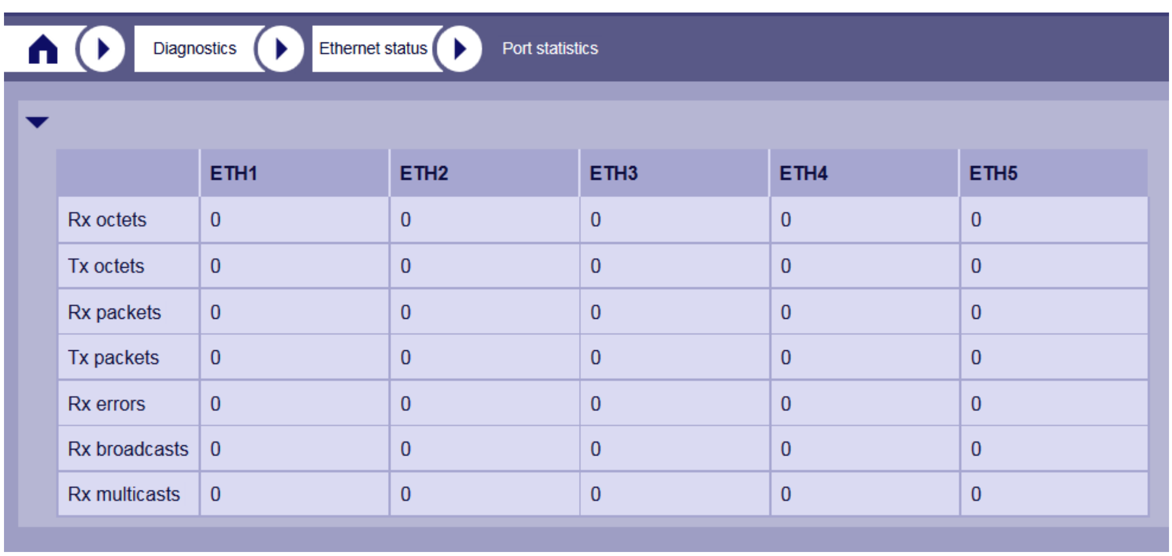


Name	MARC AL Value	MARC A Value	MARC AU Value	MARC B Value
Mft	0	0	0	0
Taid	0	3	0	4
Fam	0	1120	0	1720
Talm	0.0	0.0	0.0	0.0
Fal	0	804	0	1504
Fau	0	1196	0	1812
Rfal	0	800	0	1500
Rfau	0	1200	0	1816
Pbra	0.0	284.5	0.0	285.7
Cbra	0.0	295.7	0.0	278.5
Tbid	0	4	0	3
Fbm	0	1720	0	1120
Tlbm	0.0	0.0	0.0	0.0
Rlbm	0.0	0.0	0.0	0.0

[sc_plc_marc_status, 1, --_--]

3.4.3.4 Ethernet status

Port statistics



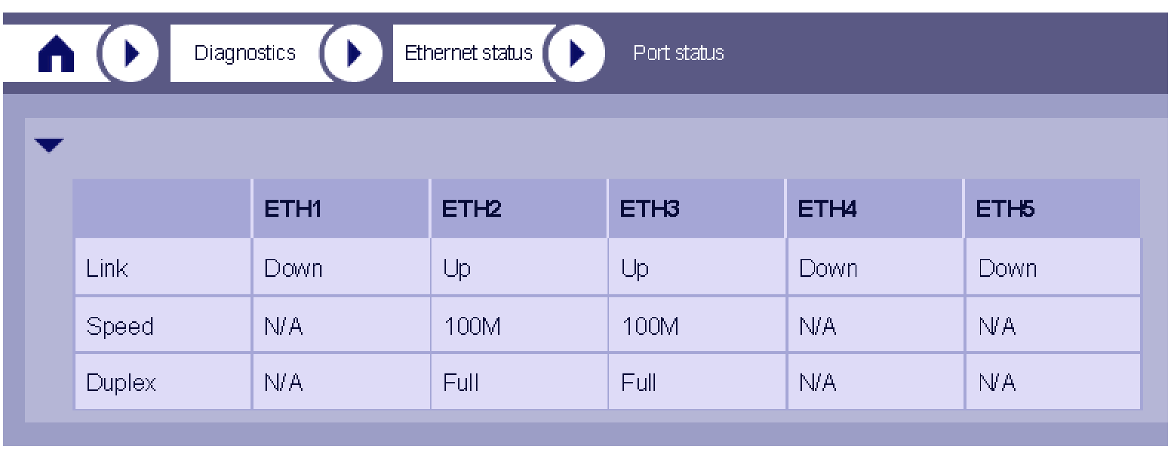
	ETH1	ETH2	ETH3	ETH4	ETH5
Rx octets	0	0	0	0	0
Tx octets	0	0	0	0	0
Rx packets	0	0	0	0	0
Tx packets	0	0	0	0	0
Rx errors	0	0	0	0	0
Rx broadcasts	0	0	0	0	0
Rx multicasts	0	0	0	0	0

[sc_ethernet_port_statistics, 2, --_--]

Setting	Comments
Rx octets	Number of data bytes received by a port, including bad packets
Tx octets	Total number of good bytes of data transmitted by a port

Setting	Comments
Rx packets	Total number of good packets received by a port, including: • Number of good packets direct to unicast address • Number of good packets direct to multicast address • Number of good packets direct to broadcast address
Tx packets	Total number of good packets transmitted by a port, including: • Number of good packets direct to unicast address • Number of good packets direct to multicast address • Number of good packets direct to broadcast address
Rx errors	Total number of error packets received by a port, including: • Number of alignment errors • Number of FCS errors • Number of fragment errors • Number of packet oversize errors
Rx broadcasts	Number of good packets received by a port that are directed to the broadcast address
Rx multicasts	Number of good packets received by a port that are directed to the multicast address.

Port status



	ETH1	ETH2	ETH3	ETH4	ETH5
Link	Down	Up	Up	Down	Down
Speed	N/A	100M	100M	N/A	N/A
Duplex	N/A	Full	Full	N/A	N/A

[sc_ethernet_port_status, 2, --_--]

The auto-negotiation mechanism is enabled by default, it chooses automatically the mode of operation:

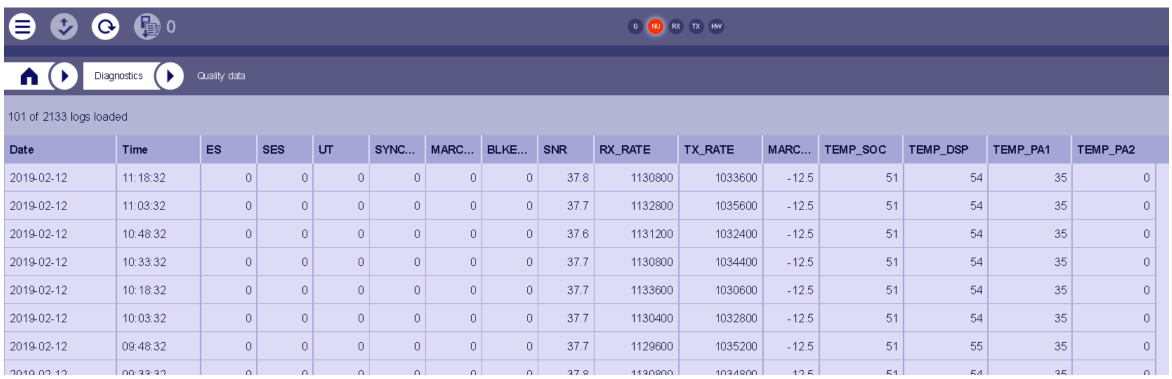
- 100BASE-TX full-duplex or half-duplex
- 10BASE-T full-duplex or half-duplex

ETH4 / 5 are fiber optical interfaces,they are configured to 100BASE-TX full-duplex without auto-negotiation.

Setting	Comments
Link	Link status of Ethernet port Up/Down
Speed	Link speed of Ethernet port. N/A, 10 M, 100 M
Duplex	Duplex mode of Ethernet port. N/A, Full, Half

3.4.3.5 Quality data

Quality data (date, time and the measured values) are updated every 15 minutes (default value, configurable). Quality data measurement is disabled by default, it can be enabled in Web UI > Configuration > System



Date	Time	ES	SES	UT	SYNC...	MARC...	BLKE...	SNR	RX_RATE	TX_RATE	MARC...	TEMP_SOC	TEMP_DSP	TEMP_PA1	TEMP_PA2
2019-02-12	11:18:32	0	0	0	0	0	0	37.8	1130800	1033600	-12.5	51	54	35	0
2019-02-12	11:03:32	0	0	0	0	0	0	37.7	1132800	1035600	-12.5	51	54	35	0
2019-02-12	10:48:32	0	0	0	0	0	0	37.6	1131200	1032400	-12.5	51	54	35	0
2019-02-12	10:33:32	0	0	0	0	0	0	37.7	1130800	1034400	-12.5	51	54	35	0
2019-02-12	10:18:32	0	0	0	0	0	0	37.7	1133600	1030600	-12.5	51	54	35	0
2019-02-12	10:03:32	0	0	0	0	0	0	37.7	1130400	1032800	-12.5	51	54	35	0
2019-02-12	09:48:32	0	0	0	0	0	0	37.7	1129600	1035200	-12.5	51	55	35	0

[sc_quality_data, 3, --_--]

Measured items

Item	Comments
ES	Error seconds, when PLC modem block error or PLC modem is not sync, range 0..900 in seconds
SES	Severely Error Seconds, when PLC modem BER > 10E-3, or DP is not sync, range 0..900 in seconds
UT	Unavailable time, when PLC modem is not synchronized or system pilot alarm, range 0..900 in seconds
SYNCLOSS	Sync loss seconds, range 0..900 in seconds
MARC	MARC signal alarm, range 0..900 in seconds
BLKERR	Number of PLC modem block error, range 0..65535
SNR	Minimum SNR, range 0..255
RX_RATE	RX Rate, in bps
TX_RATE	TX Rate, in bps
MARC_LEVEL	RX MARC level in dB
TEMP_SOC	Maximum temperature of DMB-SoC, range 0..99
TEMP_DSP	Maximum temperature of DMB-DSP, range 0..99
TEMP_PA1	Maximum temperature of AMP-1, range 0..99
TEMP_PA2	Maximum temperature of AMP-2, range 0..99

3.4.3.6 iSWT

Statistics counter

The following statistic counters are available:

- Command counter

Command counter

Input	Value	Output	Value
IN1	255	OUT1	255
IN2	255	OUT2	255
IN3	255	OUT3	255
IN4	255	OUT4	254
IN5	160	OUT5	159
IN6	146	OUT6	165
IN7	147	OUT7	156
IN8	135	OUT8	149

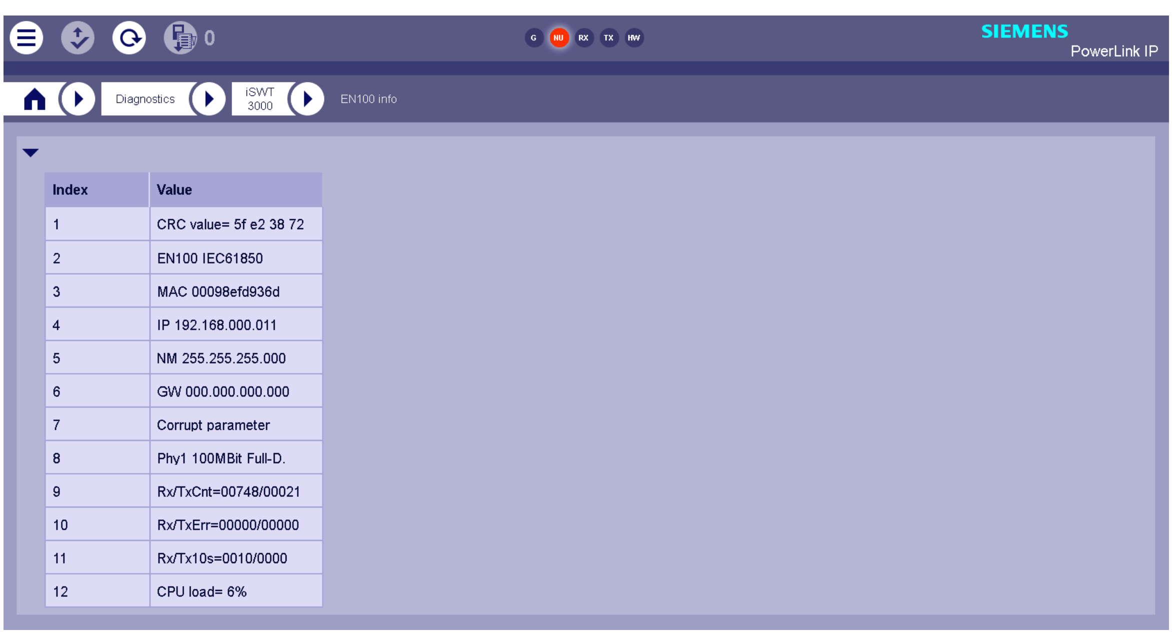
[sc_iswt3000_statistics_command_counter, 2, --_--]

The following statistics counter are for expert use only

- BCU (Board Control Unit): Internal status information of PU4
- LIA (Line Interface Analog): Internal status information of analog transmission path
- IFC (Interface Command): Internal status information of IFC
- Service Info: Internal status information

To clear the counters, press "Clear counter" button.

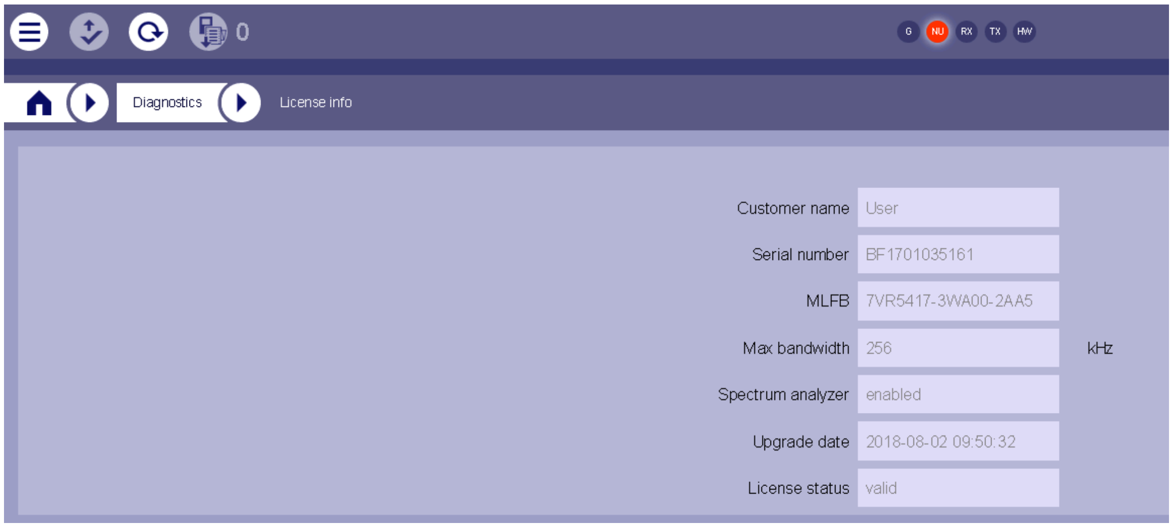
EN100 info



Index	Value
1	CRC value= 5f e2 38 72
2	EN100 IEC61850
3	MAC 00098efd936d
4	IP 192.168.000.011
5	NM 255.255.255.000
6	GW 000.000.000.000
7	Corrupt parameter
8	Phy1 100MBit Full-D.
9	Rx/TxCnt=00748/00021
10	Rx/TxErr=00000/00000
11	Rx/Tx10s=0010/0000
12	CPU load= 6%

Service info

3.4.3.7 License info



[sc_diagnostics_license_info, 2, --_--]

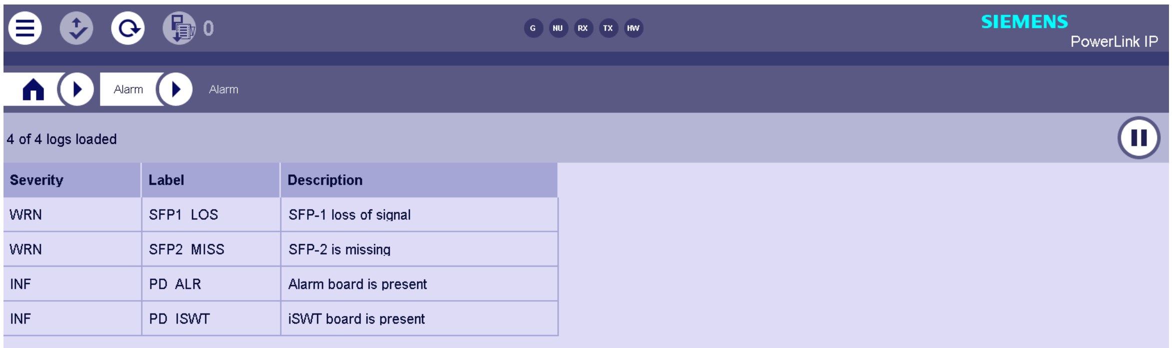
Information about verified and installed license of PowerLink IP, the displayed license information is the same as in the uploaded license file.

Setting	Comment
Customer name	Customer name, set in manufacturing
Serial number	Serial number of DMB board (BF number)
MLFB	Order number, defines the scope of features of PowerLink IP
Max bandwidth	Max. transmission bandwidth according selected license variety
Spectrum analyzer	The spectrum analyzer mode is enabled, if the appropriate license file is installed.
Upgrade date	Date of last license upgrade
License status	License validity

3.4.4 Alarm

3.4.4.1 Alarm

Alarm log



[sc_alarm_log, 1, --_--]

Severity

Setting	Comments
ERR	Active error event
ALA	Active alarm event
WRN	Active warning event
INF	Active information event

Alarms

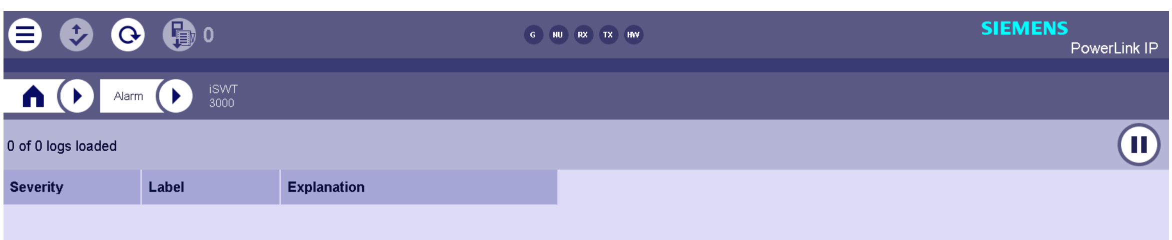
Alarm	Description
Severity Error	
BGAL	Board alarm
BGAL_SYS	System error
TEMP_DEV	Device temperature is too high Critical Error : > damage level (BGAL)
ISWT_ERR	iSWT board alarm (if any ISWT_xxx error occurred)
ISWT_MISS	iSWT board missing
ISWT_ARES	iSWT request for auto-reset (=iSWT board alarm)
ISWT_ADDR	iSWT board address error
ISWT_CFG	iSWT configuration mismatch
ISWT_TO	iSWT communication timeout
ALR_MISS	ALR board missing
FW_UPDATE	Firmware update failed
TEST_FAIL	Hardware test failed
PLC_ERR	PLC-Modem error
HW	HW alarm
LICENSE	License check failed
FOM1_FPGA	FOM-1 FPGA fail
Severity Alarm	
SYNC	PLC-Modem sync alarm
MARC	MARC signal is too low
BER	PLC-Modem BER ≥ 10E-3

Alarm	Description
PF	Power supply failure
IP_DEF	Start device with default IP address
CLOCK_SYNC	Clock synchronization alarm (severity: error or warning)
F6SV	F6 supervision alarm. The F6SV alarm is a supervision of the iSWT transmit level when it is working in the alternate multi-purpose (AMP) operation mode. The alarm is activated if the level of the guard signal from an iSWT is lower than allowed.
NOTRDY	Device not ready (device or task startup in progress)
ISWT_GEN	iSWT general alarm
ISWT_RX	iSWT Rx alarm (=F6 unblocking. This allocated alarm output will be used by F6 unblocking exclusively.)
ISWT_NU	iSWT 3000 non-urgent alarm
SFP1_TXF	SFP-1 transmit fault
SFP2_TXF	SFP-2 transmit fault
PA1_DR	AMP-1 dynamic range alarm AMP1_LED_ALR=RED
PA1_OFF	AMP-1 switched off AMP1_LED_RDY=OFF AMP1_LED_ALR=RED
PA2_DR	AMP-2 dynamic range alarm AMP1_LED_ALR=RED
PA2_OFF	AMP-2 switched off AMP1_LED_RDY=OFF AMP1_LED_ALR=RED
TEMP_DMB	Temperature of DMB board is too high Warning : > warning level (NUALR)
TEMP_AMP1	Temperature of AMP-1 board is too high Warning : > warning level (NUALR)
TEMP_AMP2	Temperature of AMP-2 board is too high Warning : > warning level (NUALR)
PARA	Configuration parameter error
FOM1_MISS	FOM-1 SFP missing
FOM1_LOS	FOM-1 loss of signal
FOM1_TXF	FOM-1 transmit fault
FOM1_MOD	FOM-1 modulation alarm
FOM1_COM	FOM-1 communication alarm
FOM1_BUF	FOM-1 buffer overflow
FOM1_GEN	FOM-1 general alarm
GENALR	General alarm
TXALR	Transmit alarm (if PA1/2_OFF alarm occurred)
RXALR	Receive alarm
NUALR	Non-urgent alarm
Severity Warning	
REMALR	PLC-Modem remote alarm (MARC signal in remote station is not OK)
BLKERR	PLC-Modem block error
AUTH_FAIL	Authentication failure
SFP1_LOS	SFP-1 loss of signal
SFP1_MISS	SFP-1 is missing

Alarm	Description
SFP2_LOS	SFP-2 loss of signal
SFP2_MISS	SFP-2 is missing
FWDL	Firmware download active
TEST	Test mode active
RST_REQ	Restart of the device is required to activate parameter changes
TEMP_SET	Temporary setting active (and when session is disconnected)
APPLY	Apply failed
COMM_TO	Communication timeout
HW_TEST	Hardware test is running
PLC_DOWN	PLC-Modem down
DEF_LIC	Default license
Severity Information	
PD_ALR	ALR board is present
PD_ISWT	iSWT board is present
CFG_CHG	Configuration changed without apply

In "Web UI > Diagnostics > Error statistics counter" you can find the number of each alarm occurence since last device reset.

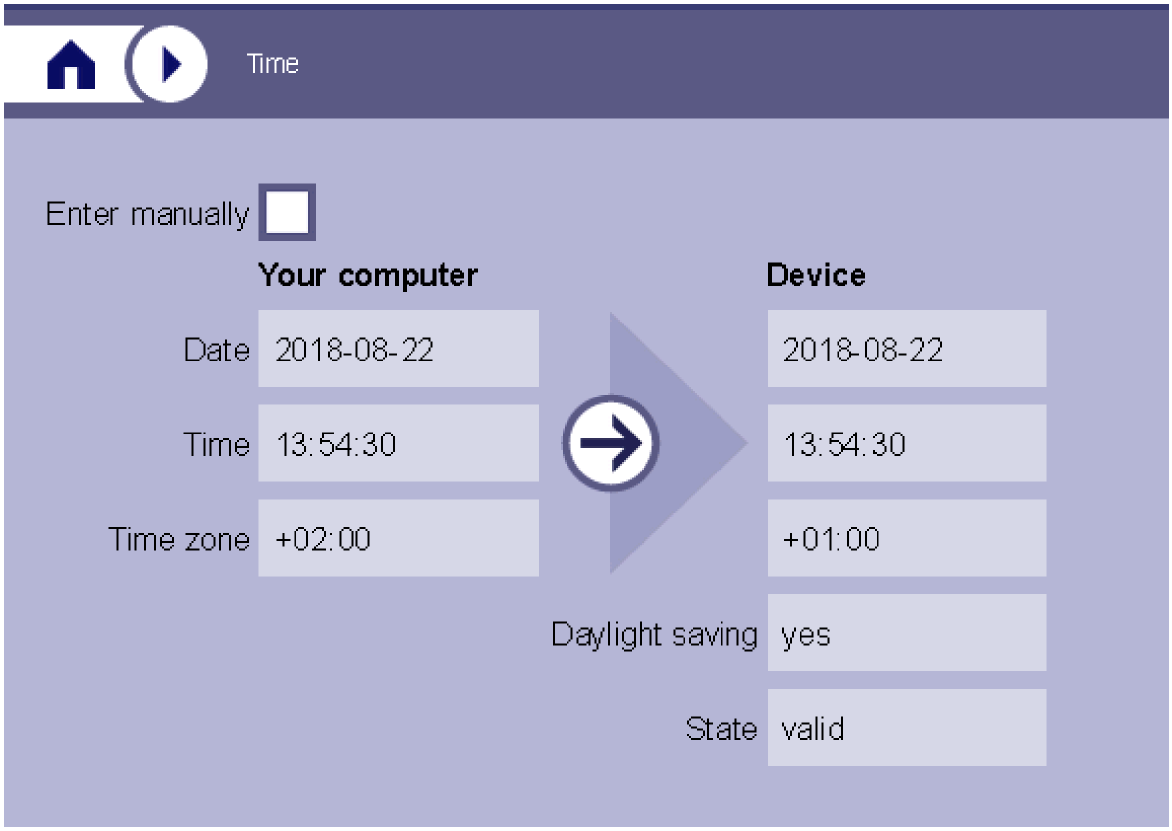
3.4.4.2 iSWT Alarm log



[sc_iswt3000_alarm_log, 1, --_--]

3.4.5 Time

It is possible to set the device time manually. Data source is date and time of your computer. If you tick the box "Enter manually" you are able to fill in the required date and time in the input fields. A time change is recorded in the event log.

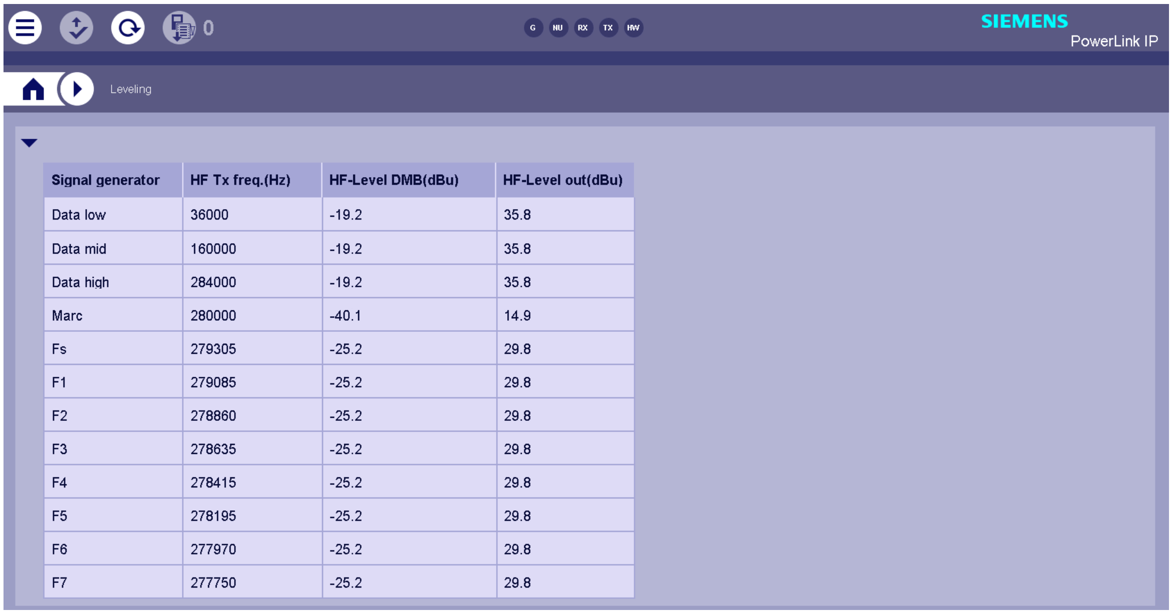


[sc_time_manually, 2, --_--]

NOTE

Time zone and daylight saving are device parameters and are not modified when the time is set. The given time will be transformed to UTC time before transmission to the device. The device applies this UTC time according to the parameters time zone and daylight saving time.

3.4.6 Leveling



Signal generator	HF Tx freq.(Hz)	HF-Level DMB(dBu)	HF-Level out(dBu)
Data low	36000	-19.2	35.8
Data mid	160000	-19.2	35.8
Data high	284000	-19.2	35.8
Marc	280000	-40.1	14.9
Fs	279305	-25.2	29.8
F1	279085	-25.2	29.8
F2	278860	-25.2	29.8
F3	278635	-25.2	29.8
F4	278415	-25.2	29.8
F5	278195	-25.2	29.8
F6	277970	-25.2	29.8
F7	277750	-25.2	29.8

[sc_leveling, 1, --_--]

The Tx output level of the MARC has to be measured with a level meter and verified with the displayed values. In case of a difference a correction can be carried out with the Tx level correction.

When the analyzer mode is switched on, it can generate a sine frequency at low, center and upper position in the PLC modem frequency band. The corresponding HF frequencies and levels are calculated and displayed in Web UI.

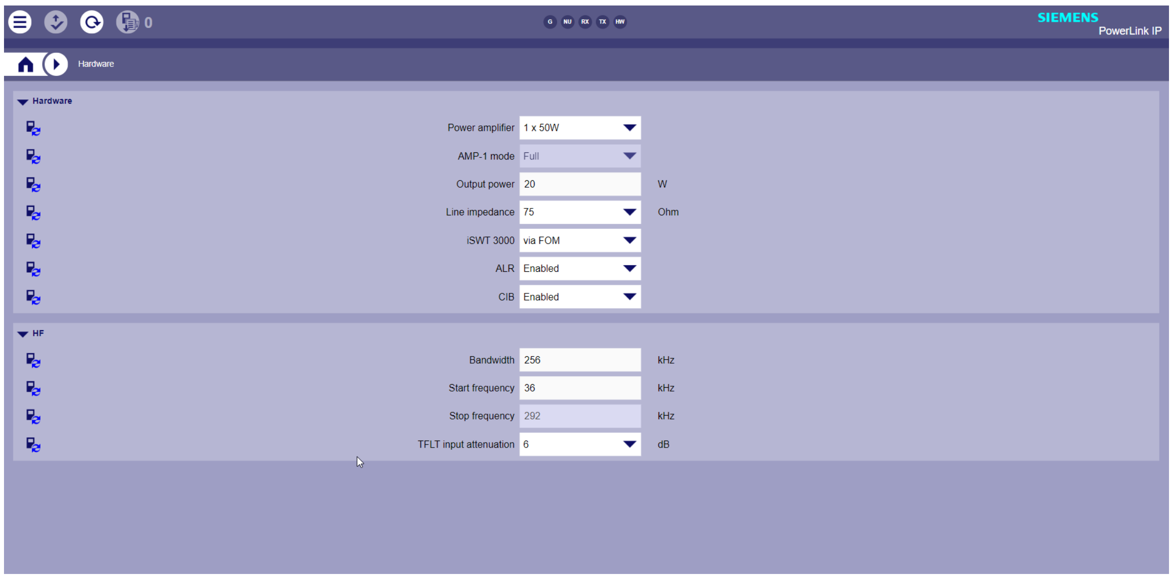
At TFLT measurement output configure the level meter as follows to get the correct HF-line values:

System Impedance	75 Ohm	150 Ohm
Reference impedance	75 Ohm	150 Ohm
Input Impedance	High (infinite)	High (infinite)
Reference Level Offset	-40 dB	-40 dB

3.5 Commissioning

3.5.1 Hardware

Hardware Configuration



[sc_commissioning_hardware, 4, --_--]

Setting	Comments
Power amplifier	No amplifier (Test) 1x50W (47dBm) max. 50 W amplifier 2x50W (50dBm) max. 100 W amplifier
AMP-1/2 mode	This parameter displays the actual AMP output power. The AMP mode is only visible if an amplifier is equipped. Half 25 W Full 50 W
Output power	This parameter adjusts the output power between 10 to 50 W or 20 to 100 W depending on the number of equipped AMP modules. Default: 50 W or 100 W
Line impedance	This parameter specifies if the output impedance is 75 Ohm unbalanced or 150 Ohm balanced. 75/150 Ohm Default: 75 Ohm
iSWT3000	via DMB: iSWT is integrated in PowerLink IP directly via FOM: Standalone SWT 3000 can be integrated into PowerLink IP via connection to optional FOM module Default: Disabled
ALR	Enabled/disabled ALR (alarm module) Default: Disabled
CIB	Enabled/disabled CIB (classic interface board) Default: Disabled

HF

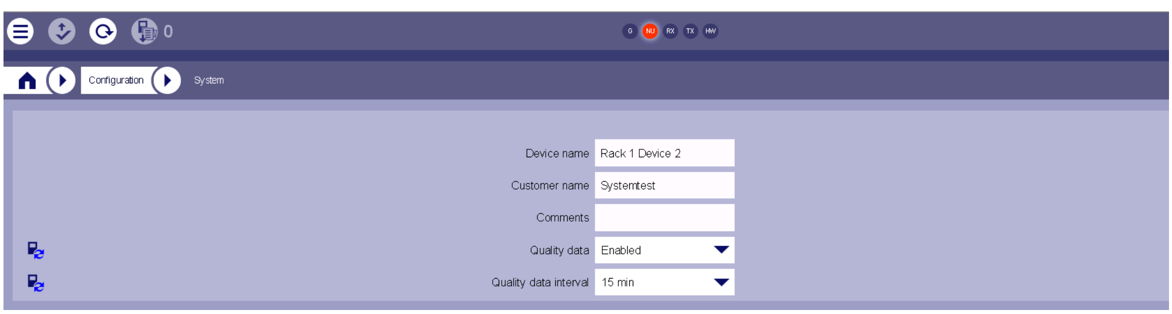
Setting	Comments
Bandwidth	This parameter specifies local TFLT bandwidth. 4 to 256 kHz in 4 kHz steps Default: 32 kHz
Start frequency	This parameter specifies the local TFLT start frequency 24 to 496 kHz in steps of 2 kHz Default: 64 kHz
Stop frequency	This parameter specifies the local TFLT stop frequency. 28 to 500 kHz in steps of 2 kHz Default: 96 kHz
TFLT input attenuation	Has to be identical With TFLT input attenuation selected in PLPAStraps program. 0 to 9 dB in steps of 3 dB Default: 6 dB

NOTE

After hardware configuration changes, a restart of the device is required.

3.5.2 Configuration

3.5.2.1 System



[sc_commissiong_system, 2, --_--]

Setting	Comments
Device name	User defined device name
Customer name	User defined customer name
Comments	User defined comments
Quality data	Enable/disable quality data
Quality data interval	Selectable interval 1 / 15 / 30 min

3.5.2.2 Alarm output allocation

Alarm output allocation

[sc_alarm_output_allocation, 2, --_--]

The allocation of the system alarms to the relays of the ALR module is user selectable.

The following alarms can be enabled/disabled on ALR1, ALR2 or ALR3.

Alarm	Comments
GENALR	General Alarm
TXALR	Transmission Alarm
RXALR	Receive Alarm
NUALR	Non-urgent Alarm
SYNC	Synchronisazion
REMALR	Remote Alarm
F6SV	F6 Alarm
iSWT RX	iSWT Receive Alarm

Alarm output delay

You can configure the delay time in seconds, before an alarm relay is activated.

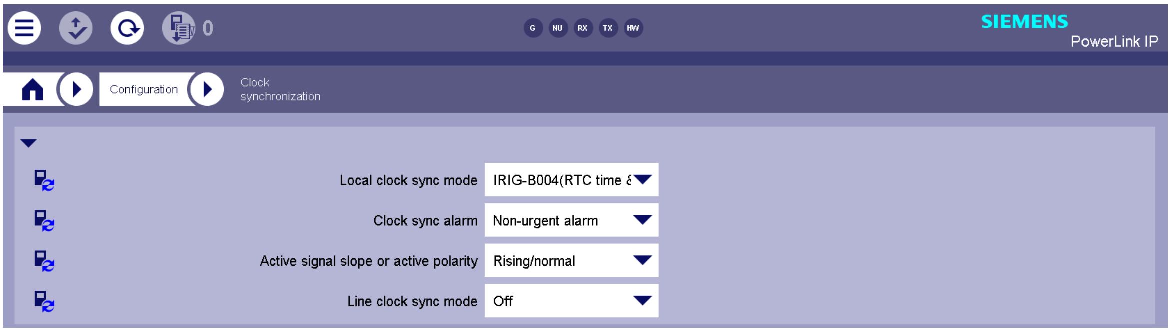
NOTE

After configuration changes of the alarm output delay time a reboot of the device is required.

3.5.2.3 Clock Synchronization

The system internal clock of PowerLink IP can be synchronized by an external clock. The internal clock of iSWT (PU4) is synchronized accordingly. A change of time is registered in the event log and in iSWT event log.

A synchroniszation of two PowerLink IP devices by the same clock is also possible.



[sc_configuration_clock_synchronization, 1, --_--]

Setting	Comments
Local clock sync mode (Settings will be ignored, if the line clock sync mode is slave)	• Off No local clock synchronization • NTP The date and time are syncronized according to a NTP server. • IRIG-B00X The second is syncronized according to the IRIG-B source. • IRIG-B000 The time is syncronized according to the IRIG-B source. The date is not changed. • IRIG-B004 The date and time are syncronized according to the IRIG-B source. With IRIG-B synchronization mode, the system time is only adjusted, if the time difference is bigger than 2 sec.
Clock sync alarm	Off Non-urgent alarm: Any clock sync failure will trigger a clock sync alarm.
Active signal slope or active polarity (only applicable for IRIG-B)	Rising/normal Falling/inverted
Line clock sync mode	Off Slave Master Two PowerLink IP devices can be synchronized to the same clock. One device serves as master, the other device as slave.

3.5.2.4 Leveling

[sc_configuration_leveling, 2, --_--]

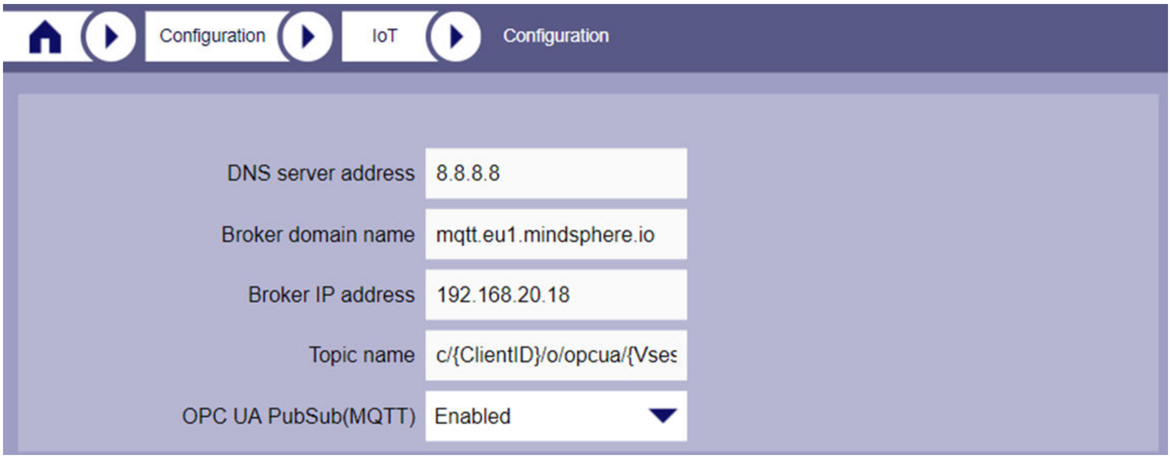
<table>
<tr><th>Setting</th><th colspan="2">Comments</th></tr>
<tr><td>Tx level adjustment</td><td colspan="2">Value to level out inaccuracies of the AMP- and TFLT-module.
This value is normally not changed. Only after changing the TFLT configuration a change might be applicable.</td></tr>
<tr><td rowspan="7">iSWT Rx level adjustment</td><td colspan="2">Value to raise the received guard level to an appropriate level.
This value has influence on the “iSWT Rx level”.
iSWT Rx level shall be adjusted according to the actual line attenuation. It can be measured in WebUI Spectrum analyzer page, the difference level between the Rx MARC at local side and the Tx MARC at remote indicates the actual line attenuation.</td></tr>
<tr><td>line attenuation (from local Tx output to Remote Rx input)</td><td>iSWT Rx level adjustment</td></tr>
<tr><td>≤6</td><td>6 dB</td></tr>
<tr><td>≤12</td><td>12 dB</td></tr>
<tr><td>≤18</td><td>18 dB</td></tr>
<tr><td>≤24</td><td>24 dB</td></tr>
<tr><td>≤30</td><td>30 dB</td></tr>
<tr><td>iSWT Rx level</td><td colspan="2">This is the guard level measured by the iSWT. The shown value should be between -9 dB and -3 dB. To achieve this, the “iSWT Rx level adjustment“ needs to be changed.</td></tr>
</table>

3.5.2.5 IoT

Overview

OPC UA Pub/Sub is the extension of OPC UA (Open Platform Communications, Unified Architecture) standard to enable a model in which a server sends its data to the network (publish) and every client can receive this data (subscribe). Publisher and subscriber use standard messaging protocol MQTT (Message Queuing Telemetry Transport) to communicate with broker. All messages are published to specific queues (e.g. topics) that the Broker exposes and Subscribers can listen to these queues. End-to-end security with MQTT is primary provided by a TLS connection between the pub/sub and the broker. This requires that the broker be trusted.

Configuration



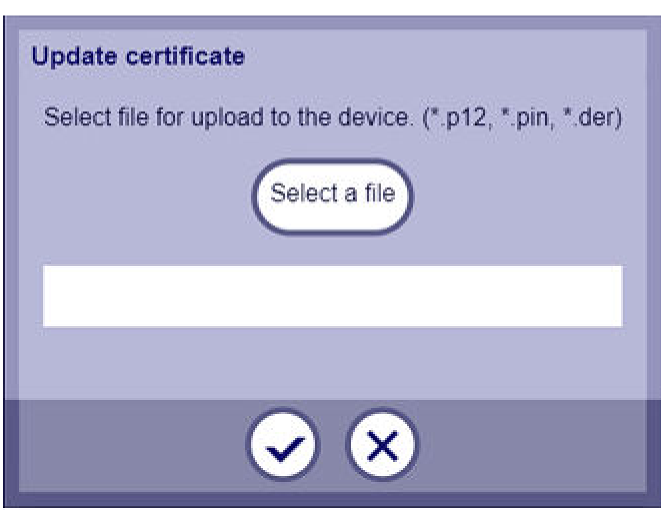
[sc_configuration_iot_configuration, 2, --_--]

Setting	Comments
DNS server address	IP address for the DNS server, which is used to convert the “Broker domain name” to IP address
Broker domain name	Domain name for the broker, it’s useful when the “Broker IP address” is set to “0.0.0.0”
Broker IP address	IP address of broker
Topic name	Topic name defined in the broker
OPC UA PubSub(MQTT)	Enable / disable OPC UA Pub/Sub MQTT protocol to publish data to the Broker. Default: Disabled
Update certificate	Import certificate of broker to enable TLS connection. Three files are required(*.p12, *.pin, *.der)

Web UI > Configuration > IoT

If OPC UA Pub/Sub is enabled, all data points as shown below are transmitted to broker. Additionally to these data points, the device asset information (serial number, device type, device name) is transmitted during device startup.

Update certificate



[sc_configuration_iot_update_certificate, 2, --_--]

Import certificate of broker to enable TLS connection. Three files are required(*.p12, *.pin, *.der)

Alarm indication

Index	Name	Description
0	dmb.state.genalr	General alarm
1	dmb.state.txalr	Tx alarm
2	dmb.state.rxalr	Rx alarm
3	dmb.state.nualr	Non-urgent alarm
4	dmb.state.iswtgenalr	General alarm of iSWT
5	dmb.state.iswtrxalr	Tx alarm status of iSWT
6	dmb.state.iswtnualr	Rx alarm status of iSWT
8	dmb.state.nosync	Sync loss alarm
9	dmb.state.marc	Marc level too low alarm
10	dmb.state.ber3	Block error rate alarm
11	dmb.state.remalr	Remote terminal alarm
12	dmb.state.f6sv	Transmit level alarm of iSWT
13	dmb.state.auth	Authentication alarm of web access

Command counter iSWT

Index	Name	Description
0	pu3x.stat.ifc.be.1	Number of activated command input 1
1	pu3x.stat.ifc.be.2	Number of activated command input 2
2	pu3x.stat.ifc.be.3	Number of activated command input 3
3	pu3x.stat.ifc.be.4	Number of activated command input 4
4	pu3x.stat.ifc.ba.1	Number of activated command output 1
5	pu3x.stat.ifc.ba.2	Number of activated command output 2
6	pu3x.stat.ifc.ba.3	Number of activated command output 3
7	pu3x.stat.ifc.ba.4	Number of activated command output 4

PLC Modem status

Index	Name	Description
0	dmb.plcSta.snr	SNR signal level [dB]
1	dmb.plcSta.fep	Frame error probability [%]
2	dmb.plcSta.marcBrxLevel	Receive level of MARC B [dB]
3	dmb.plcSta.totalTxFrmCnt	Transmitted frames since the last sync
4	dmb.plcSta.link	Link status
5	dmb.plcSta.txBitRate	Transmit bit rate [bps]
6	dmb.plcSta.rxBitRate	Receive bit rate [bps]
7	dmb.plcSta.txFrmCnt	Transmitted frames per second
8	dmb.plcSta.errFrmCnt	Error frames per second
9	dmb.qdata.temp1	Temperature of DMB-CPU [°C]
10	dmb.qdata.temp2	Temperature of DMB-DSP [°C]
11	dmb.qdata.temp3	Temperature of AMP-1 [°C]
12	dmb.qdata.temp4	Temperature of AMP-2 [°C]

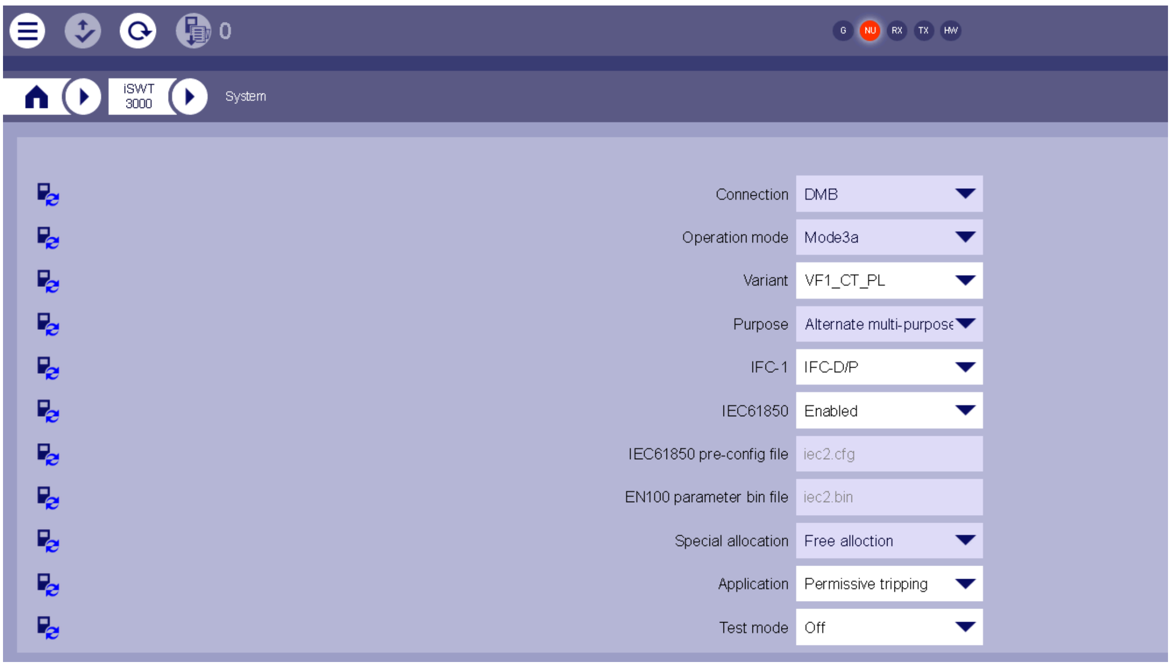
3.5.3 iSWT

3.5.3.1 System

NOTE

iSWT related menu items are available only when an iSWT board is equipped and enabled in hardware configuration.

Please check chapter *3.5.4.1 Inband MARC signal* for correct MARC signal channel/guard configuration in combination with iSWT.



[sc_configuration_iswt_system, 2, --_--]

Setting	Comments
Connection	Connection can be set in WEB UI Commissioning > Hardware > iSWT 3000
	DMB iSWT is integrated in PowerLink IP directly
	FOM Standalone SWT 3000 can be integrated into PowerLink IP via connection to optional FOM module Before you can use the external SWT 3000 device, the FOM connection has to be configured with the PowerSys program. Menu SWT 3000 - Configuration > Line Interface> Analog "FOM-1 analog" > Line Interface > Configuration via PowerLink (Slot) "iSWT-1" Unplug the USB cable from PU4 board after PowerSys configuration is done successfully, the further commissioning or status monitoring of iSWT has always to be done via PowerLink IP Web UI. Do not use the PowerSys connection to PU4 any more.
Operation mode	Mode3a (4 independent commands) Mode3b (2 plus 2 commands) Mode 7a (8 independent commands) Default: Mode 3a

Setting	Comments
Variant	VF1_CT_PL / VF40_CT_PL (read-only) Default: VF1_CT_PL VF1_CT_PL: Frequencies for coded tripping used for operating mode 3a and 3b when SWT 3000 is integrated in PowerLink IP VF40_CT_PL: Frequencies for coded tripping used for operating mode 7a when SWT 3000 is integrated in PowerLink IP
Purpose	Alternate multi purpose
IFC-1	--- IFC-D/P Only IFC-D or IFC-P modules can be inserted at the corresponding slot IFC-1.
IFC-2	--- IFC-D/P IFC-S Slot IFC-2 can also be equipped with the IFC-D/P modules or alternatively with the IFC-S module.
IEC61850	Enable/disable
Special allocation	Free allocation
Application	Direct tripping (This adjustment offers a higher transmission security of the analog communication interface. It should be selected when using protection systems with intertripping. The transmission time is approx. 3 ms longer compared with the adjustment "permissive".) Permissive tripping (This adjustment should be selected when using permissive protection systems.)
Test mode	Off IFC-Test In this mode you can enter commands on the IFC module for every input by means of DIL switches S1.1 to S1.4 on the IFC module.

Setting	Comments	
Digital 2 connection	Default: Off Available when iSWT is connected via FOM DCE: The clock is provided for the remote SWT 3000 device. DTE: The clock is expected from the connected SDH/PDH multiplexer or remote SWT 3000 device. DCE is only used for FO direct connection. One SWT 3000 device is DCE mode. The remote SWT 3000 device must be DTE mode. If connection with SDH/PDH mulitplexer, both local and remote SWT 3000 devices must be configured to DTE mode. In this case, the clock is always provided by mulitplexer. The wrong clock configuration (e.g. DCE-DCE) will cause a DLE sync loss alarm.	
	X.21 DCE	Digital interface X.21 DCE
	X.21 DTE	Digital interface X.21 DTE
	G703.1 DCE	Digital interface G703.1 64 kbpsDCE
	G703.1 DTE	Digital interface G703.1 64 kbps DTE
	G703.6 DCE	Digital interface G703.6 2 Mbps DCE
	G703.6 DTE	Digital interface G703.6 2 Mbps DTE
	FOM 64k-DCE	Fiber-optic connection between 2 SWT 3000 with 64 kbps DCE
	FOM 64k-DTE	Fiber-optic connection between 2 SWT 3000 with 64 kbps DTE
	FO-Box 64k	Fiber-optic connection to the FOBox bit rate 64 kbps
	FOM 2M-DCE	Fiber-optic connection between 2 SWT 3000 with 2 Mbps DCE
	FOM 2M-DTE	Fiber-optic connection between 2 SWT 3000 with 2 Mbps DTE
	FO-Box 2M	Fiber-optic connection to the FOBox bit rate 2 Mbps
	C37.94-DCE	Fiber-optic connection between 2 SWT 3000 with C37.94 protocol DCE
	C37.94-DTE	Fiber-optic connection between 2 SWT 3000 with C37.94 protocol DTE
Digital 2 path	Secondary / Primary Default: Primary Available when iSWT is connected via FOM	

Setting	Comments
Date rate for C37.94	Available when iSWT is connected via FOM 1 * 64 kbps 2 * 64 kbps 3 * 64 kbps 4 * 64 kbps 5 * 64 kbps 6 * 64 kbps 7 * 64 kbps 8 * 64 kbps 9 * 64 kbps 10 * 64 kbps 11 * 64 kbps 12 * 64 kbps auto The data rate must be 1 to 12 x 64 kbps. For C37.94 DTE, it is also possible to detect the data rate of the DCE device automatically by selecting Auto in the data rate field. If only one interface has been selected, only the corresponding data rate filed is enabled. The other one is disabled.
Tx address	Default: 1 Unique addressing of transmitting device Available when iSWT is connected via FOM
Rx address	Default: 1 Unique addressing of receiving device Available when iSWT is connected via FOM
Redundant power supply	Enabled / Disabled Default: Disabled Monitoring the second power supply if two power supplies are equipped Available when iSWT is connected via FOM

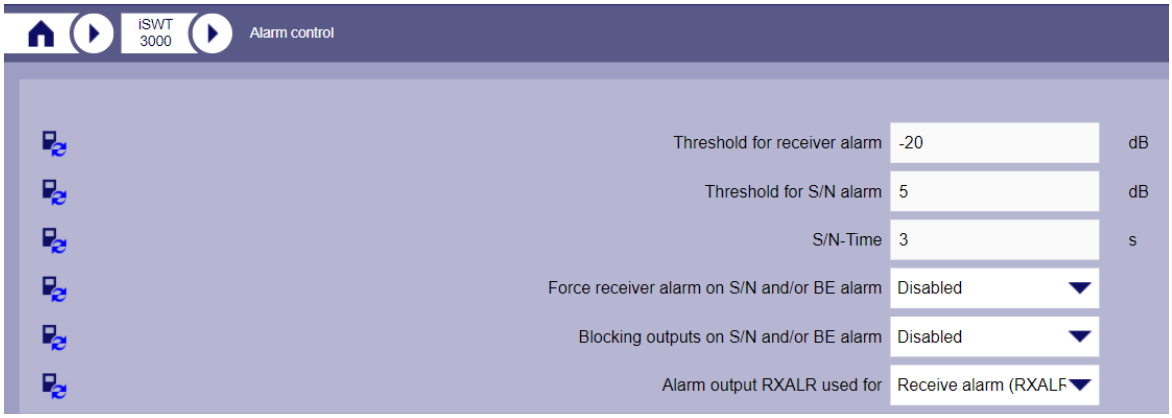
NOTE

For security reasons after switching over to IFC-test mode all inputs are signaled by the controller as “off” regardless of the actual switch position. The “ON” state can only be reached by switching all switches to the “Open” position and then “ON”. To prevent false trips, make sure that the command outputs in the remote station are disconnected from protection relay.

NOTE

After configuration changes a reboot of the device is required.

3.5.3.2 Alarm Control



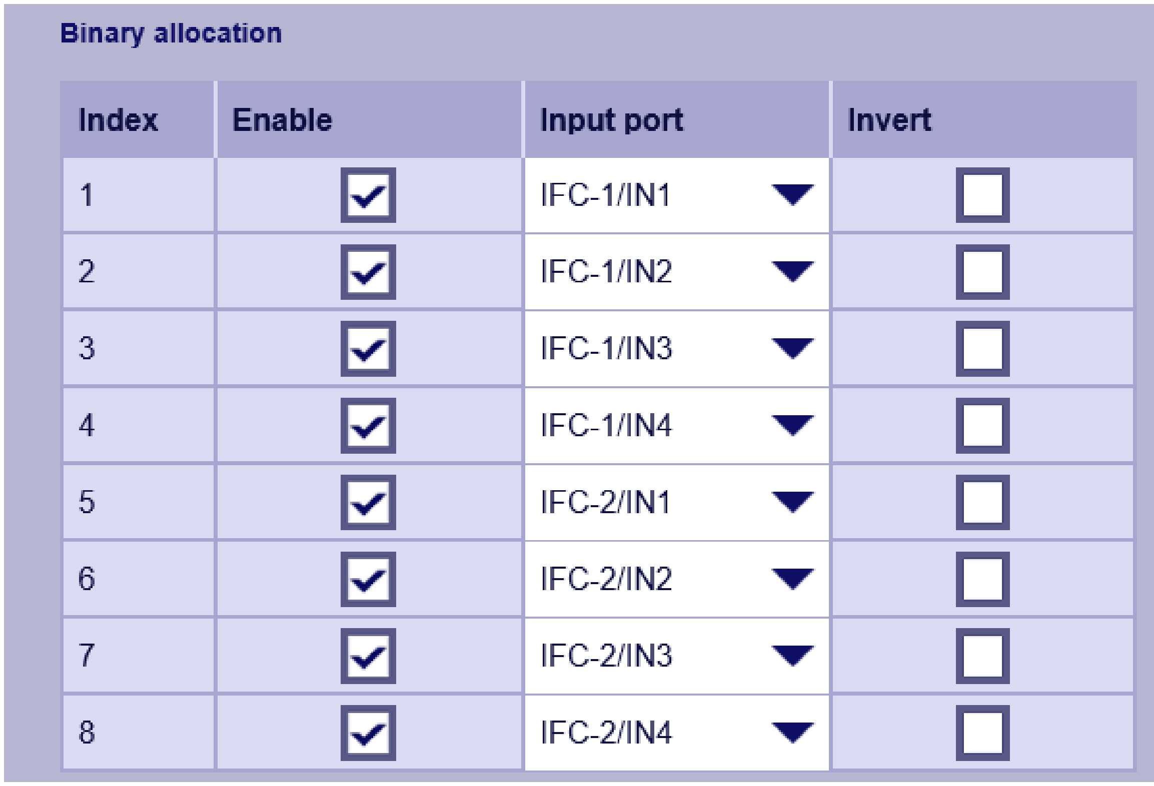
[sc_configuration_iswt_alarm_control, 3, --_--]

Setting	Comments
Threshold for receiver alarm	-30 to -10 dB in steps of 5 dB Default: -20 dB When the PU4 input level drops below the adjusted value, a receive alarm is triggered.
Threshold for S/N alarm	5 to 20 dB in steps of 5 dB Default: 5 dB In case of a worse SNR than the adjusted value, this condition causes S/N alarm. S/N alarm supervision is only enabled if "force receiver alarm on S/N" or "blocking outputs on S/N" is enabled. That means, if S/N alarm supervision is enabled, in case of a worse SNR than the threshold, S/N alarm is triggered. If S/N alarm supervision is disabled, S/N alarm is never triggered.
S/N-Time	1 to 30 s Default: 3 s Measuring time for the signal to noise ratio.
Force receiver alarm on S/N and/or BE alarm	Default: Disabled In case of an S/N alarm, receiver alarm relay is activated if this function is enabled.
Blocking outputs on S/N and/or BE alarm	Default: Disabled In case of an S/N alarm, command outputs are blocked if this function is enabled.
Alarm output RXALR	Receive alarm (RXALR) Unblocking (UNBL) Input limitation alarm (INPLIM)

NOTE

After configuration changes a reboot of the device is required.

3.5.3.3 Input Command Allocation



Binary allocation

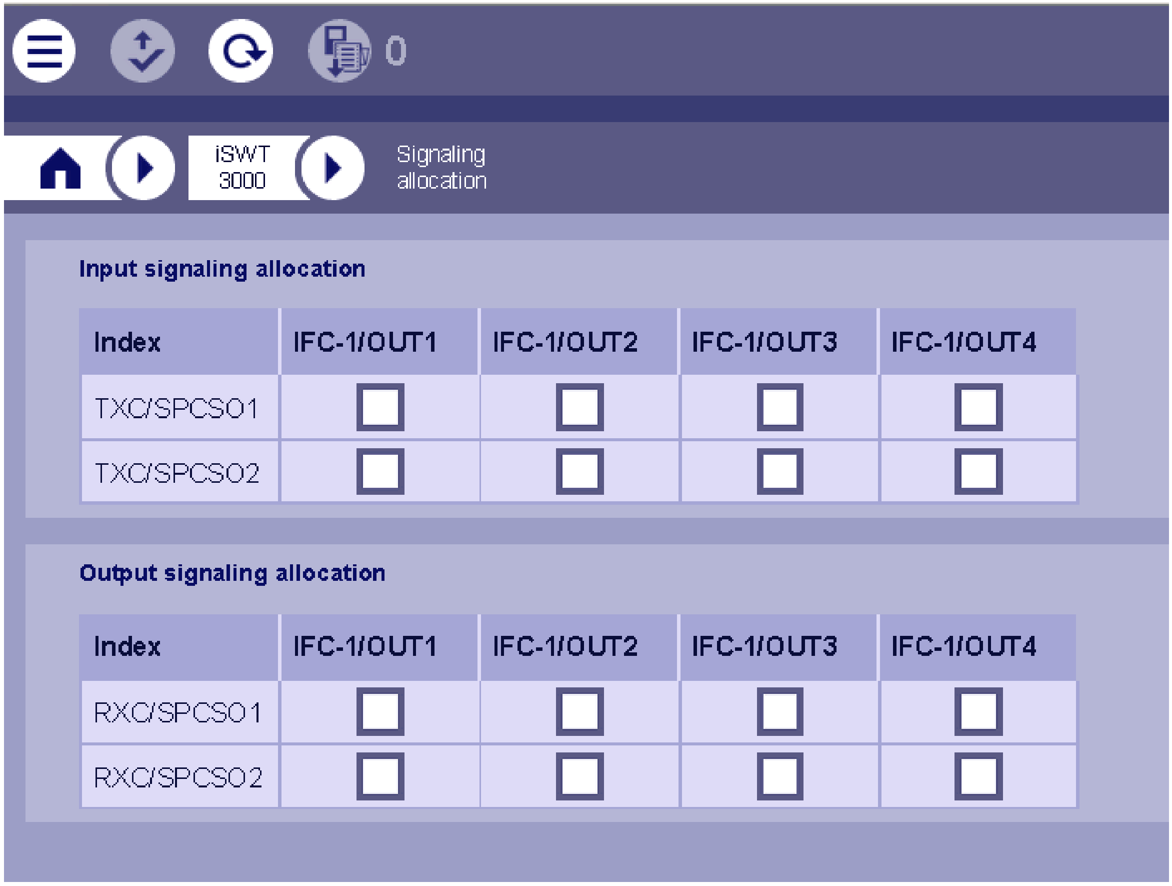
Index	Enable	Input port	Invert
1	☑	IFC-1/IN1	☐
2	☑	IFC-1/IN2	☐
3	☑	IFC-1/IN3	☐
4	☑	IFC-1/IN4	☐
5	☑	IFC-2/IN1	☐
6	☑	IFC-2/IN2	☐
7	☑	IFC-2/IN3	☐
8	☑	IFC-2/IN4	☐

[sc_configuration_iswt_input_command_allocation, 3, --_--]

At the transmit side, every possible combination of binary inputs is assigned to a protection frequency according to the input allocation. For the operation Mode 3a/3b, 4 binary inputs are available, while for Mode7a 8 binary inputs are available.

Setting	Comments
Enable	enable/disable command input [1...8]. If the command input x is disabled, this command is not transmitted.
Input port	Off, IFC-1/IN1...4, IFC-2/IN1...4 Default: 1:1 mapping This parameter specifies which command input [1...8] is allocated to which IFC or GOOSE input port. The IFC input port can be freely configured to any command input, but one IFC input port only can allocate to one command input. Default input allocation: Input 1 : IFC-1/IN1 Input 2 : IFC-1/IN2 Input 3 : IFC-1/IN3 Input 4 : IFC-1/IN4 If mode7a is selected and IFC-2 = IFC-D/P Input 5 : IFC-2/IN1 Input 6 : IFC-2/IN2 Input 7 : IFC-2/IN3 Input 8 : IFC-2/IN4
Invert	checked/unchecked Default: unchecked This parameter specifies whether the IFC input port is inverted or not.

3.5.3.4 Signaling Allocation



[sc_configuration_iswt_signaling_allocation, 2, --_--]

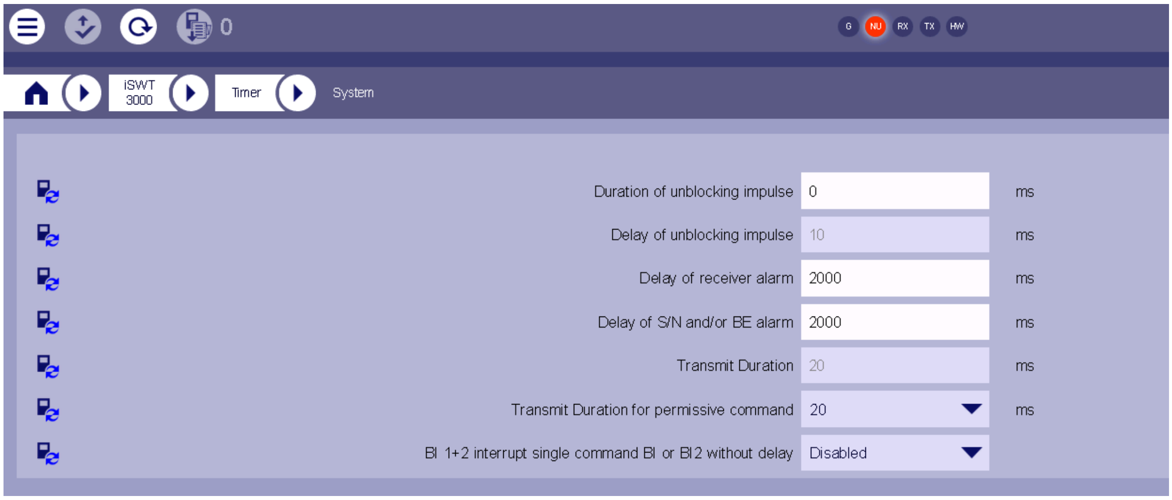
The signaling allocation is used to configure in a flexible way the output ports of IFC-D/P/S as command signaling outputs for any input or output command.

Signaling allocation affects the following allocations:

- Contact doubling
- IFC-S signaling

3.5.3.5 Timer

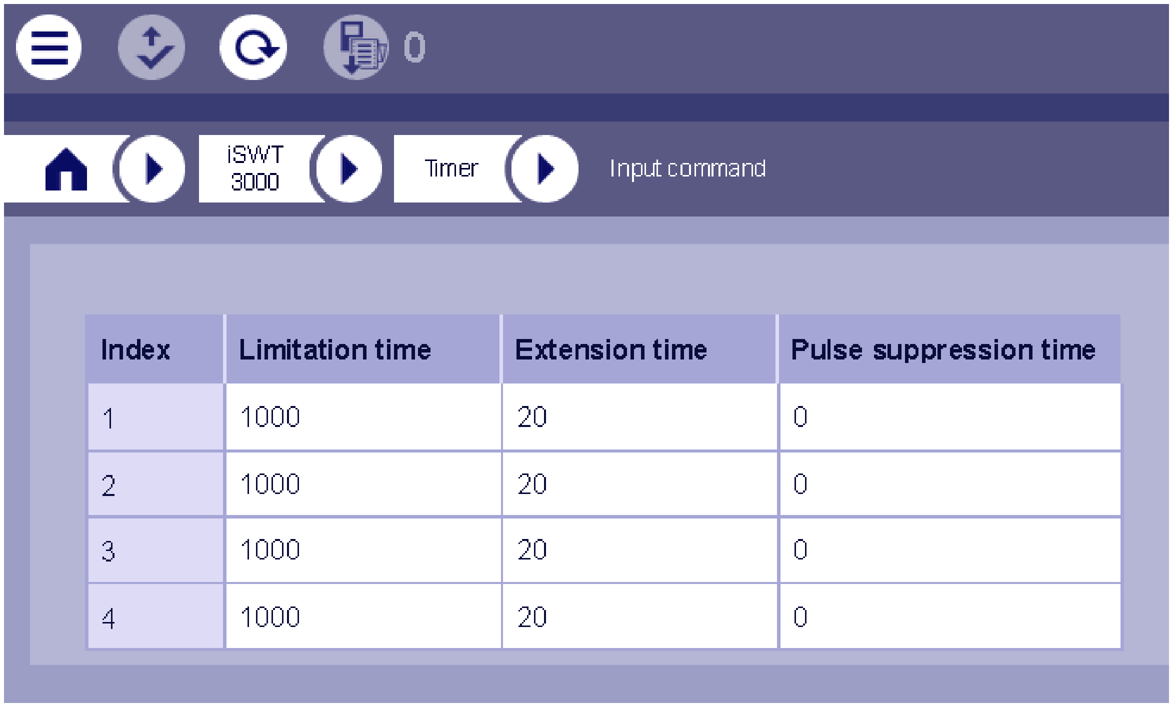
System



[sc_configuration_iswt_timer_system, 3, --_--]

Setting	Comments
Duration of unblocking impulse	0 to 300ms in steps of 10 ms "0" means no unblocking signal Default: 0
Delay of unblocking impulse	10 to 100ms in steps of 1 ms Adjustment only possible when duration of unblocking is >0ms
Delay of receiver alarm	0 to 2000ms in steps of 50ms Delay time for activation of the receive alarm Default: 2000
Delay of S/N and/or BE alarm	0 to 2000ms in steps of 50ms Delay time before output of the S/N alarm signal. Default: 2000
Transmit Duration	ms Default: 20
Transmit Duration for permissive command	15 / 20 ms Default: 20 for Protection Operating mode 3b
BI 1+2 interrupt single command BI or BI2 without delay	Enabled / Disabled for Protection Operating mode 3b

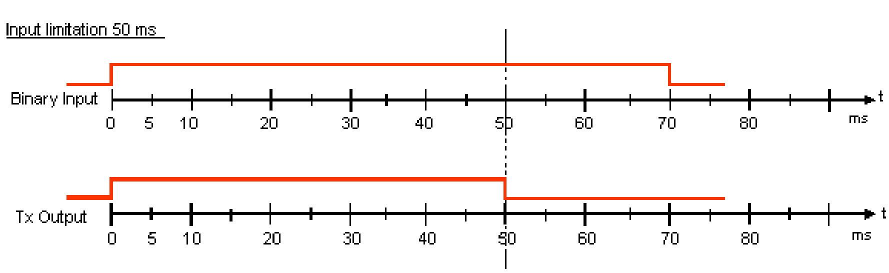
Input Command



Index	Limitation time	Extension time	Pulse suppression time
1	1000	20	0
2	1000	20	0
3	1000	20	0
4	1000	20	0

[sc_configuration_iswt_timer_input_command, 2, --_--]

Setting	Comments
Limitation time	0 to 2000 ms in steps of 1 ms The transmission of the tripping signal is stopped when this value is exceeded. "0" setting means no limitation. Default: 0
Extension time	0 to 100 ms in steps of 1 ms "0" setting means no extension. Default: 20
Pulse suppression	0 to 100 ms in steps of 1 ms can be adjusted for each released binary input to filter the input signal. Default: 0

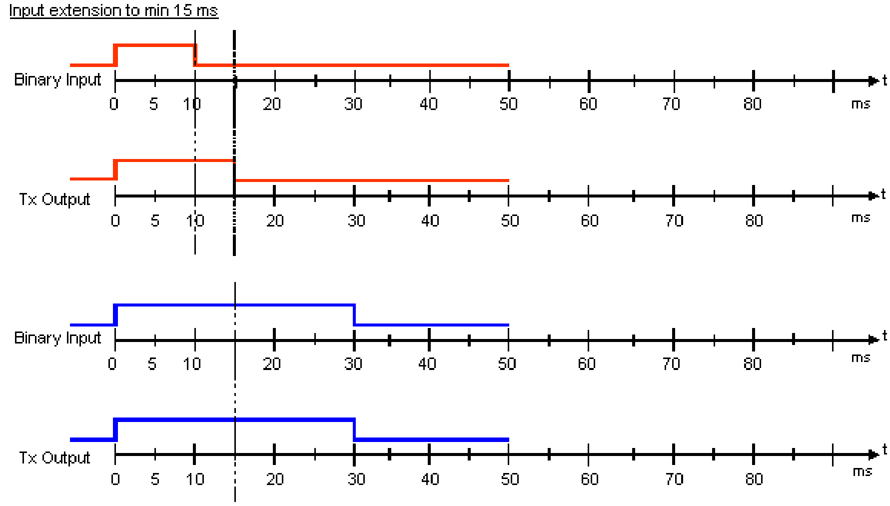


[dwinlm50-011210-01.tif, 1, en_US]

Figure 3-2 Example for input limitation set to 50 ms

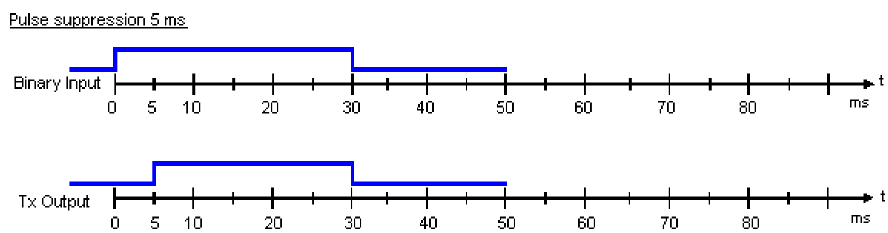
The commands at the binary input are extended to adjusted value in case they are shorter. If they are longer this adjustments is irrelevant.

The figure below shows 1 command (red) at the binary input with a length of 10 ms. This is extended to 15 ms. The next command (blue) has a length of 30 ms. This command is not extended.



[dwince15-011210-01.tif, 1, en_US]

Figure 3-3 Example for an input command extension to min 15 ms



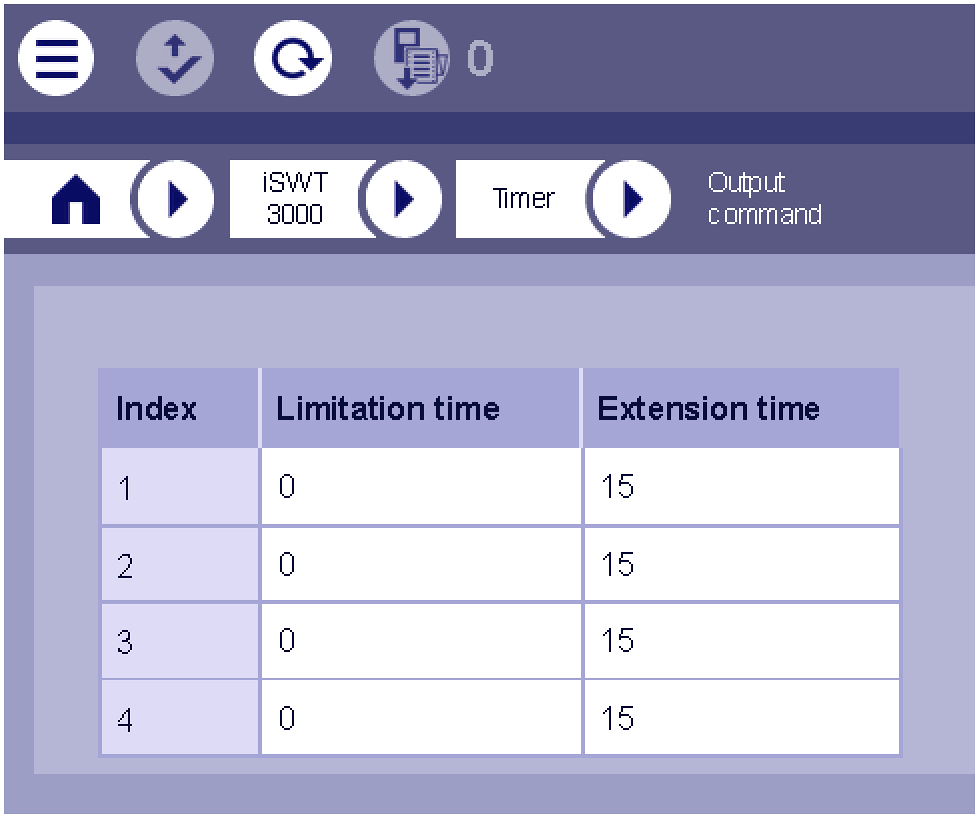
[dwplssp5-021210-01.tif, 1, en_US]

Figure 3-4 Example for a pulse suppression of 5 ms

NOTE

Commands which are **shorter** than the adjusted pulse suppression time are **not** transmitted by the iSWT!

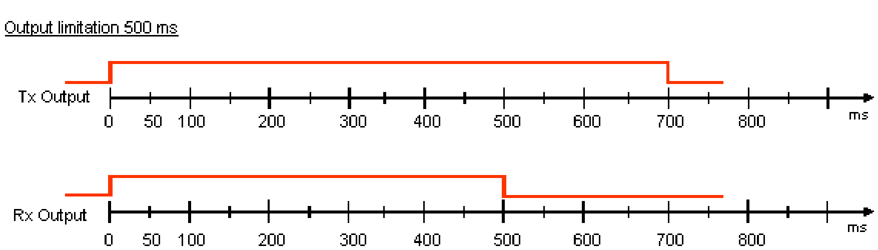
Output Command



[sc_configuration_iswt_timer_output_command, 2, --_--]

Setting	Comments
Limitation time	0/500 ms 0 = no limitation Default: 0
Extension time	0 to 2000 ms in steps of 5 ms Default: 15

The command in the example below is transmitted for 700 ms (Tx output). With the activated output limitation the command output is switched off after 500 ms.



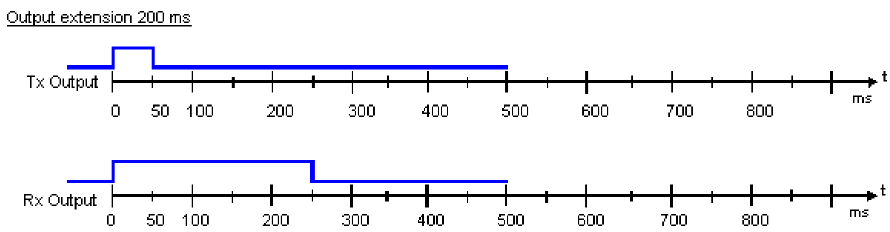
[scactocl-021210-01.tif, 1, en_US]

Figure 3-5 Example of an activated output command limitation

The command in the example below is transmitted for 50 ms (Tx output). With the output command extension on the Rx output it is extended for 200 ms.

Output limitation alarm triggers Rx alarm ON.

Any interruption of receiving a command (Rx output changed, e.g. from BO1+BO2 to BO2), the timer for output limitation restarts from the beginning.



[dwoex200-021210-01.tif, 1, en_US]

Figure 3-6 Example for an output extension of 200 ms

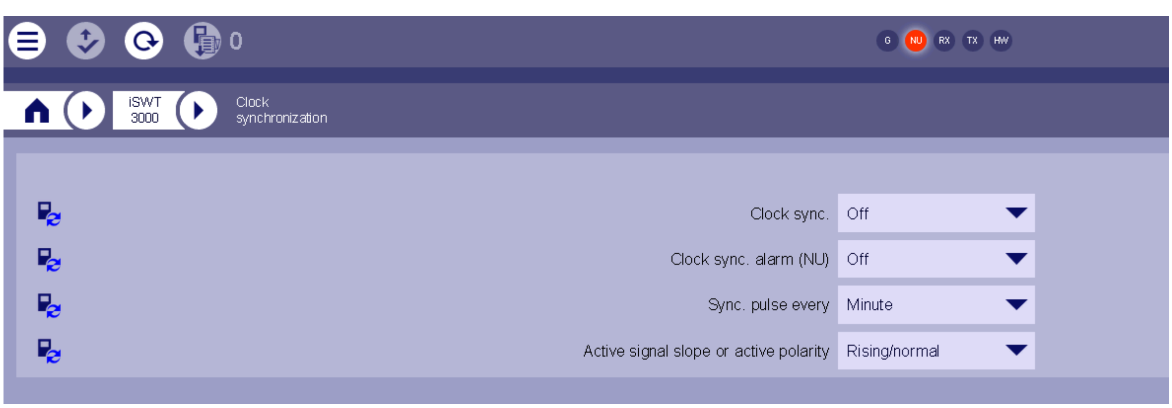
Setting Recommendations for iSWT Timer Configuration

AMP operation	Timer			Command input		Command output	
	Duration of the Unblocking pulse	EALR relay delay [ms]	S/N alarm delay [s]	Pulse suppression [ms]	Command extension to min. [ms]	Limiting of output time [ms]	*) Increase in output time by [ms]
Double system protection	0	2000	2	0	15	to 500	0
Single-phase protection	0	2000	2	0	15	to 500	0
Switching functions	0	2000	2	0	15	none	100

3.5.3.6 iSWT Clock synchronization

The date and time of DMB is synchronized to PU4. A time change is registered in iSWT event log.

A standalone SWT 3000, integrated in PowerLink IP via FOM module, can alternatively use the SWT 3000 clock synchronization (NTP, IRIG-B). Therefore a setup of the WebServer and NTP/IRIG-B configuration for the standalone SWT 3000 is necessary.

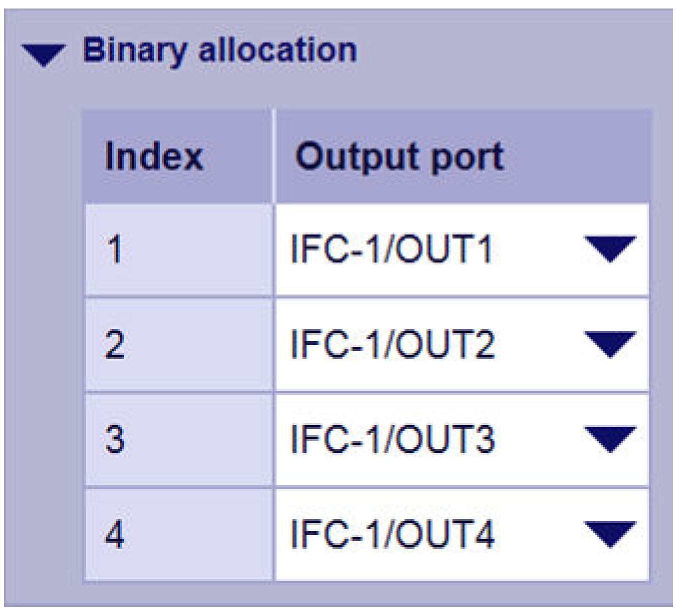


[sc_configuration_iswt_clock_synchronization, 2, --_--]

Setting	Comments
Clock sync.	Off USYNC signal IRIG-B00X IRIG-B000 IRIG-B004 NTP
Clock sync. alarm (NU)	Off On
Sync. pulse every	Minute Hour
Activate signal slope or active polarity (IRIG)	Rising/normal Falling/inverted

3.5.3.7 Output command allocation

Binary allocation



[sc_configuration_iswt_output_command_allocation, 3, --_--]

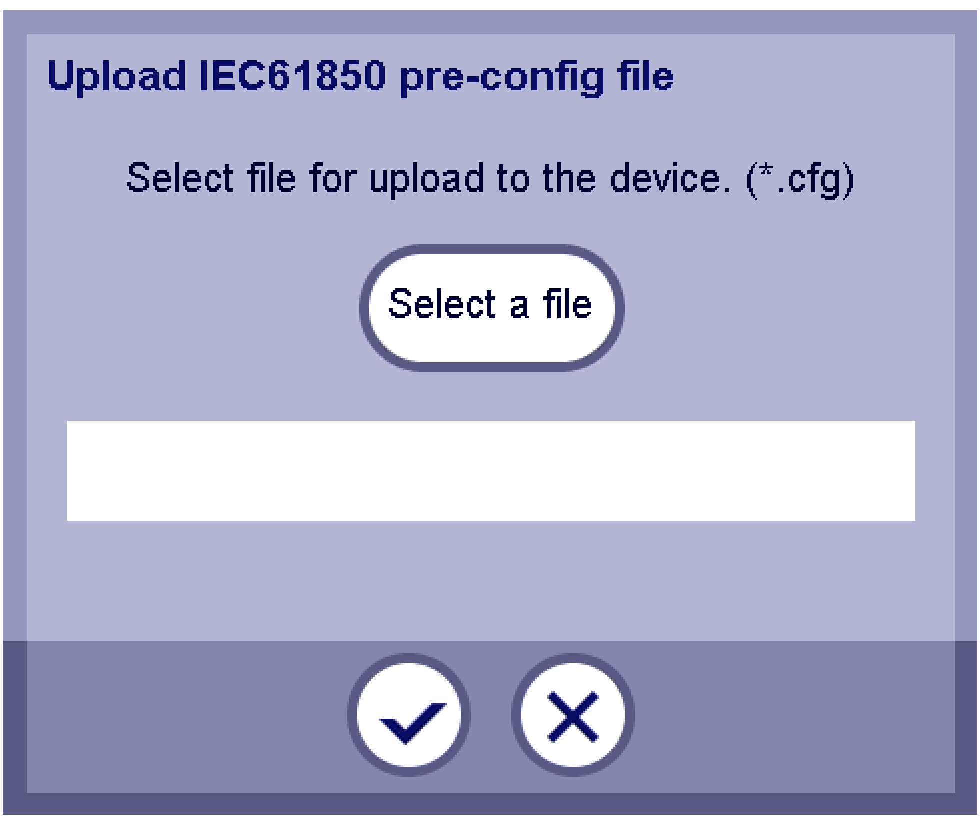
At the receive side, every protection frequency is assigned to one or more command outputs according to the output allocation.

Setting	Output port
Index	
Output port	Off, IFC-1/OUT1...4, IFC-2/OUT1...4 Default: 1:1 mapping This parameter specifies command output is allocated to which IFC or GOOSE output port. The IFC output port can be freely configured to any command output, but one IFC output port only can allocate to one command output. The default out allocation: Output 1 : IFC-1/OUT1 Output 2: IFC-1/OUT2 Output 3: IFC-1/OUT3 Output 4 : IFC-1/OUT4 If mode7a is selected and IFC-2 = IFC-D/P Output 5 : IFC-2/OUT1 Output 6 : IFC-2/OUT2 Output 7 : IFC-2/OUT3 Output 8 : IFC-2/OUT4

For a re-sort of allocations, set all to "Off" first, before configuring the new settings.

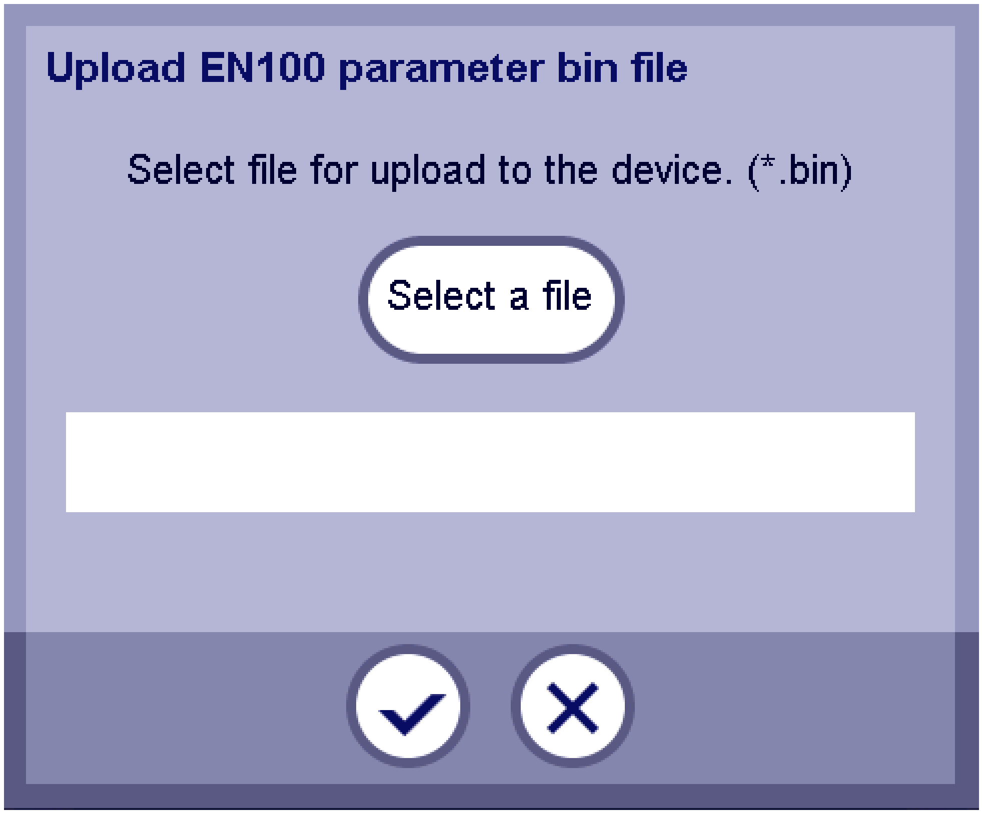
3.5.3.8 IEC61850

Upload IEC61850 pre-config file



[sc_configuration_iswt_iec61850_upload_iec61850_preconfig_file, 1, --_--]

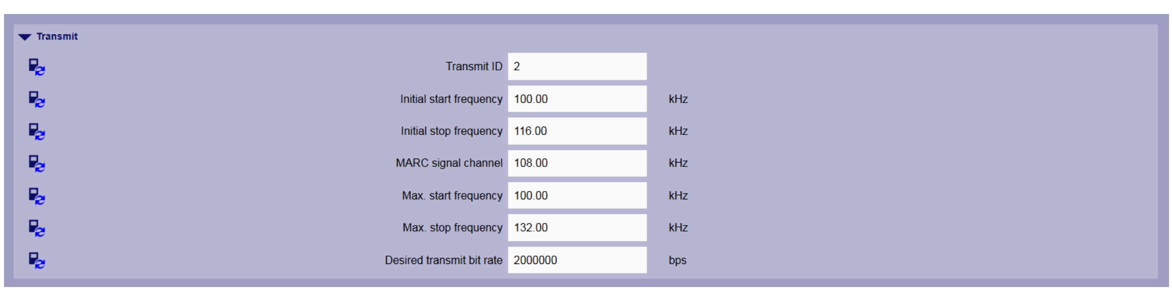
Upload EN100 parameter bin file



[sc_configuration_iswt_iec61850_upload_en100_parameter_bin_file, 1, --_--]

3.5.4 PLC Modem

3.5.4.1 Inband MARC signal



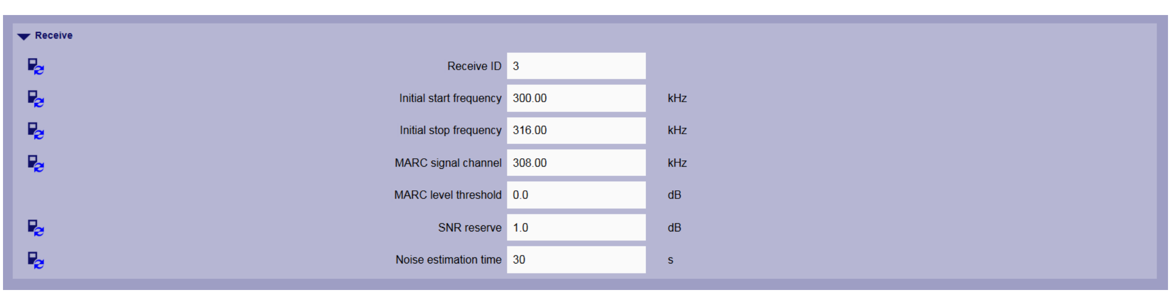
[sc_configuration_plc_modem_inband_marc_signal_transmit, 2, --_--]

Transmit

NOTE

If an iSWT board is equipped and enabled in hardware configuration, the distance between MARC signal channel and lower band limit of the initial frequency band must be at least 4 kHz.

Setting	Comments
Transmit ID	Transmit ID of local device. 0 - 15 Default: 0
Initial start frequency	Initial start frequency for transmit and receive. The initial start Tx frequency shall be within the range of hardware settings for TFLT. 24 - 496 kHz in 0.25 kHz steps Default: 64 kHz
Initial stop frequency	Initial stop frequency for transmit and receive. The initial stop Tx frequency shall be within the range of hardware settings for TFLT. 28 - 500 kHz in 0.25 kHz steps Default: 96 kHz
MARC signal channel	MARC channel of PowerLink IP device 24 - 500 kHz in 0.25kHz steps This parameter specifies MARC signal channel for transmit, receive, lower neighbor and upper neighbor. After entering the initial frequency values, the MARC signal channel is set to a default value within this interval. If necessary, this setting can be changed again manually.
Max. start frequency	Max. start frequency for transmit. The max. start Tx frequency shall be within the range of hardware settings for TFLT. 24 - 496 kHz in 0.25 kHz steps Default: = Tx start frequency
Max. stop frequency	Max. stop frequency for transmit. The max. stop Tx frequency shall be within the range of hardware settings for TFLT. 28- 500 kHz Default: = Tx stop frequency
Desired transmit bit rate	Desired transmit bit rate (bps). This value is used during optimization phase of MARC control algorithm.

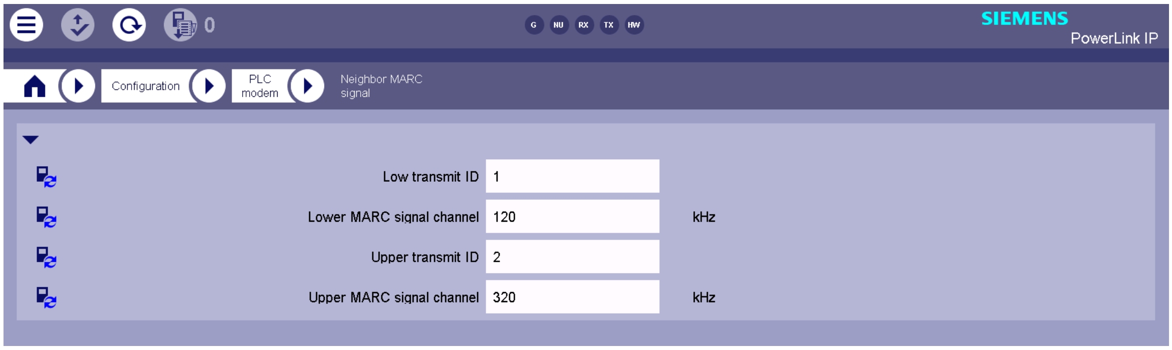


[sc_configuration_plc_modem_inband_marc_signal_receive, 3, --_--]

Receive

Setting	Comments
Receive ID	Transmit ID of remote device. 0 - 15 Default: 0
Initial start frequency	Initial start frequency for transmit and receive. The initial start Tx frequency shall be within the range of hardware settings for TFLT. 24 - 496 kHz in 0.25 kHz steps Default: 128 kHz
Initial stop frequency	Initial stop frequency for transmit and receive. The initial stop Tx frequency shall be within the range of hardware settings for TFLT. 28 - 500 kHz in 0.25 kHz steps Default: 160 kHz
MARC signal channel	MARC channel of PowerLink IP remote device 24 - 500 kHz This parameter specifies MARC signal channel for transmit, receive, lower neighbor and upper neighbor. After entering the initial frequency values, the MARC signal channel is set to a default value within this interval. If necessary, this setting can be changed again manually.
MARC level threshold	MARC level threshold is used to trigger MARC level alarm. The alarm will be mapped to NU alarm (when iSWT3000 is enabled) or RX alarm (when iSWT3000 is disabled). MARC level alarm on: Receive level of MARC B < MARC level threshold MARC level alarm off: Receive level of MARC B > MARC level threshold + 1.0dB
SNR reserve	If the noise of the channel has not a constant level, it will lead to single symbol errors or even resyncs, when noise bursts occur. To avoid this a distance between the currently available SNR and the necessary SNR of a certain modulation grade can be preserved. This distance is the SNR reserve. If a small amount of the bit rate is expandable, a good value for SNR-reserve is between 0.8 and 3 dB, (in hard cases even more). This will also decrease the permanent change of channel bit loading and the traffic caused by it.
Noise estimation time	For constantly recurring disturbances it is beneficial to observe the noise for a longer time period. Practical noise estimation times are in the scope of 30 s up to 60 s, but for disturbances that recur once per hour for example, 3600 s may also be applicable.

3.5.4.2 Neighboring MARC signal



[sc_configuration_plc_modem_neighbor_marc_signal, 1, --_--]

Setting	Comments
Low transmit ID	Transmitter identification number of lower MARC signal channel neighbour
Lower MARC signal channel	24 - 500 kHz in 0.25 kHz steps MARC signal channel of lower neighbor PowerLink IP device
Upper transmit ID	Transmitter identification number of upper MARC signal channel neighbor
Upper MARC signal channel	24- 500 kHz in 0.25 kHz steps MARC signal channel of upper neighbor PowerLink IP device

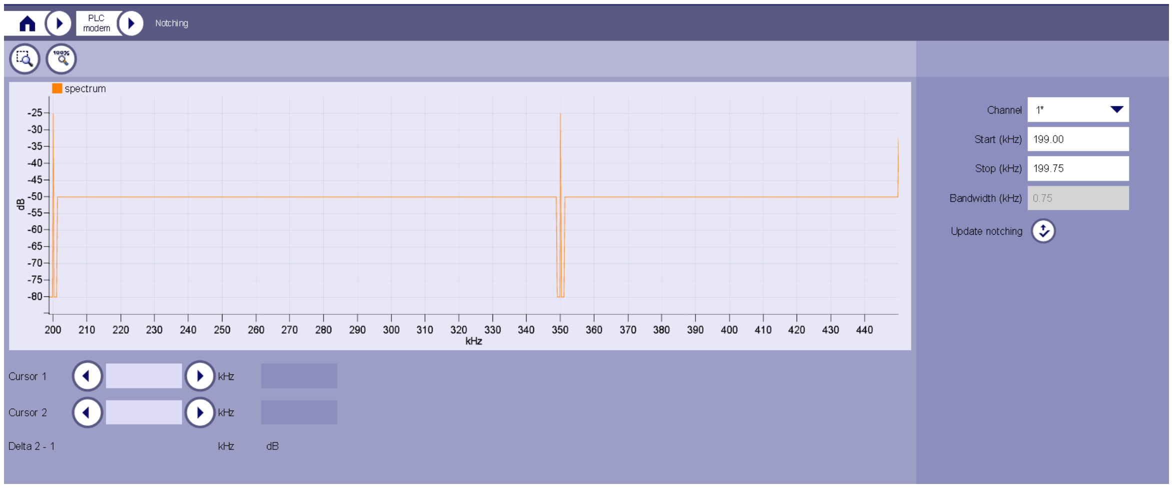
Neighboring PLC must not be confused with **remote** PLC. The remote PowerLink IP system represents the receiving end of the link; its used frequency range may be anywhere in the allowed frequency spectrum. A neighboring PowerLink IP system is defined by its frequency range being adjacent or even overlapping to the used frequency range of the system. The neigboring PowerLink IP system may be located at a neighboring line or section, thus causing potential interference with the system.

3.5.4.3 Notching

Notching is required to ensure coexistence of PowerLink IP with other HV-PLC and radio services. Up to 20 channels can be notched. It is possible to set notches in the whole frequency band.

NOTE

Notch settings on both devices of one link have to be identical. To assure this an export and import functionality for the notches is available.



[sc_configuration_plc_modem_notching, 2, --_--]

Setting	Comments
Channel	Notching channel number 1 - 20
Start (kHz)	Notching start frequency
Stop (kHz)	Notching stop frequency
Bandwidth (kHz)	Notching bandwidth. Stop frequency - Start frequency 0 - 256 (read only)
Update notching	Notch settings are applied to the graphic immediately. A device reset is required after a notch update, to apply it to the modem.

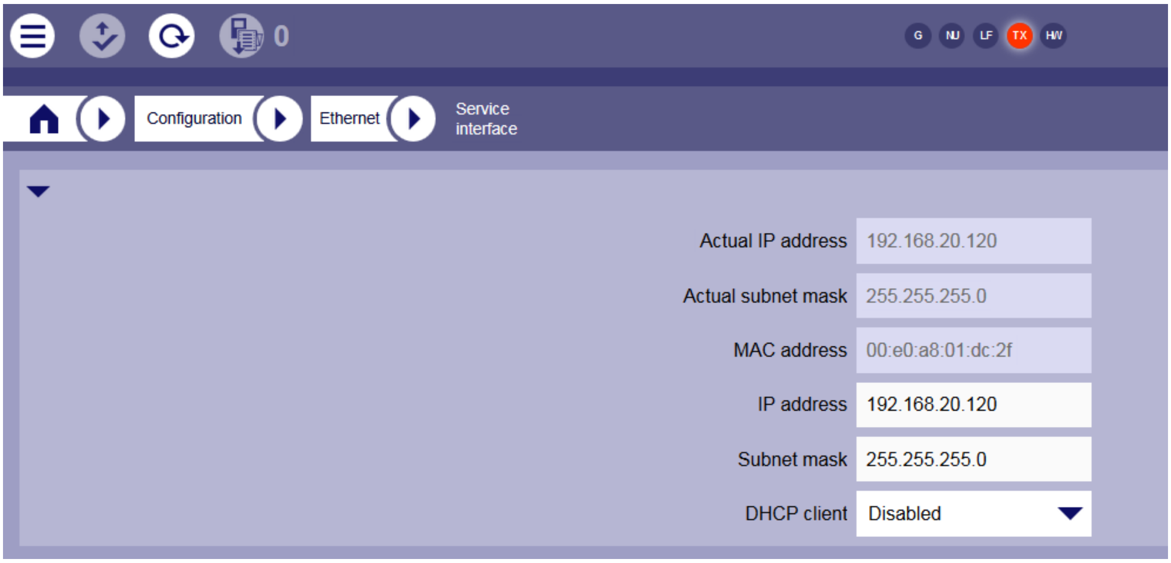
3.5.4.4 Frequency Bar

[sc_configuration_plc_modem_frequencybar, 2, --_--]

Visual display of initial bandwidth, max. bandwidth and MARC channel.

3.5.5 Ethernet

3.5.5.1 Service Interface



[sc_ethernet_service_interface, 2, --_--]

The connection between the service PC and the PowerLink device is done via the 100BASE-TX Ethernet service interface LCT (local craft terminal). The LCT connector is located at the front of the DMB module. The connection is realized by using a standard shielded CAT5e patch cable.

Connection to the device

Default IP address 192.168.20.20

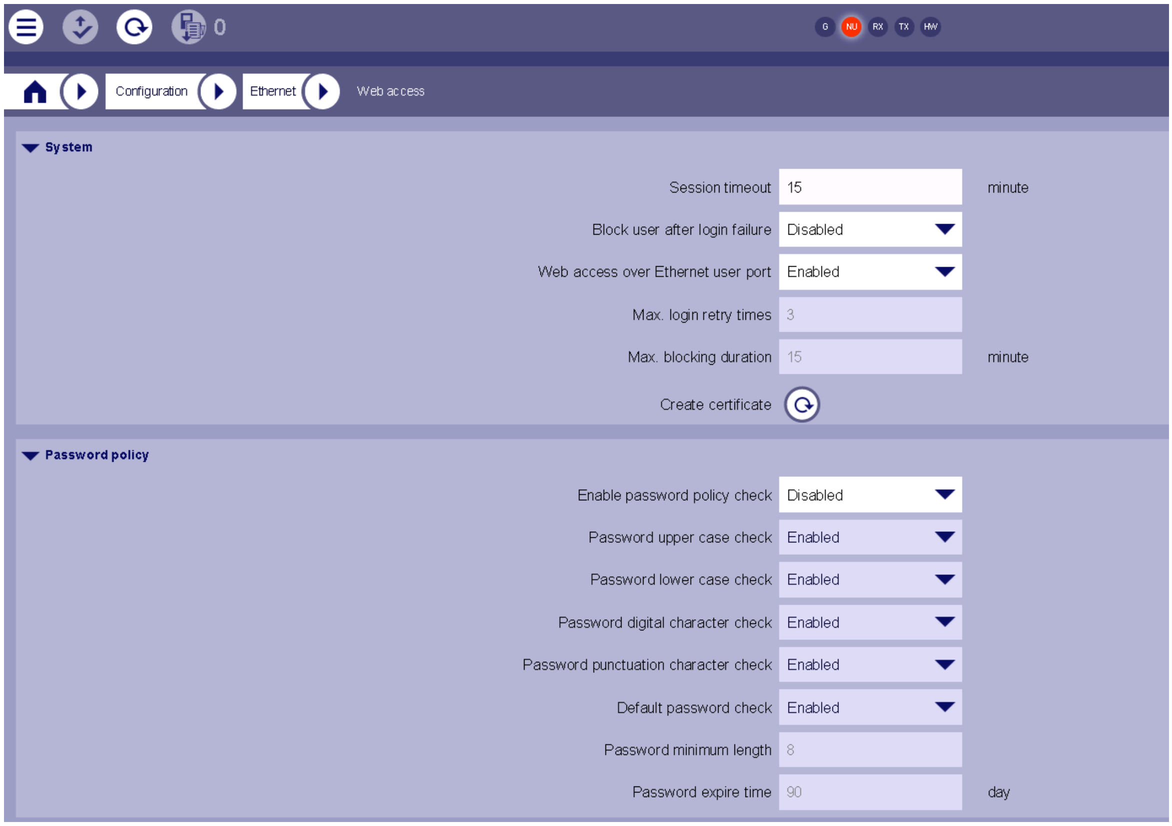
For the initial connection between the service PC and the service interface use the default IP address.

The service PC and the device must be located in the same IP address range.

After entering the IP address in the browser of your service PC you can login to the Web UI to configure the service interface and for information, monitoring and configuration.

Setting	Comments
Actual IP address	Actual IP address of service interface
Actual subnet mask	Actual subnet mask of service interface
MAC address	MAC address of service interface
IP address	User defined ip address of service interface
Subnet mask	User defined subnet mask of service interface
DHCP client	Enable/disable DHCP client

3.5.5.2 Web access



[sc_ethernet_web_access_system, 3, --_--]

Setting	Comments
Session timeout	Time in minutes without user action, before session is deleted and the user is logged out. Max. session time 12 hours.

Blocking after Login failure

Setting	Comments
Enable user login blocking	Enable/disable user blocking after login failure.
User max block time	Time in minutes, before the next login is possible.
User max retry limit	Number of max. allowed login retries.

Web access over Ethernet user port

Setting	Comments
Enable Web access over Ethernet user port	Enable/disable the access (e.g. for security reasons).

Password Policy

Setting	Comments
Enable password policy check	Enable/disable the check of the defined password policy.
Password upper case check	Password must contain at least one upper case char-acter
Password lower case check	Password must contain at least one lower case char-acter

Setting	Comments
Password digital character check	Password must contain at least one digital character
Password punctuation character check	Password must contain at least one punctuation character
Default password check	Enable/disable check, that the password must not be a previous password and must not be one of the predefined passwords (i.e. admin, engineer, viewer, secaud). When activating this option, a user has to change the password immediately after login, if the password matches any of the predefinded passwords. The user will not be allowed to access any other web pages until the password is changed and accepted.
Password mininum length	Minimum password length
Password expire time	Password expire time in days.

Certificate

For the use of the secure HTTPS protocol between device and browser a self signed certificate can be created and manually installed in your used web browser. After the certificate is installed correctly, HTTPS can access the device without any risk warning in the web browser.

At initial use create a certificate with default IP addresses (IP of service interface and/or user interface). A change of IP addresses requires a new creation of the self signed certificate and an import into the web browser.

Setting	Comments
Create Certificate	true/false

NOTE

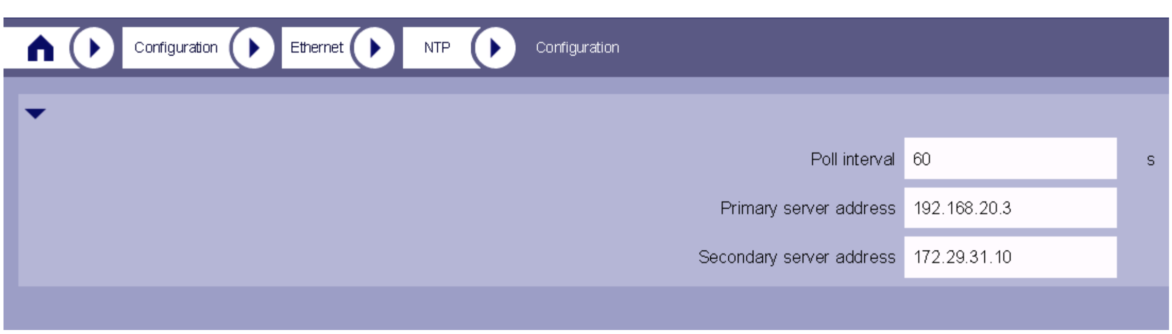
A certificate creation requires a restart of the device.

3.5.5.3 NTP

Configuration

Network Time Protocol (NTP) is a networking protocol to synchronize the clock between an NTP server and the device. No information of time zone or daylight saving time (daylight saving) is provided by NTP, which has to be configured manually in the NTP client.

The Universal Time Coordinated (UTC) received from the NTP server will be adjusted with the setting of local time zone or daylight saving time.



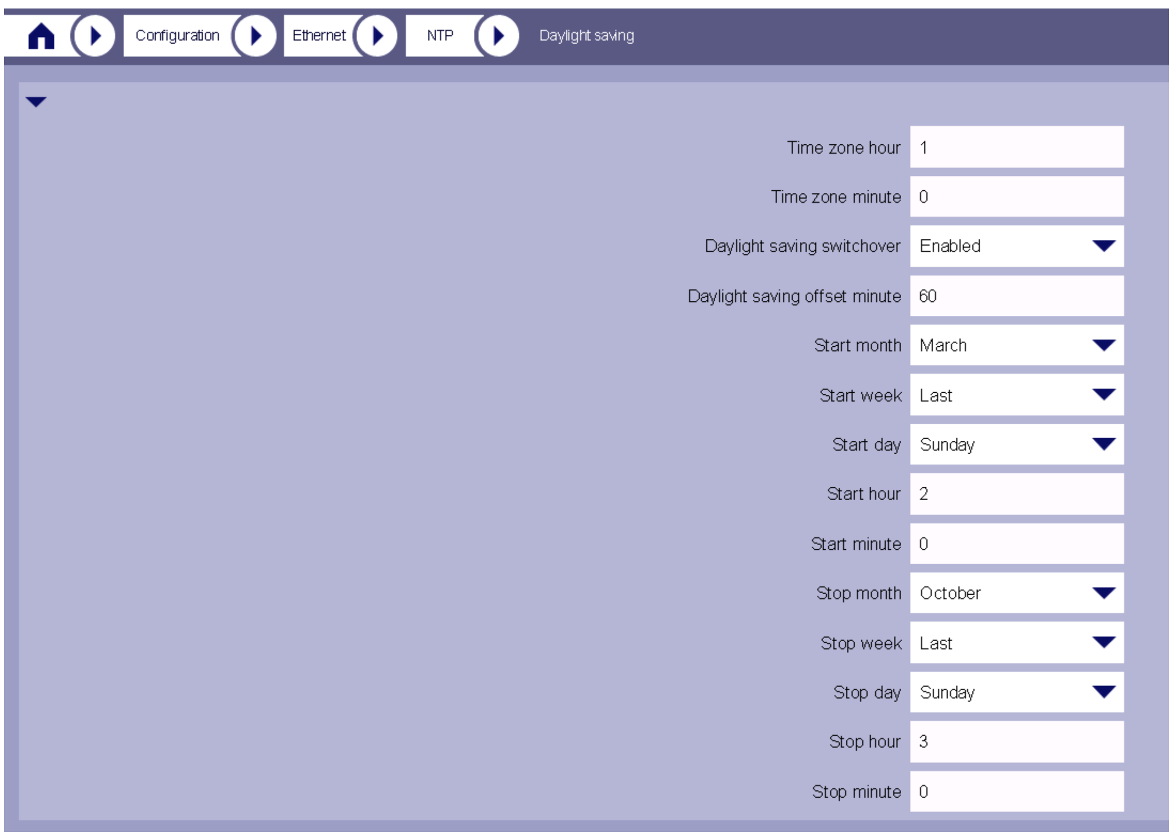
[sc_ethernet_ntp_configuration, 2, --_--]

Setting	Comments
Poll interval	1 - 86400 sec Default: 60 sec It is recommended to use a polling cycle not less than 60 seconds.
Primary server address	actual IP address of primary NTP server Default: 0.0.0.0
Secondary server address	actual IP address of secondary NTP server Only activated if primary server connection is lost. Default: 0.0.0.0

Daylight saving

The Daylight saving time is adjusted automatically according to the configured settings at the defined point of time.

For countries without daylight saving time, set "Switchover" to disabled.



[sc_daylight_saving, 3, --_--]

Setting	Comments
Time zone hour	Time zone offset hours to UTC.
Time zone minute	Time zone offset minutes to UTC.
Switchover	Enable/disable switchover to daylight saving time.
Time offset	Time offset in minutes.
Start month	Start month of daylight saving time.
Start week	Start week of switchover month.
Start day	Start weekday of switchover week.
Start hour	Start hour of switchover

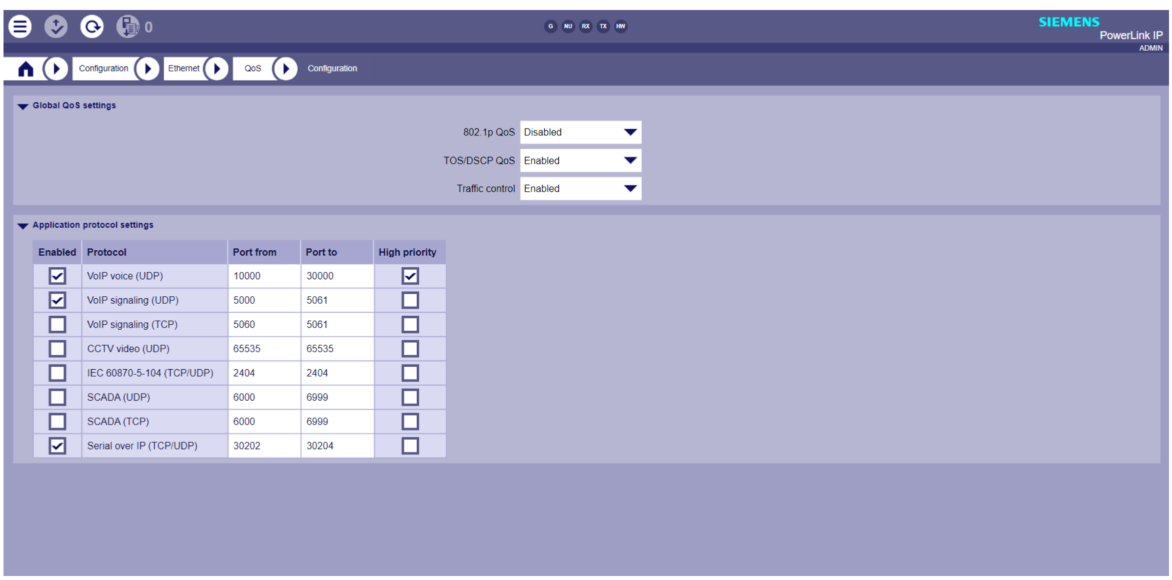
Setting	Comments
Start minute	Start minute of switchover
Stop month	Month for switchback to regular time.
Stop week	Week of switchback month.
Stop day	Weekday of switchback week.
Stop hour	Hour for switchback.
Stop minute	Minute for switchback.

3.5.5.4 QoS

Configuration

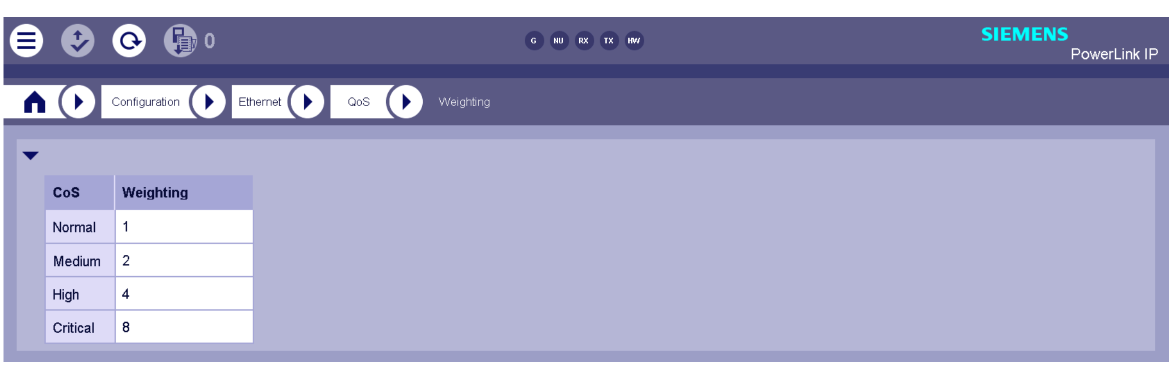
The Quality of Service (QoS) feature consists of a HW QoS and SW QoS processing stage. The HW QoS provides four internal queues to support different traffic classes (Critical, High, Medium and Normal). The traffic classes (TC) can be configured so that higher priority TC experiences less delay than lower priority TC under congested conditions. For PowerLink IP, VoIP (voice over IP) is the highest priority traffic than other traffic by default in the SW QoS processing stage.

The QoS priority of received Ethernet frame is determined from: 802.1p QoS> TOS/DSCP QoS > Traffic control by service protocol.



[sc_ethernet_qos_configuration, 4, --_--]

Weighting



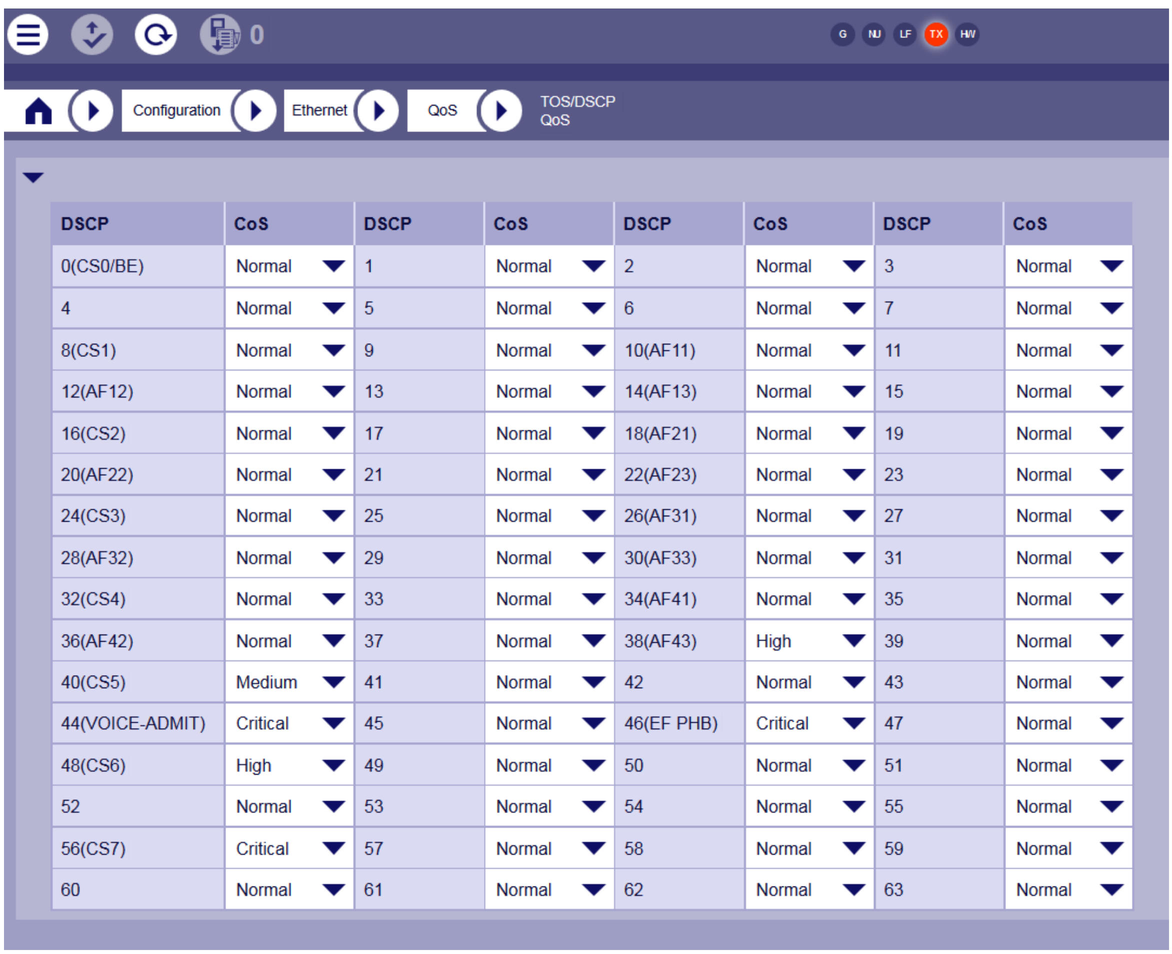
[sc_ethernet_qos_weighting, 2, --_--]

Setting	Comments
Weighting	This parameter specifies the weight for the egress queues CoS 0 - CoS 3. Default: 1:2:4:8 range: 1 to 49

The Ethernet switch egress port serves four transmit queues (CoS 0 normal traffic - CoS 3 critical traffic). The incoming frames are assigned to an egress transmit queue depending on their assigned Traffic class. The high priority TC queues are given greater access to the switch egress port than the lower TC queues.

Ethernet switch uses the Weighted Round Robin (WRR) algorithm for queue scheduling on CoS 0 to CoS 3 queues. It is suggested, that the weight of each queue is CoS3 > CoS 2 > CoS 1 > CoS 0. The default weight value is 1:2:4:8. So for each round, it will send 1 packet from CoS 0, 2 packets from queue CoS 1, 4 packets from queue CoS 2, and 8 packets from queue CoS 3.

TOS/DSCP QoS



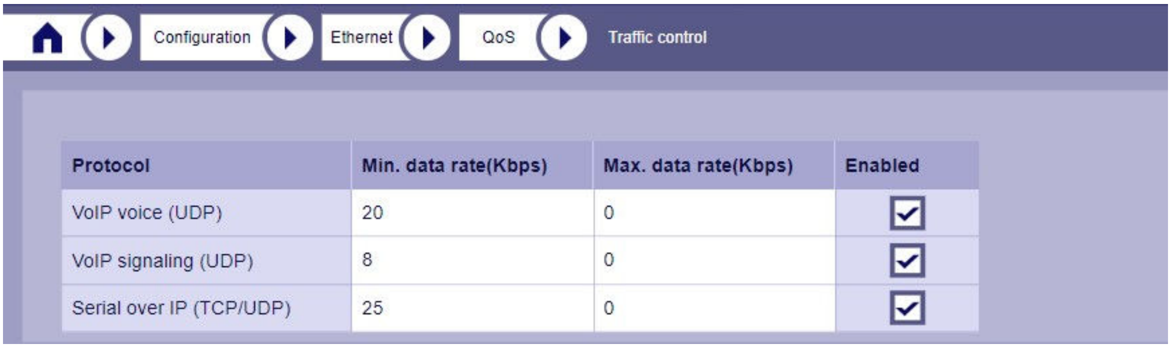
DSCP	CoS	DSCP	CoS	DSCP	CoS	DSCP	CoS
0(CS0/BE)	Normal	1	Normal	2	Normal	3	Normal
4	Normal	5	Normal	6	Normal	7	Normal
8(CS1)	Normal	9	Normal	10(AF11)	Normal	11	Normal
12(AF12)	Normal	13	Normal	14(AF13)	Normal	15	Normal
16(CS2)	Normal	17	Normal	18(AF21)	Normal	19	Normal
20(AF22)	Normal	21	Normal	22(AF23)	Normal	23	Normal
24(CS3)	Normal	25	Normal	26(AF31)	Normal	27	Normal
28(AF32)	Normal	29	Normal	30(AF33)	Normal	31	Normal
32(CS4)	Normal	33	Normal	34(AF41)	Normal	35	Normal
36(AF42)	Normal	37	Normal	38(AF43)	High	39	Normal
40(CS5)	Medium	41	Normal	42	Normal	43	Normal
44(VOICE-ADMIT)	Critical	45	Normal	46(EF PHB)	Critical	47	Normal
48(CS6)	High	49	Normal	50	Normal	51	Normal
52	Normal	53	Normal	54	Normal	55	Normal
56(CS7)	Critical	57	Normal	58	Normal	59	Normal
60	Normal	61	Normal	62	Normal	63	Normal

[sc_ethernet_qos_tos_dscp_qos, 2, --_--]

The Traffic class of packet received from an Ethernet port is assigned to TC configured for the corresponding IP TOS/DSCP.

Setting	Comments
DSCP QoS	This parameter specifies the TC assigned to TOS / DSCP (0...63) Normal, Medium, High, Critical Default: Normal

Traffic control



[sc_ethernet_qos_traffic_control, 4, --_--]

In this menu a min. and max. data rate (kbps) for the traffic class VoIP and serial IP protocol can be set.

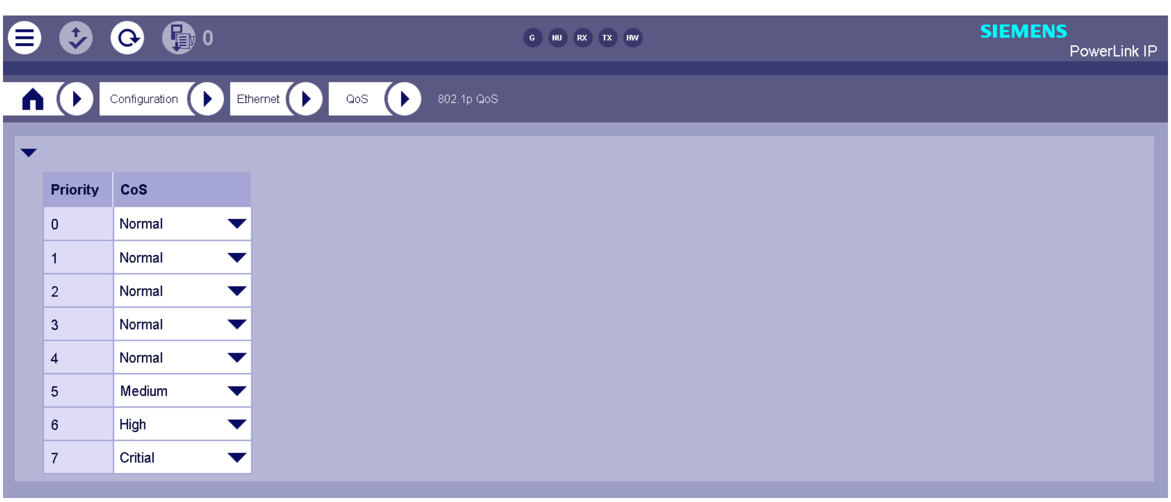
Traffic control recognizes internally UDP destination or source port 5004 to 5019 (default value, changeable) as VoIP packets. Serial IP messages will be detected if carried in either TCP or UDP and destination or source port 30201-30204 (default value, changeable).

The range between the min. and the max. value is guaranteed for the enabled service and only if PowerLink IP has free resources. This reservation is only active if those traffic classes are detected by SW QoS according the UDP and TCP ports and are currently received by PowerLink IP. Otherwise the reserved data rate can be used by other Ethernet data.

If the data rate of traffic class exceeds the given max. value, the exceeding data will be dropped. The max. data rate of other date frames (execpt VoIP and serial IP) is the total current bit rate achieved by PLC Modem minus current VoIP data rate minus current serial IP data rate it is not configurable in Web UI. So other data can use the remaining WAN bitrate if available, otherwise it will be buffered or dropped. VoIP packets, complying to configurable UDP port in PowerLink IP will be sent per default always via the SW QoS High Priority Queue to PLC Modem, without any additional settings in Web UI.

Setting	Comments
Min. data rate	Minimum data rate for VoIP or serial IP. Default: 20 kbps (VoIP voice) / 8 kbps (VoIP signaling)
Max. data rate	Maximum data rate for VoIP or serial IP. Default: 0 (unlimited to max PLC modem data rate)
Enabled	Enable/disable traffic class for VoIP or serial IP

802.1p QoS

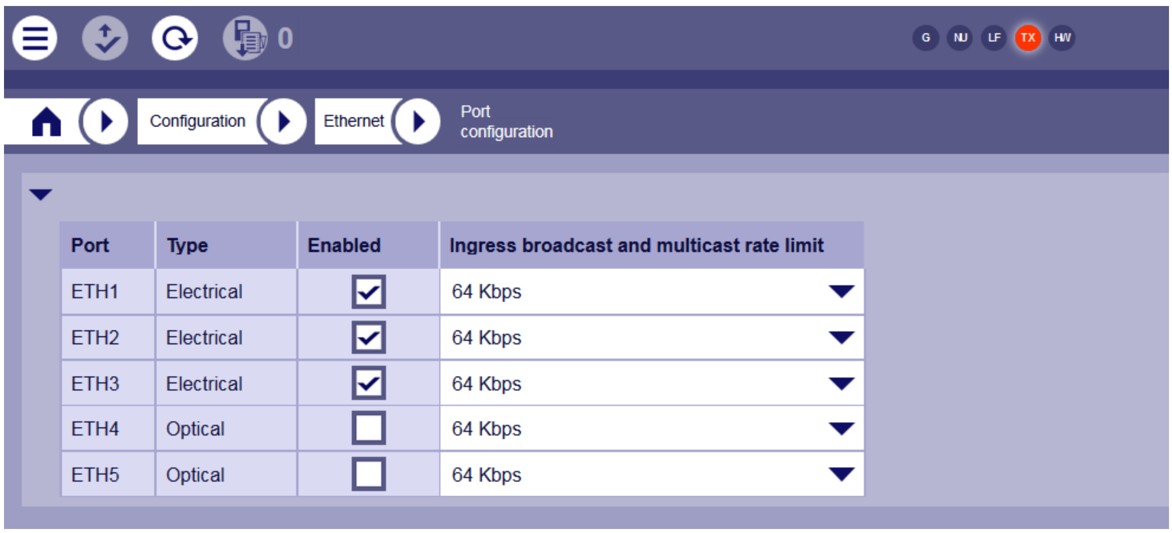


[sc_ethernet_qos_802_1p_qos, 1, --_--]

Four possible Traffic Classes (CoS queues Normal/Medium/High/Critical) are assigned in this menu to the corresponding internal Priorities (0/lowest to 7/highest). "Critical" should be used by all VoIP devices and "High" by all IEC 60870-5-104 RTUs to get HW QoS preferred handling.

Setting	Comments
802.1p QoS	TC assigned with 802.1p priority Normal/Medium/High/Critical Default: Normal

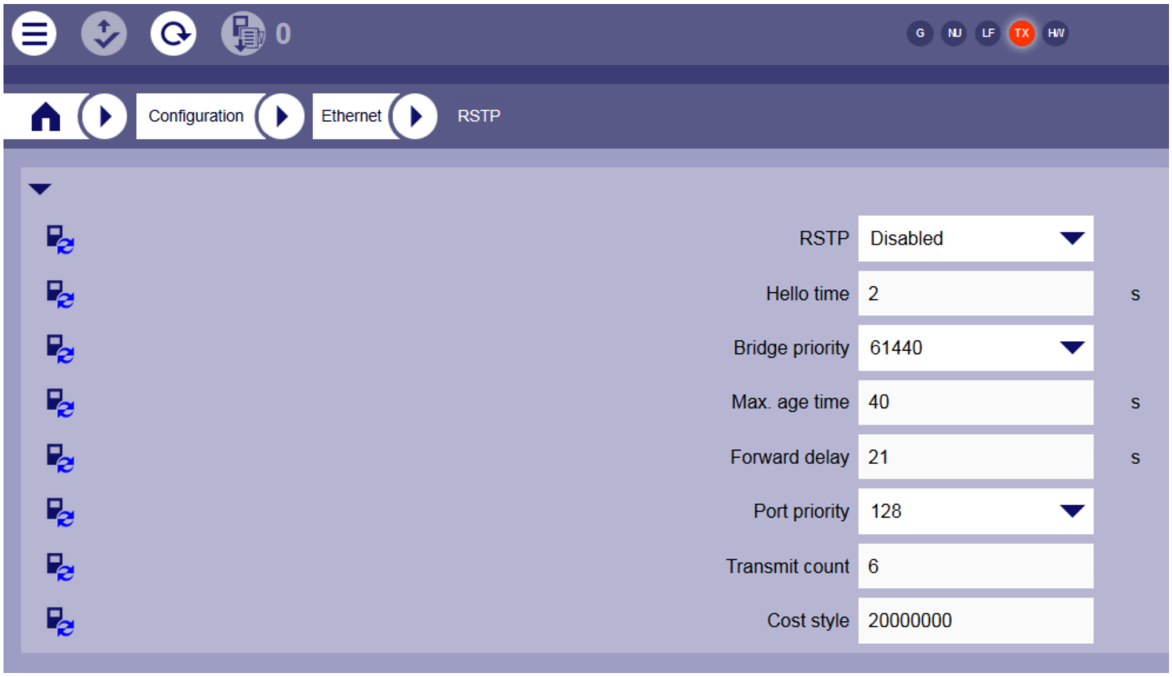
3.5.5.5 Port configuration



[sc_ethernet_port_configuraton, 2, --_--]

Setting	Comments
Enabled	Enable/disable Ethernet port. If the port is disabled, transmit and receive function of Ethernet frames are disabled.
Ingress rate limit	This parameter specifies the ingress bit rate limit of Ethernet port for the following packet types to suppress broadcast and multicast storms: • Broadcast • Reserved multicast MAC address (01-80-C2-00-00-00 to 01-80-C2-00-00-2F) • Multicast lookup failure • Unicast lookup failure no limit/64 kB (kbps) to 4 MB (Mbps)

3.5.5.6 RSTP



[sc_ethernet_rstp, 3, --_--]

The purpose of 802.1D Spanning Tree Protocol (STP) is to build a robust network to prevent loops. The 802.1w Rapid Spanning Tree Protocol (RSTP) provides significantly faster spanning tree convergence after a topology change. RSTP is back-wards-compatible with standard STP.

Setting	Comments
RSTP	disabled/enabled Default: disabled This parameter enables RSTP on Ethernet bridge.
Hello time	1 to 10 s Default 2 s If no BPDU message is received 3 times in a row during the specified max. age time, the connection is considered faulty. The affected port will go into the descarding state, where it cannot receive or transmit data, cannot add MAC addresses to its MAC table and can receive BPDUs only. Permissible values are from 1 s to 10 s (the IEEE 802.1D and IEEE 802.1w standard recommends a default setting of 2 s).

Setting	Comments
Bridge priority	0 to 61440 in steps of 4096 Default: 61440 This value represents a priority for a switch. Every switch in the ring network has a specific user defined priority that has been set equally to 32768 for all switches by default. The bridge priority is preset by the switch manufacturer. Furthermore, this priority is prefixed to the switch MAC address to from the bridge ID (BID) for RSTP root bridge elction process. Lowest bridge ID (BID) among all interconnected RSTP switches in the same layer 2 broadcast domain will elect this switch to the root bridge. A root bridge should always be an external central and powerful switch which should form the root instance of the spanning tree logical topology. PowerLink IP switch should never become a root bridge, so you should set its bridge priority to a higher value then that of the active root bridge. Permissible values are: 0, 4096, 8192, 12 288, 16 384, 20 480, 24 576, 28 672, 32 768, 36 864, 40 960, 45 056, 49 152, 53 248, 57 344, and 61 440.
Max. age time	6 to 40 s Default: 40 s Set a time from 6 s to 40 s. After this time has elapsed, the affected switch port will move to discarding state, where it cannot receive or transmit data, cannot add MAC addresses to its MAC table and can receive BPDUs only.
Forward delay	4 to 30 s Default: 21 s The ports of the switch remain in one of the states discarding, learning or forwarding - not longer than for the time set here. The value shall met following condition: 2 * (forward delay - 1 sec) ≥ max age time.
Port priority	0 to 240 in steps of 16 Default: 128 Every switch port in the same layer 2 broadcast domain has a specific priority that has been set equally for all switches by default. The priority is preset by the switch manufacturer. The port priority is prefixed to the port number to form the port ID. The lowest port priority (identified by 0) yields to higher probability for the port to become an active root or designated port.

Setting	Comments
Transmit count	1 to 10 Default: 6 Maximum number of configuration messages sent for a specific event (structural reconfiguration). This number must exceed the number of existing switches in the ring or interconnected mesh network.
Cost style	4 bytes unsigned integer Default: 20000000 This value represents the speed of the switch ports. Change this value depending on available PowerLink IP WAN bitrate: This value represents the speed of the switch ports. Change this value depending on available PowerLink IP WAN bitrate: 20000000 for 1 Mbps 200000000 for ≤ 100 kbps

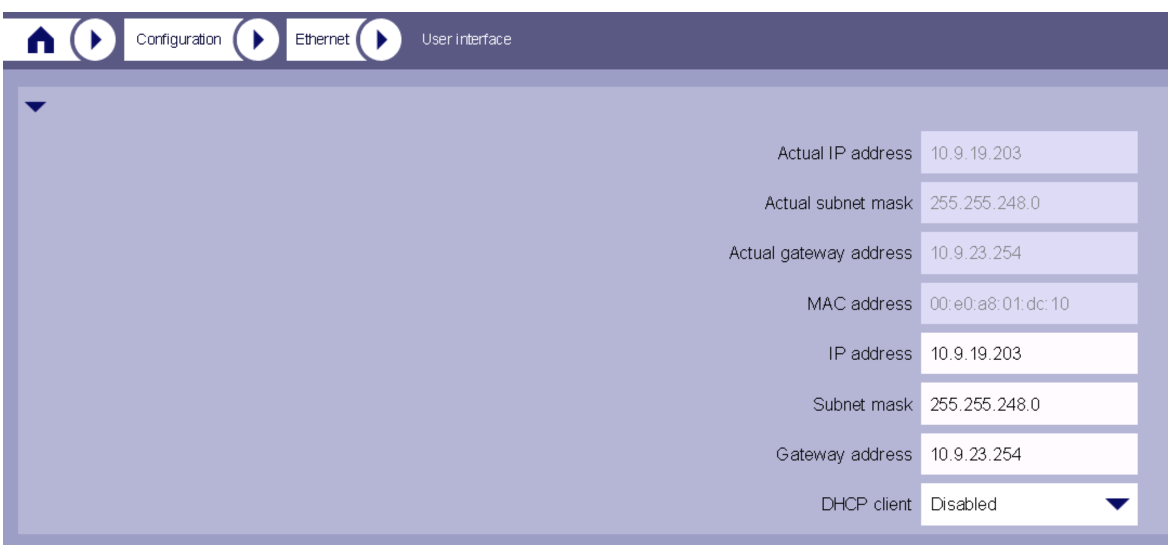
3.5.5.7 User Interface

The connection between a PC/Web UI and the device is done via Ethernet interface. The connectors are located at the front of the DMB module.

Connection to the device

Default User IP address 192.168.30.20

(Note: Default IP address on LCT interface is 192.168.20.20)
For the initial connection use the default IP address.
After entering the IP address in the browser of your PC you can login to the Web UI to configure the user interface and for configuration, supervision and maintenance of the system.



[sc_ethernet_user_interface, 2, --_--]

Setting	Comments
Actual IP address	Actual IP address of user interface
Actual subnet mask	Actual subnet mask of user interface
Actual gateway address	Actual gateway address of user interface

Setting	Comments
MAC address	MAC address of user interface
IP address	User defined IP address
Subnet mask	User defined subnet mask
Gateway address	User defined gateway address (It is needed only if the device is managed remotly from a PC located in a different IP network.)
DHCP client	Enable/disable DHCP client

3.5.5.8 SNMP

SNMP Function

The SNMP agent allows the request of system parameters of the PowerLink IP from a central NMS (Network Management System) via UDP/IP. The SNMP agent provides the status of the PowerLink IP device and transmitts spontaneous alarm indications (traps) to the NMS.

The necessary MIBs are part of the PL IP software package. They have to be integrated in the NMS. After the NMS has been configured, traps from the SNMP agent are received and it is possible to read PowerLink IP and iSWT information.

PowerLink IP device will support following SNMP function:

- SNMP version v1/2c and 3
- SNMP GET command to read status information, alarms, event record, quality data etc.
- SNMP SET command to support setting for standard MIB. It is not support to change the device settings via SNMP, all device configurations are done via Web UI
- SNMP Notification (TRAP / Inform) to inform NMS of alarms. (Inform is a acknowledged trap.) Up to 4 trap addresses can be specified.
- SNMPv3 user management (create / clone user, delete user, restore default user and user password change)
- Private MIB files for PowerLink IP and iSWT

MIB	Comments
SIEMENS-POWERLINK-IP-DMB.MIB	The MIB module which defines the textual convention for the PowerLink IP and PowerLink CM device.
SIEMENS-POWERLINK-IP-DMB-ISWT3000.MIB	The MIB module which defines the textual convention for the integrated SWT 3000 device in PowerLink IP.

- Siemens common product inventory MIB ((DGPI-MIB / DGSM-MIB)

MIB	Comments
SIEMENS-SMI.mib	The Structure of Management Information for Siemens Smart Infrastructure Digital Grid products.
digitalGridProductInventory.mib	Inventory data of Siemens Smart Infrastructure Digital Grid products
digitalGridSecurityMonitoring.mib	Security monitoring of Siemens Smart Infrastructure Digital Grid products

PowerLink IP Read Information

- Device information (e.g. release version info)
- Event Recorder
- Quality data
- Diagnostic status information

- Alarm/error information
- iSWT information
- iSWT event recorder
- iSWT alarm/error information
- iSWT diagnostic status information
- Line fault detection (for PowerLink CM)
- Common product inventory data contains product & components table
- Common security log monitoring

Alarm Trap

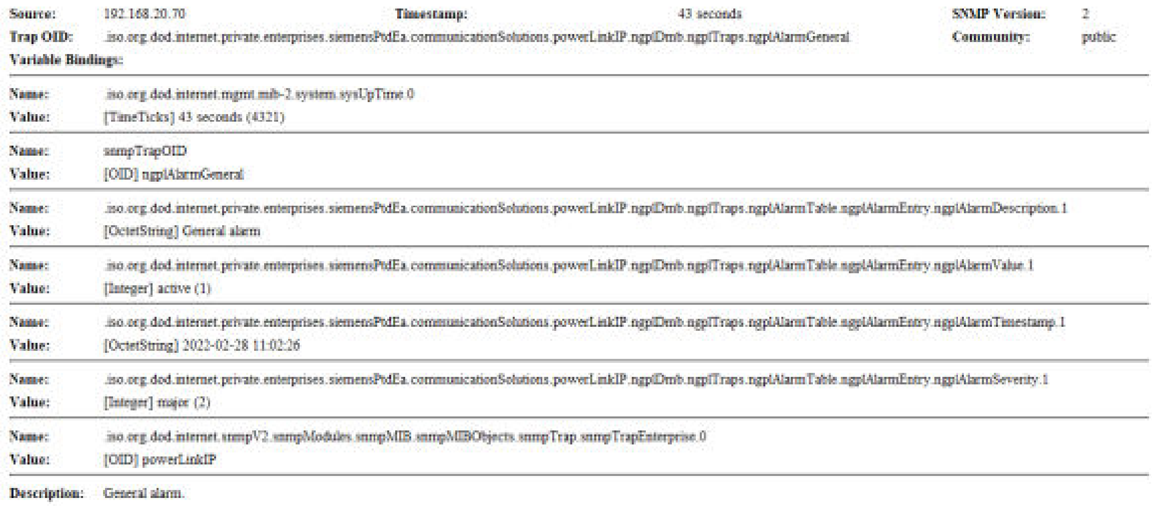
If there is a status change during a configured time range, the alarm state (active or not active) is assigned to each alarm and transmitted to the programmed NMS. The cyclic repetitive alarms within an adjustable time range are transmitted only once. Each alarm contains the severity level and a short description of the alarm.

Alarm table (ngplAlarmTable) contains following device alarm states:

Alarm Index	Alarm Description	Alarm TrapEnabled	Alarm Value	Alarm Timestamp	Alarm Severity
1	General alarm	enabled	noactive	YYYY-MM-DD HH:MM:SS	Major
2	Tx alarm	enabled	noactive	YYYY-MM-DD HH:MM:SS	Major
3	Rx alarm	enabled	noactive	YYYY-MM-DD HH:MM:SS	Major
4	Non-urgent alarm	enabled	noactive	YYYY-MM-DD HH:MM:SS	Minor
5	iSWT General alarm	enabled	noactive	YYYY-MM-DD HH:MM:SS	Major
6	iSWT Rx alarm	enabled	noactive	YYYY-MM-DD HH:MM:SS	Major
7	iSWT Non-urgent alarm	enabled	noactive	YYYY-MM-DD HH:MM:SS	Minor
8	Line fault alarm [PowerLink CM]	enabled	noactive	YYYY-MM-DD HH:MM:SS	Major
9	SYNC loss alarm	enabled	noactive	YYYY-MM-DD HH:MM:SS	Major
10	MARC signal alarm	enabled	noactive	YYYY-MM-DD HH:MM:SS	Major
11	Bit Error Ratio alarm	enabled	noactive	YYYY-MM-DD HH:MM:SS	Major
12	Remote alarm	enabled	noactive	YYYY-MM-DD HH:MM:SS	Warning
13	Guard supervision alarm	enabled	noactive	YYYY-MM-DD HH:MM:SS	Major
14	Authentication alarm	enabled	noactive	YYYY-MM-DD HH:MM:SS	Warning

- alarmTrapEnabled is read-write access for enable or disable alarm trap sending
- alarmValue indicates the state of alarm (active = 1 / not active = 2)
- alarmSeverity indicates the different severity from 1 to 5
- alarmDescription indicates the alarm description for active alarm

When the alarm state is changed from inactive to active or vice versa, the alarm trap is sent out with binding objects in alarm table.


Source: 192.168.20.70 **Timestamp:** 43 seconds **SNMP Version:** 2
Trap OID: .iso.org.dod.internet.private.enterprises.siemensPtdEa.communicationSolutions.powerLinkIP.ngplDmb.ngplTraps.ngplAlarmGeneral **Community:** public
Variable Bindings:

Name: .iso.org.dod.internet.mgmt.mib-2.system.sysUpTime.0
Value: [TimeTicks] 43 seconds (4321)

Name: snmpTrapOID
Value: [OID] ngplAlarmGeneral

Name: .iso.org.dod.internet.private.enterprises.siemensPtdEa.communicationSolutions.powerLinkIP.ngplDmb.ngplTraps.ngplAlarmTable.ngplAlarmEntry.ngplAlarmDescription.1
Value: [OctetString] General alarm

Name: .iso.org.dod.internet.private.enterprises.siemensPtdEa.communicationSolutions.powerLinkIP.ngplDmb.ngplTraps.ngplAlarmTable.ngplAlarmEntry.ngplAlarmValue.1
Value: [Integer] active (1)

Name: .iso.org.dod.internet.private.enterprises.siemensPtdEa.communicationSolutions.powerLinkIP.ngplDmb.ngplTraps.ngplAlarmTable.ngplAlarmEntry.ngplAlarmTimestamp.1
Value: [OctetString] 2022-02-28 11:02:26

Name: .iso.org.dod.internet.private.enterprises.siemensPtdEa.communicationSolutions.powerLinkIP.ngplDmb.ngplTraps.ngplAlarmTable.ngplAlarmEntry.ngplAlarmSeverity.1
Value: [Integer] major (2)

Name: .iso.org.dod.internet.snmpV2.snmpModules.snmpMIB.snmpMIBObjects.snmpTrap.snmpTrapEnterprise.0
Value: [OID] powerLinkIP

Description: General alarm.

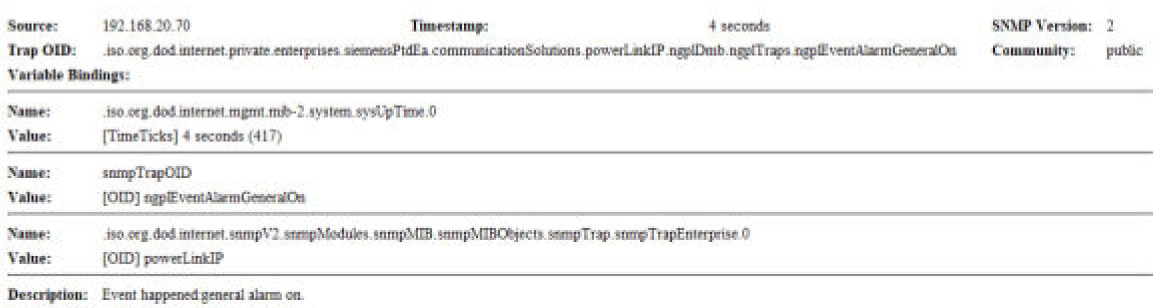
[sc_example_alarm_trap, 1, --_--]

Event Trap

In addition to four alarm traps, the alarm on / off state change event traps are also supported.

Trap OID	Description
ngplEventAlarmGeneralOn	Event happend: general alarm on
ngplEventAlarmGeneralOff	Event happend: general alarm off
ngplEventAlarmTxOn	Event happend: transmit alarm on
ngplEventAlarmTxOff	Event happend: transmit alarm off
ngplEventAlarmRxOn	Event happend: receive alarm on
ngplEventAlarmRxOff	Event happend: receive alarm off
ngplEventAlarmNonUrgentOn	Event happend: non-urgent alarm on
ngplEventAlarmNonUrgentOff	Event happend: non-urgent alarm off
dgpiProdCompTableLastChange	Component change notification from DGPI-MIB (Not supported in PowerLink IP/CM)
dgsmLogAuditNotification	Not supported in the device

Event traps do not have the binding objects of description, severity, timestamp, and alarm value.


Source: 192.168.20.70 **Timestamp:** 4 seconds **SNMP Version:** 2
Trap OID: .iso.org.dod.internet.private.enterprises.siemensPtdEa.communicationSolutions.powerLinkIP.ngplDmb.ngplTraps.ngplEventAlarmGeneralOn **Community:** public
Variable Bindings:

Name: .iso.org.dod.internet.mgmt.mib-2.system.sysUpTime.0
Value: [TimeTicks] 4 seconds (417)

Name: snmpTrapOID
Value: [OID] ngplEventAlarmGeneralOn

Name: .iso.org.dod.internet.snmpV2.snmpModules.snmpMIB.snmpMIBObjects.snmpTrap.snmpTrapEnterprise.0
Value: [OID] powerLinkIP

Description: Event happened general alarm on.

[sc_example_event_trap, 1, --_--]

Enable / disable trap sending

By default, alarm traps are enabled, and event traps are disabled. It can be changed via SNMP set command to following OID:

Trap OID	Description
ngplAlarmTrapEnabled <AlarmIndex>.	Enable(1) / disable(2) individual alarm trap sending
ngplEventTrapEnabled	Enable(1) / disable(2) all event traps sending
dgpiNotificationsEnabled	Determines whether the SNMP agent is sending DGPI notifications. The allowed set value is no(1), yes(2)
ngplActivationReq	storeToFlashAndRestart(1): Apply and store the changes into flash

SNMP Versions

SNMP versions 1, 2c and 3 are supported.

In SNMP version 1 and version 2 a authentication results in a password (community string), which is sent in plain text between the Network Manager and the SNMP agent.

In SNMP version 3 a User-based Security Model (USM) for authentication is implemented. Each user has a name, authentication key and privacy key. MD5 or SHA-1authentication protocol is used. The SNMP v3 agent authenticates the incoming request message with authentication key and rejects the access, if the authentication has failed. The SNMPv3 message data is encrypted and decrypted with privacy key using DES or AES protocol.

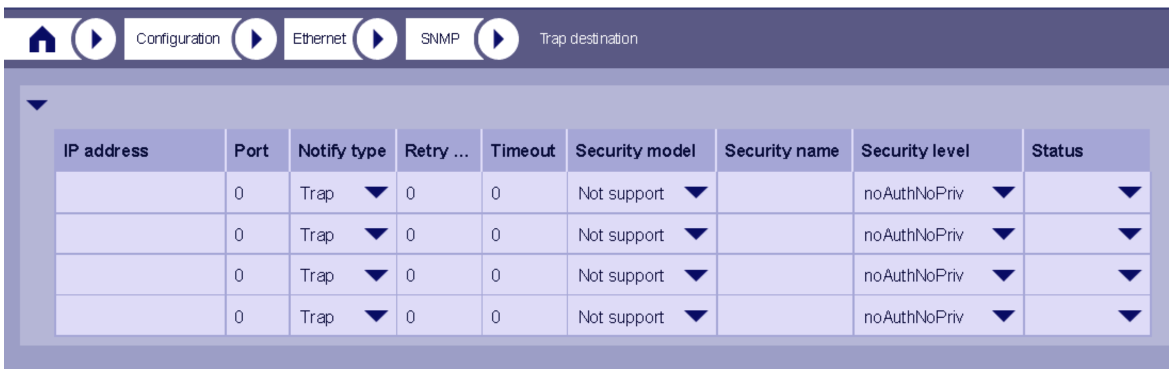
SNMP Configuration

[sc_ethernet_snmp_configuration, 2, --_--]

Setting	Comments
SNMP version	Configure SNMP version • Disabled: Disable SNMP function • SNMP v1/2: Enable SNMP version 1 and 2c • SNMP v3: Enable SNMP version 3
SNMP engine ID	Displays unique identifier of SNMP engine. It contains following parts • Start bit : 0x8000 • Enterprise OID: 0x586E • Indicator for identifier MAC address: 0x03 • Identifier <MAC address>
Read-only community string	Displays the read only community string for SNMPv1/2c GET access. Default: dmbread

Setting	Comments
Read-write community string	Displays the read and write community string for SNMPv1/2c SET access. Default: dmbwrite
Min. active time	Displays the minimum time in seconds that the alarm must be active before a rising trap is sent. It is used for both, SNMP v1/2c and v3. Default: 3
Fall down delay	Displays the minimum time in seconds that the alarm must be inactive before a falling trap is sent. It is used for both SNMP v1/2c and v3. Default: 3

SNMP Trap Destination



[sc_ethernet_snmp_trap_destination, 2, --_--]

Setting	Comments
IP address	IP address of trap destination (NMS) Default: 0.0.0.0
Port address	Default 162
Notify type	Trap: Agent sends SNMP traps to NMS, if an alarm occurs. No acknowledgement is sent from NMS to SNMP agent. Inform: SNMP trap with acknowledgement. If the trap is not acknowledged by NMS, the agent will retransmit it until timeout. Default: Trap
Retry count	This parameter specifies the number of retries in addition to the first transmission, if the SNMP inform message is not acknowledged by NMS. It is only valid for SNMP inform. It is recommended to use a small retry and timeout value. 0 to 10 Default: 1 (means 1+1=2 total transmissions)
Timeout	Time (ms) to wait for acknowledged message from NMS in unit of 10ms. 0 to 10,000 ms Default: 100 (means 100 x 10ms = 1000ms)

Setting	Comments
Security model	This parameter specifies the security module to be generated for sending the notification message. Default: SNMPv2c Possible settings: Not supported, SNMPv2c, USM
Security name	This parameter specifies the security name, which is sending the notification message. If security module is SNMPv2c, it will be communication string of the trap. If security module is SNMPv3, it will be SNMPv3 user name. This user name has to be configured in both agent and NMS in advance. Default: public
Security level	This parameter specifies the security level for sending the notification message. If the security model is SNMPv2c, it is noAuthNo-Priv (No authentication and no Privacy protocol). If the security model is SNMPv3, it is authNoPriv (Authentication and no privacy protocol) or authPriv (Authentication and Privacy protocol) depending on the SNMPv3 user type. Default: noAuthNoPriv Possible settings: noAuthNoPriv, authNoPriv, authPriv
Status	Trap address status. Destroy: The configured trap address will be deleted. Default: “” Possible settings: Destroy, “”

Trap Severity

The alarm severity for alarm on or off might be different. It is possible to configure alarm (on or off) severity in Web UI. Usually, alarm off shall be lower severity, e.g. Normal (5). The active alarm status (on / off) and severity are defined as table object in PowerLink IP MIB file and can be queried by SNMP GET command.

[sc_ethernet_snmp_trap_severity, 3, --_--]

Setting	Comments
Trap on	Configuration of trap on alarm severity.
Trap off	Configuration of trap off alarm severity.
Enabled	Enable/disable alarm trap

User table

The initial SNMPv3 users and password are defined as below table. The working users shall be cloned from these user templates. Up to 10 users can be created. The default password shall be changed and the unused user shall be deleted.

User name	Auth. protocol	Auth. password	Priv. protocol	Priv. password
initial	MD5	cssnmpv3auth	AES	cssnmpv3priv
templateMD5	MD5	cssnmpv3auth	AES	cssnmpv3priv
templateSHA	SHA	cssnmpv3auth	AES	cssnmpv3priv

Setting	Comments
User engine ID	Unique identifier of SNMP engine for the user when creating new user. 1 to 32 characters
Name	User name when creating or cloning a new user. 1 to 32 characters
Auth protocol	Authentication protocol of the user, can be specified only when creating new user. No MD5 (less secure) SHA (more secure)
Auth password	Authentication password when creating a new user. The password shall be confirmed twice before entering it. 8 to 32 characters Default: ---
Auth old password	Old authentication password for password change. If the old password does not match, the password change fails. 8 to 32 characters Default: ---
Auth new password	New authentication password for password change. 8 to 32 characters Default: ---
Priv protocol	Privacy protocol of the user. Can be specified only when creating new user. No DES (less secure) AES (more secure) Default: ---
Priv password	Privacy password when creating a new user. The password shall be confirmed twice before entering it. 8 to 32 characters Default:
Priv old password	Old privacy password for password change. If the old password does not match, the password change fails. 8 to 32 characters Default: ---
Priv new password	New privacy password for password change. 8 to 32 characters Default: ---
User status	Active: The user will be enabled, and can access to SNMP agent. Not in service: The user will be disabled, and can’t access to SNMP agent Destroy: The user will be deleted. Default: Active

Setting	Comments
Clone from	User template, which is used for user cloning. The password and protocol are the same as in the template. All existing user Default: ---
Add user	This parameter triggers the creation of user. The new user will be created or cloned without apply settings. Default: False
Restore default user	The default user template with default password will be restored. All new created users will be deleted.(It can be used if you forgot the password.) Default: False

3.5.5.9 Firewall

The firewall module embedded in the device can filter received network packets to prevent the transmission of specified communication packets of the local network to the device´s network.

[sc_ethernet_firewall, 3, --_--]

Setting	Comments
Firewall enabled	Enabled/disabled firewall function
Internet Protocol Version 4 (IPv4)	Accept/Drop blocking of received Internet Protocol Version 4 network packets
Internet Protocol Version 6 (IPv6)	Accept/Drop blocking of received Internet Protocol Version 6 (IPv6) network packets
GSE (IEC 61850-8-1)	Accept/Drop blocking of received GSE(IEC 61850-8-1)network packets

Setting	Comments
GOOSE (IEC 60850-8-1)	Accept/Drop blocking of received GOOSE (IEC 60850-8-1) network packets
SV (IEC 61850-9-1)	Accept/Drop blocking of received SV (IEC 61850-9-1) network packets
VLAN Tag	Accept/Drop blocking of received network packages with VLAN tag
PPP over ethernet (Discovery Stage)	Accept/Drop blocking of received PPP over ethernet (Discovery Stage) network packets
PPP over ethernet (PPP Session Stage)	Accept/Drop blocking of received PPP over ethernet (PPP Session Stage) network packets
Address Resolution Protocol (ARP)	Accept/Drop blocking of received Address Resolution Protocol (ARP) network packets
Reverse Address Resolution Protocol (RARP)	Accept/Drop blocking of received Reverse Address Resolution Protocol (RARP) network packets

3.5.5.10 Port security

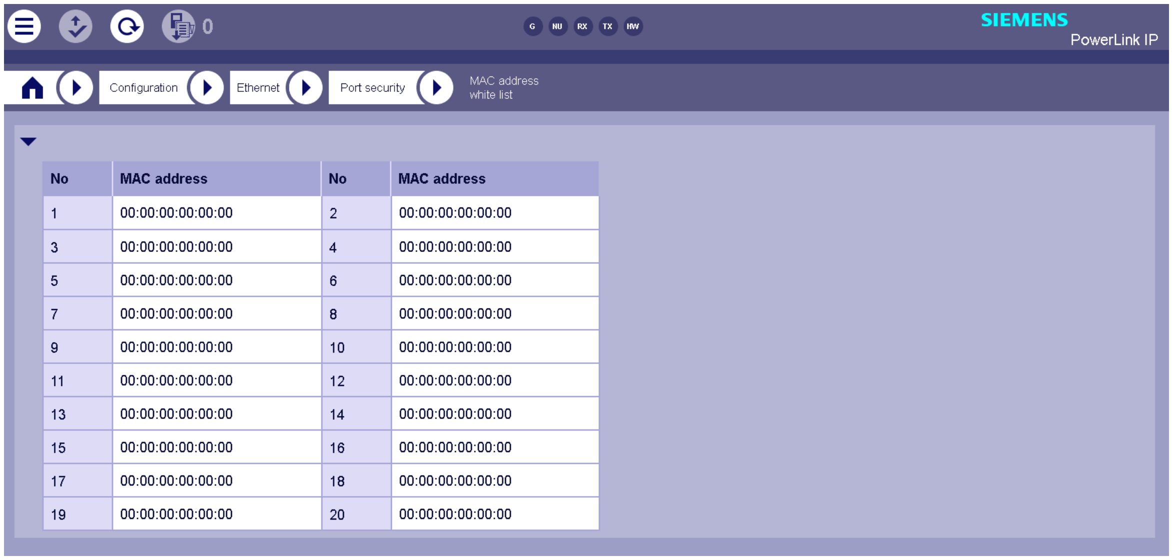
The view defines the static MAC address list which is allowed to access local or remote device from user port. Ethernet frames not in the white list are rejected.

Configuration

[sc_ethernet_port_security_configuration, 3, --_--]

Additionally, ports can be individually enabled / disabled. Please refer to chapter *3.5.5.5 Port configuration* for further details.

MAC address white list



[sc_ethernet_port_securit_mac_address_whitelist, 1, --_--]

Setting	Comments
Port security	Enable/disable port security on SW layer 2 bridge to protect the WAN port from undesired traffic. Port security is enabled via MAC address white list. Specified addresses are allowed to access the WAN port in local device. Note: MAC address white list is not supported for service port (LCT)
MAC address	MAC address white list, up to 20 MAC addresses can be specified.

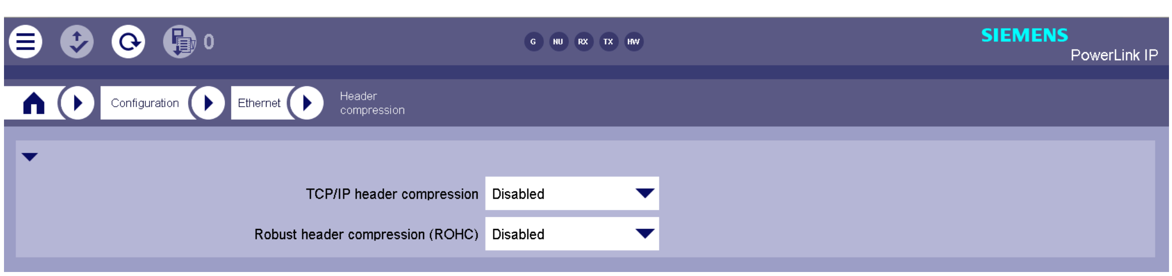
3.5.5.11 Header compression

Header compression is the process of compressing excess protocol headers before transmitting them on a link and decompressing them to their original state upon reception.

TCP / UDP header compression only for enabled QoS application protocol (See Web UI > Configuration > Ethernet > QoS > Configuration).

PowerLink IP supports RFC 1144 and RFC 3095 header compression standards:

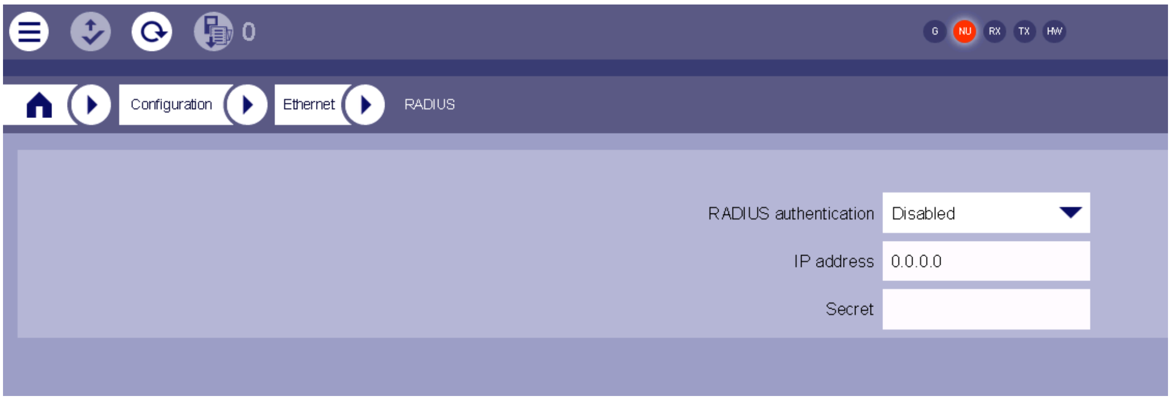
- RFC 1144: Header compression for low-speed serial links
- RFC 3095: **Robust Header Compression** (ROHC) is a highly robust and an efficient header compression scheme for RTP/UDP/IP, UDP/IP, and ESP/IP headers.



[sc_ethernet_header_compression, 1, --_--]

Setting	Comments
TCP/IP header compression	enable/disable TCP/IP header compression for low-speed serial links (RFC 1144)
Robust header compression (ROHC)	enable/disable robust header compression (RFC 3095)

3.5.5.12 RADIUS



[sc_configuration_ethernet_radius, 1, --_--]

RADIUS (Remote Authentication of Dial In User Service) provides a service for user authentication.

When RADIUS is enabled, the user management and authentication are performed on the RADIUS server. Otherwise, it is performed on the local device.

If the RADIUS server is out of service, the local user still can be used as emergency account to login to the device successfully.

Setting	Comments
RADIUS authentication	Disabled: Only the users of the device can log on Enabled: User authentication by the remote server Default: Disabled
IP address	Default: 0.0.0.0 IP address of RADIUS server
Secret	String Default: empty Security for RADIUS connection. Secret has to have the same value as configured on RADIUS server. The secret key has to be definded by the customer during commissioning.

IEC 62351-8 standard roles defined in RADIUS are mapped to 4 roles in the device.

Roles on RADIUS server	Roles on Device
GUEST VIEWER	VIEWER
OPERATOR ENGINEER INSTALLER	ENGINEER
SECAUD SECADM	SECAUD
ADMIN RBACMNT	ADMIN

Multi-role is available. The user on the RADIUS server can be configured with several roles, and the device recognizes the role info and displays the accordant Web UI view.

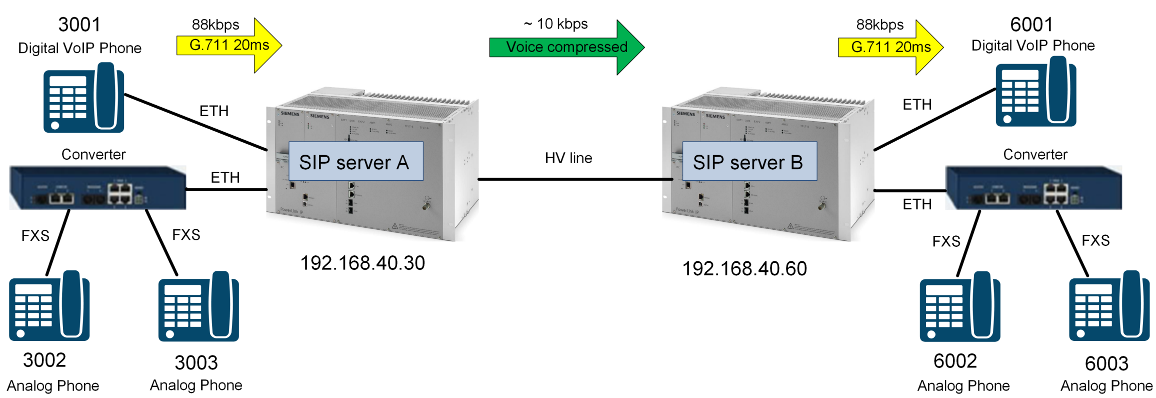
3.5.5.13 Voice Compression using SIP Server

The Session Initiation Protocol (SIP) is a signaling protocol used for initiating, maintaining, and terminating real-time sessions that include voice, video, and messaging applications.

The SIP server is an intermediary entity for the purpose of performing requests, which integrated into PowerLink IP plays the role of call routing. In addition, the function of voice compression in SIP server can provide more VoIP channels in less bandwidth. For instance, the bitrate of one VoIP voice call with G.711 codec can be compressed from 88 kbps to approximately 10 kbps (Robust header compression (ROHC) is enabled).

External telephony devices connected into PowerLink IP are SIP endpoint performing as registrars.

An example for compressed VoIP communication via SIP server is shown in *Figure 3-7* below. A digital VoIP phone registers into SIP server A via SIP account, e.g.3001, which can perform a local call with other registrars, e.g. analog phone connected media converter which has account name 3002. In addition, the phone can also perform a remote call after an address book item appended into SIP server A. For example, a remote digital phone has already registered into SIP server B via SIP account name 6001, so the item in address book of SIP server A consists of 6001 as dial number and 6001@192.168.40.60:5060 as Uniform Resource Identifier (URI). Meanwhile the Ethernet packet of VoIP voice stream between endpoints is compressed through high voltage line.



[sc_example_voip_communication, 2, --_--]

Figure 3-7 Example for VoIP communication

SIP server configuration is in Configuration > Ethernet > SIP server.

SIP account and Address book are visible only when SIP server is enabled in configuration.

[sc_configuration_ethernet_sipserver, 1, --_--]

Table 3-2 Configuration

Setting	Comments
SIP server	Allowed values: Disabled, Enabled Default: Disabled This parameter specifies if SIP server is enabled.
Port	Allowed values: - Default: 5060 (read-only) This parameter displays the transport port number for SIP signaling.
Transport	Allowed values: - Default: UDP (read-only) This parameter displays the transport type for SIP signaling.
Voice compress	Allowed values: Disabled, Enabled Default: Enabled Enables the voice compression for all VoIP and analog voice ports.
SIP log level	Allowed value: Disabled, Level 0-8 Default： Level 0 Enable verbose log level for SIP server. Higher number means more detailed log.

Up to 4 SIP accounts can be specified. External telephony devices registering with SIP server use SIP protocol for creating and terminating sessions between the points that have SIP accounts. For instance, when one subscriber makes a phone call to another subscriber, this means that a media session is created between two SIP accounts.

Table 3-3 SIP account

Setting	Comments
Account name	Allowed values: 0 to 30 characters Default: This parameter specifies SIP account login name. PowerLink IP devices support only strings that consist of digits (0...9) for account name.
Account password	Allowed values: 4 to 32 characters Default: This parameter specifies SIP account login password.

Up to 16 address book items can be specified. Each item associates a dial number with SIP URI which consists of account name, IP address, transport port number (account@ip:port).

Only calls between phones that are registered with the respective SIP server in each PowerLink IP device will use voice compression as described above.

Table 3-4 Address book

Setting	Comments
Dial number	Allowed values: 0 to 30 characters Default: This parameter specifies SIP dial short number. The dial number support only strings that consist of digits (0...9).
Account name	Allowed values: 0 to 30 characters Default: This parameter specifies SIP account name of URI.
IP address	Allowed values: xxx.xxx.xxx.xxx Default: 0.0.0.0 This parameter specifies IP address of URI
Port	Allowed values: 1024 to 65535 Default: 5060 This parameter displays the transport port number of URI.
Transport	Allowed values: Default: UDP (read-only) This parameter displays the transport type using by URI.

3.5.5.14 Remote Log

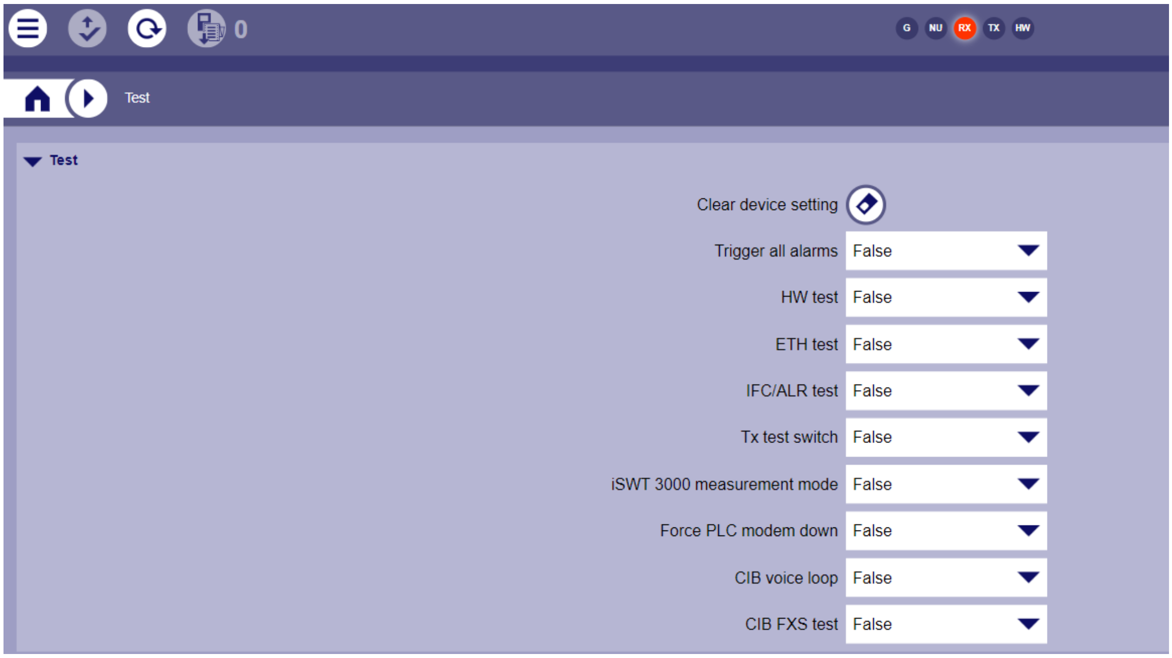
The product supports UDP-based logging of secure log message datagrams to remote log server.
Up to two server IP addresses can be configured.

Server IP	Port	Transport
0.0.0.0	514	Disable
0.0.0.0	514	Disable

[sc_remote_log, 1, --_--]

Setting	Comments
Server IP	Default: 0.0.0.0 This parameter specifies the remote log server IP address.
Port	Allowed values:0 - 65535 Default: 514 This parameter specifies the transport port number.
Transport	Allowed values: Disabled, UDP Default: Disabled Only UDP protocol can be selected to enable remote log transmission.

3.5.6 Test



[sc_commissioning_test, 3, --_--]

Test

A test influences the normal working conditions. Transmitted frequencies or activation of command inputs can cause wrong commands at the output of the remote device. For iSWT tests, command outputs have to be disconnected from the protection relay.

For test purposes the generated signal of the PLC modem (also in signal generator mode) can be observed at the TX_OUT jack. Nominal level is -17 dB into 150 Ohm. When enabling the TX_IN port it is possible to inject an external signal into the TX path, which is added to the internal signal. Level is -17 dB into 150 Ohm for nominal output power of 50 W (or 100 W for a 100 W system). For normal operation "TX test switch" must be disabled and TX_IN must be left open. Connecting a cable to TX_IN even without an external generator can introduce noise into the TX path, which degrades the system performance.

Setting	Comments
Clear device setting	Previous settings are erased from flash
Trigger all alarms	For development purpose only. Device shall be reset after test.
HW test	Automatic HW test, verify the test result in event log For development purpose only. Device shall be reset after the test.
ETH test	Transmits ETH packets, verify received ETH packets in the event log
IFC/ALR test	Transmits binary commands, verify received command counter in event log
Tx test switch	Disables/Enables TX-IN port on the backplane of the device (for example, for external signal generator). Must be disabled for normal operation.
iSWT measurement mode	Command input limitation time (default 1 s) will be bypassed. Command frequency is always transmitted. For test purpose only, after leveling measurement is done, it has to be switched off manually.
Force PLC modem down	Turn off PLC modem

Setting	Comments
CIB voice loop	Enable voice PCM local loop for internal test only. Voice port LED is slow blinking.
CIB FXS test	Start FXS measurement for internal test only

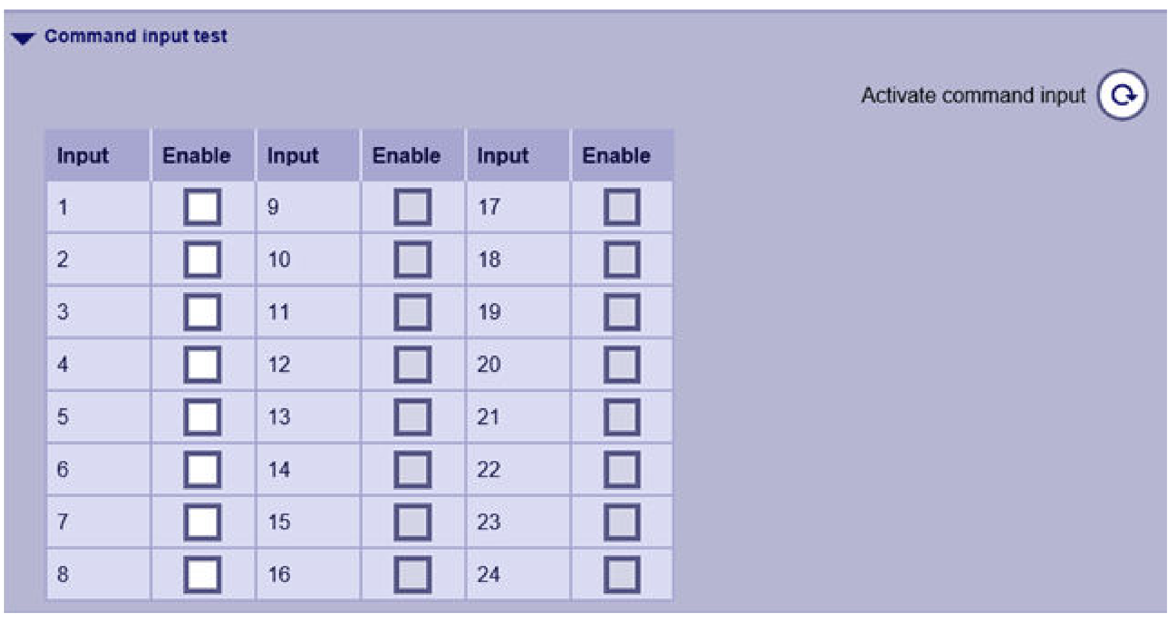
Command Input Test

Command input test is a test function to verify command input / output during the commissioning phase. It must be switched off in normal operation. To avoid unwanted command by incident, the command input test can only be enabled when:

- IFC-Test mode configured (GEN alarm activated)
- PU4 switch S3.4 is enabled for test purpose

If the command input test is enabled, command input from IFC or EN100 port is ignored. Instead, the input from the test page is assigned to a protection frequency and transmitted as in normal operation.

The command input test page is only available when iSWT is active. Any command input combinations can be triggered on by enabling the corresponding inputs and then clicking ‘Activate command input’ button. Disable all command inputs and click ‘Activate command input’ button will trigger all commands off.



[sc_command_input_test, 1, --_--]

NOTE

Any test command input should work according to the actual configuration. For example, if mode 3a is selected, only input 1 to 4 can be transmitted.

Another example, if command 1 is not assigned to a valid input port in input command allocation, command 1 will never be sent.

3.6 Measurement

3.6.1 Signal generator

The signal generator offers the possibility to generate test signals to check the functionality of the HF TX and RX path within the PowerLink IP device, or to qualify the transmission path to the remote device.

It is possible to change the level of the test signal as well as the start and stop frequencies of the test signal.

In the graphical display of the spectrum, the X-axis is frequency (kHz) and Y-axis is received signal magnitude (dB).

To place a cursor click in the area below the x-axis. For fine positioning of the cursor (i.e. to navigate through the single data points) use the cursor buttons.

The windowing function is selectable to adapt the spectral display to certain measurement needs (frequency vs. amplitude accuracy). The user can get an overview of the whole frequency range as well as viewing details when zooming in. If the view is zoomed, the center-frequency has to be configurable to select the appropriate frequency window.

It is possible to apply averaging to reduce noise in the measured spectra. The number of averaged measurements is configurable. To identify the occasional appearance of signals a peak hold function is available. Both, averaging and peak hold are resetable.

To determine the exact frequency / level values of certain measurement points, two cursors are available. The cursors can be moved along the available data points (NOT the pixels). The coarse positioning of the cursors is done by mouse. Fine positioning is done with cursor keys. The current cursor positions and the differences between the two cursors are displayed below the spectrum chart.

Changed parameters take effect immediately without apply setting. The spectrum display is updated automatically twice per second.

[sc_signalgenerator, 2, --_--]

Setting	Comments
On	Start/stop signal generator
Peak hold	Start/stop peak hold
Averaging	Start/stop averaging

Signal generator

Setting	Comments
Start / stop signal generator	**Activation of the signal generator may cause unwanted commands and interrupt data transmission.** A warning of test mode ON is displayed and it triggers a general alarm ON.
Select the output wave form	Muted (Default): no signal is generated Sine: a single sine signal is generated; frequency and amplitude are configurable Dual sine: two sine signals are generated; frequency and amplitude are individually configurable for each signal Triple sine: three sine signals are generated; frequency and amplitude are individually configurable for each signal Sweep: a swept sine signal is generated; start and stop frequency, signal amplitude and sweep time are configurable Filter analyzer: mode to qualify the TFLT; this mode has to be used in conjunction with a dummy load connected to the PL IP´s HF terminal Reflection: for development use only
Set the output level	Set the output level for the generated wave form(s). -100.0 dB to 0.0 dB Default: -20 dB
Set the wave form’s frequency (frequency range)	Set the frequency for the generated wave form(s). 0 to 512,000 Hz Default: 30,000 Hz
Set sweep signal’s start and stop frequencies	Start and a stop frequency input field. Frequency f1 might be smaller or bigger than frequency f2 (f1=f2 is possible too, but makes no sense). 0 to 512,000 Hz Default: 30,000 / 35,000 Hz
Set sweep time	This parameter specifies the sweep time. The sweep time increment is 100 us. 0.1 to 10,000 ms Default: 1000.0 ms

NOTE

Generator mode can generate frequencies, which may release a trip command of iSWT and/or extended teleprotection equipment connected to other PLC.
The Ethernet data transmission via PLC link is interrupted.

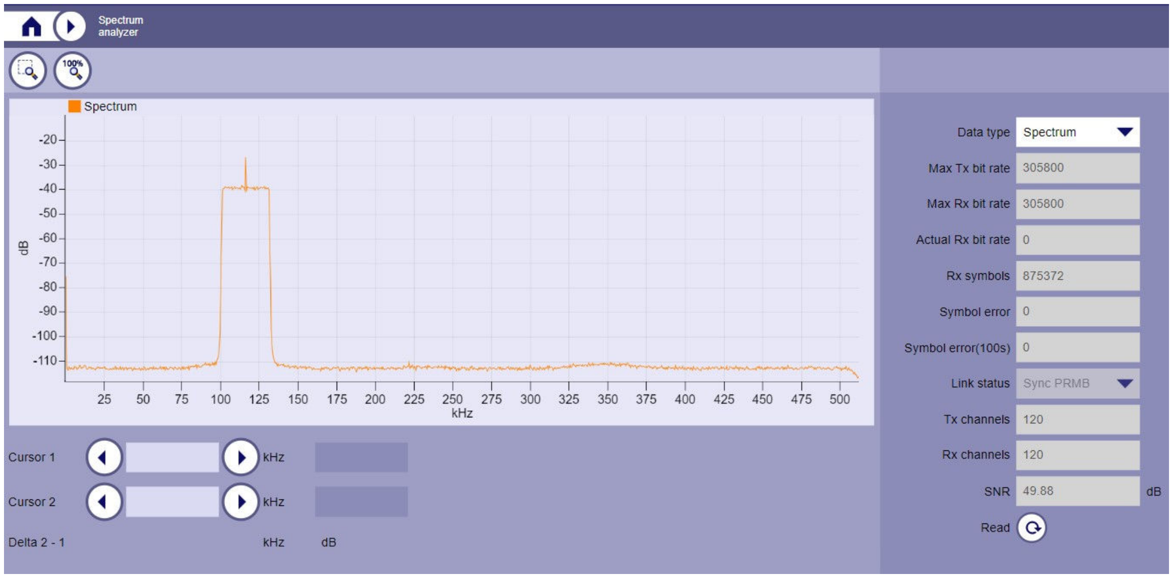
Setting	Comments
Set center frequency	kHz The center frequency is in the middle of the chart. For zoom factors x2 and x4 the center frequency can be adjusted to move the visible window.
Set zoom factor	Spectrum is zoomed. For zoom factors x2 and x4 the center frequency can be adjusted to move the visible window Possible zoom factors of spectrum: • x1 • x2 • x4
Set number of averaged spectral measurements	A moving average is applied to the spectral measurements. Possible values range from 0 (no averaging) to 255 (infinite averaging). Each calculated FFT result is evaluated (independently of the display update interval). Default: 50
Reset the averaging memory (if averaging is active)	Restart averaging
Activate peak hold	Peak level of each individual frequency is captured and displayed. Each calculated FFT result is evaluated (independently of the display update interval).
Set Fast Fourier Transformation (FFT) window function	Rectangular (remarkable scalloping loss and reduced dynamic range) Hanning (increased side lobe roll off, increased frequency measurement accuracy) Blackman (increased side lobe roll off, increased level measurement accuracy) Default: Hanning
Set cursor 1 / 2 position	The selected cursor is displayed at the expected position. Absolute cursor values (x/y) are displayed. Relative cursor values (dx/dy) to the other cursor(s) are displayed. Cursor moves along the data points (not the pixels). Cursor position is changed using the mouse (coarse positioning) and / or keyboard keys / soft keys (fine positioning, one hit steps one data point).

3.6.2 Spectrum analyzer (optional)

The analyzer allows to measure the spectrum of the signals on the HV (high voltage) line.

To determine the exact frequency / level values of certain measurement points two cursors are available.

The cursors may be moved along the available data points (NOT pixels). The coarse positioning of the cursors are done by mouse of the Web UI terminal. A fine positioning of the cursor is done with cursor keys or soft keys. The current cursor positions and the differences between the two cursors are displayed below (above, inside) the spectrum chart.



[sc_spectrumanalyzer, 3, --_--]

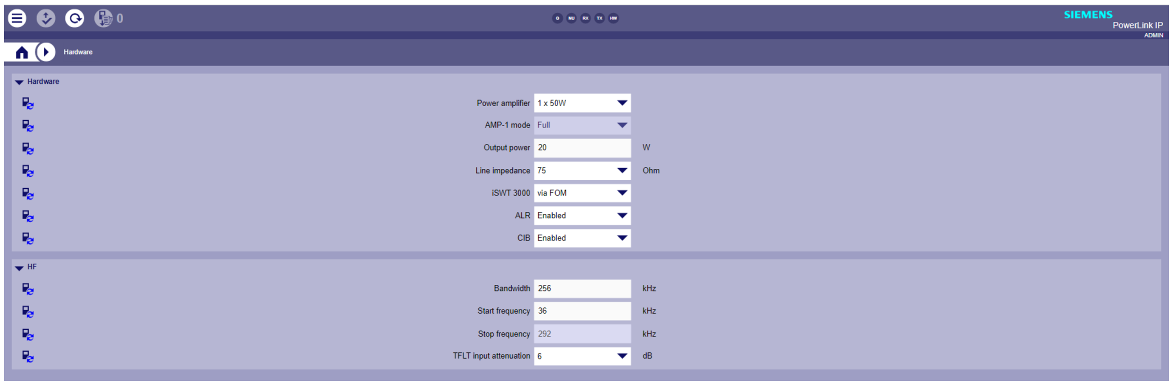
Setting	Comments
Data type	Type of Graphic that shall be displayed available graphic types: Spectrum Received bits/error bits Gc |Gest()| Angle(gest()) AM Bps SNR in channels SNr in the time domain Processor load
Max Tx bit rate	Max transmit bit rate by PLC modem
Max Rx bit rate	Max receive bit rate that is transmitted from remote PLC device.
Actual Rx bit rate	Actual receive bit rate that is transmitted from remote PLC device. The value is calculated when selecting chart data type "Received bits/error bits".
Rx symbols	Number of symbols received since last sync. If synchronization is stable, exactly 200 symbols per second will be received.
Symbol error	Number of errored symbols, received since last sync.
Symbol error (100s)	Number of errored symbols, received in last 100 seconds.
Link Status	PLC modem link status • Startup: No MARC signal transmission • NO Sync: MARC signal is transmitted • Sync PRMB: MARC signal and a synchronization preamble have been transmitted • TxDATA: MARC signal and data are transmitted

Setting	Comments
Tx channels	Number of channels that are used for data transmission (each channel has a bandwidth of 250 Hz)
Rx channels	Number of channels on which data is received (each channel has a bandwidth of 250 Hz)
SNR	Average SNR of the received signal over the complete bandwith
Read	Button to update the above parameters

3.7 CIB

3.7.1 Voice

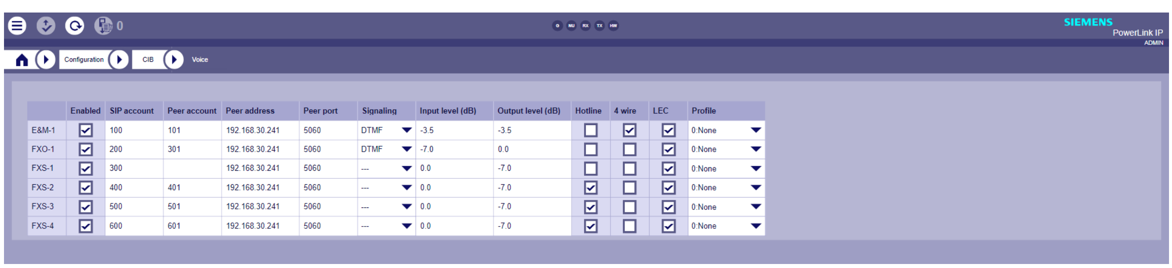
Hardware > CIB



[sc_HW-CIB, 1, --_--]

Setting	Comments
CIB	Default: Disabled If CIB is not equipped, enabling is not possible. If this setting is disabled, all configured voice ports and RS-232 ports are cleared.

Configuration > CIB > Voice



[sc_config-CIB-voice, 1, --_--]

Setting	Comments
Enabled	Voice port is enabled if checked. Default values will be set when changed from disable to enable. Values will be cleared when changed from enable to disable.
SIP account	Registered SIP account. Up to 18 digits are acceptable and must be not empty.
Peer account	Remote peer SIP account for direct SIP call setup. Up to 18 digits are acceptable and could be empty for FXS port when hotline is disabled.
Peer address	Remote SIP endpoint IP address (same as user port IP address). Only valid when the peer account is not empty.

Setting	Comments
Peer port	Remote SIP endpoint port number. Default value is 5060. Only valid when the peer account is not empty.
Signaling	DTMF or Dial pulse signaling mode for FXO port. DTMF signaling mode for E&M port.
Input level	-60.0~20.0 dB Default value see table *Table 3-5*.
Output level	-60.0~14.0 dB Default value see table *Table 3-5*.
Hotline	For FXS-FXS hotline application, it must be checked. Dial automatically the peer account number when off-hook. For FXS-FXO application, it must not be checked.
4 wire	Only available for E&M port. 4 wire is selected if checked, otherwise 2 wire is selected. Default is 4 wire.
LEC	Line echo cancelation is enabled if checked.
Profile	Only valid for FXO port. Default FXO AC profile is set to none for best echo cancellation and voice quality.

Table 3-5 Default settings of the input and output levels for voice interfaces

Voice Interface	Input Level dB	Output Level dB
E&M	-3.5	-3.5
FXS	0	-7
FXO	-7	0

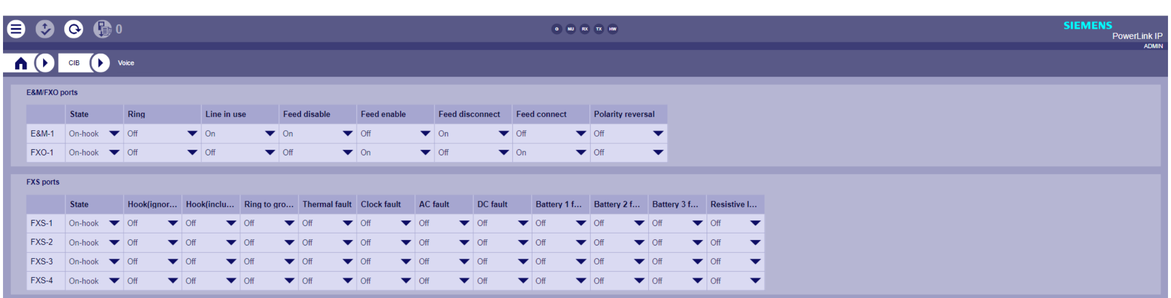
NOTE

When doing voice level measurement, voice compress should be temporarily disabled.

In the default factory setting, all voice ports are enabled. The enabled E&M voice port will consume a data rate about several Kbps because permanent communication is established. The unused E&M port can set to disable if necessary.

Voice activity detection (VAD) is enabled by default for all voice ports. If voice port is in silence, the transmission is discontinued to reduce the consumed data rate.

CIB > Voice



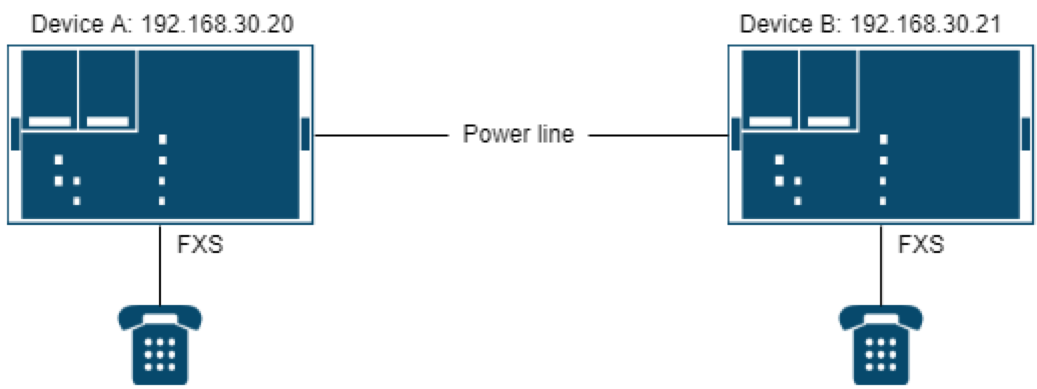
[sc_CIB-voice, 1, --_--]

Setting	Comments
State	Disabled: voice port is disabled On-hook: voice port is in on-hook state Off-hook: voice port is in off-hook state Ring: FXS port is in ringing state
Status	For internal test only.

FXS-FXS direct connection

FXS is a port connect to an analog telephone and supplies ring voltage, battery current and dial tone. When telephone is off hook, the peer telephone connected at same port is start ringing. Answer the phone call will start talking each other. The FXS-FXS telephone call is hotline application without dialing number and PBX connection.

The following figure shows the example configuration for FXS-FXS hotline application. Pickup telephone will establish phone call without dialing number.



[sc_example_FXS_FXS_connection, 1, --_--]

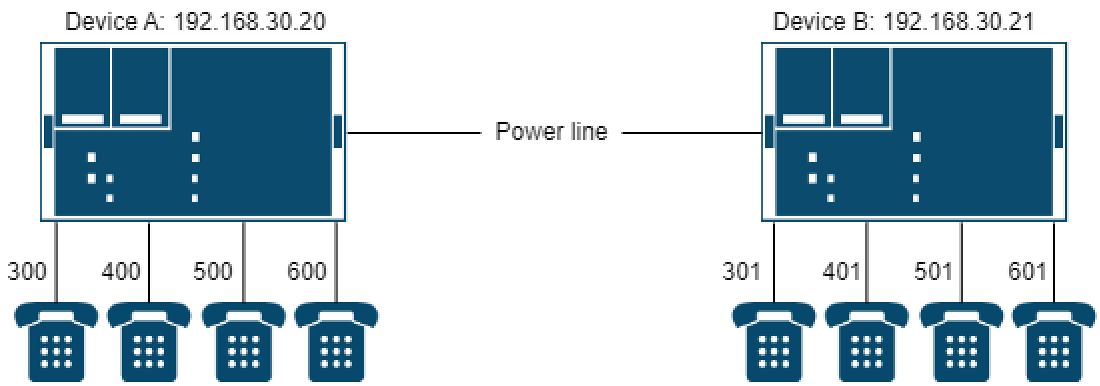
Figure 3-8 Example FXS - FXS connection

	Device A > FXS-1/2/3/4	Device B > FXS-1/2/3/4
User port IP address	192.168.30.20	192.168.30.21
SIP account	400	401
Peer account	401	400
Peer address	192.168.30.21	192.168.30.20
Peer port	5060	5060
Signaling	---	---
Hotline	Checked	Checked

FXS-FXS dialing mode

Example configuration for FXS-FXS dialing mode application:

- Pickup telephone (e.g., 300)
- Dial number 400 / 500 / 600 will make a phone call in local device
- Dial number 301 / 401 / 501 / 601 will make a remote phone call in opposite device



[sc_FXS_Dialing, 1, --_--]

Figure 3-9 Example FXS-FXS dialing mode

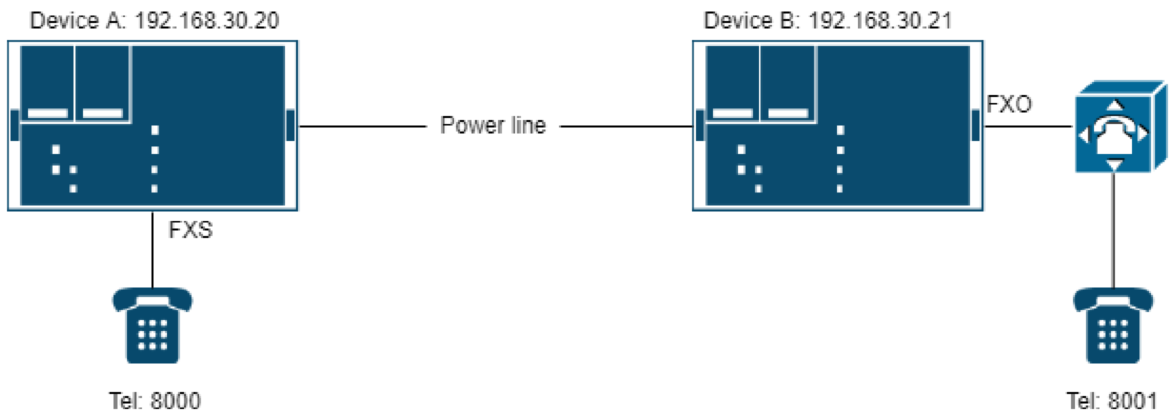
	Device A > FXS-1/2/3/4	Device B > FXS-1/2/3/4
User port IP address	192.168.30.20	192.168.30.21
SIP account	300/400/500/600	301/401/501/601
Peer account	---	---
Peer address	0.0.0.0	0.0.0.0
Peer port	5060	5060
Signaling	---	---
Hotline	Unchecked	Unchecked
Configuration > Ethernet > SIP server		
SIP server	Enabled	Enabled
Address book	sip:301@192.168.30.21:5060 sip:401@192.168.30.21:5060 sip:501@192.168.30.21:5060 sip:601@192.168.30.21:5060	sip:300@192.168.30.20:5060 sip:400@192.168.30.20:5060 sip:500@192.168.30.20:5060 sip:600@192.168.30.20:5060

FXS-FXO connection of telephone subscriber to exchange

FXO is the port attached to analog phone and connects the analog line directly to PSTN (Public Switch Telephone Network) line or PBX (Private Branch Exchange) extension line. The exchange switch thinks FXO port as standard telephone device which delivers on-hook / off-hook signals and generate dial tone.

The telephone connected at FXS port will be extended via power line to remote FXO and attached to the PBX. The telephone attached at same PBX can dial the phone number for local and remote extended telephone.

The following figure shows the example configuration for FXS-FXO application. Pickup telephone and dial the remote phone number to establish the phone call.



[sc_example_FXS_FXO_connection, 1, --_--]

Figure 3-10 Example FXS - FXO connection

	Device A > FXS-1	Device B > FXO-1
User port IP address	192.168.30.20	192.168.30.21
SIP account	300	201
Peer account	201	300
Peer address	192.168.30.21	192.168.30.20
Peer port	5060	5060
Signaling	---	DTMF
Hotline	Unchecked	Unchecked

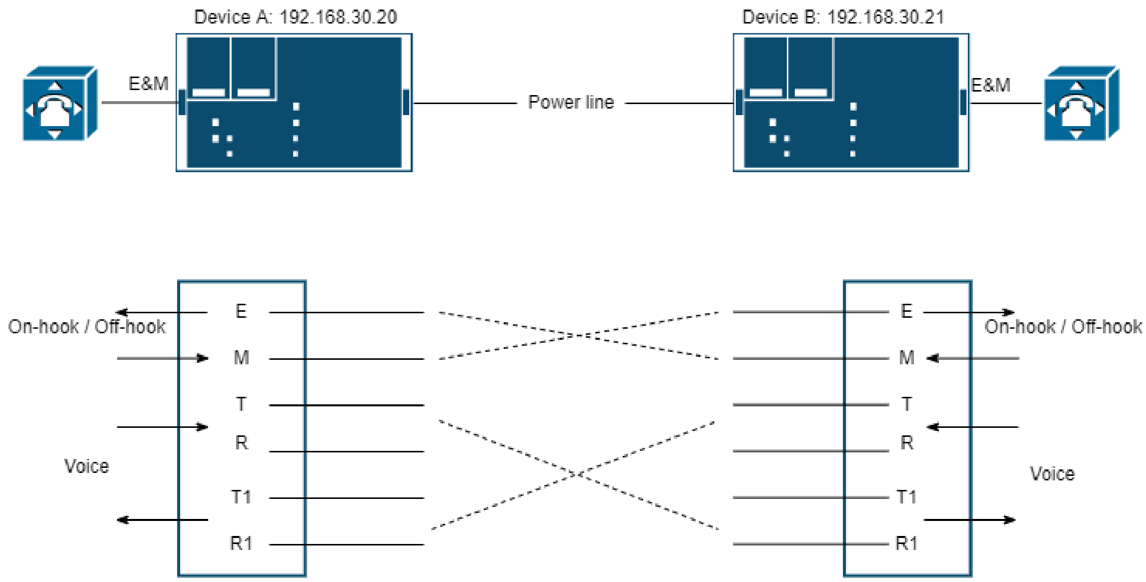
E&M analog trunk connection between exchanges

E&M is a port supports connecting the analog trunk line of two PBX telephone switches. The E&M Interface divides into two parts, the 4 wires (or 2 wires) voice transmission line and the two wires S2 signaling (E-lead / M-Lead) line for on-hook / off-hook control signaling.

E&M virtual voice communication channel is permanently established after device startup without signaling control. When device detects a local M-lead is grounded, it transmits transparently to remote peer and the remote side device grounds its E-lead. The E&M port assigned with bigger SIP account is master to start the connection request to the peer address. The slave E&M accepts to master request and the peer address is not checked.

The low data rate codec is used for sampling voice frequency data, it is not suitable for analog modem data transmission. Instead, the high data rate codec G.711 (88 Kbps) can be used via disabling voice compress in SIP server configuration. The selected codec applied for all voice ports. Please note the total data rate shall not exceed the PLC transmission capacity.

The following figure shows the example configuration for E&M <> E&M application:



[sc_example_EM_EM_connection, 1, --_--]

Figure 3-11 Example E&M - E&M connection

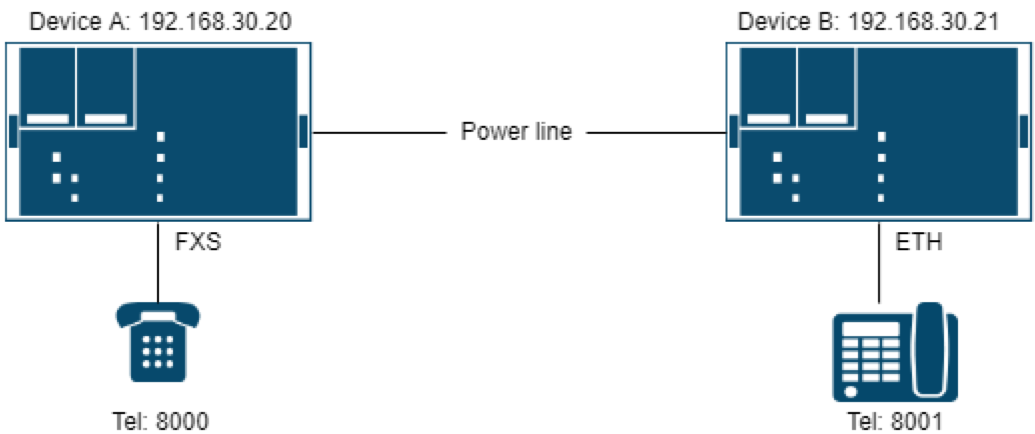
	Device A > E&M-1	Device B > E&M-1
User port IP address	192.168.30.20	192.168.30.21
SIP account	100	101
Peer account	101	100
Peer address	192.168.30.21	192.168.30.20
Peer port	5060	5060
Signaling	DTMF	DTMF
Hotline	Unchecked	Unchecked
4 wire	Checked	Checked

FXS-VoIP connection of telephone subscriber to IP telephone

The following figure shows the example configuration for FXS <> VoIP application. Analog telephone 8000 is hotline. At remote device B, IP telephone is registered in device with SIP account 8001.

- Pickup analog telephone 8000, make a direct call to 8001
- Pickup IP telephone 8001, dial number 8000 to establish the phone call

The Ethernet user port may generate untended traffic to remote peer. The high broadcast traffic might exceed the max PLC modem data rate. The Ethernet traffic control and firewall setting shall be configured correctly to allow only intended traffic.



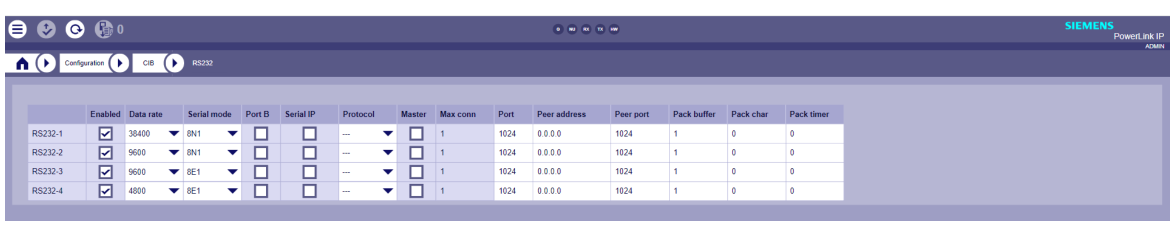
[sc_example_FXS_VoIP_connection, 1, --_--]

Figure 3-12 Example FXS - VoIP connection

	Device A > FXS	Device B > SIP Server
User port IP address	192.168.30.20	192.168.30.21
SIP account	8000	---
Peer account	8001	---
Peer address	192.168.30.21	---
Peer port	5060	---
Signaling	DTMF	---
Hotline	Checked	---
Configuration > Ethernet > SIP server		
SIP account / password	---	8001 / 8001
Address book	---	sip:8000@192.168.30.20:5060

3.7.2 RS-232

Configuration > CIB > RS-232



[sc_config-CIB-RS232_1, 1, --_--]

Setting	Comments
Enabled	RS-232 port is enabled if checked. Default values will be set when changed from disable to enable. Values will be cleared when changed from enable to disable.
Data rate	Setting options: 300, 600, 1200, 2400, 4800, 9600, 19 200, 38 400, 57 600, 115 200 bps Default is 300 bps

Setting	Comments
Serial mode	Serial data bits, parity, stop bits. Setting options: 7N1, 7N2, 7E1, 7E2, 7O1, 7O2, 8N1, 8N2, 8E1, 8E2, 8O1, 8O2 Default: 8N1
Port B	Only available in RS-232-2 and RS-232-4. Devices which are connected to the RS-232-2 and / or RS-232-4 ports must activate a RTS signal for data transmission. In this case Port B check box must be activated.
Serial IP	Enable / disable serial over IP. Checked: Serial data transmission via TCP/UDP Ethernet packet. Unchecked: Serial data transmission via PLC-Modem dedicated data channels. Default value is unchecked (non-IP mode) Default parameters will be set when changed from disable to enable. Values will be cleared when changed from enable to disable.
Protocol	Serial over IP transport protocol (TCP / UDP). Default value is TCP.
Master	Option only valid in TCP protocol. Master means TCP client initiating connection request. Slave means TCP server listening and accepting connection request.
Max conn	Option only valid in TCP slave mode. How many clients are allowed to connect to serial port server. The exceeding connection requests are rejected. Setting options: 1...2
Port	Local serial port server TCP / IP port number. Default value is 30201...30204. Local IP address is Ethernet user port IP address similar like VoIP. If the default port number is changed, the port range in enabled QoS application protocol shall be changed accordingly (See Web UI > Configuration > Ethernet > QoS > Configuration).
Peer address	<u>UDP and TCP master mode</u> The remote peer IP / port is used to initiate the connection request as target address. Peer address and port must be configured. <u>TCP slave mode</u> Only accept incoming calls from configured IP address and port number and will respond to the same IP address and port number. If the incoming IP address / port does not match the configured, the connection will be rejected. 0.0.0.0: means any master IP address can be connected in.

Setting	Comments
Peer address 2	Option only valid for TCP slave mode. Secondary remote peer IP address if max connection set to 2. Peer address is main serial connection. Peer address 2 is backup serial connection. If both peer address is set to 0.0.0.0, the first one who send the poll request will be the main serial connection.
Peer port	Remote peer TCP / IP port number. Default value is 30201...30204 If max connection set to 2, the default value is set to 0. No check for connected peer port number.
Pack buffer	Transmit buffer to store the serial bytes. Start packetize when transmit buffer (1...1024) is full. Default value is 512 bytes. Short buffer size generates more packets but offers short delay time.
Pack char	Start packetize when receive this character (8 bits). Default is disabled (-1). Typical character is LF: 10 (Line Feed \n)
Pack timer	Waiting interval for next coming characters. Start packetize when timeout even buffer is not full. Default value is 10 ms. 0 ms means no timeout. Start packetize immediately after reading out all available bytes. (9600bps, 10bits per packet, packet interval is about 1ms)

In the default factory setting, all RS-232 ports are enabled by default with lowest data rate. The default settings shall be changed during on site commissioning. The unused ports shall set to disable.

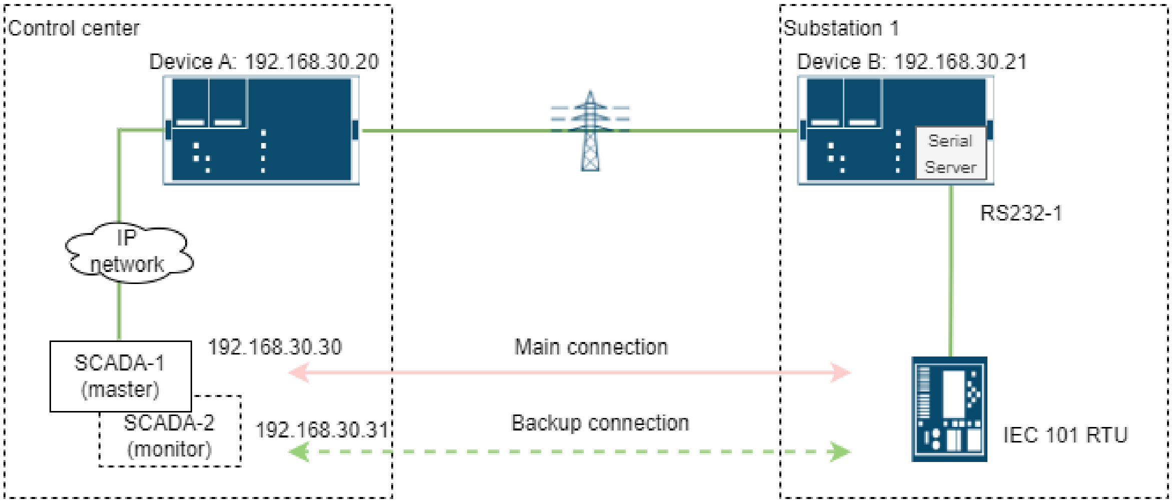
Secondary serial IP connection

It is possible to setup two serial IP connection (main / backup) to same serial port server and RTU. If the link of main connection failed, backup SCADA can take over the RTU data polling automatically to avoid any data lost.

A TCP connection is established between main SCADA system and serial port server. A dynamic poll request from backup SCADA with different IP address will cause main connection suspended.

After backup connection disconnected or switch over timeout (30 sec), the main connection session will be resumed.

The following figure shows the example configuration for secondary serial IP connection. Main SCADA 1 is running at master mode for sending RTU polling request. Backup SCADA is running at monitor mode for receving polled RTU data.

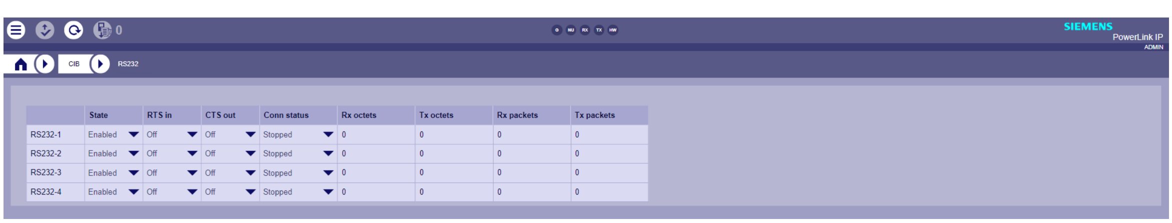


[dw_Serial_IP_Secondary, 1, --_--]

Figure 3-13 Secondary serial IP connection

	Device A > RS232-1	Device B > RS232-1
User port IP address	192.168.30.20	192.168.30.21
Enabled	Unchecked	Checked
Data rate		2400
Serial mode		8N1
Serial IP		Checked
Protocol		TCP
Master		Unchecked
Max conn		2
Port		30201
Peer address		192.168.30.30
Peer address 2		192.168.30.31
Peer port		0
Pack buffer		512
Pack char		-1
Pack timer		10 ms

CIB > RS-232



[sc_CIB-RS232, 1, --_--]

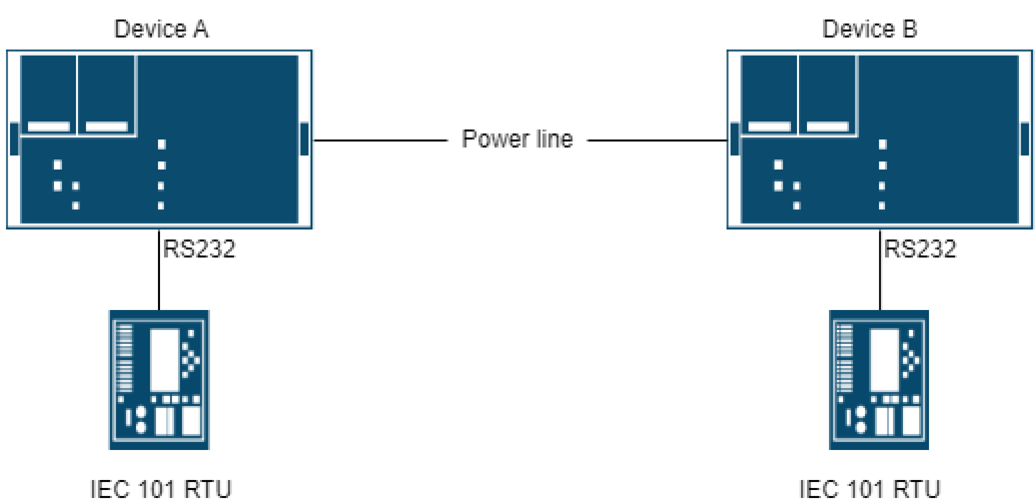
Setting	Comments
State	Disabled: RS-232 port is disabled Enabled: RS-232 port is disabled
RTS	RTS (Request to send) signal activated or deactivated
CTS	CTS (Clear to send) signal activated or deactivated

Setting	Comments
Conn status	Serial port server connection status. Started: Serial port server has been started. Connected: TCP / IP connection has been established (TCP mode). Ready to transmitted data. Stopped: Serial port server has been stopped.
Rx octets	The number of bytes received via serial port server.
Tx octets	The number of bytes transmitted via serial port server.
Rx packets	The number of packets received via serial port server.
Tx packets	The number of packets transmitted via serial port server.

Serial transmission

IEC60870-5-101 is communication protocol for Remote Terminal Unit (RTU). Master station send out the polling request to all the child stations. The subscribed RTU in child stations will response the measurement values or execute commands. RTS / CTS control signals only used locally between RTU and CIB. These control signals will not be transmitted over PLC link.

The following figure shows the example configuration for serial transmission. Serial IP is not enabled, the RTU data is transmitted using fixed bandwidth allocated by PLC-Modem. The remaining data rate for other service (e.g., voice) is reduced.



[dw_serial_transmission, 1, --_--]

	Device A > RS232-1	Device B > RS232-1
Enabled	Checked	Same as Device A
Data rate	2400	
Serial mode	8N1	
Port B	Unchecked	
Serial IP	Unchecked	

RS-232 splitter for polling mode

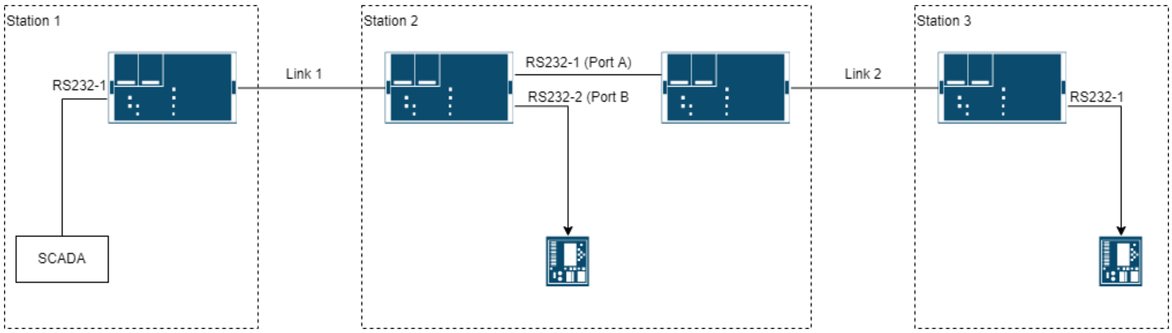
Typically, several RTUs are spread over several substations and connected in a daisy chain to a centralized power system control center (SCADA).

The RS-232-1/2 and RS-232-3/4 interfaces provide an RS-232 splitter for using in the polling mode of RTU. All RTUs assigned to the same group will receive the polling request from the control center. If the local RTU is addressed, activate RTS (Request to send) signal to switch the transmit data line (TxD) to the local RTU. After data transmission is finished in Port B, deactivate RTS signal to switch back the TxD line to Port A.

Port B must configure same data rate and serial mode as Port A.

The following figure shows the example configuration for RS-232-1/2 splitter at intermediate station.

Port B function only available for non-IP mode.



[sc_example_RS232-1_2_splitter, 1, --_--]

Figure 3-14 Example configuration RS-232-1/2 splitter

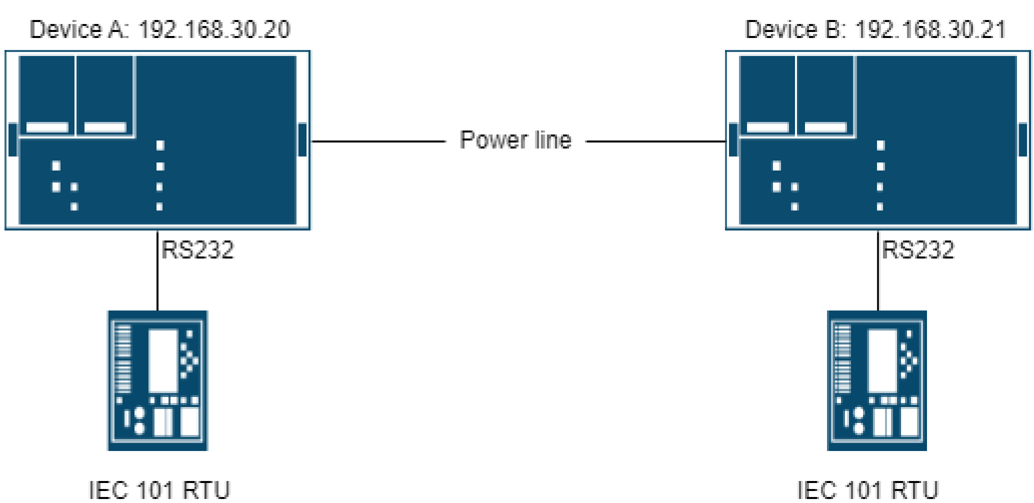
	Device > RS-232-1	Device > RS-232-2
Enabled	Checked	Checked
Port B	Unchecked	Checked

Serial over IP

The serial data is encapsulated in Ethernet / IP packets and transmitted to remote end, or next hop according to target IP address. Serial over IP has some advantages:

- Much easier QoS handling as serial and voice data are IP-based traffic.
- Idle times between RTU or voice packets can be used for other data transmission.

The following figure shows the example configuration for serial transmission over IP packet.



[dw_serial_transmission_over_ip, 1, --_--]

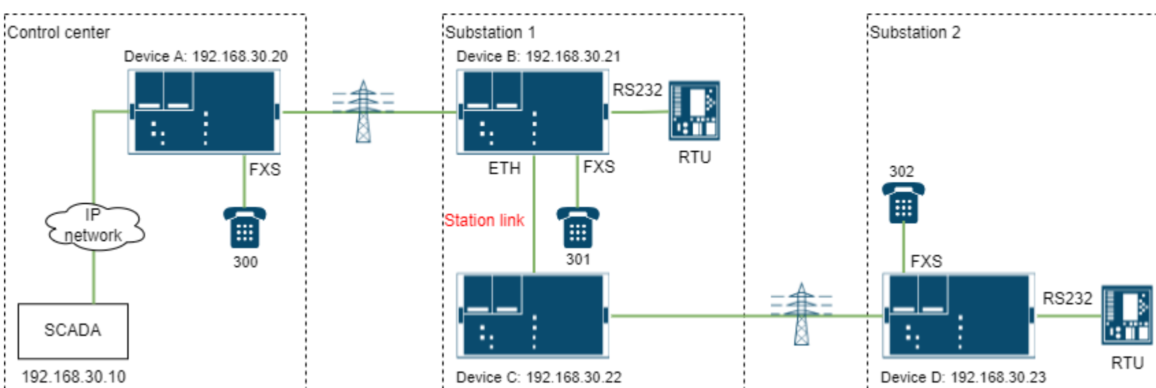
	Device A > RS232-1	Device B > RS232-1
User port IP address	192.168.30.20	192.168.30.21
Enabled	Checked	Same as Device A
Data rate	2400	
Serial mode	8N1	
Port B	Unchecked	
Serial IP	Checked	
Protocol	TCP	
Master	Checked	Unchecked
Port	30201	Same as Device A
Peer address	192.168.30.21	192.168.30.20
Peer port	30201	Same as Device A
Pack buffer	512	
Pack char	-1	
Pack timer	10 ms	

3.7.3 Station Link

Station link over IP encapsulates legacy IEC60870-5-101 serial data channels and analog voce into TCP / IP packets so that they can directly be transported via IP network. It provides the routing of voice and data channels between different PLC in one substation. With station link, user data channels from one PLC link can be routed to other PLC links without reconstruction of the user data:

- No decompression / compression of voice channels to improve the speech quality
- Less delay of asynchronous RS232 data channels
- SCADA (master) can poll RTU data via TCP connection to serial port server in Device B and D
- FXS telephone 300, 301 and 302 can talk each other via dial number

The figure below shows an example station link connection over IP network.



[dw_station_link_over_ip_network, 1, --_--]

	Device A	Device B	Device C	Device D
User port IP address	192.168.30.20	192.168.30.21	192.168.30.22	192.168.30.23
Configuration > CIB > RS232 > RS232-1				
Enabled	Unchecked	Checked	Unchecked	Checked

	Device A	Device B	Device C	Device D
Data rate	---	2400	---	2400
Serial mode		8N1		8N1
Serial IP		Checked		Checked
Protocol		TCP		TCP
Master		Unchecked		Unchecked
Port		30201		30201
Peer address		0.0.0.0		0.0.0.0
Peer port		---		---
Configuration > CIB > Voice > FXS-1				
Enabled	Checked	Checked	Unchecked	Checked
SIP account	300	301	---	302
Peer account	---	---		---
Peer address	0.0.0.0	0.0.0.0		0.0.0.0
Peer port	5060	5060		5060
Hotline	Unchecked	Unchecked		Unchecked
Configuration > Ethernet > SIP server				
Address book	sip:300@192.168.30.20:5060 sip:301@192.168.30.21:5060 sip:302@192.168.30.23:5060			

3.8 Offline Configuration

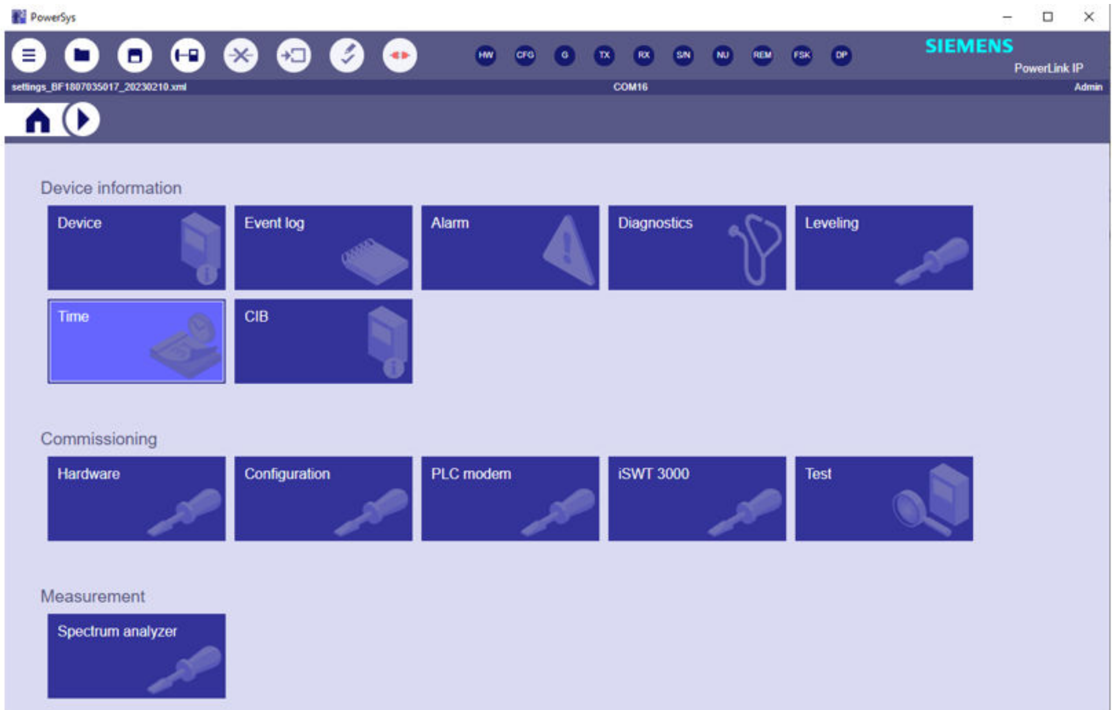
The device setting xml file can opened in offline tool for commissioning, monitoring and diagnostics without real device. Offline PowerSys has same look and feel as online WEB UI view.

The procedure to load the offline setting file in PowerSys is as below:

- Export device setting file from online WEB UI Export device setting into a file (.xml) or create system log file (.zip) via Web UI main menu.
- Open device setting file in PowerSys Open device setting xml file from PowerSys main menu > Open...

[sc_open_device_setting_file, 1, --_--]

- Display device configuration and diagnostic data. Device home page are displayed with different configuration parameter goup.



[sc_display_device_information, 1, --_--]

- Open specturm analyzer view to display the stored spectrum data. The exported setting file only contains spectrum data type. The other data types are triggerred by create system log for diagnostic by exports.

[sc_display_stored_spectrum_data, 1, --_--]

- Change IP address or HF settings. Device specific settings (Service IP address and HF frequency band) can be changed in PoweSys. Save the changed settings to xml file.
- Import changed settings to other device. Open web browser and access to online device web home page, import the setting file, online change the device settings in Web UI.

3.9 IEC 61850 Configuration

3.9.1 Configuration > IEC 61850

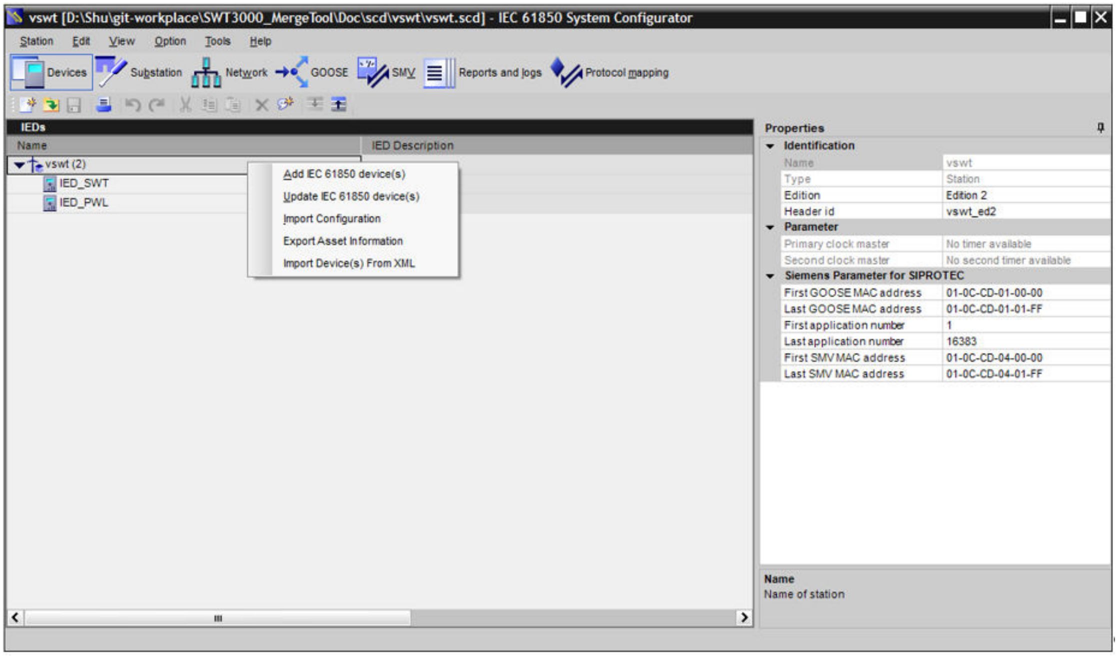
Setting	Comments
IEC 61850 Update	Enable IEC 61850 function on DMB board. Default pre-config and parameter bin file name are displayed as read-only. • iec61850_para.cfg • iec61850_para.bin The default config enables basic MMS connection. The customized function (e.g. report) shall be configured in IEC 61850 System Configurator tool and MergeTool and updated into device.
Pre-config file	Plain text format file contains the IP address and assigned Tx / Rx commands. IP address must match with Ethernet service or user port IP setting.
Update parameter bin file	Binary format parameter file contains all necessary information that is parameterized in the IEC 61850 system configurator. Bin file must match with pre-config file generated from MergeTool.

The parameter bin file is not included in the exported setting XML file. If the setting file is imported in another device, the pre-config and parameter file must be uploaded to the device again.

IEC 61850 System Configurator

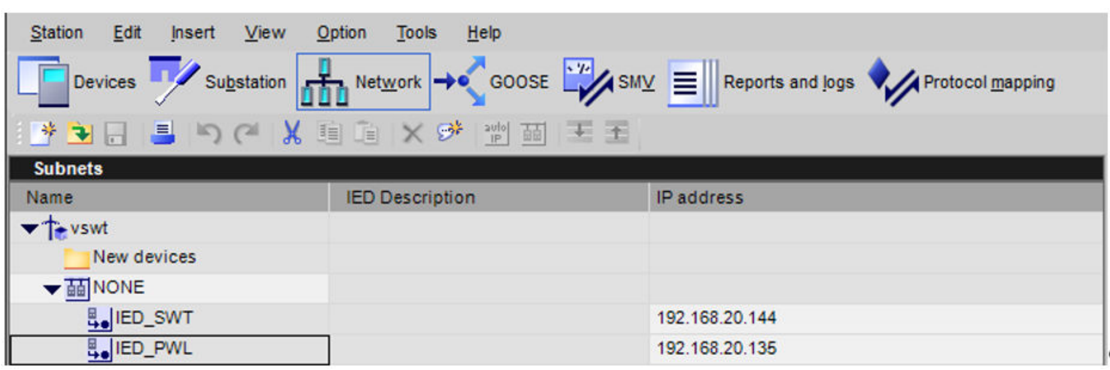
IEC 61850 System Configurator Tool is used to generate station SCD file and mapping datasets between devices.

- Create a new IEC 61850 station in IEC 61850 System Configurator
- Add IEC 61850 devices with ICD file from MergeTool > ICD_IEC61850-Edition-2
  powerlink.icd for PowerLink IP without EN100 module
  swt3000_cx.icd for PowerLink IP with EN100 module.



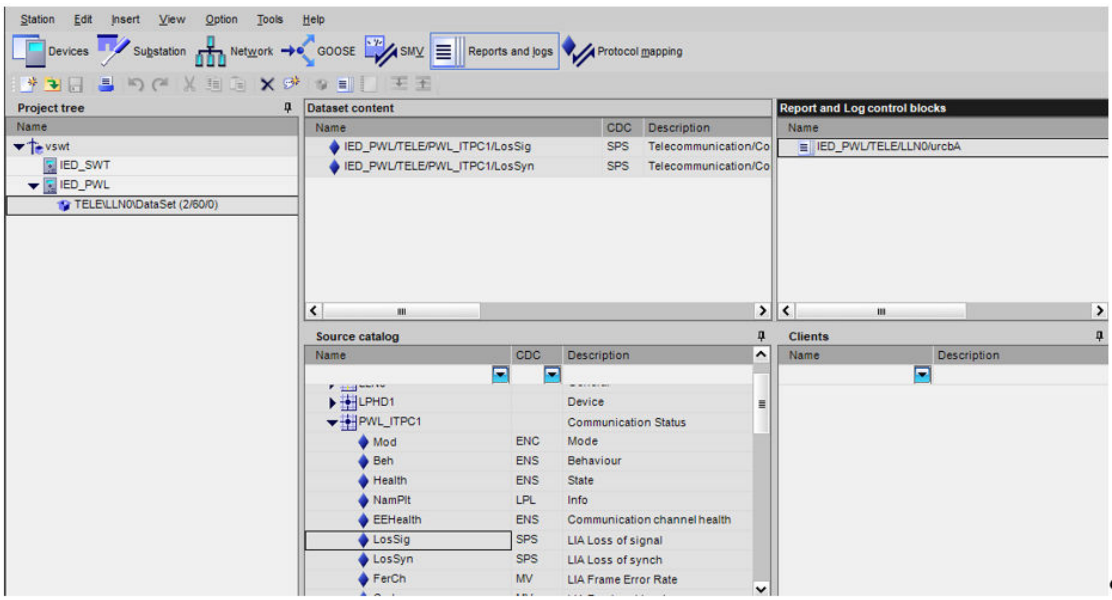
[sc_add_iec61850_device, 1, --_--]

- Configure device IP address and subnet mask



[sc_iec61850_configure_ip_subnet, 1, --_--]

- GOOSE mapping is only supported in iSWT / EN100 module (swt3000_cx.icd)
  EN100 / IEC 61850 GOOSE communication quality alarm (non-urgent) is reported in case of:
  – LN TXC_GGIO quality attribute is not good if local GOOSE I/O mapping to protection device not established
  – LN RXC_GGIO quality attribute is not good if line interface communication link not established (Rx alarm)
- Configure a report and mapping dataset with ITPC status information. The changed status will report to substation control center.

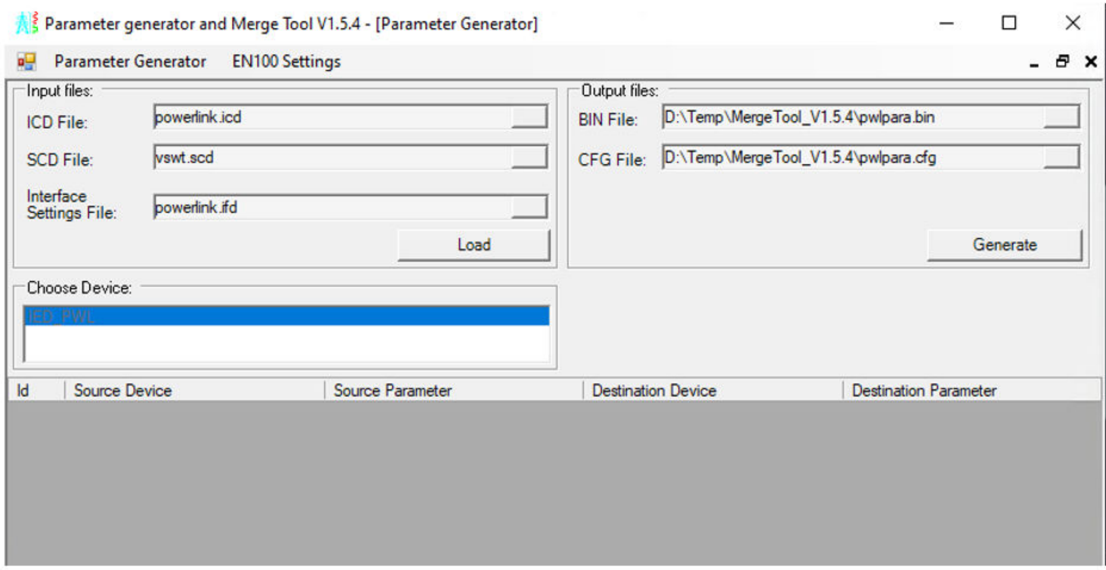


[sc_iec61850_configure_report_mapping, 1, --_--]

MergeTool for cfg / bin file generation

MergeTool loads the station SCD file and generates pre-config and parameter bin files.

- Select ICD, SCD and IFD file, click load button to choose PWL or SWT device
- Enter bin / cfg file name, click generate button to generate output files

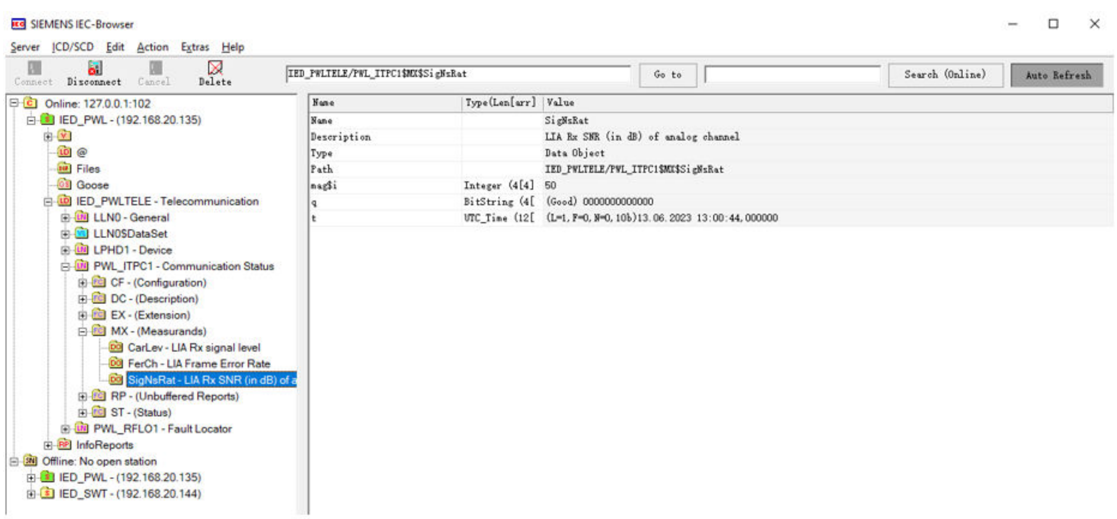


[sc_parameter_generator_mergetool, 1, --_--]

- Upload generated pre-config and bin file to device via web UI

Display IEC data

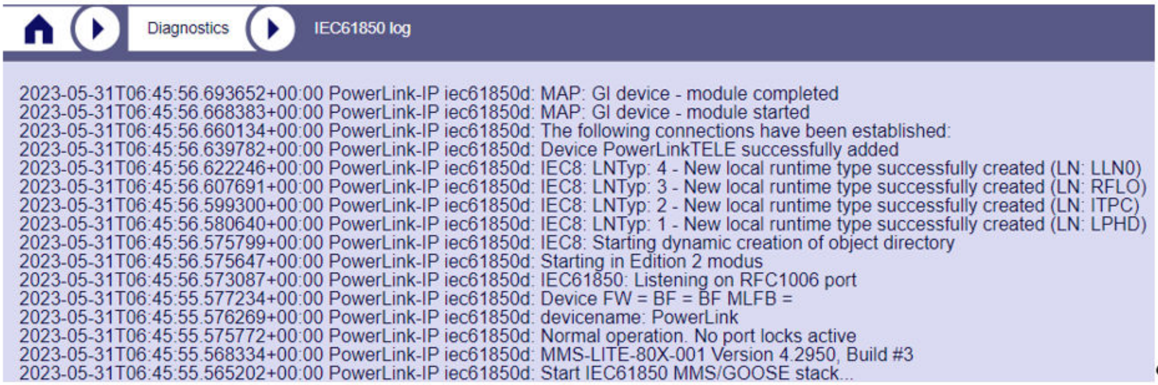
- Open IEC-Browser from IEC 61850 System Configurator Tool > Tools > Display IEC data
- Navigate to read specific IEC data (e.g., SigNsRat for signal to noise ratio)
- Changed status report is stored under InfoReports tree node



[sc_siemens_iec_browser, 1, --_--]

Diagnostics > IEC 61850 log

IEC 61850 startup information are stored for diagnostics purpose. The log is also exported in the system log file.



[sc_diagnostics_iec61850_log, 1, --_--]

4 Installation and Commissioning

4.1 Installation

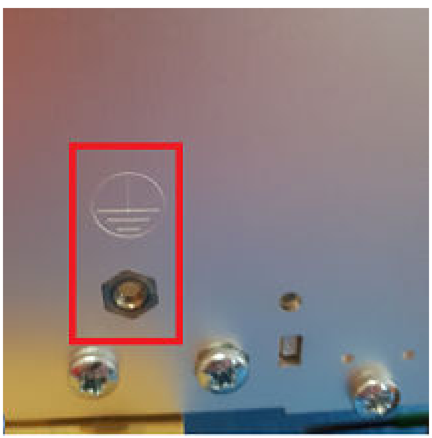
4.1.1 Introduction

The module carriers are suitable for installation in 19" swing frames or mounting frames. Required fastening elements are included in the scope of delivery. No special tools are needed for the installation.

4.1.2 Electric Earthing

With rack mounting of the device, no additional earth connection is required because the device is connected to the earthed rack via the four screws on the front.

Table top devices require earthing connections on the marked screw threads on the left and right side of the device with screw M4 / 1.57 Nm.



[ph_earthing_left_right, 1, --_--]

4.1.3 Connection of the Supply Voltage

[ph_connection_of_the_supply_voltage, 1, --_--]

Figure 4-1 Connection of the supply voltag

General

The AC supply voltage is connected to the terminals PE-N-L1.
In case of DC voltage the (-) is connected to the N and (+) to the L1 terminal.
The terminals are covered.

CAUTION

This equipment can be supplied by and connected to different independent energy sources.

✧ Before any maintenance work, disconnect the equipment from all energy sources to ensure that no dangerous voltage is present.

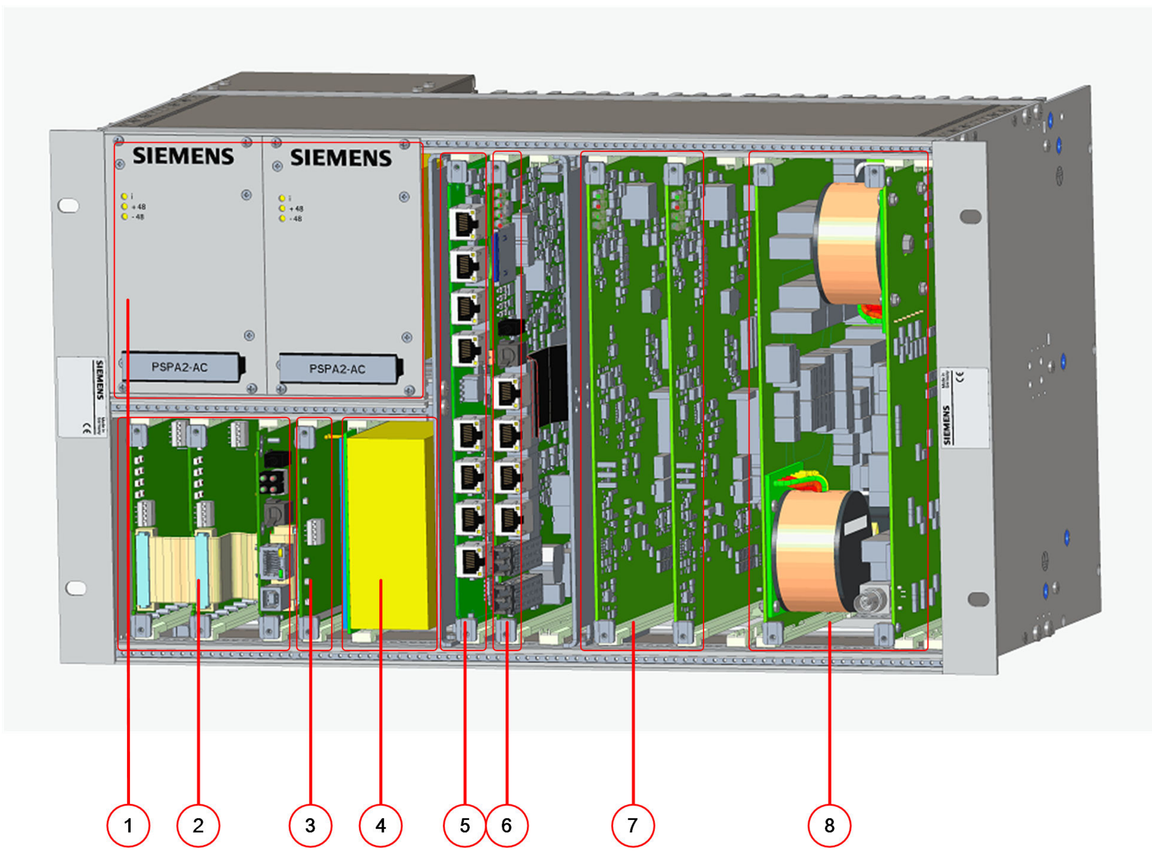
CAUTION

An easily accessible all pole disconnect device with a contact gap of at least 3.0 mm must be included/ installed in the building-installation-wiring.

✧ The value of the external fuse has to be max. 16 A!

4.1.4 Module Slot Positions in PowerLink IP

PowerLink IP



[dw_overview_mechanical_design_PLIP, 1, --_--]

(1) +/- 48 VPower Supply
(2) Integrated Protection Signaling System
(3) Alarm Module
(4) +/- 12V, +5V and +3,3 V Power Supply
(5) Classic Interface Board
(6) Digital Modulation Board
(7) Power Amplifier
(8) Transmit Filter - Line Termination

4.1.5 Dummy Load for PowerLink

CAUTION

Hot surface! Do not touch! Do not cover the ventilation openings!

Risk of injury and fire hazard!

- Do not cover the ventilation openings.
- Do not operate longer than 5 min.
- Mount the device on flat surfaces.
- Allow the device to cool down after use.

WARNING

- Hot surface! Do not touch!

NOTE

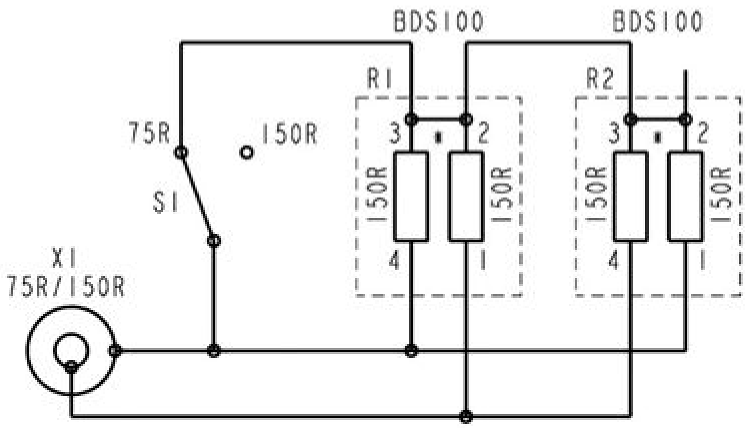
The dummy load is not included in delivery of the PowerLink IP.

The dummy load serves for termination of the PowerLink IP HF output in case the system is not connected to the transmission line. It is necessary for output level measurement.

[ph_dummy_load, 1, --_--]

Figure 4-2 Dummy load for PowerLink IP

The input impedance is selectable between 75 or 150 Ohm.

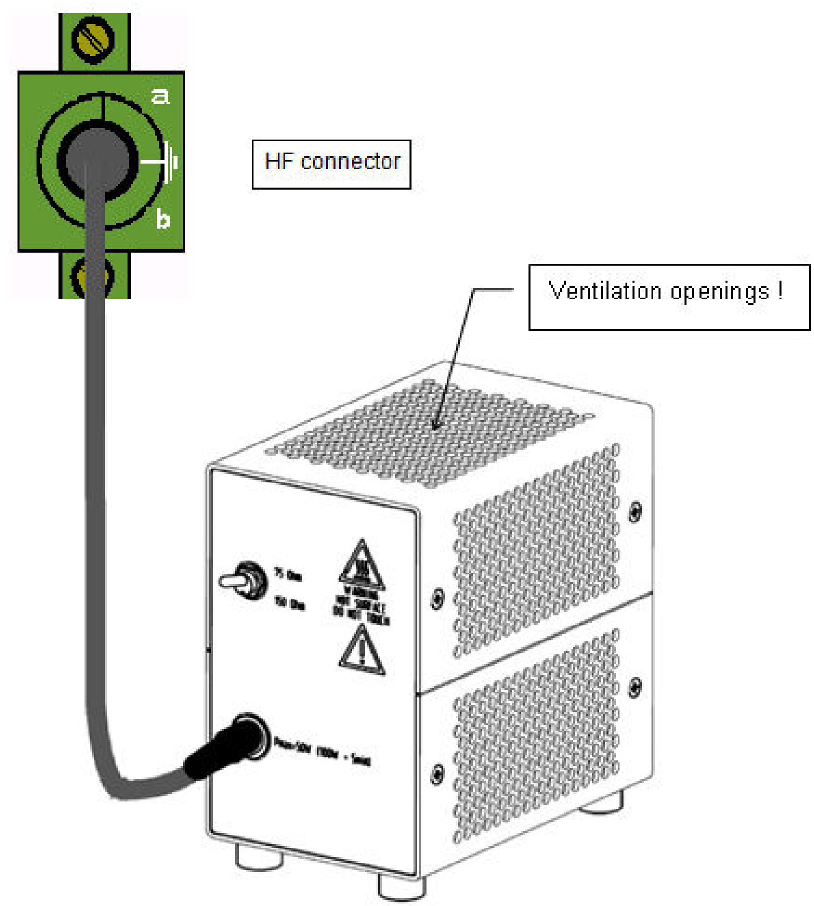


[cdcddmyl-021210-01.tif, 1, en_US]

Figure 4-3 Circuit diagram of the dummy load

Installation

The dummy load is connected by the enclosed connection cable. Please connect **first** the cable with the **safety BNC plug** to the dummy load and then the to the green HF connector at the rear side of PowerLink IP instead of the output cable.



[dw_dummy_load, 2, --_--]

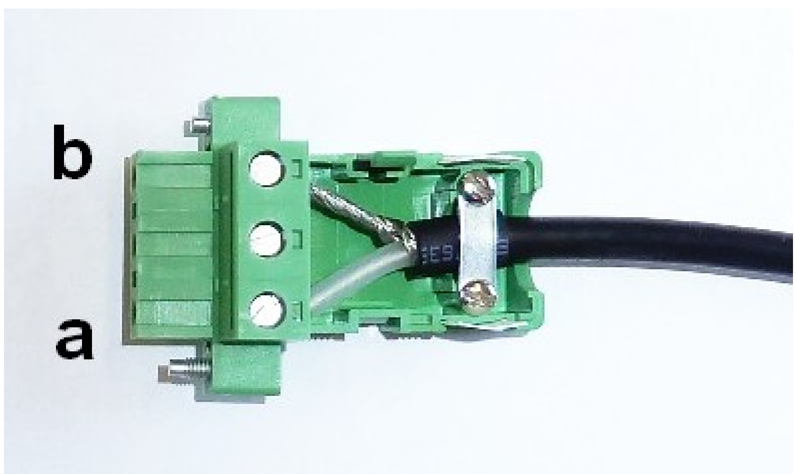
Figure 4-4 Connection of the dummy load

4.1.6 HF connector

HF OUT/IN socket

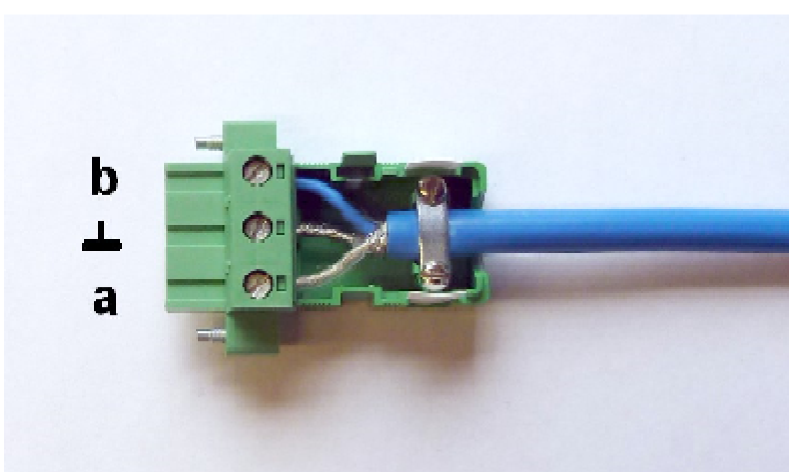
[ph_hf_connector_socket, 1, --_--]

HF OUT/IN plug 75 Ohm



[ph_hf_out_in_75ohm, 1, --_--]

HF OUT/IN plug 150 Ohm



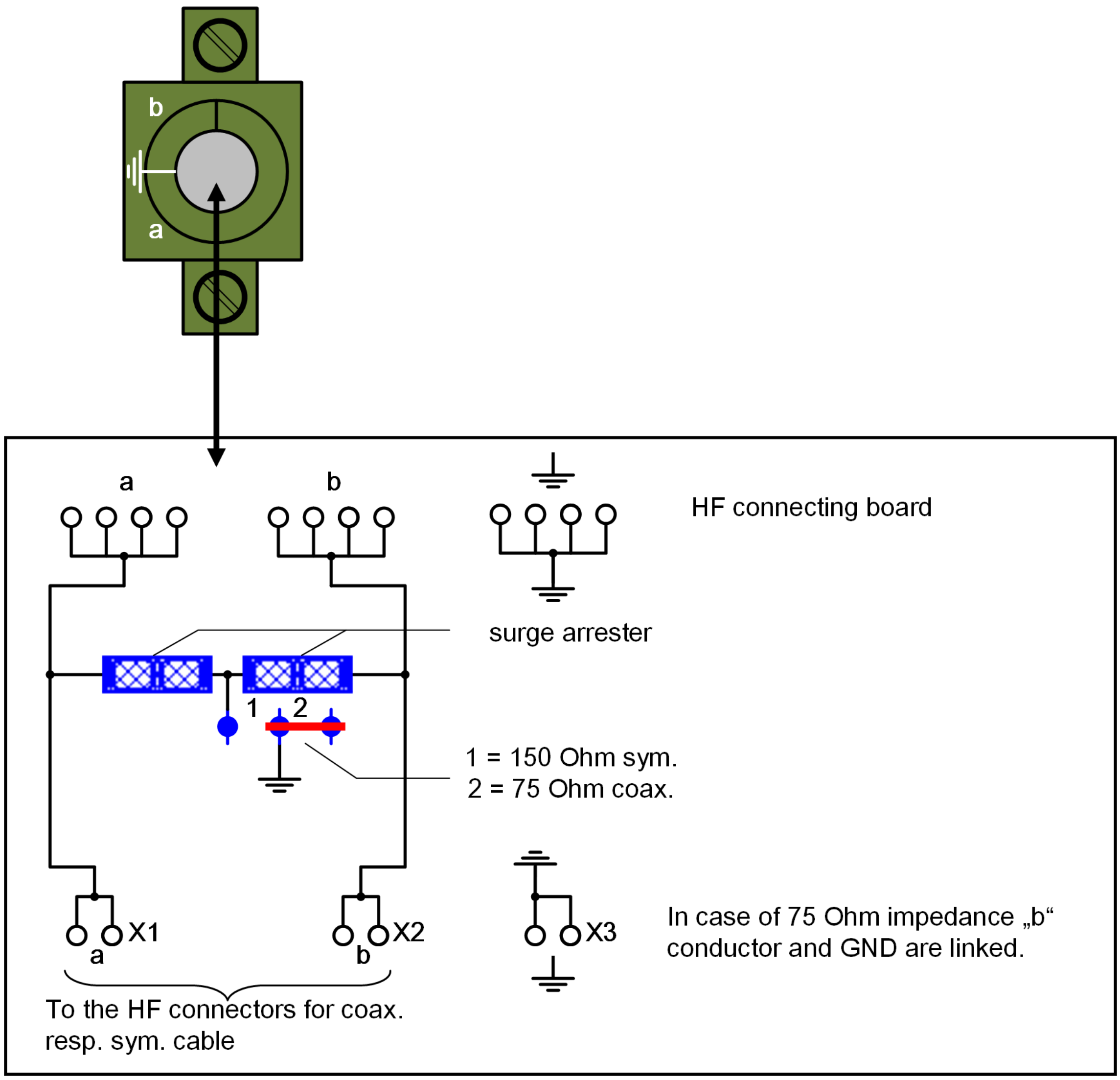
[ph_hf_out_in_150ohm, 1, --_--]

4.1.7 Connection of HF OUT/IN with HF connecting board

HF connecting board

The HF connecting board is used to protect the device from overvoltage and to connect more than one device to a coupling unit.

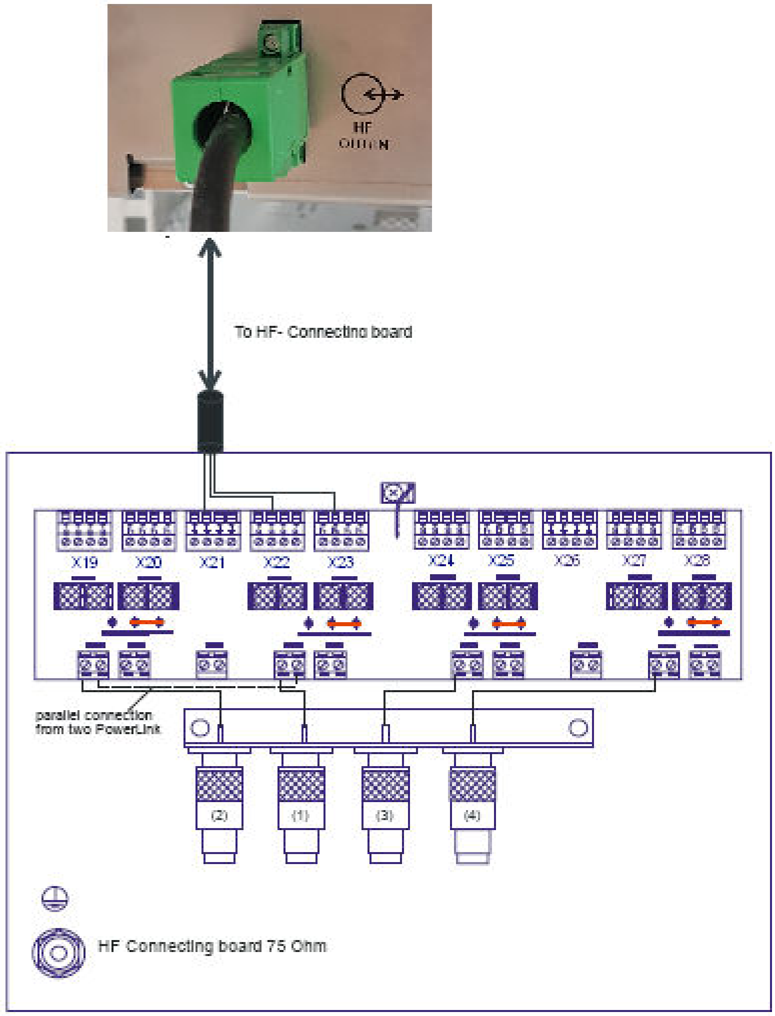
Overall Connection Diagram



[dw_hf_connector, 1, en_US]

Figure 4-5 Connection diagram from the HF_OUT/IN connector to the HF connecting board.

PowerLink – HF Connecting Board 75 Ohm

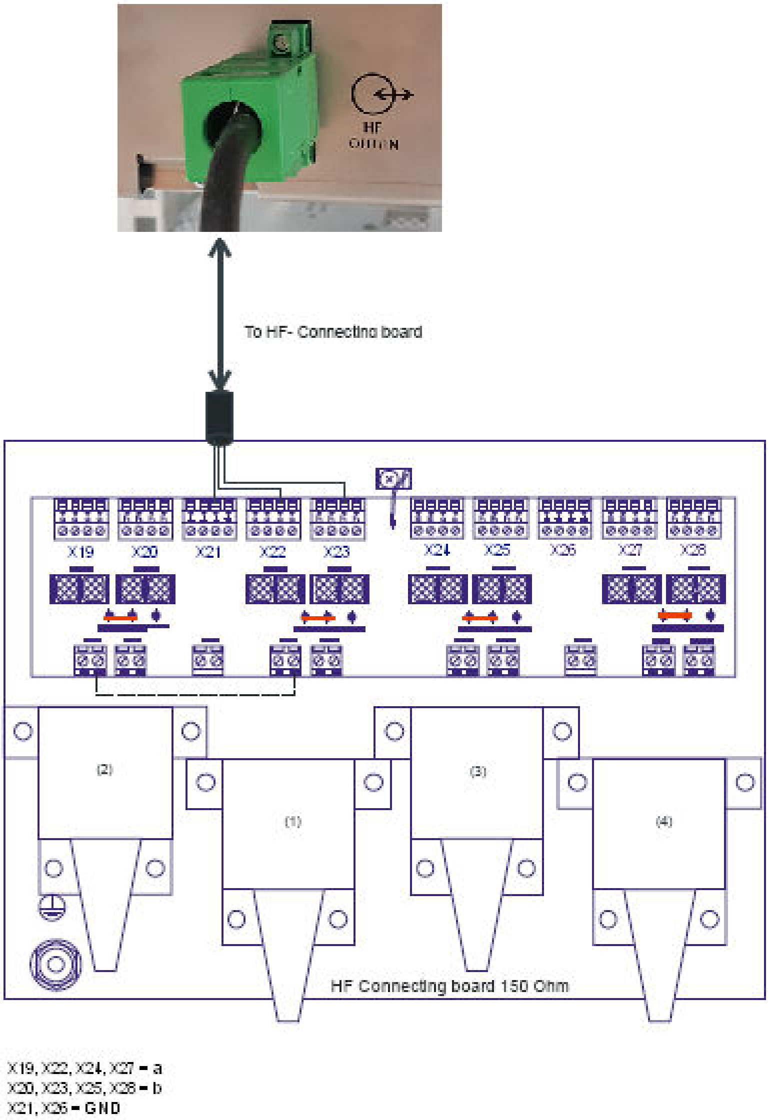


X19, X22, X24, X27 = a
X20, X23, X25, X28 = b
X21, X26 = GND

[sc_hf_out_in_hf_connection_board_75_ohm, 1, --_--]

Figure 4-6 Connection of PowerLink and the HF connecting board 75 Ohm

PowerLink – HF Connecting Board 150 Ohm



[sc_hf_out_in_hf_connection_board_150_ohm, 1, --_--]

Figure 4-7 Connection of PowerLink and the HF connecting board 150 Ohm

Technical Data

Gas-filled surge arrester	
Nominal DC sparkover voltage	75 Ω Config: 4x230 V = 920 V DC; P to PE 150 Ω Config: 460 V DC; P,N, to PE
Impulse spark over voltage	75 Ω Config: 4x700 Vp= 2.8k Vp; P to PE 150 Ω Config: 1.4 kVp; P,N to PE

4.2 Jumper Settings

4.2.1 PLPAStraps

Overview

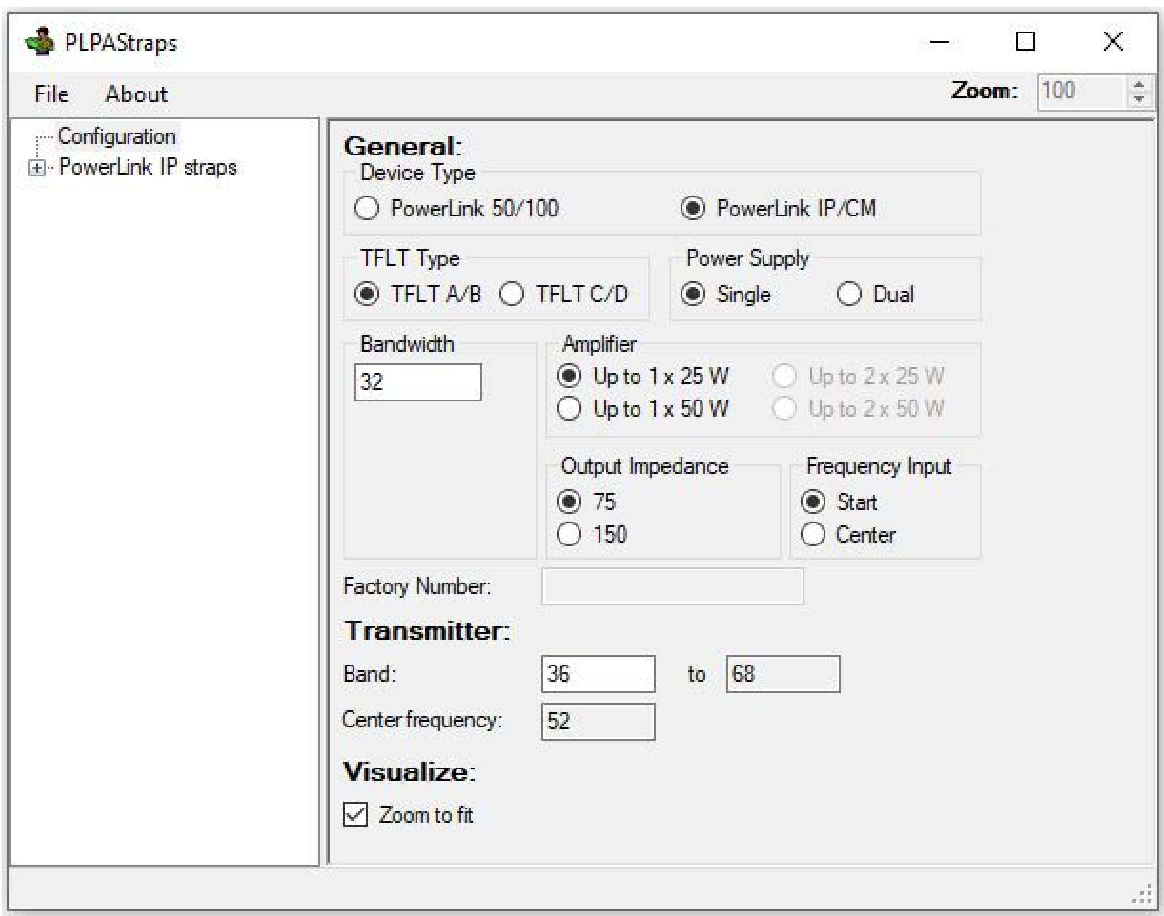
The TFLT bandwidth, the amplifier power mode and the single or redundant use of power supplies are configured by jumpers on the corresponding modules or in case of the power supplies on the backplane.

If the factory settings have to be adjusted, the program PLPA Straps is used to indicate the necessary jumper settings on the modules.

The program is part of the software package. It has to be installed on the service PC. Run the PLPAStraps Setup file and follow the instructions on the screen. PLPAStraps can be used for PowerLink IP, PowerLink CM as well as for PowerLink 50/100.

For an easy reuse of the chosen values it is possible to save your configuration.

Configuration



[sc_PLPAStraps_configuration, 3, --_--]

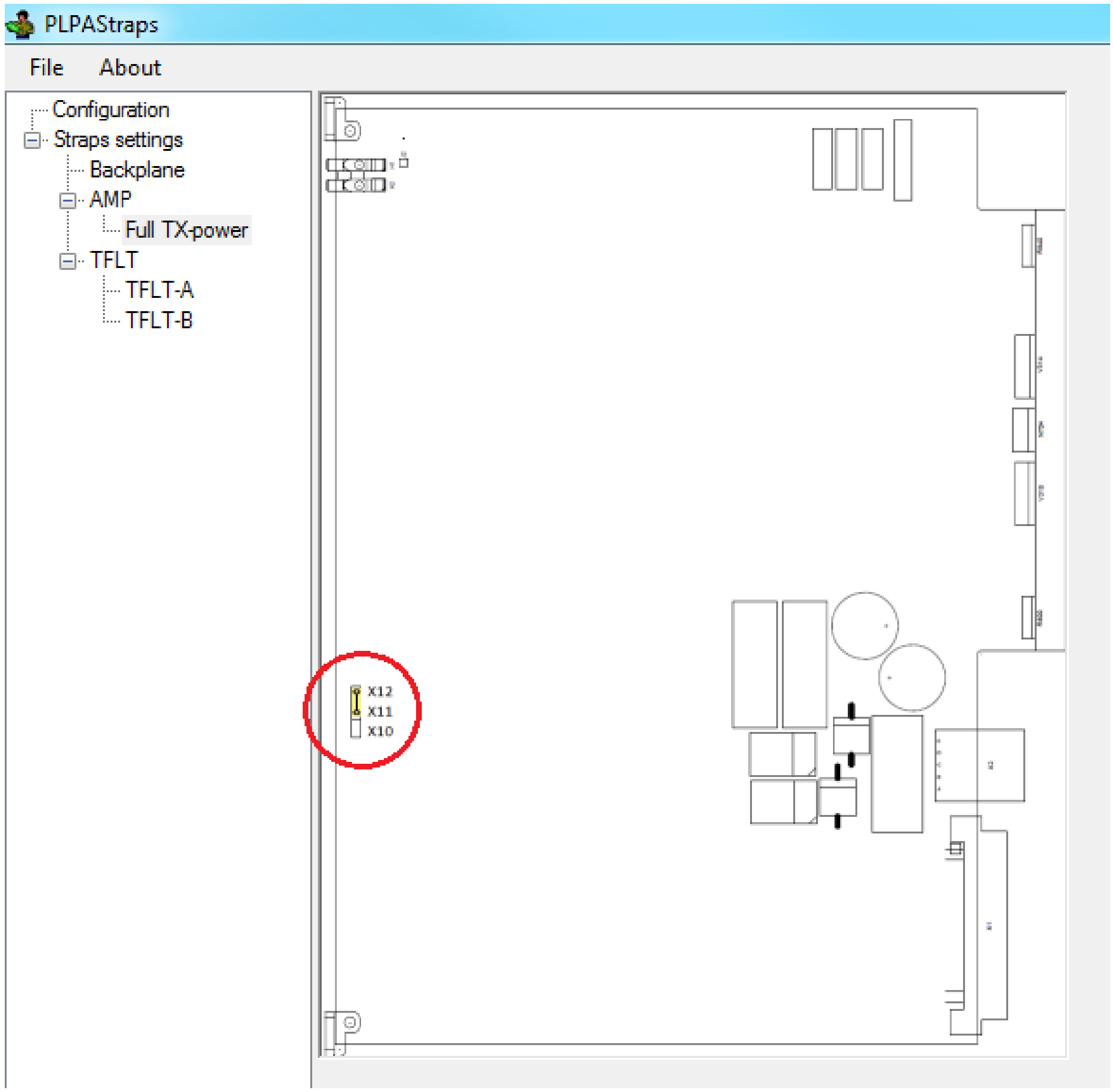
Setting		Comments
Device Type	PowerLink PowerLink IP	Select the device type, the tool can be used for Power-Link IP and PowerLink
Power Supply	Single Dual	one power supply two power supplies

Setting		Comments
Amplifier	Up to 1 x 25 W Up to 1 x 50 W Up to 2 x 25 W Up to 2 x 50 W	Number and output power of amplifier boards. • One power supply, one amplifier: no redundancy. • Two power supplies, one amplifier: redundant power supplies of the same amplifier. • Two power supplies, two amplifier: redundant amplifier
Output impedance	75 Ohm 150 Ohm	Output impedance of the power amplifier module.
Frequency input	Start Center	Transmit frequency input done with the start or the center frequency of the transmission band.
Bandwidth	TFLT A/B ≥ 32 kHz TFLT C/D ≤ 16 kHz Step: 4 kHz	Bandwidth of the transmitter. Possible bandwidth values of transmit filter in TFLT modul
Transmitter band	Min: 24 kHz Max: 500 kHz Step: TFLT A/B 4 kHz TFLT C/D 0.5 kHz	Start or center frequency of the transmitter band. (Depending on frequency input setting.)

4.2.2 Amplifier full/half power mode

The power mode of the amplifier is selectable by jumper. Half power mode decreases the amplifier limits for over voltage and over current by 3 dB. The amplifier gain is the same as in full mode. Both AMPs must be jumpered to the same mode.

Power	Jumper position
50 W for single AMP, 100 W for dual AMPs	X11 – X12 (upper position or no jumper)
25 W for single AMP, 50 W for dual AMPs	X10 – X11 (lower position)



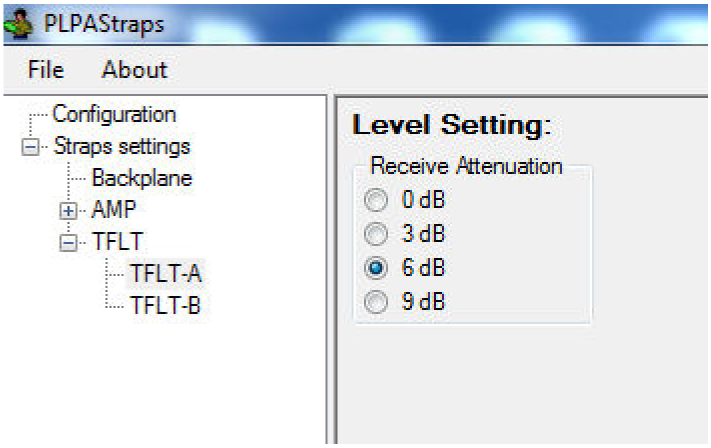
[PLPA_STRAPS_AMP, 1, --_--]

4.2.3 TFLT Receive Attenuation

Adaption of attenuation to the line conditions.

Use lower attenuation for long, undisturbed lines, and higher for impaired lines.

Insert the selected value also during the device commissioning in Web UI Menu Commissioning > Hardware > "TFLT input attenuation".



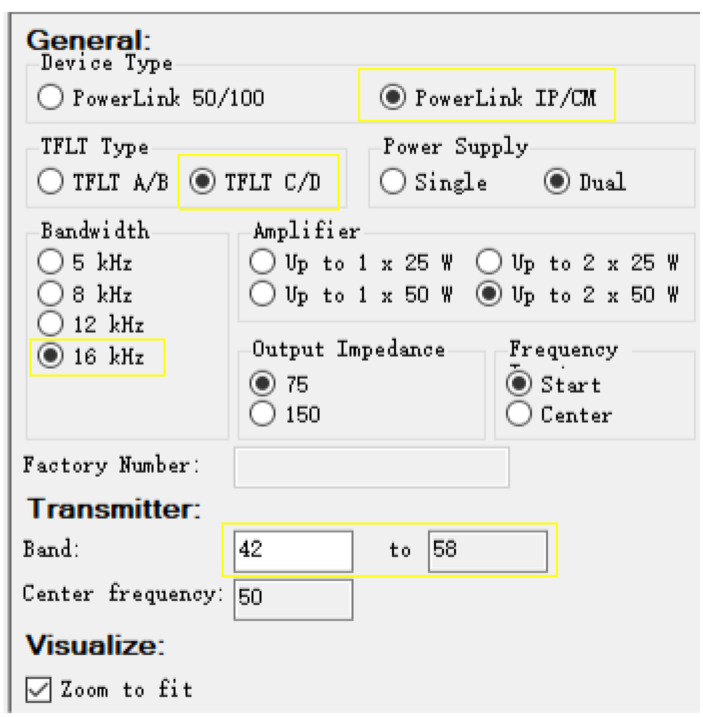
[sc_receive_attenuation, 1, --_--]

4.2.4 TFLT Filter Tuning

The transmit filter can be tuned using PLPAStraps PC software and the integrated spectrum analyzer of device web UI. A dummy load connected to the HF output port is required.

Initial jumper setting

- Enter filter configuration
  Open PLPAStraps, select the device type, frequency band in configuration view. For example, Tx frequency 42 ~ 58 kHz for bandwidth 16 kHz.



[sc_enter_filter_configuration, 1, --_--]

Figure 4-8 Filter configuration

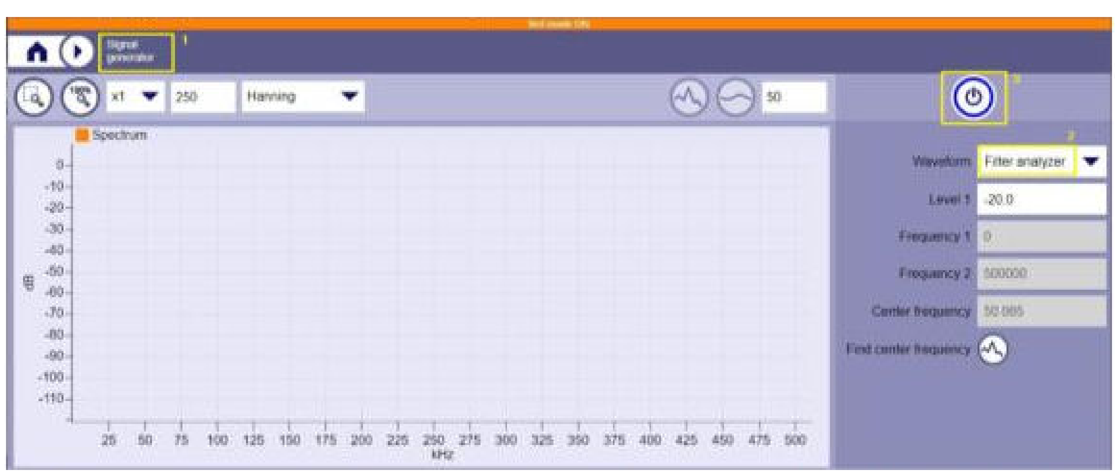
- Adjust TFLT jumper settings
  Select TFLT board, enter the expected receive attenuation, adjust the jumper settings in TFLT board according to the displayed jumper positions.

[sc_adjust_tflt_jumper_settings, 1, --_--]

Figure 4-9 TFLT jumper settings

Filter analyzer in web U

- Plugin TFLT boards into the PowerLink IP device, connect the dummy load into HF output port and switch on the device.
- Open the web browser to access the device home page. Configure the hardware settings according to the settings in PLPAStraps (Power amplifier, impedance, start / stop HF frequency, input attenuation).
- Start the filter analyzer in web UI > Signal generator, select wave form “Filter analyzer” and activate the signal generator (mode on).
  Note: When filter analyzer mode is activated, the AMP is switched off (LED_READY is off). You can plug in / out the TFLT board without power off device.



[sc_start_filter_analyzer, 1, --_--]

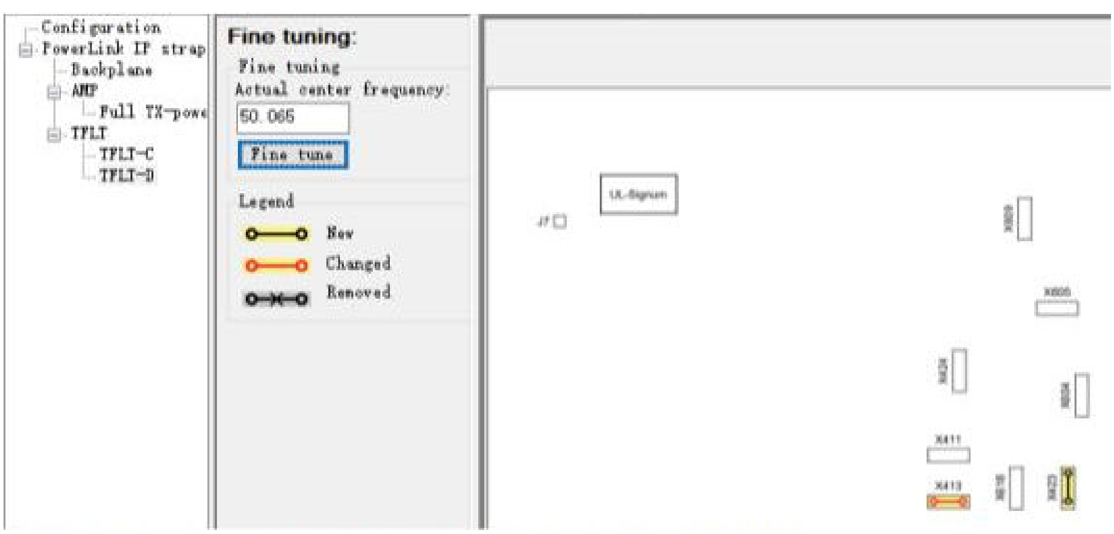
- Click "find center frequency" button, wait until the spectrum sweep stops, and the found center frequency is displayed.
  For TFLT-C/D board, the center frequency is displayed as red color if it is out of range (+/- 600 Hz). Then a second step of fine tuning is required.
  For TFLT-A/B board, start / stop frequency shall be measured using two cursors and a verification, if the frequency response is within the range.

[sc_start_signal_generator, 1, --_--]

Fine tuning for TFLT-D

This step is only required if the measured center frequency is out of range.

- Copy the measured center frequency from web UI (keyboard “CTRL+C”)
- Paste the value into PLPAStraps > TFLT-D > Actual center frequency (keyboard “CTRL+V”), click the “fine tuning” button.
  The changed jumper position is marked as a different legend.



[sc_PLPAStraps_fine_tuning, 1, --_--]

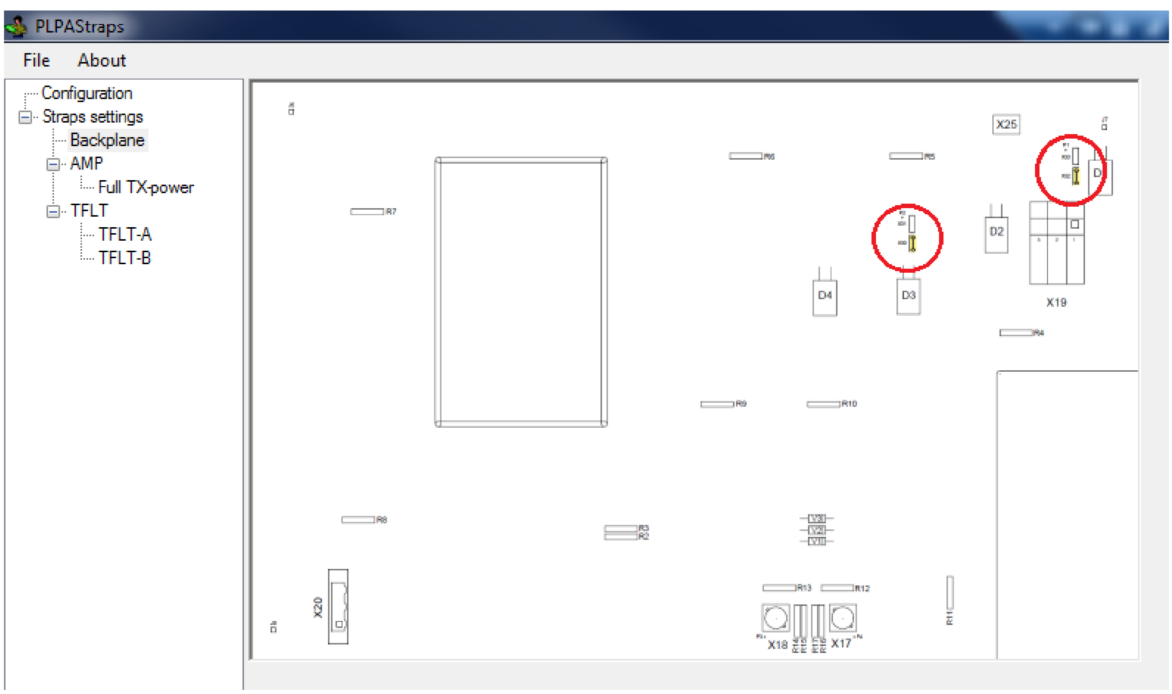
- Plug out TFLT-D board and re-adjust the jumpers as shown in PLPAStraps.
- Plug in TFLT-D board and re-check the measured center frequency within the acceptance range.
- Usually two steps tuning (initial and fine tuning) are enough for TFLT-D board.

4.2.5 Configuration Single or Redundant Power Supply for AMP

With the Jumpers X30...X33 located on the backplane of the device, it is possible to configure whether AMP-1 is supplied by a single power supply PS-1 or by redundant power supplies (PS-1/PS-2). AMP-2 is always supplied by PS-2.

- Single Power Supply (50 W/100 W)
  - Jumper on X32, X30 (1xPower Supply, 1x50 W AMP or 2xPower Supply, 2x50 W AMP)
  - PS-1 powers AMP-1
  - PS-2 powers AMP-2
  - Both power supplies power DMB redundantly
- Redundant Power Supply (50 W)
  - Jumper on X33, X31 (2x Power Supply,1x 50 W AMP):
  - both power supplies power AMP redundantly
  - both power supplies power DMB redundantly

For 100W version each AMP is supplied by one power supply. I.e. PS-1->AMP-1, PS-2->AMP-2. The DMB is supplied redundantly from both power supplies. Therefore, even if one AMP or one power supply fails, the system will still work with reduced transmit level.



[PLPA_STRAPS_PS, 1, --_--]

4.2.6 ALR Jumper Settings

The function of the ALR jumpers is shown in the table below.

Table 4-1 ALR Jumper Settings

Jumpers					
	X2	**X3**	**X4**	**X5 – X13**	**X14 – X17**
Binary Input 1 – used with Sync Pulse					
250 V	X2 – 7/8 *)	open	---	---	X14 – X15 *)
110 V	X2 – 1/2	open	---	---	X14 – X15
48 V / 60 V	X2 – 3/4	open	---	---	X14 – X15
24 V	X2 – 5/6	open	---	---	X14 – X15
Debounce time		≈ 0.6 ms ≈ 1.0 ms	X18 – 3/4 X18 – 1/2		
24 V	open	X3 – 1/2		---	X16 – X17
12 V	open	X3 – 3/4		---	X16 – X17
5 V	open	X3 – 5/6		---	X16 – X17
Binary Input 2 – for future application					
250 V	---	---	X4 – 7/8 *)	---	---
110 V	---	---	X4 – 1/2	---	---
48 V / 60 V	---	---	X4 – 3/4	---	---
24 V	---	---	X4 – 5/6	---	---
Debounce time		≈ 0.6 ms ≈ 1.0 msX4 – 7/8 *)	X19 – 3/4 X19 – 1/2		
Alarm Output 1 Relay K1					
NC	---	---	---	X5 – X6 *)	---
NO	---	---	---	X6 – X7	---
Alarm Output 2 Relay K2					
NC	---	---	---	X8 – X9 *)	---
NO	---	---	---	X9 – X10	---
Alarm Output 3 Relay K3					
NC	---	---	---	X11 – X12 *)	---
NO	------	---	---	X12 – X13	---

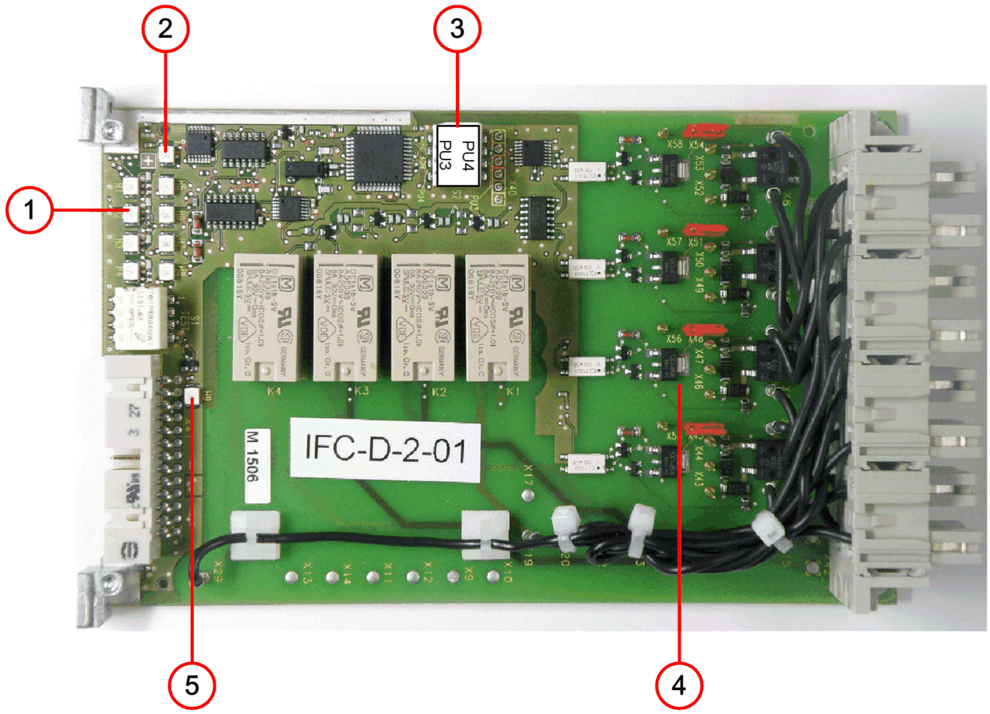
NC Break contact

NO Make contact

*) Default setting

4.2.7 iSWT Jumper Settings

4.2.7.1 Jumper Settings for IFC Modules



[scjumper-220513-01.tif, 2, en_US]

Figure 4-10 Position of Jumpers for the IFC-Modules

(1) LED H1 to H4 (red): activated outputs
LED H5 to H8 (green): activated inputs

(2) Test Operation Display (H10)

(3) S2: IFC Slot Address Selection (S2.1, S2.2) and PU3 / PU4 switch:
S2.3: closed/down - PU3
S2.3: open/up - PU4

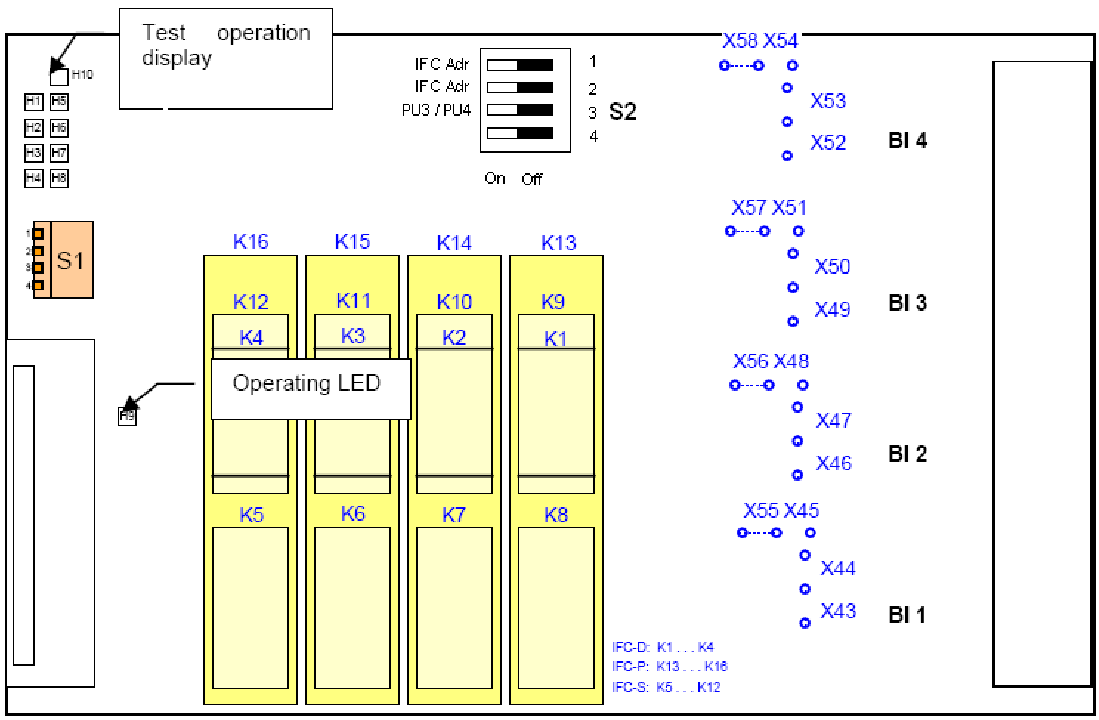
(4) Jumpers X43 to X58

(5) Operating LED (H9)

Table 4-2 Assignment of Jumpers X43 to X58

Signal Input	250 V	110 V	48 V/60 V	24 V
BI1	**X55 = inserted** X43 = open X44 = open X45 = open	X55 = open **X43 = inserted** X44 = open X45 = open	X55 = open X43 = open **X44 = inserted** X45 = open	X55 = open X43 = open X44 = open **X45 = inserted**
BI2	**X56 = inserted** X46 = open X47 = open X48 = open	X56 = open **X46 = inserted** X47 = open X48 = open	X56 = open X46 = open **X47 = inserted** X48 = open	X56 = open X46 = open X47 = open **X48 = inserted**

Signal Input	250 V	110 V	48 V/60 V	24 V
BI3	**X57 = inserted** X49 = open X50 = open X51 = open	X57 = open **X49 = inserted** X50 = open X51 = open	X57 = open X49 = open **X50 = inserted** X51 = open	X57 = open X49 = open X50 = open **X51 = inserted**
BI4	**X58 = inserted** X52 = open X53 = open X54 = open	X58 = open **X52 = inserted** X53 = open X54 = open	X58 = open X52 = open **X53 = inserted** X54 = open	X58 = open X52 = open X53 = open **X54 = inserted**



[scifcjum-010813-01.tif, 1, en_US]

Figure 4-11 Position of jumpers X43 to X58

The second interface module is used in the case of an **IFC-D/P** module for doubling the output contacts. The binary inputs are only connected to **one** module (in slot IFC-1).

If the IFC-S module is used, jumpers X43 to X58 are not provided because the binary inputs do not exist. The module contains 8 signaling relays. For 7 relays, one change-over contact is brought out in each case. The contact of relay K5 can be used as a make contact or a break contact with jumper X42. All 8 signaling contacts have a **common root (3A1)**.

4.2.7.2 DIP Switches on IFC Modules

There are 2 Dual Inline Package (DIP) switches added to each IFC modules:

- DIP switch S1 for the **Test Mode**.
  The activated output relays are displayed with LEDs H1 to H4 (red), and the activated binary inputs with LEDs H5 to H8 (green).
- DIP switch S2 for the selection of PU3 or PU4 module and to indicate the slot address of each IFC module.

Table 4-3 Function of S2 Switch

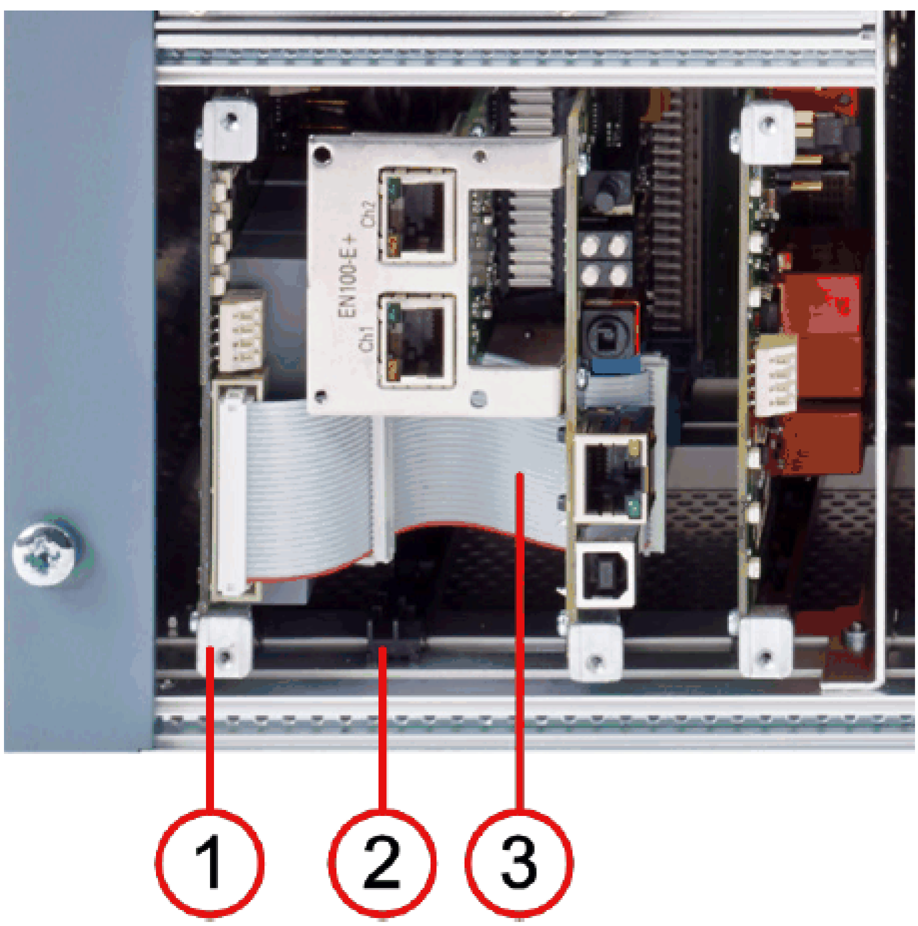
Switch	Function
S2.1	IFC slot address selection
S2.2	IFC slot address selection
S2.3	PU3 or PU4 selection
S2.4	Not connected

Table 4-4 IFC Slot Address

Selection	S2.1 Position	S2.2 Position
IFC-1	Open = up position = OFF	Open = up position = OFF
IFC-2	Close = down position = ON	Open = up position = OFF
IFC-3	Open = up position = OFF	Close = down position = ON
IFC-4	Close = down position = ON	Close = down position = ON

Table 4-5 PU3 or PU4 Selection

Selection	S2.3 Position
PU3	Close = down position = ON
PU4	Open = up position = OFF



[ph_iSWT_slot_position_IFC_modules, 1, --_--]

Figure 4-12 Slot positions of IFC-x modules in the iSWT system - PowerLink IP

(1) Slot position IFC-1
(2) Slot position IFC-2 or EN 100
(3) PU4-module

NOTICE

Changing the position of an IFC module without changing its address may lead to a failure in the transmission.

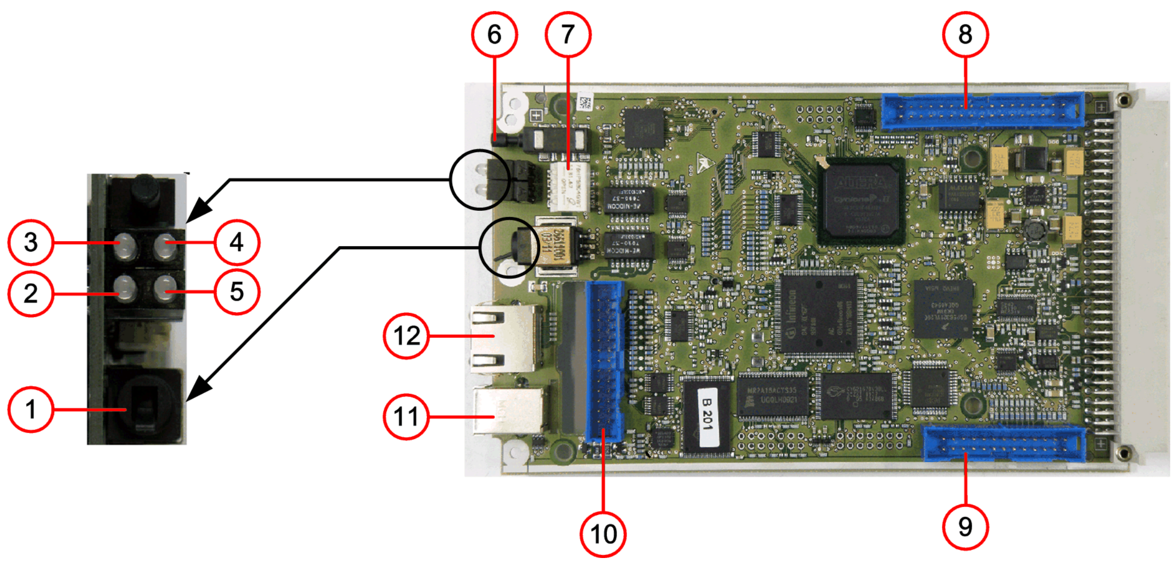
The IFC module will not be detected in a wrong slot. No information or wrong information may be transmitted to the corresponding protection relay.

✧ Make sure that the IFC address corresponds with the IFC slot position according *Figure 4-12*

NOTE

The slots IFC-3 and IFC-4 are available only for PU4 in a Stand Alone SWT 3000.

4.2.7.3 Jumper Settings for the PU4 Module



[le_pu4jum, 1, en_US]

Figure 4-13 Position of Jumpers, Input and Signaling Elements on the PU4 Module

1 S2: Power ON/OFF
2 LED OK/BGAL
3 LED Status Interface LID-2
4 LED Status Interface LID-1
5 LED Status Interface LIA
6 S1: Reset button
7 S3 (3.1 to 3.4)
8 Connection of DLE
9 Connection of DLE
10 Connection of the IFC Modules
11 LCT: Service Interface (USB)
12 NMS: Ethernet Interface

The Digital line interfaces can not be used in combination with PowerLink IP.

Table 4-6 Function of the S3 DIP Switch on the PU4 Module

Switch Number	Position	Function
S3.1	OFF ON	Normal operation Programming with Memtool
S3.2	OFF ON	Monitor inactive Monitor active
S3.3	OFF ON	Disable debugger Enable debugger
S3.4	OFF ON	Disable Enable monitor initialization, command input test

NOTE

For normal operation all switches must be in the **OFF**-position.

4.2.8 Programming of Flash Memory in iSWT (PU4) with MemTool

4.2.8.1 Connecting the PC

In order to program the PU4 module of iSWT, use the **USB connector of the PU4 module**. The connection to the service PC is established with with the USB connecting cable supplied with the device.

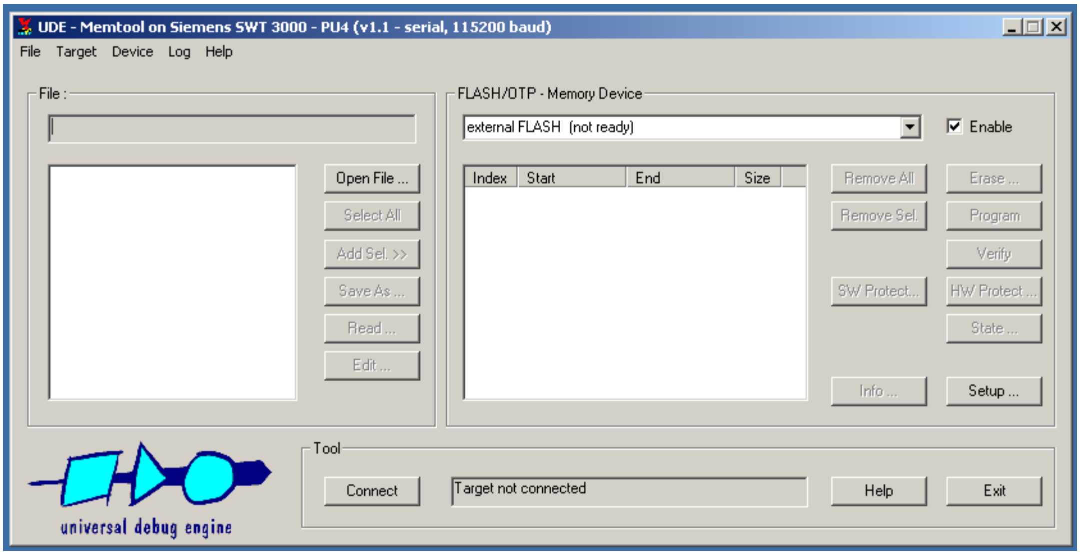
- Turn off the device with the **S1** switch on the DMB module.
- To enable the programming with MemTool, close the **DMB S5.4 and PU4 S3.1 DIP switch** .
- Turn on the device with the **S1** switch on the DMB module.
- Press the **S1** reset button on the PU4 to proceed the upgrade.

CAUTION

✧ During the update operations with MemTool the iSWT will be out of regular service.

4.2.8.2 Starting MemTool

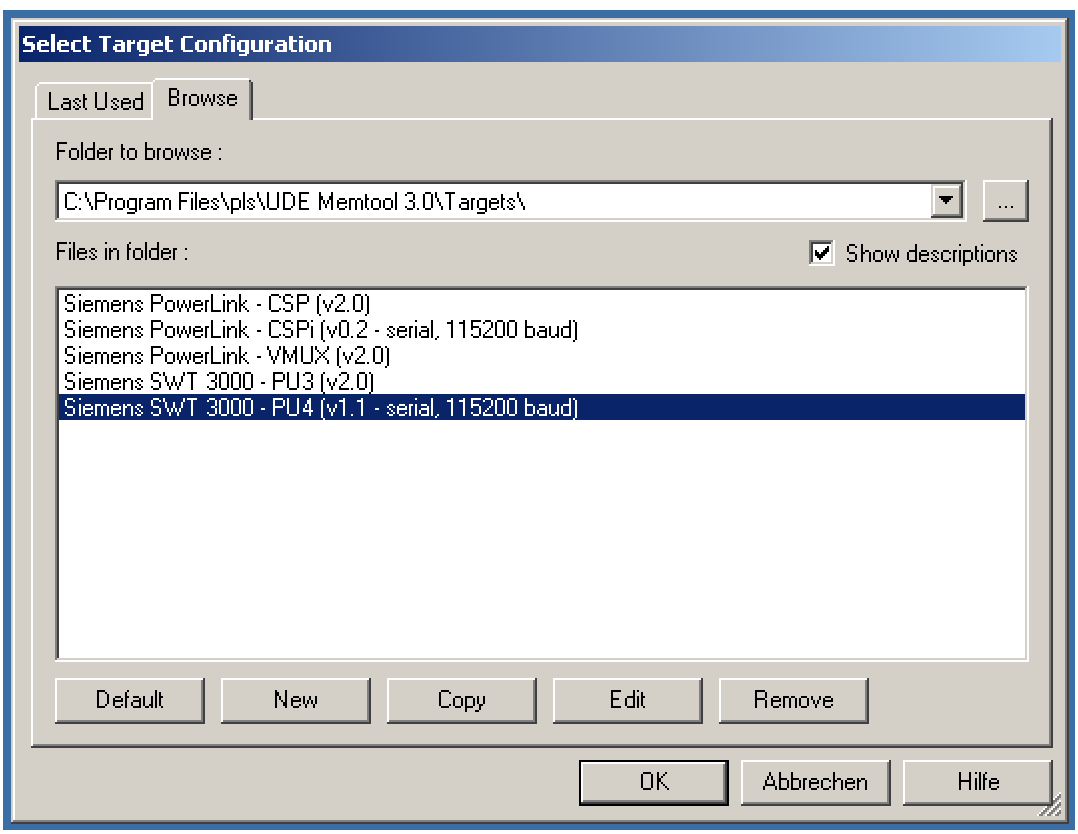
In order to launch MemTool as a stand-alone tool, execute Memtool.exe via the Windows main menu **Start > Programs > UDE MemTool**.



[scstrmem-020413-01.tif, 1, en_US]

Figure 4-14 MemTool with the PU4 Target

When starting MemTool for the first time, the **Select Target Configuration** dialog is displayed. Otherwise, you can reach this dialog via the menu bar **Target > Change**.



[sctarget-020413-01.tif, 1, en_US]

Figure 4-15 Selecting the Siemens SWT 3000 - PU4 (v0.1 - serial, 115200 baud)

Select **Siemens SWT 3000 - PU4 (v1.1 - serial, 115200 baud)** and click **OK**.

NOTE

Wrong target selection results in unsuccessful flash programming. Verify that the **selected target** is the **physically connected device**.

4.2.8.3 Connection to the SWT 3000 Target

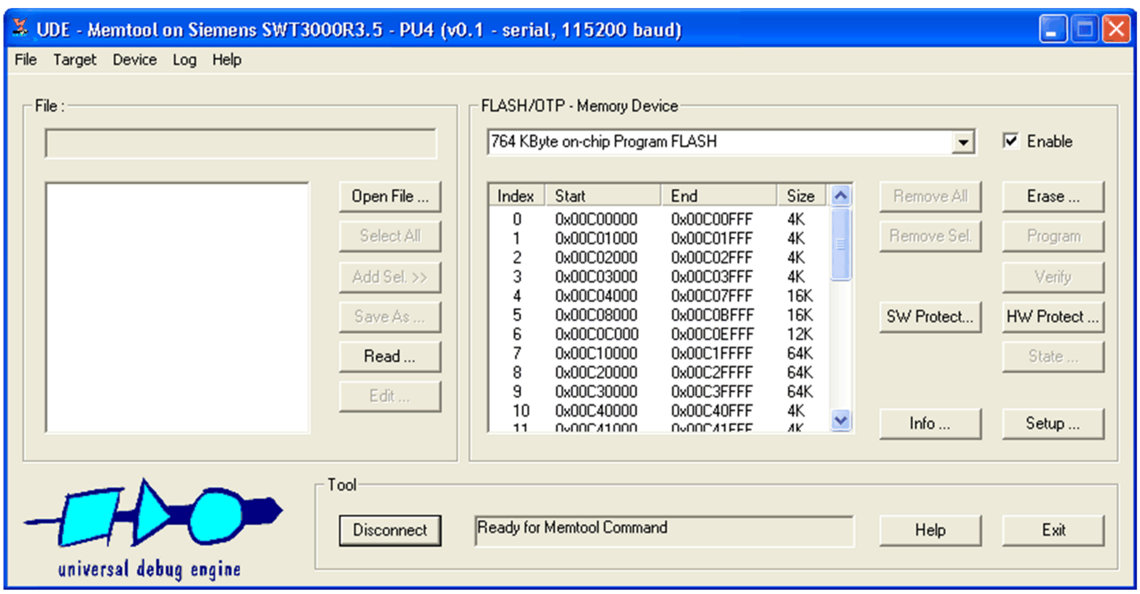
The PU4 memory consists of an internal FLASH (on-chip flash) and an external FLASH module. Both are programmed sequentially with the same procedure.

For **764 KByte on-chip Program FLASH** module, the sector table is created after determining the actual type of the FLASH and clicking **Connect**.

Select **764 KByte on-chip Program FLASH (not ready)** in the **Flash/OTP - Memory Device** list box.

Click **Connect** to establish a connection to the target SWT 3000 system. The sector list box contains now the sector table of the selected FLASH module. The **Connect** button changes to **Disconnect**.

If the connection fails, reset the PU4 module and try again.

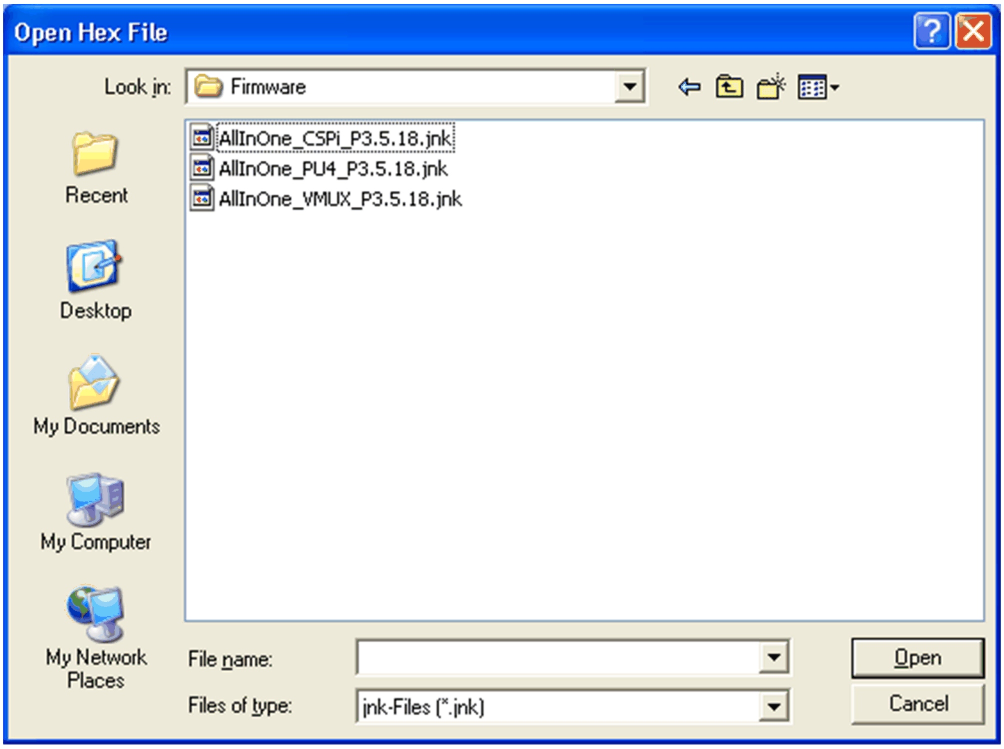


[scdicosw-171011-01.tif, 1, en_US]

Figure 4-16 Dialog of the Connection to SWT 3000 for 764 KByte On-Chip Program FLASH

4.2.8.4 Programming the Application into the Flash Memory

Click **Open File** and select the AllInOne_PU4_Px.y.z.jnk.



[scsealli-171011-01.tif, 1, en_US]

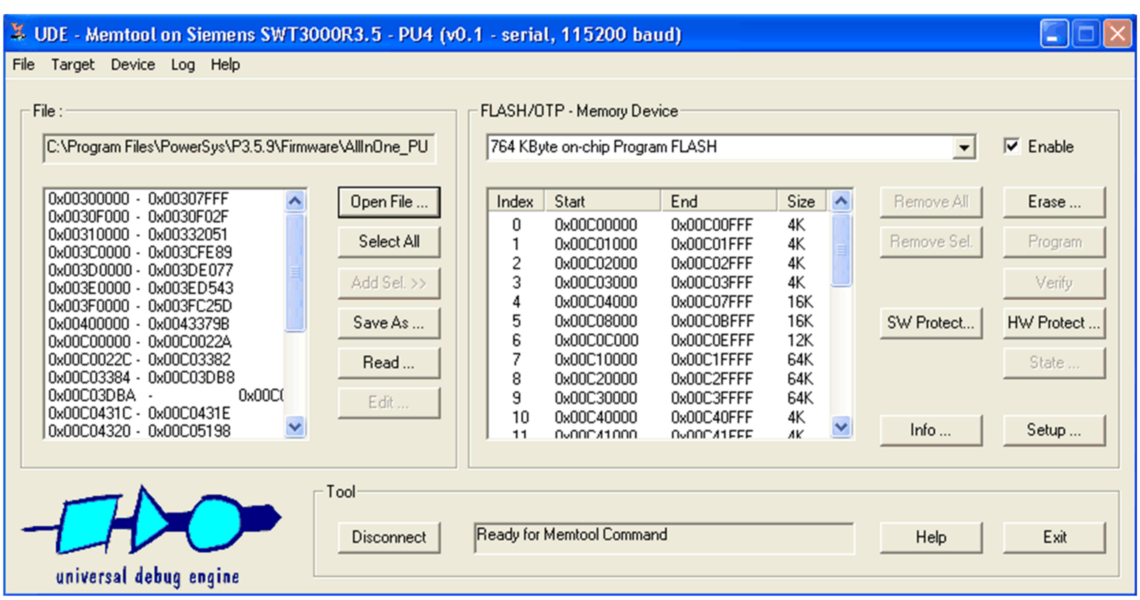
Figure 4-17 Selection of the AllInOne_PU4_Px.y.z.jnk File

NOTE

For the first time, it can be possible that you have to select **All Files** or **jnk Files** in the **Files of type** list box and navigate to the source folder.

Click **Open**.

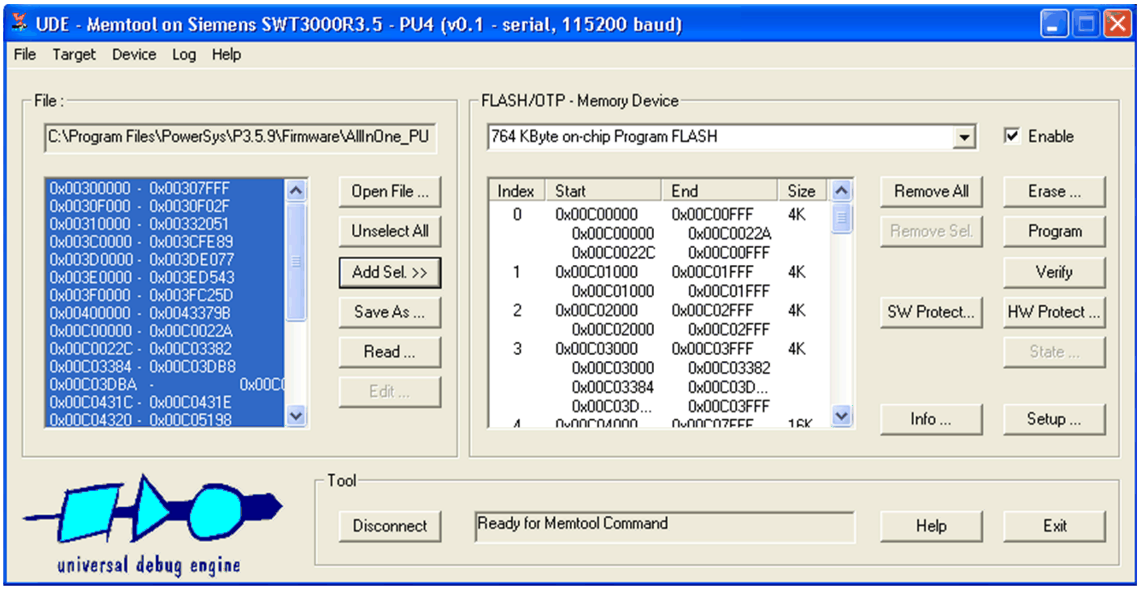
After loading this file in the left part of the MemTool main dialog, the file name and a list of sectors of the application are displayed.



[scfilena-171011-01.tif, 1, en_US]

Figure 4-18 After Selection of the AllInOne_PU4_Px.y.z.jnk File

Click **Select All** and then **Add Sel. >>**. The sectors of the application are displayed (according to the sectors they belong to) in the list box on the right-hand side.



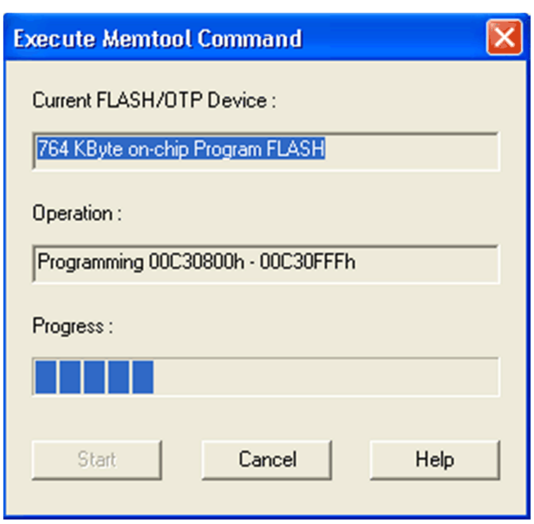
[scaddsel-171011-01.tif, 1, en_US]

Figure 4-19 Dialog of the Sectors in the List Box After clicking Add Selection

NOTE

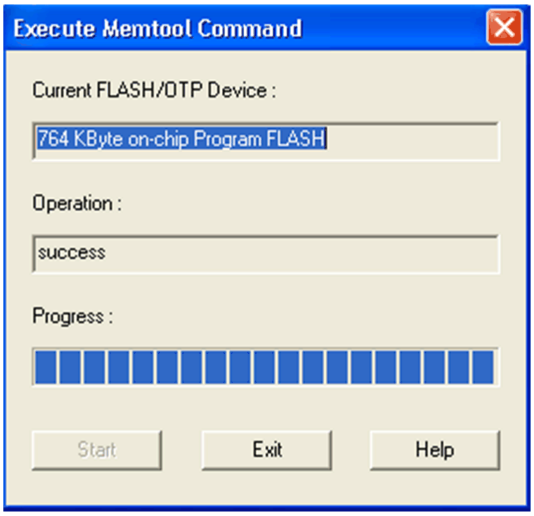
Wrong file selection results in unsuccessful flash programming. Verify that the **selected file matches to the target**, the correct FLASH memory device is selected and enabled and the device is physically connected.

Click **Program** to start the programming cycle. The **Execute MemTool Command** dialog appears and shows the programming progress. The upgrade starts with programming and verification.



[scstprog-250711-01.tif, 1, en_US]

Figure 4-20 Starting of the Programming Process

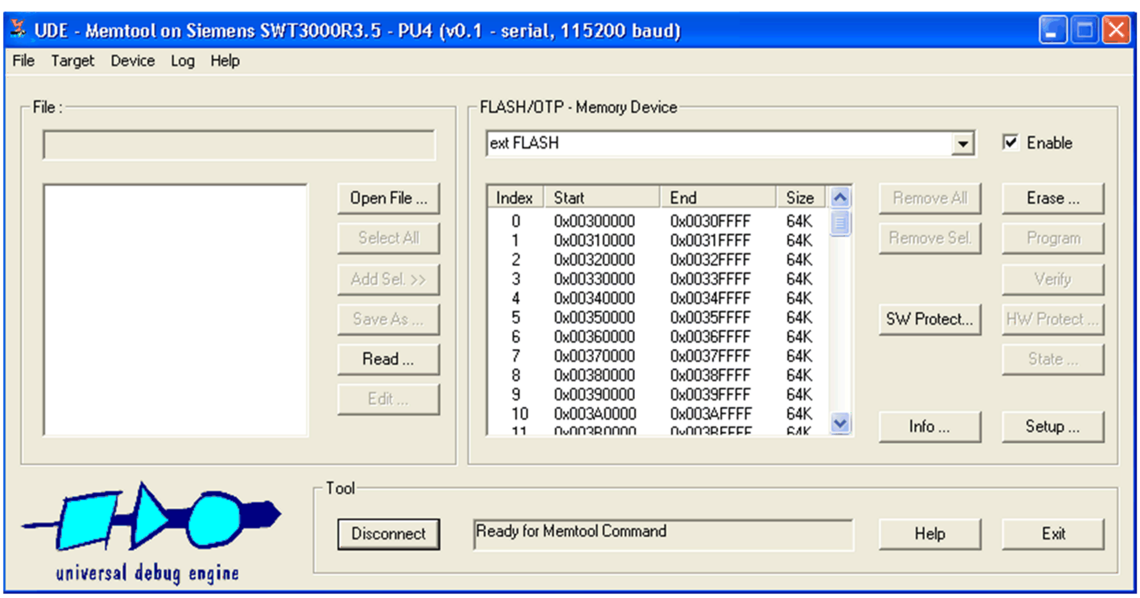


[scsucpro-250711-01.tif, 1, en_US]

Figure 4-21 Dialog After a Successful Programming

After successful upgrade, click **Exit**.

For **external FLASH** module, the sector table is created after determining the actual type of the FLASH.
Select **ext FLASH** in the **Flash/OTP - Memory Device** list box.
If the connection fails, reset the PU4 module and try again.
Click **Erase ...** to erase the external FLASH.



[scdicose-150911-01.tif, 1, en_US]

Figure 4-22 Dialog of the Connection to SWT 3000 for External FLASH

Click **Program** to start the programming cycle. The **Execute MemTool Command** dialog appears and shows the programming progress. The upgrade starts with programming and verification.
After successful upgrade, click **Exit**.
Click **Disconnect** and then **Exit** to close the MemTool main dialog.

NOTE

Turn off the device with the **S2** switch on the PU4 module.
Open **S3.1 of DIP switch PU4**.
Turn on the device with the **S2** switch on the PU4 module (PU4-Reset).

NOTE

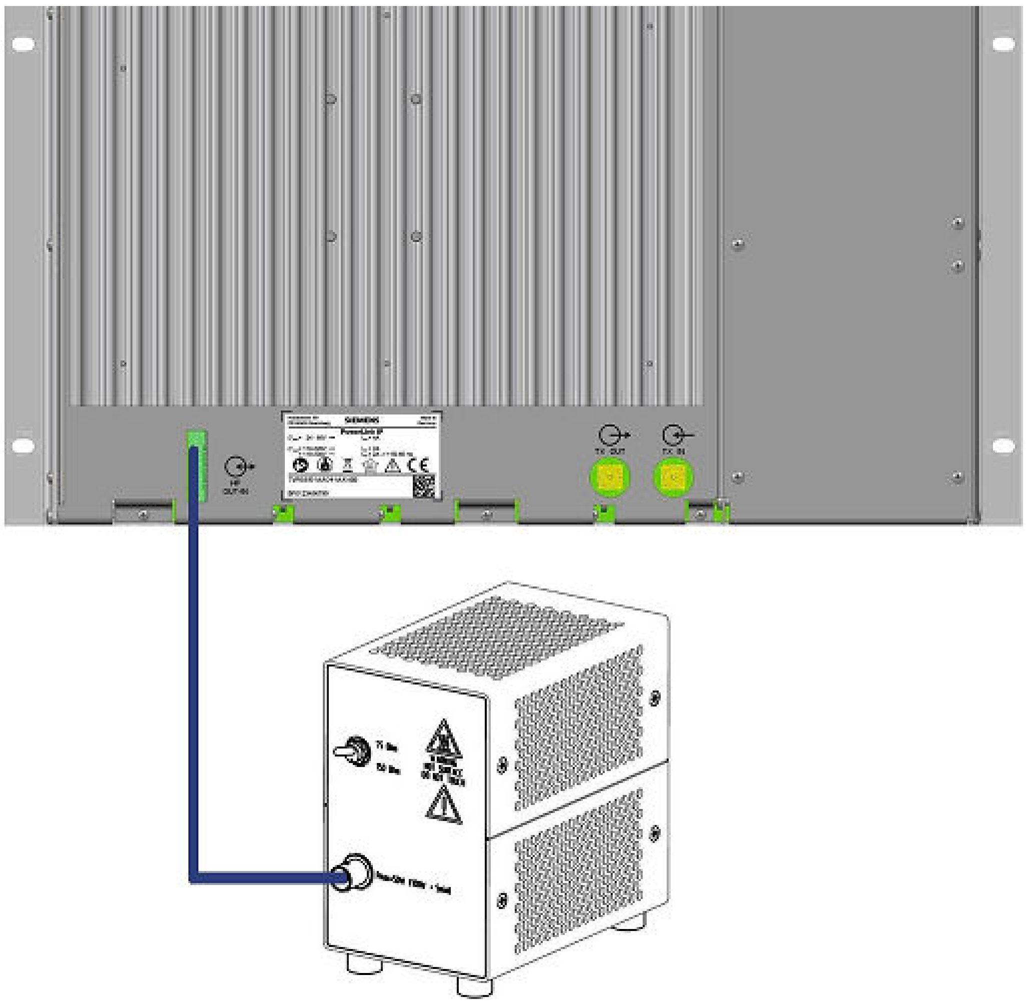
- Turn off the device with the **S1** switch on theDMB module.
- Open **S5.4 of DIP switch DMB**.
- Turn on the device with the **S1** switch on the DMB module.

4.3 Leveling

4.3.1 TX Leveling Adjustment

Connecting dummy load

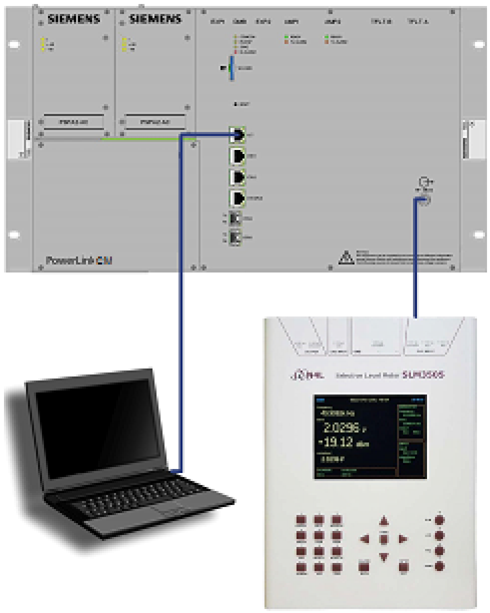
Connect dummy load (75 Ohm or 150 Ohm according to the requested impedance) to the HF_OUT/IN connector at the rear.



[sc_connecting dummy load, 1, en_US]

Connecting level meter

Connect level meter to HF measurement port at the front cover. If there is no level meter available, it is possible to use internal spectrum analyzer in Web UI.



[sc_connecting level meter, 1, en_US]

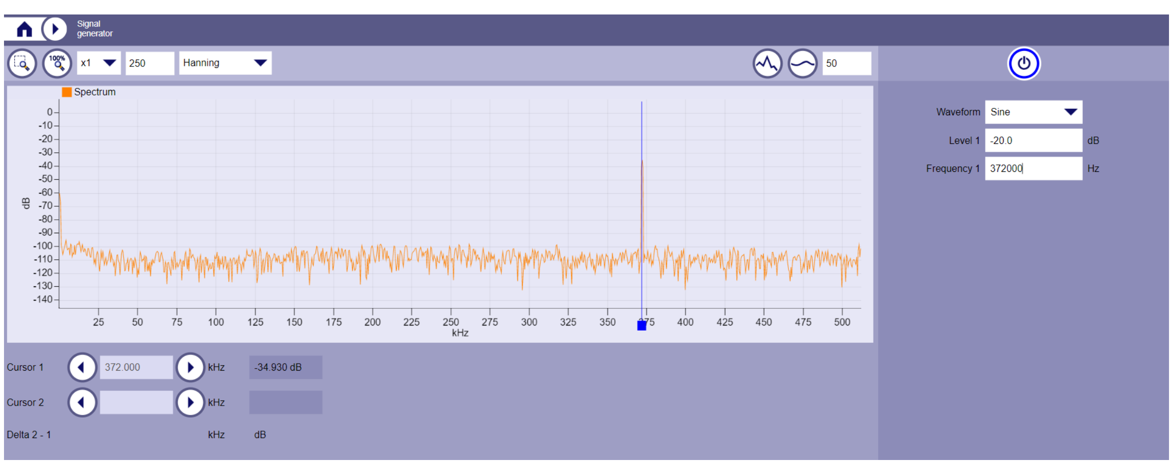
Check expected HF level

The expected signal level at HF measurement port is displayed in Web UI (last column).
Leveling example:

Signal generator	HF Tx freq. (Hz)	HF-Level out (dBu)
Data low	244000	38.0
Data mid	372000	38.0
Data high	500000	38.0

Generate test sine signal

Open signal generator page, generate test sine signal at frequency data low / mid / high with output level -20 dB.



[sc_signal generator, 2, en_US]

Figure 4-23 Web UI > Signal generator

To generate a signal via an external signal generator device, connect it via BNC cable to TX_IN port on the backplane. Enable this port in Web UI >Test "Tx test switch" = true. Test sine signal at frequency data low / mid / high with output level -20 dB and check in Web UI > spectrum analyzer.

Measure Tx leveling

If the measured level is not the same as the target value (tolerance: +/-1dB), it can be adjusted at Web UI > Configuration > Leveling.

75-Ohm impedance	
target value in level meter and internal spectrum analyzer	Sine signal (-20 dB) + Expected HF out (38 dB) - Attenuation (40 dB) = -22 dBu
150-Ohm impedance	
target value in level meter and internal spectrum analyzer	Sine signal (-20 dB) + Expected HF out (41 dB) - Attenuation (40 dB) = -19 dBu

4.3.2 iSWT Rx level adjustment

If the measured iSWT Rx level is not within the listed limits, it can be adjusted by adapting the iSWT Rx level adjustement parameter at Web UI > Configuration > Leveling.

iSWT Rx level adjustment	Value to raise the received guard level to an appropriate level. This value has influence on the “iSWT Rx level”.
iSWT Rx level	This is the guard level measured by the iSWT. The shown value should be between -9 dB and -3 dB. To achieve this, the “iSWT Rx level adjustment“ needs to be changed.

4.4 MergeTool for IEC 61850 with iSWT

4.4.1 Overview

The IEC 61850 Intelligent Electronic Device (IED) configuration philosophy of iSWT is to have a separate static IED Capability Description (ICD) file for each possible iSWT I/O configuration. These ICD files are imported in the IEC 61850 system configurator (DIGSI®) for substation configuration.

When the substation configuration is finished, the **MergeTool**[1] reads the Station Configuration Description (SCD) file (of the substation configuration) and generates the following 2 files:

- EN100 parameter file (BIN file)
- Preconfiguration file (CFG file)

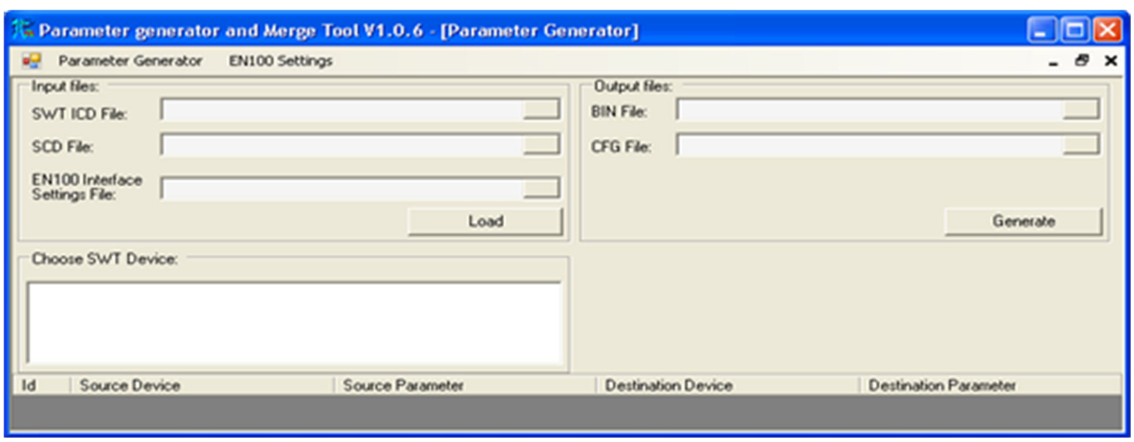
Web UI imports these 2 files into PU4 board.

The **MergeTool** dialog contains the **Parameter Generator** and **EN100 Settings** buttons.

4.4.2 Parameter Generator

Select the **Parameter Generator** button in the **MergeTool** dialog.

The following **MergeTool > [Parameter Generator]** dialog appears:



[scpargen-141011-01.tif, 1, en_US]

Figure 4-24 MergeTool > [Parameter Generator] Dialog

1 MergeTool covers the offline configuration of the IEC 61850 related settings for iSWT.

Table 4-7 Parameter Generator Settings

Parameter	Description	Selection
Input files > **SWT ICD File**	The **SWT ICD File** (a mapping of the device in a standard compliant file) is the precondition for work in the system configurator (DIGSI), which is based on these files. The ICD files describe the communication properties of the device according to IEC 61850. The ICD file of the SWT 3000 device is used for station configuration.	One of maximum 9 different available ICD files. Each file describes maximum amount of transmittable and receivable commands.
Input files > **SCD File**	Several devices form a complete station. They can also include a master unit. These components have various communication connections between them that must be parameterized. The description of all devices, their settings, and interrelations are grouped together in the SCD file. The SCD file itself is created and processed using the system configurator (DIGSI).	SCD file of the station
Input files > **EN100 Interface Settings File**	The **EN100 Interface Settings File (IFD file)** contains the interface settings for the EN100 module.	IFD file for the EN100 module A default IFD file for the selection of input file is presented to the MergeTool user in the PowerSys installation folder **\Px.y.zzz\Util\MergeTool\v01.00.11**.
Choose SWT Device	The present SWT 3000 devices appear in this window. For the generation of output files, select one of the SWT 3000 devices. After selecting the desired SWT 3000 device, the source device, source parameter, destination device, and destination parameter are listed in the option table.	One of the SWT 3000 devices
Output files > **BIN File**	The configuration for the EN100 module is provided via EN100 parameter file (binary parameter file, **BIN file**) EN100par.bin.	Select a folder for storage of the BIN file.
Output files > **CFG File**	The configuration for PowerSys is provided via PowerSys preconfiguration file (**CFG file**).	Select a folder for storage of the CFG file.

NOTE

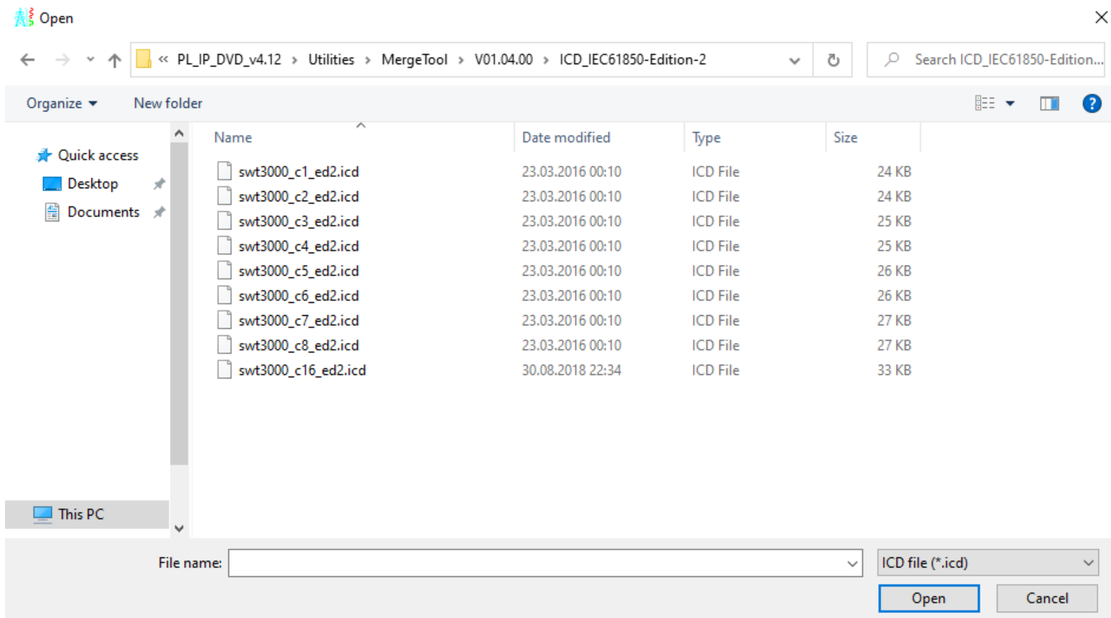
There are maximum 9 different ICD files available. Each file describes maximum amount of transmittable and receivable commands. The ICD files are available in the PowerSys installation folder **\Px.y.zzz\Util\MergeTool\v01.00.11** and on the PowerSys package in folder **\IEC61850\Config_files**.

Table 4-8 Selection of different ICD Files

Selection	Comment
SWT3000_c1_ed1/2.icd	Maximum 1 GGIO command is transmittable and receivable
SWT3000_c2_ed1/2.icd	Maximum 2 GGIO commands are transmittable and receivable
SWT3000_c3_ed1/2.icd	Maximum 3 GGIO commands are transmittable and receivable
SWT3000_c4_ed1/2.icd	Maximum 4 GGIO commands are transmittable and receivable
SWT3000_c5_ed1/2.icd	Maximum 5 GGIO commands are transmittable and receivable
SWT3000_c6_ed1/2.icd	Maximum 6 GGIO commands are transmittable and receivable
SWT3000_c7_ed1/2.icd	Maximum 7 GGIO commands are transmittable and receivable
SWT3000_c8_ed1/2.icd	Maximum 8 GGIO commands are transmittable and receivable
SWT3000_c16_ed1/2.icd	Maximum 16 GGIO commands are transmittable and receivable

Select the files in the **Input files** area **in the following order**:

- Click the **SWT ICD File** button.
  The following dialog appears:

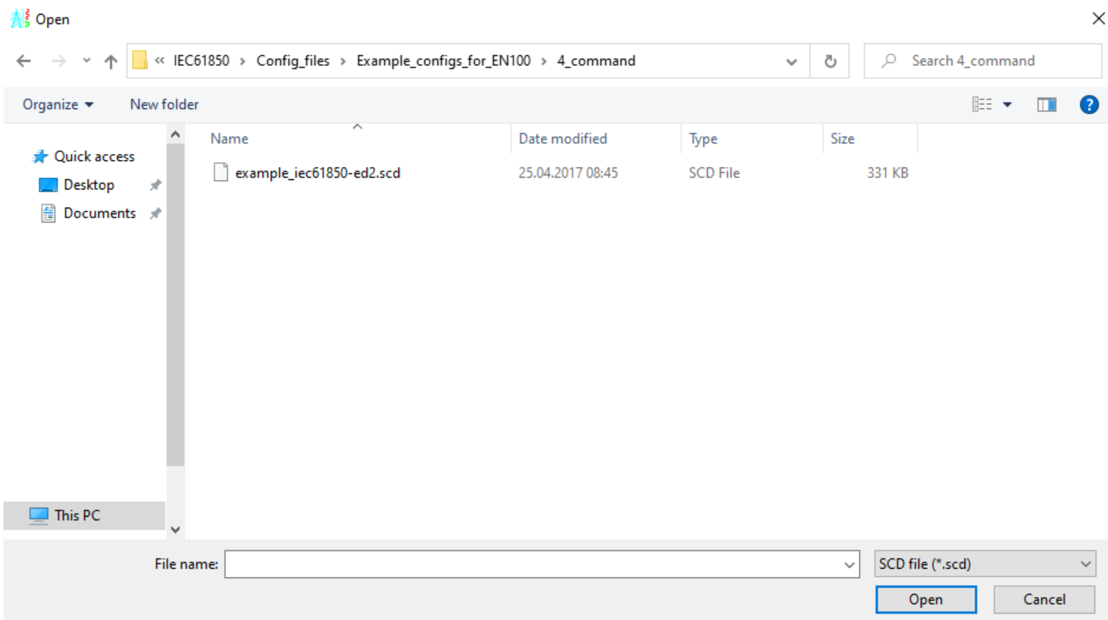


[sc_ICD_Fileselection, 1, --_--]

Figure 4-25 ICD File Selection of SWT 3000

Select the proper **SWT ICD File**, which was used in station configuration.
After selection of the **SWT ICD File**, click **Open**.

- Click the **SCD File** button.
  The following dialog appears:

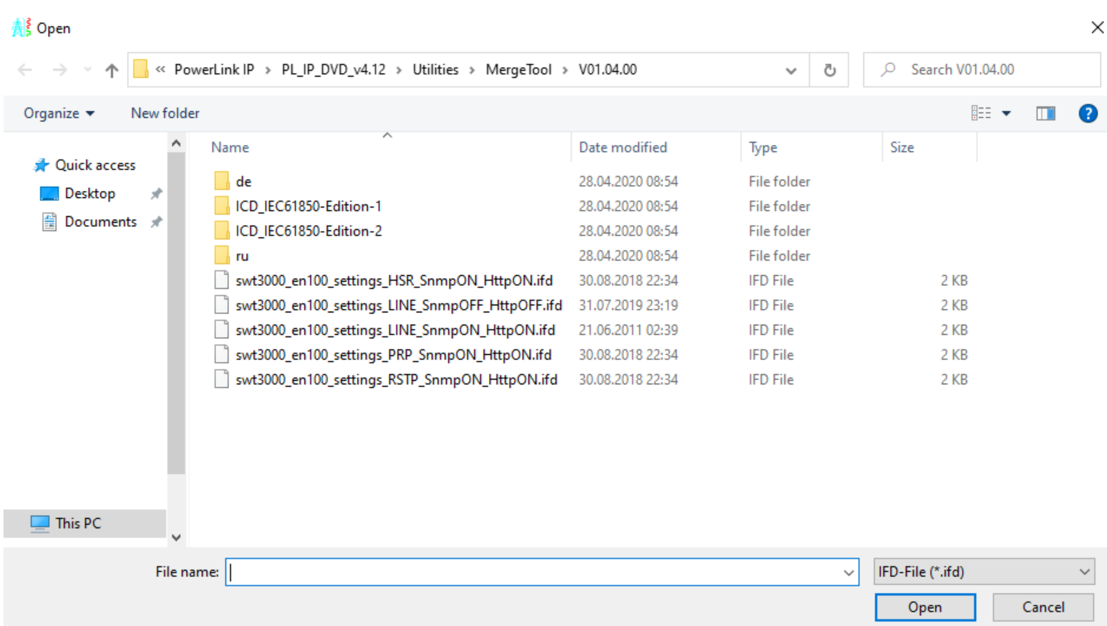


[sc_SCD_Fileselection, 1, --_--]

Figure 4-26 SCD File Selection of the Station

Select the proper **SCD File** of the station.
After selection of the **SCD File**, click **Open**.

- In the third step, click the EN100 **Interface Settings File (IFD file)** button.
  The following dialog appears:



[sc_EN100_Settingselection, 1, --_--]

Figure 4-27 IFD File Selection of the EN100 Module

Explanation for the default IFD files:

xxx_SnmpOFF_HttpOFF.ifd: EN100 SNMP and HTTP services are enabled

xxx_SnmpOn_HttpON.ifd: EN100 SNMP and HTTP services are disabled

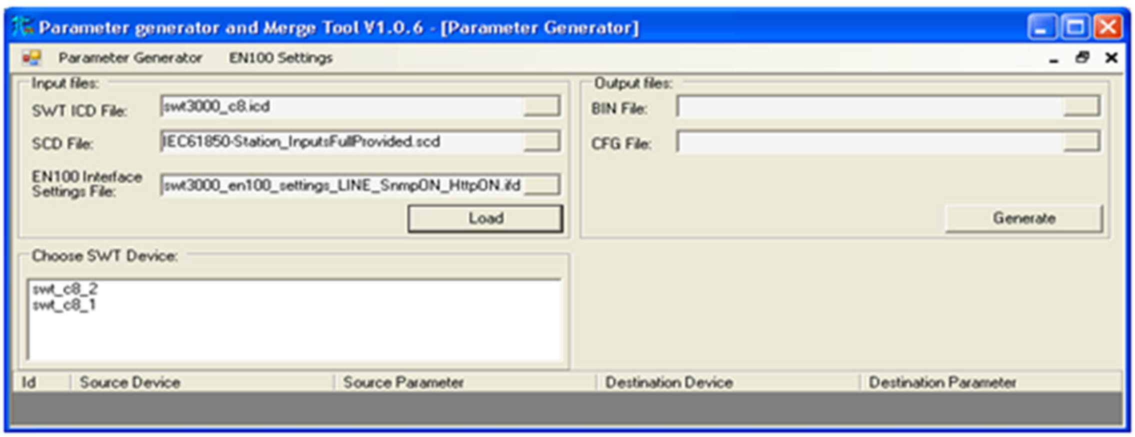
Select the proper **IFD file** of the EN100 module.

After selection of the **IFD file**, click **Open**.

NOTE

A default IFD file for the selection of input file is presented to the MergeTool user in the PowerSys installation folder **\Px.y.zzz\Util\MergeTool**.

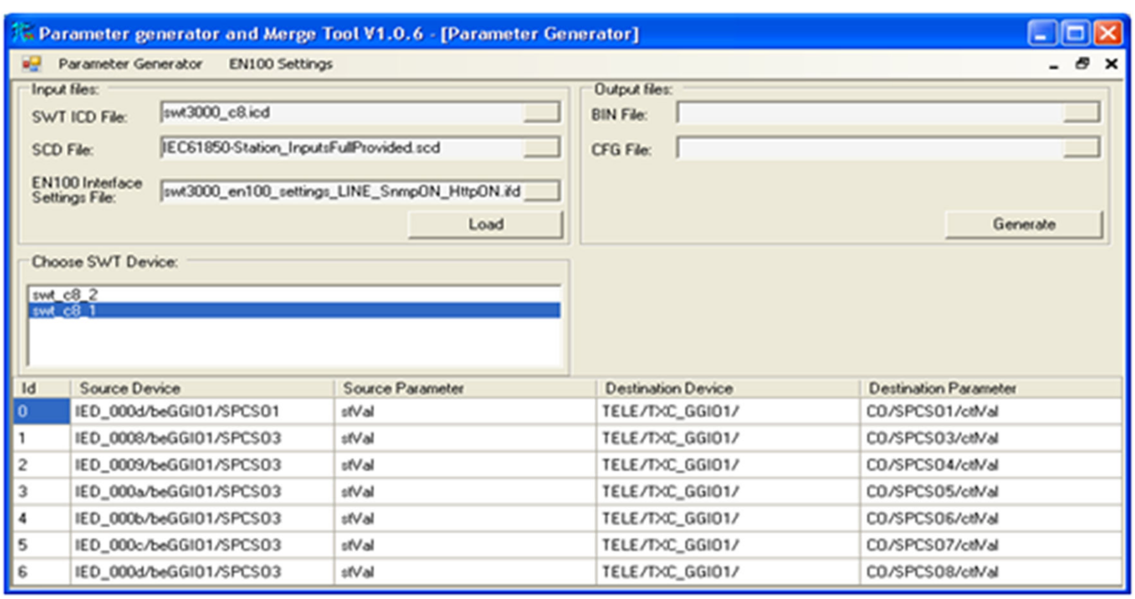
After selecting the **Input files**, click the **Load** button. If multiple matching SWT 3000 devices are found in the local station, they are listed in the **Choose SWT Device** area.



[scmtswtd-141011-01.tif, 1, en_US]

Figure 4-28 [Parameter Generator] Dialog with Choose SWT Device area

With clicking the desired device, the **Source Device, Source Parameter, Destination Device**, and **Destination Parameter** are listed in the option table.



[scmtopta-141011-01.tif, 1, en_US]

Figure 4-29 [Parameter Generator] Dialog with Option Table area

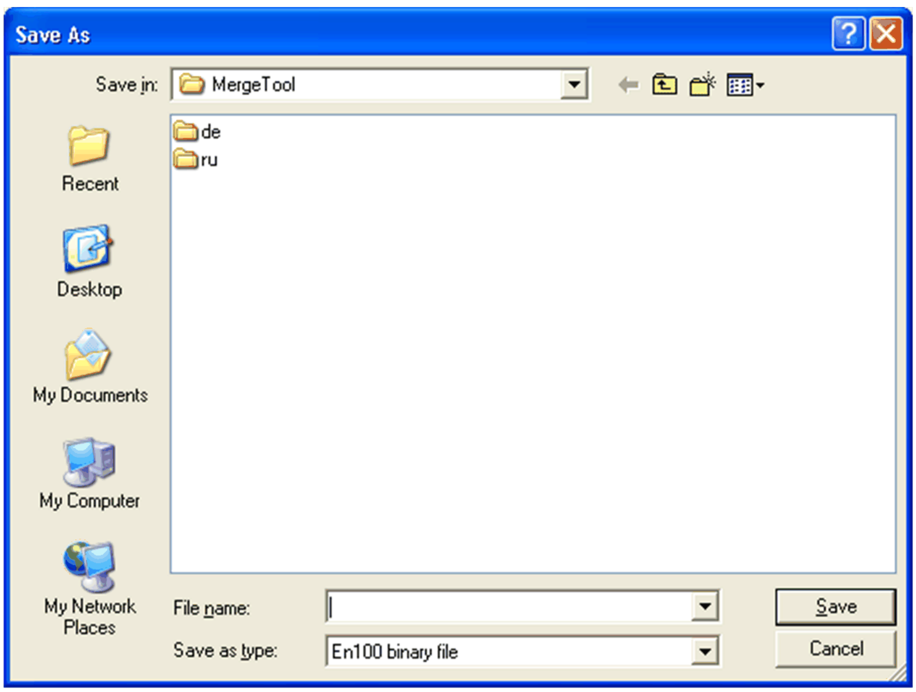
NOTE

If the SCD file does not contain the intAddr and daName tags for the inputs sections (so the substation configurator does not provide this information), manual selection of the source and destination parameters in the option table is necessary. Click the **Source Parameter** or **Destination Parameter** list box and select the specific parameters.

When using the EN100 module, it is necessary to generate the EN100 parameter file (BIN file) and PowerSys preconfiguration file (CFG file) and save them in a proper folder. The mentioned files can be uploaded to PowerSys in the SWT 3000 > Configuration > System-2 submenu. Store the content of the BIN file then in PU4 Flash. With each startup of SWT 3000, the BIN file is transferred to volatile memory of the EN100 module.

In order to generate the desired **Output files**, define the name and place of storage of the **Output files** area as follows:

- Click the **BIN File** button.
  The following dialog appears:

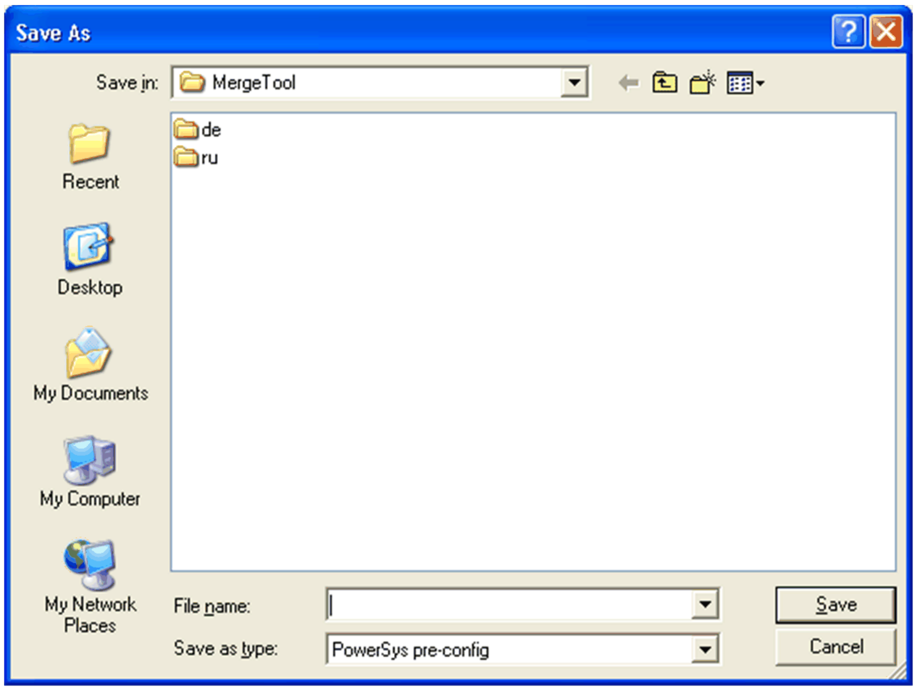


[scbinsel-080911-01.tif, 1, en_US]

Figure 4-30 Selection of Name and Place of the BIN File

Define the name and place of storage of the BIN file.
Afterwards, click **Save**.

- Click the **CFG File** button.
  The following dialog appears:



[sccfgsel-080911-01.tif, 1, en_US]

Figure 4-31 Selection of Name and Place of the CFG File

Define the name and place of storage of the CFG file.
Afterwards, click **Save**.

In order to generate the EN100 parameter file (BIN file) and PowerSys preconfiguration file (CFG file), click the **Generate** button.

NOTE

If SWT 3000 is equipped with an EN100 module, the BIN file and CFG file are configured in **PowerSys > SWT 3000 > Configuration > System-2 > EN100** area.

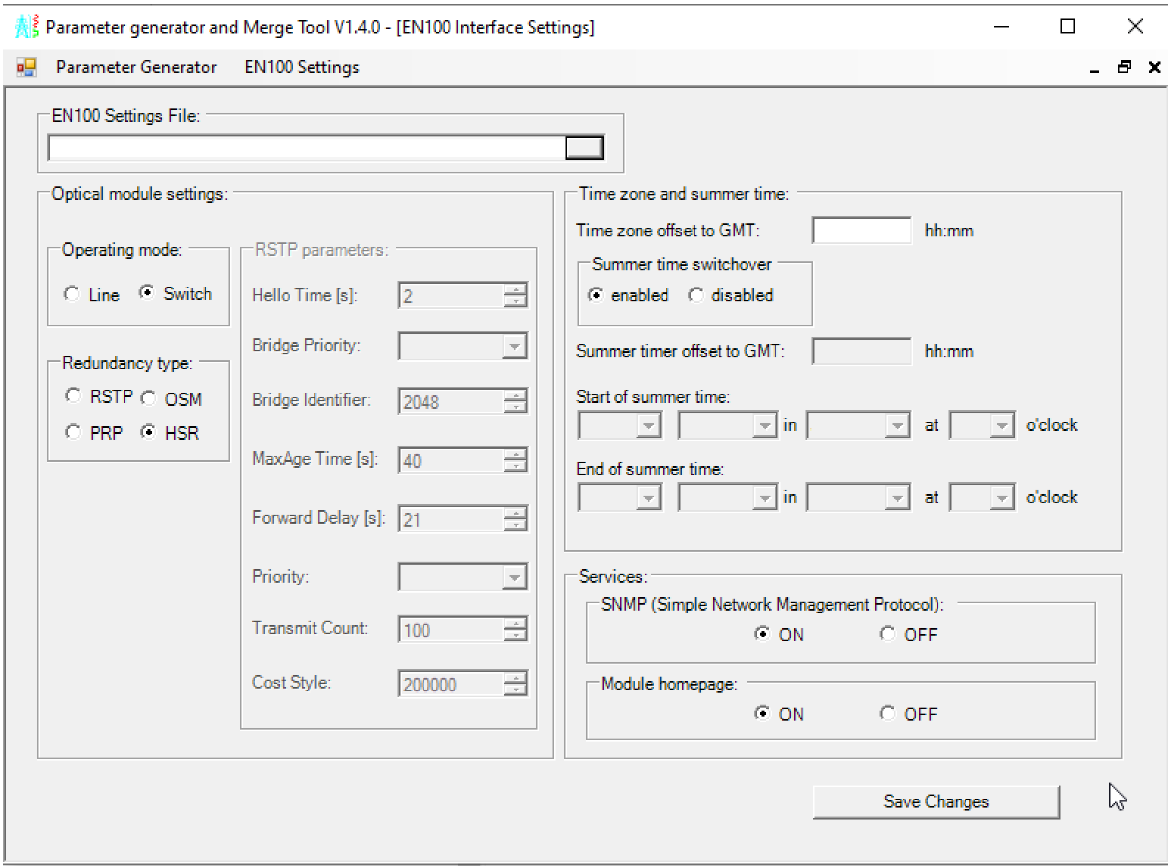
4.4.3 EN100 Settings

When using the EN100 module, there are some additional (none IEC 61850) configuration settings for the EN100 module. These settings have to be put in the parameter file downloaded to the EN100 module at startup.
Therefore, the MergeTool provides a Graphical User Interface (GUI) for the configuration of EN100 settings and stores these settings in a separate file. This option provides the implementation of the GUI elements processing the user interaction for the EN100 settings file manipulation.

NOTE

It is not necessary to create an EN100 settings file (IFD file). A default IFD file for the selection of the input file is presented to the MergeTool user.
If there is a new IFD file needed, proceed like described in the following.

Select the **EN100 Settings** button in the **MergeTool** dialog.
The following **MergeTool > [EN100 Interface Settings]** dialog appears:



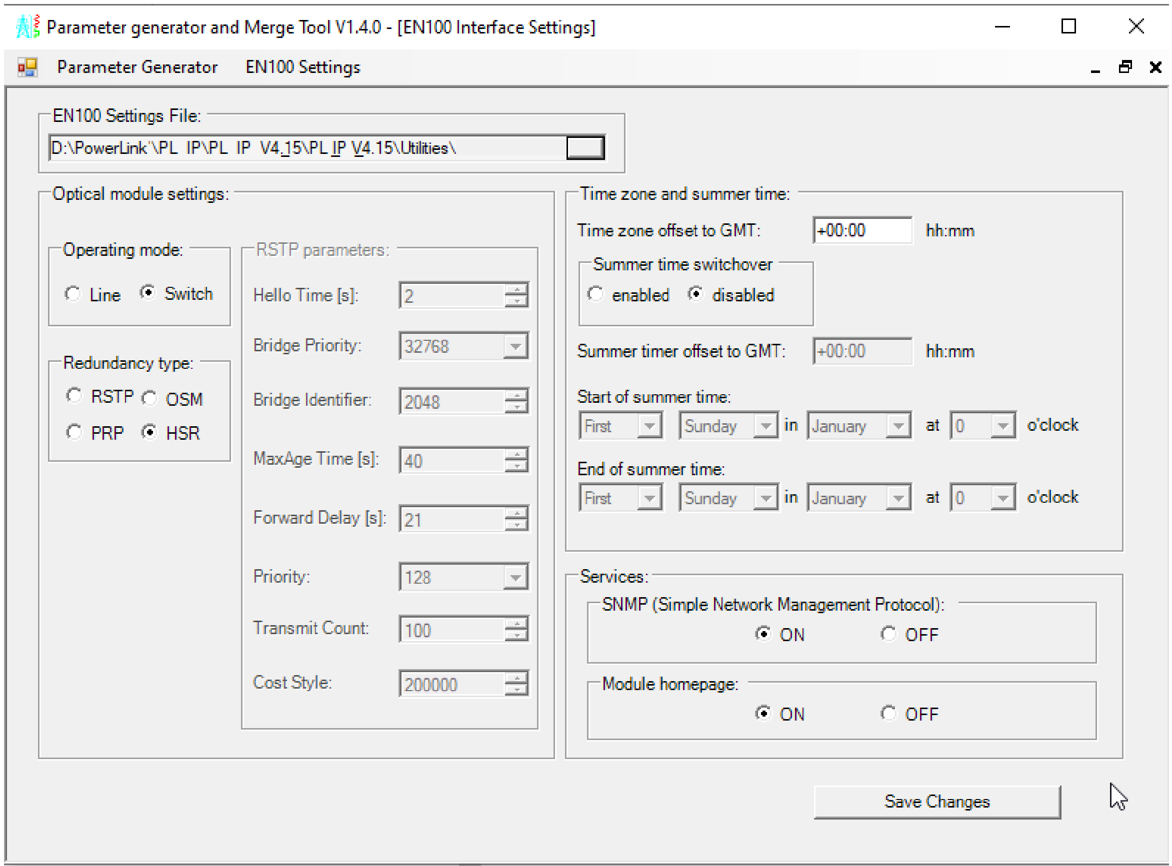
[sc_mergetool_en100_settings, 1, --_--]

Figure 4-32 MergeTool > [EN100 Interface Settings] Dialog

Copy the presented default IFD file into a desired folder.

Rename this IFD file for creation of a new IFD file and save this file in the desired folder of database.

In order to select the new created IFD file, click the button in the **EN100 Settings File** area. Select the newly created IFD file from the folder in database. You can edit now the IFD file settings.



[sc_mergetool_en100_settings_IFD, 1, --_--]

Figure 4-33 MergeTool > [EN100 Interface Settings] Dialog with Selected IFD File

Edit the **Optical module settings** as follows:

Table 4-9 Optical Module Settings of EN100 Settings

Parameter	Description	Setting Range or Selection
Operating mode	The operating mode for SWT 3000 is set to **Line** by default. The **Line** mode is equivalent to the functions of the EN100 module with electrical interface.	**Line**
Redundancy type	If the **Switch** mode has been selected, set the **Redundancy type** next. Available **Redundancy types** are **Rapid Spanning Tree Protocol (RSTP)**, **Optical Switch Module (OSM)**, **Parallel Redundancy Protocol (PRP)** and **High-availability Seamless Redundancy (HSR)**. The redundancy type depends on the ring structure. **Redundancy type OSM** is a proprietary procedure of the Siemens AG. The OSM type can only be used in combination with at least one external switch that can control this type of redundancy. Set one of the external switches as master. **Redundancy type RSTP** is used world-wide and supported by nearly all switches.	**RSTP** **OSM** **PRP** **HSR**

Parameter	Description	Setting Range or Selection
RSTP parameter > **Hello Time [s]**	If no test message is received 3 times in a row during the specified monitoring time, the connection is considered faulty. The link status is also monitored. It leads to an immediate detection of an interruption with subsequent changeover. Permissible values are from 1 s to 10 s (the standard recommends a default setting of 2 s).	From 1 s to 10 s Change the RSTP parameter settings only if this change is necessary. In particular, use the settings recommended in this manual.
RSTP parameter > **Bridge Priority**	This value represents a priority for a switch. Every switch in the ring network has a specific priority that has been set equally for all switches by default. Furthermore, this priority is linked to the MAC address within the switch, which always yields different priorities. The lowest priority defines the logical separation of the ring network. Here, the messages are output from the ring network. The highest priority (identified by zero) marks the root switch. If messages are output or input there, both logical lines must have the same length. Permissible values are: 0, 4096, 8192, 12 288, 16 384, 20 480, 24 576, 28 672, 32 768, 36 864, 40 960, 45 056, 49 152, 53 248, 57 344, and 61 440 (the standard recommends a default setting of 32768 s).	From 0 s to 61 440 s (in increments of 4096)
RSTP parameter > **Bridge Identifier**	Enter a number from 0 to 4 294 967 295 as an identifier for the switch (default setting: 2048).	From 0 to 2^{32}
RSTP parameter > **MaxAge Time [s]**	Set a time from 6 s to 40 s. After this time has elapsed, older messages will be removed from the network (default setting: 40 s).	From 6 s to 40 s
RSTP parameter > **Forward Delay [s]**	The ports of the module remain in one of the conditions - discarding, learning, and forwarding - not longer than for the time set here. Permissible values are from 4 s to 30 s (the standard recommends a setting of 21 s).	From 4 s to 30 s
RSTP parameter > **Priority**	Every switch in the ring network has a specific priority that has been set equally for all switches by default. The priority is preset by the switch manufacturer. Furthermore, this priority is linked to the MAC address within the switch, which always yields different priorities. The lowest priority defines the logical separation of the ring network. Here, the messages are output from the ring network. The highest priority (identified by zero) marks the root switch. If messages are output or input there, both logical lines must have the same length (default setting: 128).	From 0 to 240 (in increments of 16)
RSTP parameter > **Transmit Count**	Maximum number of configuration messages sent for a specific event (structural reconfiguration). This number must exceed the number of existing switches in the ring network. Permissible values are from 3 to 128 (the standard recommends a setting of 10).	From 3 to 128
RSTP parameter > **Cost Style**	This value is a variable that depends on the speed of the link controlling the reconfiguration algorithm. A value of 200000 is fixed for 200 Mbits. Changes are necessary only in special cases and if Spanning Tree Protocol (STP) switches are used. The value -1 is the identifier for the automatic mode.	200000

Edit the **Time zone and summer time** as follows:

Table 4-10 Time Zone and Summer Time Settings of EN100 Settings

Parameter	Description	Setting Range or Selection
Time zone offset to GMT	The time offset of your time to the Greenwich Mean Time (GMT).	From -12 h to +12 h
Summer time switchover	Select the option **enabled** or **disabled** summer time switchover if you do or do not wish to change to daylight saving time.	enabled or disabled
Summer time offset to GMT	The time offset of your time to the GMT.	From 0 h to +23 h
Start of summer time	Date for the change to daylight saving time.	–
End of summer time	Date for the change from daylight saving time.	–

Edit the **Services** as follows:

Table 4-11 Service Settings of EN100 Settings

Parameter	Description	Selection
SNMP	You can use this setting to activate or deactivate the SNMP protocol.	ON or OFF
Module homepage	You can use this setting to activate or deactivate the module homepage.	ON or OFF

4.5 Diagnostics and Error Handling

4.5.1 DMB

4.5.1.1 LEDs on DMB

Table 4-12 4 alarm LEDs on DMB, visible at the front cover.

LED	Description	
COMCON (bi-color)	off	Power off, system failure
	green	OK
	red	Not OK (HW alarm)
	green fast blinking	Startup in progress
	green slow blinking	General alarm (or test mode active or DIP switch on)
PLCDSP (bi-color)	off	Power off
	green	OK
	red	Not OK (HW alarm)
	green slow blinking	General alarm
Sync (bi-color)	off	Power off, IDLE mode, error occurred before starting
	green	Sync OK
	red	Sync Not OK (due to low SNR)
	green/red slowly alternating	Failed sync tries (notch or frequency parameters probably wrong)
	green with short red blink	single symbol errors
Receive Alarm	off	OK or no SWT configured
	red	Receive alarm (received guard level too low)

4.5.1.2 Diagnostic LEDs on DMB behind the front cover

LED	Description
H22	CDI telegram received
H23	IRIG-B telegram received
H24	iLAN telegram received
H25	S6 signal received
H26	Reserve
H27	Reserve
H28	Reserve
H29	Reserve

4.5.1.3 DIP Switches DMB board

DIP Switch S5

S5	State	Descriptions
1	open	default
		boot from SD card (for internal use only)
2	open	default
	close	start with default service interface IP address (192.168.20.20) and default user interface IP address (192.168.30.20)

S5	State	Descriptions
3	open	default supress auto-reset for HW alarm or FW rollback
4	open	default enable PU4 programming with MemTool

In normal operation of the device, all switches have to be in open position.

DIP Switch S6

S6	Descriptions
1	reserved, for internal use only
2	reserved, for internal use only
3	reserved, for internal use only
4	reserved, for internal use only

4.5.2 AMP

4.5.2.1 LEDs on AMP

State	Comments
Green Off	Ready Power amplifier is switch on Power amplifier is switched off
Red Off	TX alarm Set by controller if Tx alarm is active Set by controller if Tx alarm is inactive

4.5.3 PU4

4.5.3.1 LEDs on the PU4 Module

- The 2-color OK/BGAL LED is needed for displaying the PU4 module status. The following states can be displayed:

Table 4-13 Significance of the OK/BGAL LED Displays

State	Significance
Off	Power supply is disconnected or faulty
Red static	Module is not ready for operation
Red flashing	General alarm module is only operational to a limited extent
Green static	Normal operation
Green slow flashing	Test operation
Green fast flashing	Ethernet port of PU4 is not ready for operation

- The 2-color LIA LED is needed for displaying the status of the LIA. The following states can be displayed:

Table 4-14 Significance of the LIA LED Displays

State	Significance
Off	LIA is not configured
Red static	LIA is not ready for operation (for example receiver alarm)

State	Significance
Red flashing	LIA is only operational to a limited extent
Green static	LIA is working correctly

- The 2-color LID-1 LED is not used for iSWT in PowerLink IP. (Red static during reset.)
- The 2-color LID-2 LED is not used for iSWT in PowerLink IP. (Red static during reset.)

4.5.4 ALR

4.5.4.1 LEDs on Alarm Module

The module ALR provides a LED for visual indication of the state for each binary input and for each alarm output. They are visible after removal of the front panel. The significations are shown in the table below:

Table 4-15 ALR Indication

LED	Indication
H6	IRIG-B Input energized
H5	Binary Input 1 energized
H4	Binary input 2 energized
H3	Alarm output 1 activated
H2	Alarm output 2 activated
H1	Alarm output 3 activated

4.5.4.2 ALR Test Switch S1

For test purposes the module ALR provides a switch for each of the binary input circuits and for the IRIG-B circuit. Closing a switch sets the output of the assigned circuit to the active state.

Switch	Function
S1.1	Binary Input 2 test
S1.2	Binary input 1 test
S1.3	n.u.
S1.4	IRIG-B test

4.5.5 CIB

4.5.5.1 LEDs on CIB

CIB > LED indication

CIB LEDs	Comments
E&M Amber	Light on – M-lead inactive (On-hook) when port is enabled. Light off – M-Lead active (Off-hook) or port disabled.
E&M Green	Light on – E-lead inactive (Received on-hook from remote E&M peer.) Light off – E-lead active (Received off-hook from remote E&M peer.)
FXO Amber	Light on – On-hook when port is enabled. Light off – Off-hook or port disabled.

CIB LEDs	Comments
FXO Green	Light on – Received on-hook signal from remote FXS peer. Light off – Received off-hook signal from remote FXS peer.
FXS-1&2 Amber	Light on – FXS-1 on-hook when port is enabled. Light off – FXS-1 off-hook or port disabled. Fast blink – FXS-1 is ringing.
FXS-1&2 Amber	Light on – FXS-2 on-hook when port is enabled. Light off – FXS-2 off-hook or port disabled. Fast blink – FXS-2 is ringing.
FXS-3&4 Amber	Light on – FXS-3 on-hook when port is enabled. Light off – FXS-3 off-hook or port disabled. Fast blink – FXS-3 is ringing.
FXS-3&4 Green	Light on – FXS-4 on-hook when port is enabled. Light off – FXS-4 off-hook or port disabled. Fast blink – FXS-4 is ringing.
RS-232 Amber	Light on – port enabled. Light off – port disabled.
RS-232 Green	TxD / RxD active (Data in transmission).

4.5.5.2 CIB Test

Test

Setting	Comments
CIB voice loop	Enable voice PCM local loop for internal test only. Voice port LED is slow blinking.
CIB FXS test	Start FXS measurement for internal test only

4.5.5.3 CIB Alarm

CIB > Alarm

CIB Alarms	Comments
CIB board is present	CIB is enabled and CIB board is present.
CIB board missing	CIB is enabled but not equipped.
CIB voice port failure	At least one CIB voice port is enabled but initialization failed.
EM S2 test active	When DIP-switch 1 in CIB is on, E&M port will take hook signal from DIP-switch 2 for test purpose only.

5 Frequency Planning Guideline

5.1 Frequency Planning

5.1.1 General Information

The utilizable frequency range for the high voltage power-line carrier (PLC) transmission is from 24 kHz to 1000 kHz. In many countries certain frequency ranges are reserved by regulation authorities for air traffic control, broadcasting, shipping radio service etc.

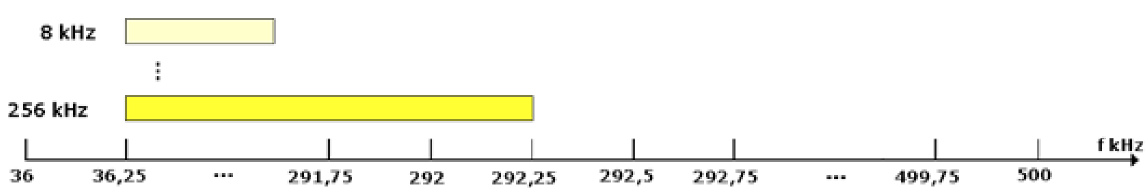
With the respect to the data transmission a PowerLink IP link has to be considered as a frequency division duplex (FDD) connection between two PowerLink IP devices (terminals) with two data channels, which are situated in separate frequency bands (one band for TX and one band for RX). Each frequency band may be located in frequency between 36 kHz and 500 kHz. The initial start and stop frequencies as well as the minimal start and the maximal stop frequency of each channel may be selected in 250 Hz steps. The bandwidth and start frequency of the transmit filter for each data channel may be selected between 32 kHz and 256 kHz in 8 kHz steps (TFLT_A/B), or 4, 5, 8, 12 and 16kHz (TFLT_C/D).

For smart frequency management each PowerLink IP terminal uses up to 4 Medium Access Request Channels (MARC):

- $MARC_A$ for transmission of smart frequency management information sent from PowerLink IP device A towards the partner PowerLink IP device B.
- $MARC_B$ to receive smart frequency management information from PowerLink IP B towards the partner PowerLink IP device A
- $MARC_{AL}$ for reception of smart frequency management information from the selected PowerLink IP device neighboring in frequency domain next to the lower edge of the transmission channel A.
- $MARC_{AU}$ for reception of smart frequency management information from the selected PowerLink IP device neighboring in frequency domain next to the upper edge of the transmission channel A.

In this manual a device-centric approach is used for naming of the transmission directions and the corresponding data channel and MARC settings. A PowerLink IP terminal transmits in the direction A to its partner PowerLink IP device and receives its signals from the direction B.

HF Bandwidth

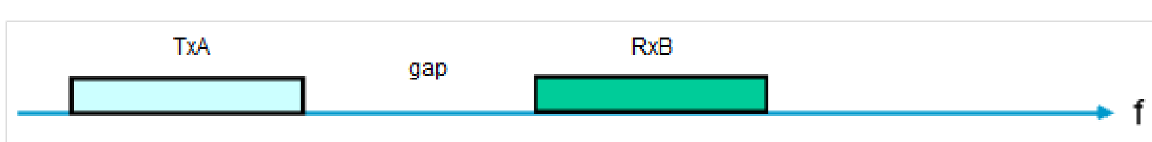


[dw_adjustable_bandwidth_for_each_powerlinkip_channel, 1, --_--]

Figure 5-1 Adjustable bandwidth for each PowerLink IP channel.

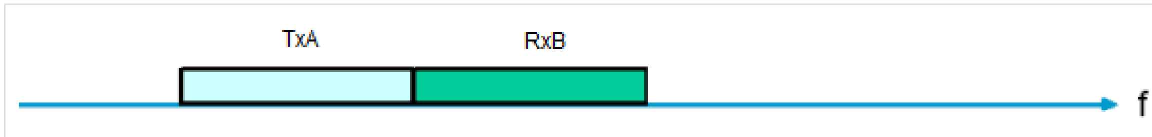
Adjacent or Non-Adjacent Bands

Depending on the frequency gap between the Tx and Rx frequency band, this is considered as an adjacent or non-adjacent transmission.



[dw_non_adjacent_frequency_bands_location, 1, --_--]

Figure 5-2 Example of an non-adjacent frequency bands location



[dw_adjacent_frequency_bands_location, 1, --_--]

Figure 5-3 Example of an adjacent frequency bands location

5.1.2 Frequency Plan

The frequency plan determines the proper frequency allocation for each PLC link in the frequency scheme to avoid cross talk between any PLC links installed in the network. Cross talk affects data transmission and protection signaling.

5.1.3 Planning Rules

During the frequency planning two different things have to be defined, the edge frequencies of the Tx-Filter and the edge frequencies of the finally used transmission band of the modem and the (i)SWT. (The edges of the receive band simply follow the transmit band of the opposite device.) For the edge (or cut-off) frequencies of the Tx-Filter, the following two different cases are distinguished.

Minimum space between terminals on the same phase line at the same place or on the same coupling unit

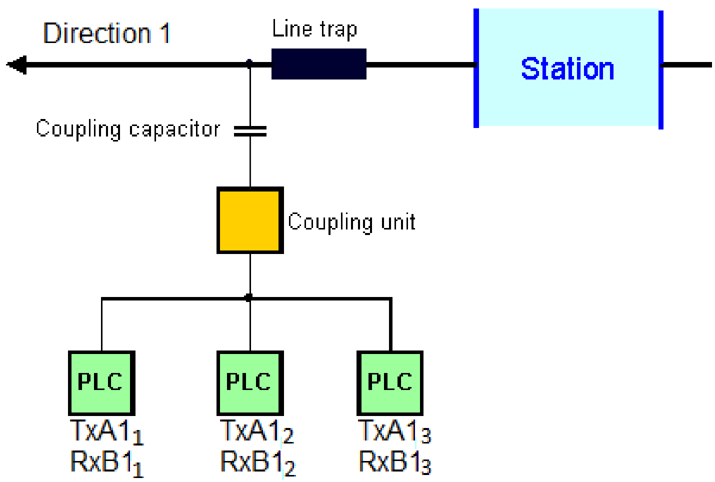
In order to avoid possible mutual tapping losses it is recommended to select non-adjacent frequency edges of all Tx filters on the same line.

The gaps between the frequency edges of the Tx filters must at least be as wide as described in *Table 5-2* (TFLT_A/B), and *Table 5-3* (TFLT_C/D).

The transmission power has to be reduced to avoid saturation events of the AMP. In many of these cases the use of the 100 W AMP version is preferred to improve dynamic headroom against the influence of external signals.

To avoid larger than necessary reduction of the transmission power, the bandwidth of the TX filter can be reduced or the frequency spacing between the HV-PLC devices, neighboring in the frequency domain, may be increased. Finally the transmission power must be reduced at least until the red LEDs of the AMPs go off permanently.

The SNR may be impaired temporarily despite sufficient signal level by small and not indicated saturation events of the remote device (transmitter). In this case a further reduction of the transmission power of the remote device may help to raise the SNR. Depending on actual conditions, reduction of the transmission power by up to 50 % may be necessary.



[dw_plc_systems_using_the_same_direction_on_the_same_line, 2, --_--]

Figure 5-4 PLC systems using the same direction on the same phase line

Table 5-1 Min. space between initial TxA and/or RxB bands for PowerLink IP systems using the same phase line at the same place or the same coupling unit

Neighboring frequency bands	Min. distanced below and above the transmit frequency band
$TxA1_i$ below $TxA1_j$	Upper Δf_{TL} of $TxA1_i$
$TxA1_i$ above $TxA1_j$	Lower Δf_{TL} of $TxA1_i$
TxA_i below or above $TxB1_j$	0 kHz
$TxB1_i$ below or above $TxB1_j$	0 kHz

Δf_{TL} – Min. gap in kHz between neighboring cut-off frequencies of the Tx filter of different PowerLink IP terminals on the same phase line at the same place or on the same coupling unit to achieve tapping losses < 1.5 dB.

If PLC systems operate on the same line via the same coupling unit (i.e. at the same station), the minimum distance is determined by the filter bandwidth, not by the transmission frequency bandwidth.

Table 5-2 TFLT A/B min. distances (Δf_{TL}) below and above the transmit frequency band TxA1 to achieve a tapping loss < 1.5 dB.

Tx Filter Bandwidth	Tx start frequency ≤ 100 kHz		Tx start frequency > 100 kHz	
	Lower Δf_{TL}	UpperΔf_{TL}	Lower Δf_{TL}	UpperΔf_{TL}
32 kHz	11	15	29	30
40 kHz	12	18	28	31
48 kHz	14	19	31	34
56 kHz	15	22	32	34
64 kHz	17	25	34	37
72 kHz	18	27	35	39
80 kHz	19	29	39	40
88 kHz	20	32	37	42
96 kHz	22	36	38	45
104 kHz	22	38	42	47
112 kHz	22	39	42	47
120 kHz	25	43	42	50
128 kHz	25	46	42	53

Tx Filter Band-width	Tx start frequency ≤ 100 kHz		Tx start frequency > 100 kHz	
	Lower Δf_{TL}	UpperΔf_{TL}	Lower Δf_{TL}	UpperΔf_{TL}
136 kHz	25	44	46	54
144 kHz	25	48	46	55
152 kHz	28	53	47	58
160 kHz	28	53	47	61
168 kHz	28	51	46	63
176 kHz	28	56	51	64
184 kHz	28	64	50	66
192 kHz	31	65	51	70
200 kHz	31	59	51	75
208 kHz	30	64	55	75
216 kHz	31	72	55	76
224 kHz	34	77	54	76
232 kHz	33	78	53	79
240 kHz	33	66	53	84
248 kHz	33	70	52	89
256 kHz	33	78	51	90

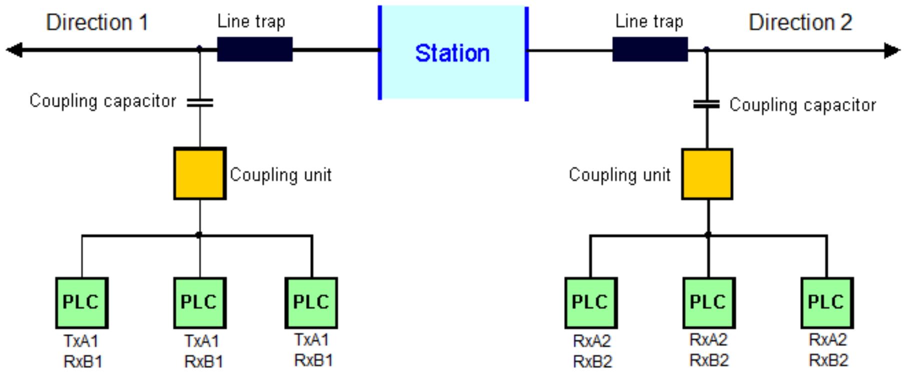
Table 5-3 TFLT C/D min. distances (Δf_{TL})

Tx Filter Bandwidth	Transmission Frequency Band-width	Δf_{TL}
4 kHz	4 kHz	8 kHz
4 kHz	5kHz	8 kHz
8 kHz	8 kHz	16 kHz
12 kHz	12 kHz	24 kHz
16 kHz	16 kHz	32 kHz

Minimum space between terminals using different lines, different phase lines or are far enough from each other on the same phase line

In this case the frequency bands of the Tx filters of the one direction may overlap the frequency bands of the Tx filter of the other direction. To allow for smart frequency management between the selected PowerLink IP terminals this is even necessary. A slight reduction of the transmission power may be necessary to avoid saturation of the ampilfier.

The modem transmission and (i)SWT transmission band of two PowerLink IP devices may be adjacent. in case of a PowerLink IP device neighbouring a differnt PLC device, the distance requirements of the other device have to be considered.



[dw_PLC_systems_using_different_directions, 1, --_--]

Figure 5-5 PLC systems using different directions

Re-use of Frequencies

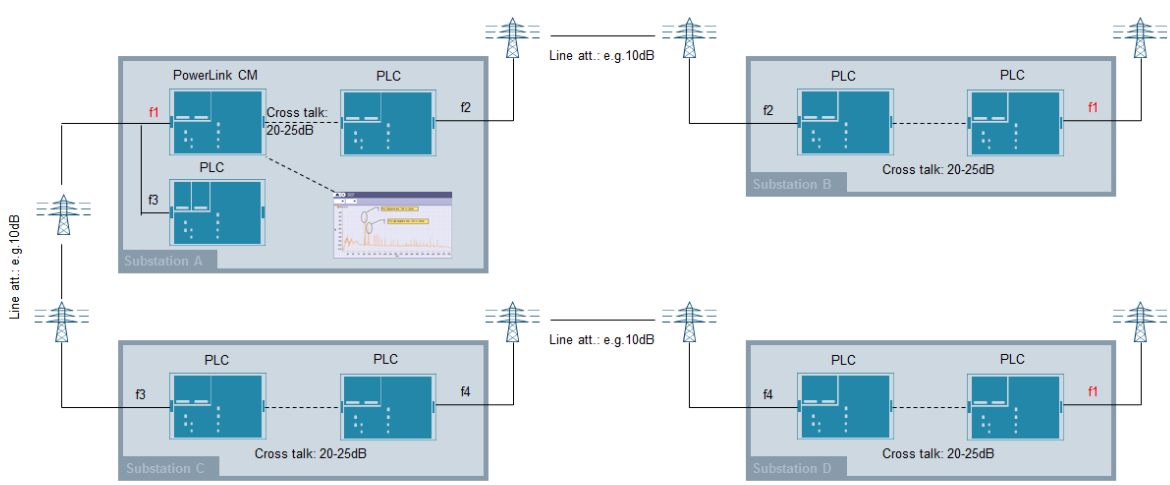
Already occupied frequency bands can be reused after a certain distance, that provides sufficient attenuation. The amout of attenuation that is necessary differs by its usage. To reuse a frequency band for modem transmission 50 dB attenuation will work (although some SNR reduction).

For (i)SWT transmission the main rule for the frequency reuse is, that at the RxB input of a PowerLink IP terminal the attenuated signals from the TxA of the PowerLink IP terminals (re)using the same frequency have to be lower than the line noise level at this frequency.

To define the frequency bands (f1) to be used respectively reused for modem transmission by a PowerLink IP device, check the Tx / Rx frequency band of the installed PLC on the same substation (in the example drawing Substation A) and the Tx /Rx frequency band of the end reflection substation (in the example drawing Substation C). Also check the measurement of the spectrum analyzer of the Web UI.

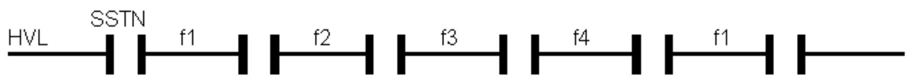
Usually it is sufficient, if the frequencies were not used at the adjacent lines of both substations (A and C) neither for Tx nor for Rx. Additionally the signal strength in the reuseable frequency bands should be at least -85 dB or below in the spectrum plot. Do not use, respectively notch all frequencies (f2, f3, f4) that do not comply to these requirements.

The frequencies used by MARC may not overlap in the whole system. For smart frequency management the MARC frequencies of the closest (in sense of MARC signal frequency) PowerLink IP terminals neighboring to the TxA band of a PowerLink IP terminal have to be parametrized.



[dw_plcm_reuse_frequencies, 1, --_--]

Figure 5-6 Reuse of data carrier frequency f1 after 1 line section

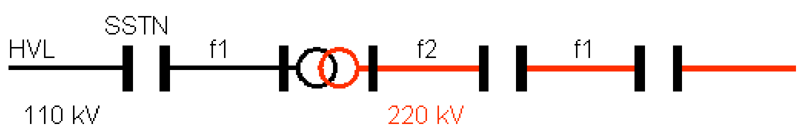


[dwrucf3l-061210-01.tif, 1, en_US]

Figure 5-7 Reuse of a frequency band (f1) for (i)SWT transmission

HVL	High voltage line
SSTN	Sub station
f1 to f4	carrier frequencies

In terms of frequency planning a change of the voltage level, for example from 110 kV to 220 kV, is considered like 2 line sections (see figure below). In this case the same frequency can be reused for (i)SWT transmission after 1 line section.

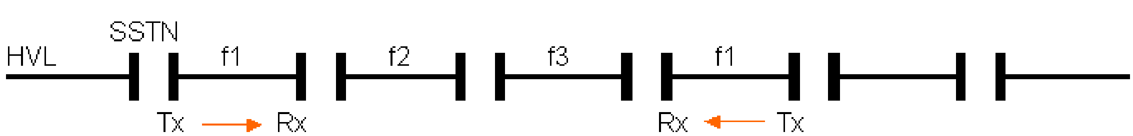


[dwruf1lv-061210-01.tif, 1, en_US]

Figure 5-8 Reuse of frequency band (f1) for (i)SWT transmission after one line section when changing the voltage level

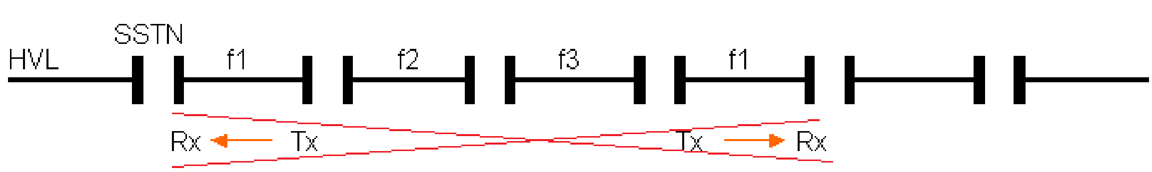
HVL	High voltage line
SSTN	Sub station
f1 to f2	carrier frequencies

With the following restriction the same frequency can be reused for (i)SWT transmission after two line sections on the same voltage level:
The **location of Tx and Rx** from the PLC systems shown in the figure below must be observed!



[dw_transmit_direction_of_TX_RX_allowed, 1, --_--]

Figure 5-9 Transmit direction of Tx and Rx when using the same frequency for (i)SWT transmission after 2 line sections



[dw_location_of Tx_RX_notallowed, 1, --_--]

Figure 5-10 This location of Tx and Rx is not allowed when using the same frequency after 2 line sections

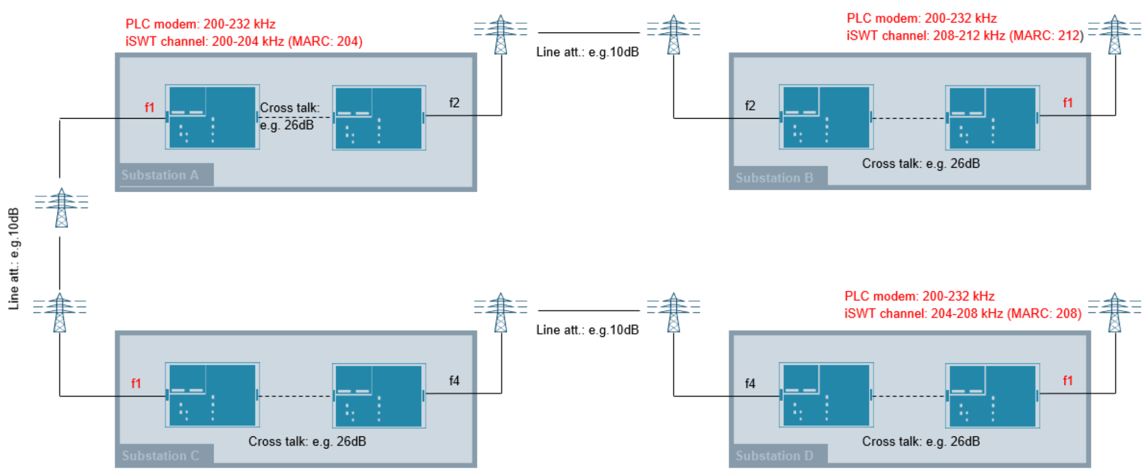
Summary Re-use of the Same Frequency

Table 5-4 Summary for repetition of the same frequency

	Modem	SWT	IEC 60663	IEEE 643
		Re-use of the same frequency after		
Standard	1 section	3 sections	2 sections	2 sections

	Modem	SWT	IEC 60663	IEEE 643
Location of Tx and Rx to be considered	1 section	2 sections	–	–
Only if very long line sections are in between and location of Tx, Rx has to be considered	1 section	2 sections	–	–
Different voltage level counts as	1 section	2 sections	2 sections	no info.
Same frequency within a station	no	no	not mentioned	Yes, if cross-station attenu-ation >40 dB

In the cases where the data carrier bandwidths are at least two times larger than the iSWT bandwidth (4 kHz), it is possible to swap the half used for the iSWT transmission within the transmission band after 2 sections, such that iSWT and data carriers can be reused at the same rate.



[sc_reuse_same_frequency_datacarrierbw_twotimeslarger_example, 1, --_--]

Figure 5-11 Reuse of data carrier frequency and iSWT at the same rate

5.1.4 Line Traps

Line traps are connected in series with HV transmission lines. The main function of the line trap is to represent a high impedance at the carrier frequency band while inserting negligible impedance at the power frequency. The high impedance limits the attenuation of the carrier signal within the power system by preventing the carrier signal from being:

- Dissipated in the substation
- Grounded in the event of a fault outside the carrier transmission path
- Dissipated in a tap line or a branch of the main transmission path.

Blocking Range of Line Traps

The blocking range of the existing line traps has to be considered when planning new frequencies for an existing line. The PLC channels have to be placed within the blocked bandwidth of the line trap.

The bandwidth of a line trap is that frequency range over which the line trap provides a certain specified minimum blocking impedance or resistance. Minimum blocking resistance should be specified if the potential exists for the reactive component of the line trap impedance to resonate with the substation impedance.

Different types of tuning may be supplied:

Single Frequency Tuning:

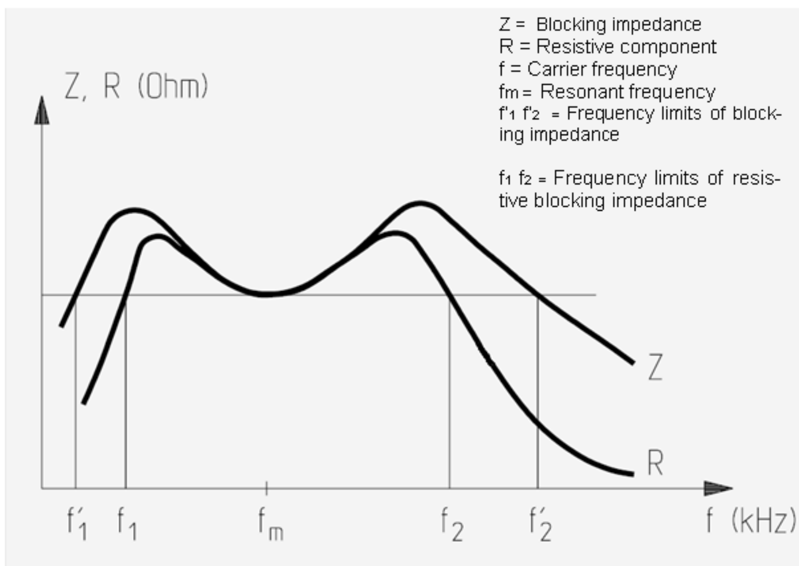
- If narrow blocking bands are required single frequency tuning is the simplest and most economical type of tuning available

Double Frequency Tuning:

- The double frequency tuning arrangement blocks 2 relatively narrow bands of frequencies. Otherwise, the blocking characteristic is similar to single frequency tuning.

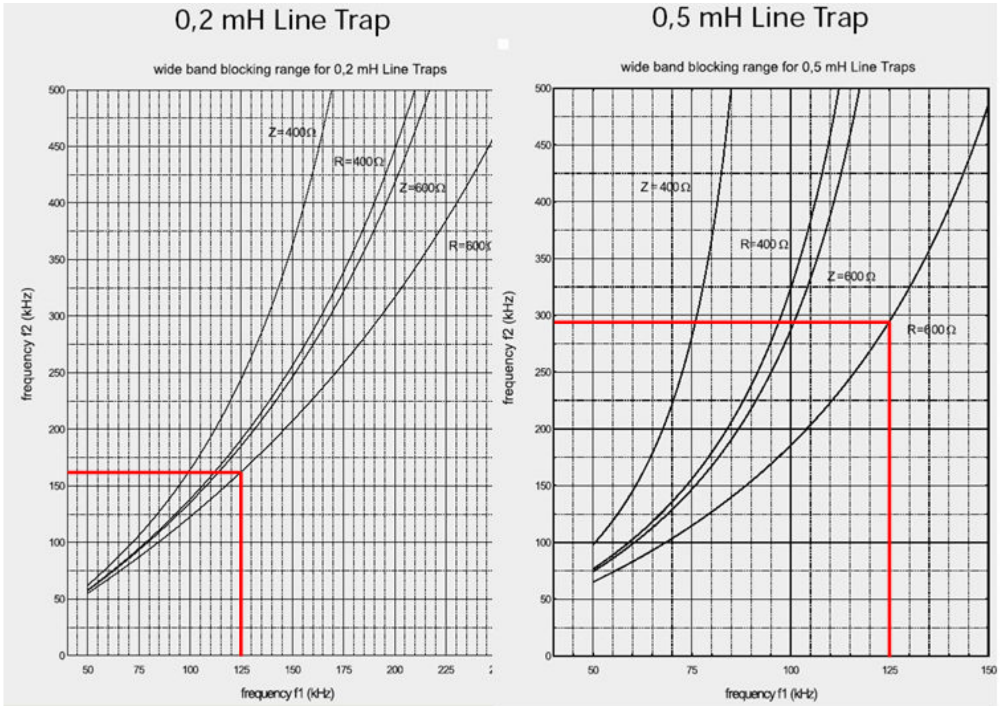
Wideband Tuning:

- Wideband tuning is the most common type of tuning as it efficiently utilizes the main coil inductance. Wideband tuned line traps are suitable for multi-channel applications, since relatively constant impedance is obtained over a broad frequency range. This type of tuning provides high-bandwidth flexibility for future changes or expansion of PLC frequencies. PLC channels can be placed anywhere within the blocked bandwidth.



[dwwfltbc-061210-01.tif, 1, en_US]

Figure 5-12 Typical wideband frequency line trap blocking characteristic



[dwblrdlt-061210-01.tif, 1, en_US]

Figure 5-13 Blocking range of different line traps (example f1 = 125 kHz)

5.1.5 Summary of the Necessary Information for Frequency Planning:

- Overview of the high voltage network (drawing)
- Frequency grid 2.5 kHz resp. 4 kHz
- Tx frequencies of existing PLC links on this section and neighboring three sections
- Blocking range of the line traps
- Frequency ranges reserved for air traffic control, shipping radio service etc.

Station Layouts

Station layouts have to be drawn containing the following information:

- All overhead lines connected to this station with voltage level and coupling type
- Entry of the blocking range from the line traps and the existing PLC Tx resp. Rx frequencies for each line.
- Entry of possibly frequency blocking zone reserved for air traffic control, shipping radio service etc.

Line Layouts

For the high voltage lines getting additional resp. new frequencies, line layouts have to be prepared containing the following information:

- Blocking range of the line traps
- Tx frequencies of existing PLCs on this line
- Through connections of frequencies
- Line sections 1 up to 3 from the view of this line with all used or occupied frequencies
- Display of the occupied frequencies

5.1.6 Planning New Frequencies

When planning new frequencies, the min. gap to the existing frequencies on the used line and in line section 1 has to be observed.

The gap and position to the frequencies used in the line sections 2 and 3 is not important. If an analog device is replaced by a digital device the gap to existing PLCs on the same line and in section 1 has to be checked .

The new frequency may not be used in the line section 1 to 3 drawn in the line layouts. Frequencies which are no longer used have to be canceled.

The new planned frequencies have to be added to all line layouts containing this line in section 1 to 3 and to all station layouts.

5.2 Transmission Range

5.2.1 General Information

The maximum transmission range of the PowerLink is the difference between the transmit level PTx and the lowest possible receive level PR_{Xmin}. The attenuation of the transmission path must be lower than this difference.

[dw_plc_transmission_path, 1, --_--]

Figure 5-14 The PLC transmission path

Output Power - HV Line attenuation = Receive Power

The lowest possible receive level PR_{Xmin} depends on the noise level P_{Noise} of the high voltage line and the required signal to noise ratio SNR for the transmitted services. For determining the transmission range, the following information has to be taken into consideration:

- The used HF bandwidth and frequencies of the PowerLink
- The power amplifier (25 W, 50 W, or 100 W)
- The attenuation of the high voltage line
- The expected noise level

5.2.2 Power Amplifier

For the PowerLinkIP equipment, transmit amplifiers with 25/50 W and 100 W peak output power are available. The necessary power rate depends on the min. required receive level. This again depends on the noise level P_{Noise} and the required signal to noise ratio SNR.

5.2.3 HV Line Attenuation

Prerequisite for an accurate planning of powerline communication connections is a careful calculation of the line attenuation. The attenuation depends on a number of parameter, such as:

- Data of the high voltage line like: Tower, voltage range, length of the line, type of conductors, sag of the line, transpositions etc.
- PLC frequencies used for transmitting and receiving
- Type of the coupling unit: Phase-to-ground, Phase-to-Phase, or Inter-System coupling.
- Conductors used for coupling

Ideally, a suitable simulation tool shall be used to calculate the line attenuation based on this parameters. Such a tool also assists in determining e.g. the best suited conductor(s) for connecting the coupling unit(s) or for the decision, which phase shall be used for mounting the coupling unit. The quality of such a simulation depends strongly on the quality of the parameters, i.e. their matching with the HV line. If required, Siemens offers support in performing such line calculations.

5.2.4 Coupling Units

A phase-to-ground coupling is often used for reasons of cost. This is generally adequate from an engineering viewpoint unless extra-high-voltage lines with a high noise level or long distances are involved. In most line protection applications, however, it is recommended to use a phase-to-phase coupling or intersystem coupling.

Table 5-5 Comparison of the different coupling types

	Coupling type	Financial outlay	Attenuation	Transmission
1	Phase-to-ground coupling	minimal	greater than for 2	not guaranteed if a coupled conductor breaks
2	Phase-to-phase coupling	twice as high as 1	smaller than for 1	possible if a coupled conductor breaks
3	Inter-system coupling	twice as high as 1	smaller than for 1	also possible in case of short circuit or grounding of a system on the line

In case the Siemens coupling unit AKE 100 or AKE 200 is not applied, Siemens offers a HF connecting board as an optional accessory to protect PowerLink IP device against line surges.

5.2.5 Noise Level

The noise level should be taken according IEC resp IEEE recommendations for adverse weather, because the transmission line has to be available throughout the whole year.

The noise level depends on the voltage level, the construction of the overhead line and the used frequency. Typical corona noise power levels on 220 kV transmission lines as mentioned in IEC 60663:

-20 dBm to -10 dBm

The values are given for a 4 kHz bandwidth. For a different bandwidth (BW) of the service a correction P_{cor} has to be added to this level.

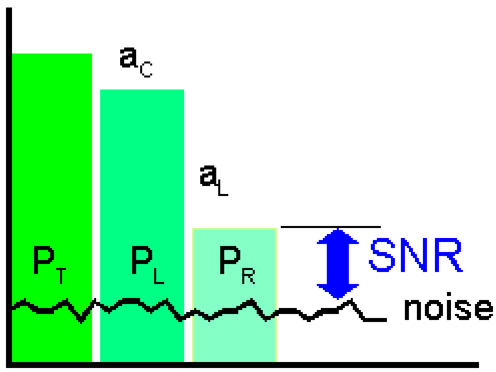
$$P_{cor} = 10 * \log (BW [kHz] / 4[kHz])$$

[fo4khzbw-061210-01.tif, 1, en_US]

5.2.6 Signal-to-Noise Ratio

The signal-to-noise ratio (SNR) is calculated with

SNR [dB] = receive level [dB] - noise level [dB]



[dwgrsnrc-061210-01.tif, 1, en_US]

Figure 5-15 The calculation of the SNR [dB]

P_T = Transmit level at the output of the PLC

P_L = Transmit level at the coupling point of the line

P_R = Receive level

a_c = Coupling loss

a_L = Line attenuation

5.2.7 Formulas for the Calculation of the Transmission Range and the SNR

Receive level	P_R [dB]= P_T [dB] - a_C [dB] - a_L [dB]
Signal to noise ratio	SNR [dB] = P_R [dB] - P_{Noise} [dB]
Minimum receive level	P_{Rmin} [dB] = P_{Noise} [dB] + $SNR_{required}$ [dB]

6 Ethernet Guideline

6.1 Overview

Ethernet interfaces

- 1x Ethernet 100BASE-TX Full Duplex; RJ45 service interface (LCT port)
- 3 x Ethernet 10BASE-T or 100BASE-TX Half/Full Duplex/Auto Negotiation; RJ45 user interfaces (ETH1, ETH2 and ETH3 port)
  Port ETH3/PoE supports Power over Ethernet with max. 15.4 W acc. IEEE 802.3af
  (to power external VoIP phones, CCTV cameras, WLAN Access Points etc.)
- 2 x Ethernet 100BASE-FX; SFP user interfaces (ETH4 and ETH5 port)

Layer 2 switch features

PowerLink IP can forward up to 2 Mbit/s Ethernet data on Physical Layer 1 in each direction.

PowerLink IP is a transparent Layer 2/Ethernet bridge which learns unicast/multicast MAC addresses of devices connected to the user LAN interfaces and can transmit transparently untagged or tagged [1)] Ethernet unicast, multicast [2)] or broadcast frames. It can forward Ethernet II, IEEE 802.3, IEEE 802.1Q, Ethernet encapsulated IPv4 packets [3)], IEEE 802.1ad Provider Bridge/Q-in-Q (Carrier Ethernet) and MPLS labeled Layer 2 or 3 VPN frames. Portbased VLANs (PVID) are not supported yet. All user interfaces are in the same Layer 2 broadcast domain.

- Maximum Ethernet Jumbo frame size is 2000 Byte (without counting the Ethernet Inter-frame gap (12 Byte) and Preamble (8 Byte)) on the five user interfaces, to enable transparent bridging of MPLS labeled frames from MPLS-TP or IP/MPLS transport devices.
- Maximum Transmit Unit (MTU) size for IPv4 over Ethernet encapsulation is 1500 Byte on the service interface (LCT).

HW Switch supports up to 2048 unicast/multicast MAC address entries. IPv4 multicasts and IGMP snooping are not supported yet. An ingress Ethernet frame containing a multicast destination address will be flooded to all user ports.

SW Layer 2 bridge Forwarding Database (FDB) has no limitation for unicast/multicast MAC address entries, when the DDR RAM is sufficient IPv4 multicasts are supported by SW Layer 2 bridge IGMP snooping not yet.

Advanced HW QoS on Layer 2/3 [3)] with ingress rate control of broadcast and multicast storms, four traffic class (TC) queues and Weighted Round Robin algorithm (WRR) with IEEE 802.1p PCP or TOS/DSCP based ingress traffic classification. Intelligent SW QoS on Layer 4 via UDP/TCP port inspection, min. and max. data rate reservation for various user application protocols and egress rate control, queuing discipline and shaper.

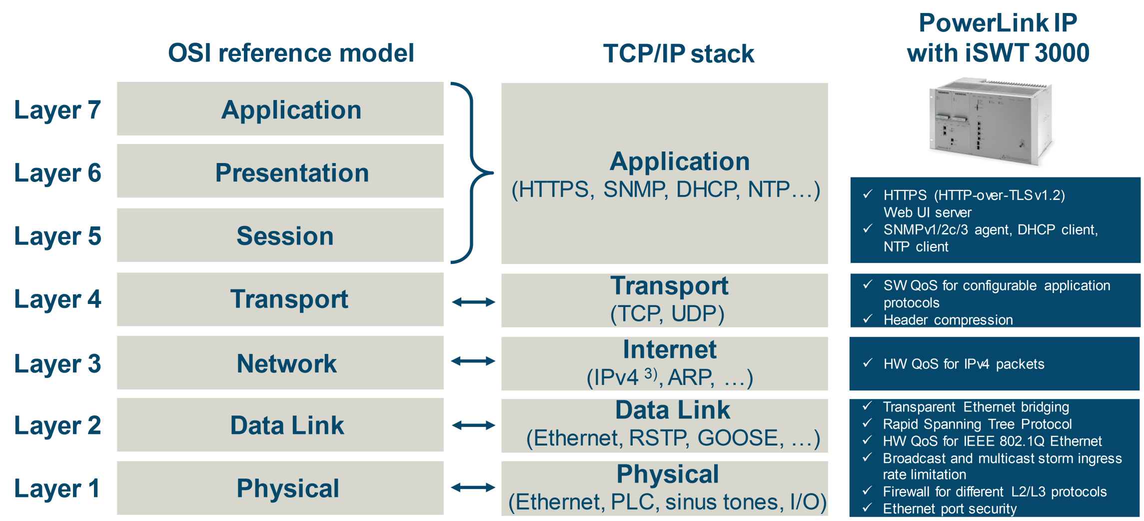
PowerLink IP supports also RFC1144 for TCP/IP header compression and RFC 3095 Robust Header Compression (ROHC), which is a highly robust and efficient header compression scheme for bandwidth limited communication links with significant error rates and long round-trip times. It compresses RTP/UDP/IPv4 (Real- Time Transport Protocol over User Datagram Protocol over Internet Protocol), UDP/IPv4, and ESP/IPv4 (Encapsulating Security Payload) headers to reduce the packet overhead load on the PLC WAN link.

State-of-the-art packet security features like port-based MACSA Access Control List with max. 20 entries, Layer 2/3 firewall, https (TLSv1.2) Web UI server and SNMPv3 counteract cyber security threats.

Rapid Spanning Tree Protocol (RSTP) acc. IEEE 802.1w for Layer 2 loop prevention is also supported.

PowerLink IP packet features in OSI reference model and TCP/IP stack view

Below figure shows how PowerLink IP various packet features map to the OSI Reference Model and TCP/IP stack.



[dw_OSI_reference_model_TCP_IP_stack, 2, --_--]

1) Portbased VLANs (PVID) are not supported yet, but PL IP can transmit transparently IEEE 802.1Q VLAN ID and PCP tagged Ethernet frames

2) For GOOSE (IEC 61850-8-1) Ethernet multicast messages, PL IP with equipped iSWT uses for maximum possible reliability not the digital packet transmission mode but the Alternative Multi-Purpose operation (AMP) using a unique combination of two sinus tones (coded tripping). This same solution has already been successfully implemented in classical SWT 3000

3) Transparent Layer 2 bridging and QoS for IPv6 packets is not released yet

6.2 Ethernet, IPv4 and Quality of Service processing

Ethernet and IPv4 header processing in HW switch chip on DMB

HW switch allows each user LAN interface to be manually enabled or disabled via Web UI GUI, for security reasons user should disable all not connected ports. To protect the PowerLink IP processing and WAN link resources, user should also configure per port an ingress rate limit to drop excess multicast and broadcast storm traffic, which always can occur in Layer 2 switched domains. Regular Ethernet unicast traffic will not be affected by this setting.

HW Layer 2 bridge learns unicast source MAC and multicast destination MAC addresses and stores them dynamically together with the ingress port ID and IEEE 802.1Q VLAN ID of the received Ethernet frame in the MAC table to perform port specific frame switching. If a specific stored MAC address is not received for a hard coded amount of time (Aging Timer) it is automatically flushed from the MAC address table to keep its size limited over time. An ingress Ethernet frame containing a multicast or broadcast destination address will be flooded to all user ports. Ingress traffic classification for HW QoS purposes can be flexibly defined by the user via Web UI and can use TOS/DSCP IPv4 header marking or IEEE 802.1p Priority Code Point (PCP) tagging.

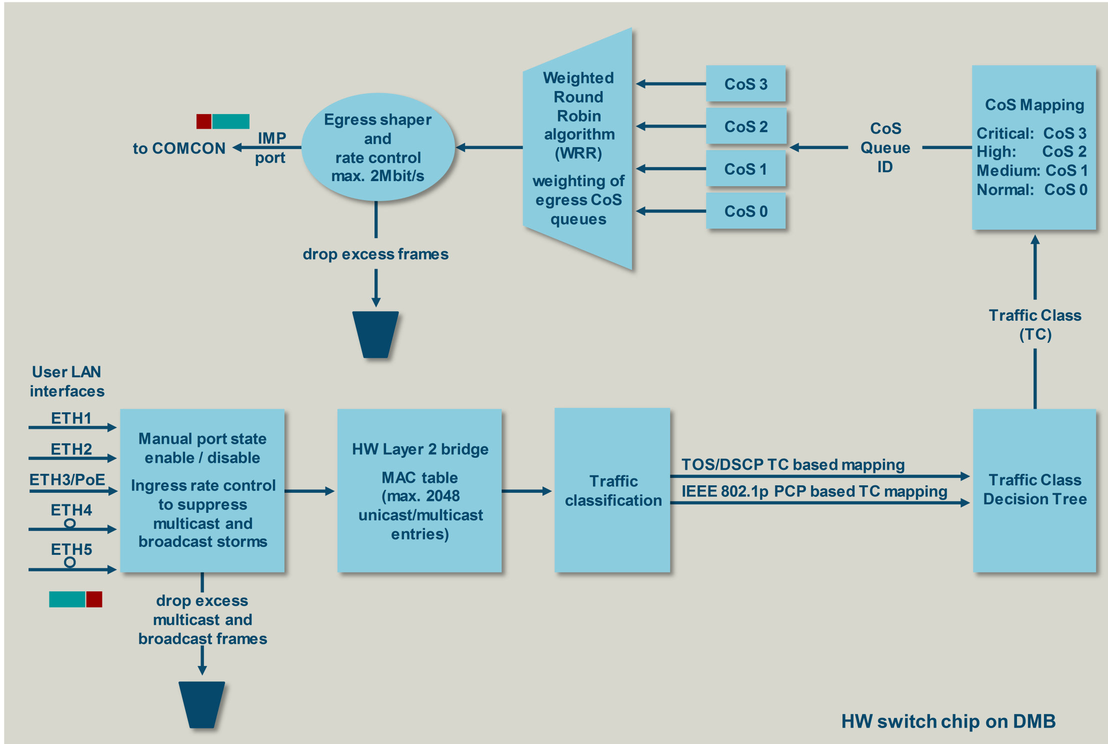
Even if all traffic classification methods can be activated at once, it is recommended to use either TOS/DSCP based or IEEE 802.1p Priority Code Point (PCP) based QoS methods of received Ethernet frame classification and prioritized processing.

NOTE

The TOS/DSCP and IEEE 802.1p based QoS Traffic Class detection and processing will only be available if the respective QoS method is enabled and the received packet has the appropriate tagging or marking.

Real-time VoIP traffic should be mapped to the highest CoS 3 queue (Critical priority traffic), RTU/SCADA traffic to next lower CoS 2 queue (High priority traffic). Other traffic can be assigned to the next lower CoS 1 queue (Medium priority traffic), and normal business LAN traffic should be mapped to the lowest available CoS 0 queue (Normal priority traffic). Weighted Round Robin (WRR) algorithm with user defined queue weight factors is used in the next processing step to allow a fair access of all four traffic classes to the egress port.

The default weight value is 1:2:4:8. So for each round, WRR will send 1 packet from CoS 0, 2 packets from queue CoS 1, 4 packets from queue CoS 2, and 8 packets from queue CoS 3. The high priority TC queues are given greater weighted access to egress port than the lower TC queues, with the result that lower priority traffic will experience just longer delays than higher priority traffic. Finally an egress shaper and rate control HW stage will buffer bursty traffic, generate a constant bitrate ≤ 2Mbit/s and drop all excess frames to protect the PLCDSP Modem on COMCON from Ethernet frame overflow.



[dw_hw_ethernet_IPv4_header_processing, 3, --_--]

Ethernet, IPv4 and TCP/UDP QoS processing in SW on COMCON

Next processing step is fully implemented in SW to provide advanced and flexiblesecurity.

Security and control features:

- Port security is a user defined source MAC address white list for protection of the PLC WAN port (cdi0) from not legitimate user traffic.
- MAC address white list is not enabled for the service interface (LCT), in order not to block arbitrary Web UI service PCs.
- Layer 2 filter firewall is intended to block completely undesired Layer 2 and/or Layer 3 protocols from PLC WAN interface (cdi0).
- RSTP can automatically resolve Layer 2 loops in case of physical looped topologies.
- Periodic update of system time via NTP client with user defined geographic time offset and optional automatic summer/winter time switchover according user defined time schedule.

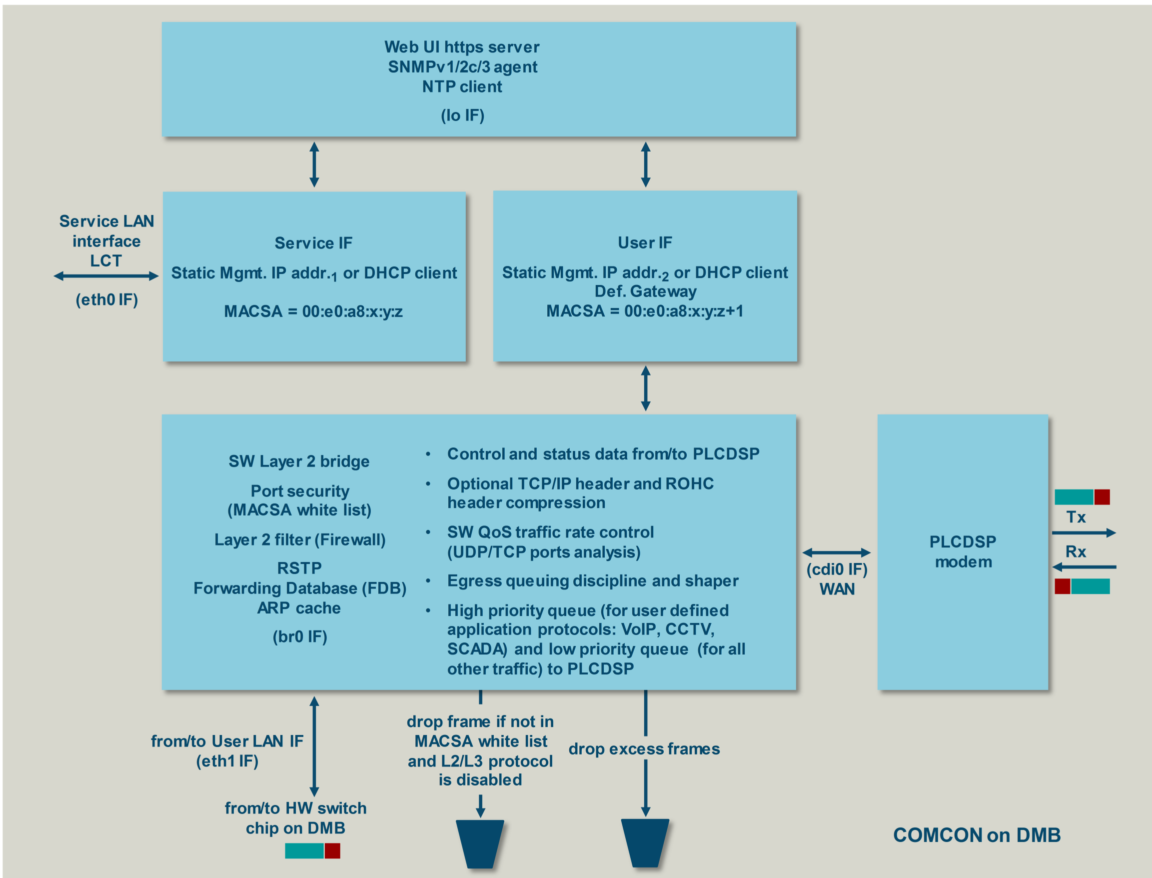
State-of-the-art management protocols:

- https Web UI server and SNMPv1/2c/3 agent.
- IPv4 communications for local and remote device management via out-of-band Service IF.
- Static or DHCP assigned IP address in ip network1 or inband User IF.
- Static or DHCP assigned IP address in another ip network2.

Advanced QoS functions on Layer 4 for various application protocols:

- VoIP voice (UDP), VoIP signaling (UDP), VoIP signaling (TCP), CCTV video (UDP).
- IEC 60870-5-104 (TCP or UDP), SCADA (UDP) and SCADA (TCP) via UDP/TCP source and destination port analysis, traffic rate reservation and control in TX direction after advanced Layer 3/4 header compression processing.

Two priority queues are implemented between SW Layer 2 bridge and PLCDSP Modem, where VoIP packets, due to their hard real time characteristics are forwarded by default via the high priority queue. User can flexibly define which application protocols (VoIP, CCTV, SCADA) should be forwarded via the high priority queue. Queuing discipline reserves and controls min. and max. bitrates of user selected application protocols and assigns the rest of the dynamical available WAN bitrate to all other traffic towards PLCDSP via the cdi0 interface. Egress shaper WAN port rate is dynamically adjusted to the current PLCDSP modulation scheme. Optional TCP/IP and ROHC header compression can be configured (should be both enabled or both disabled) to reduce the size of TCP/IPv4, UDP/IPv4, RTP/UDP/IPv4 and ESP/IPv4 headers before transmitting them via the WAN interface (cdi0).



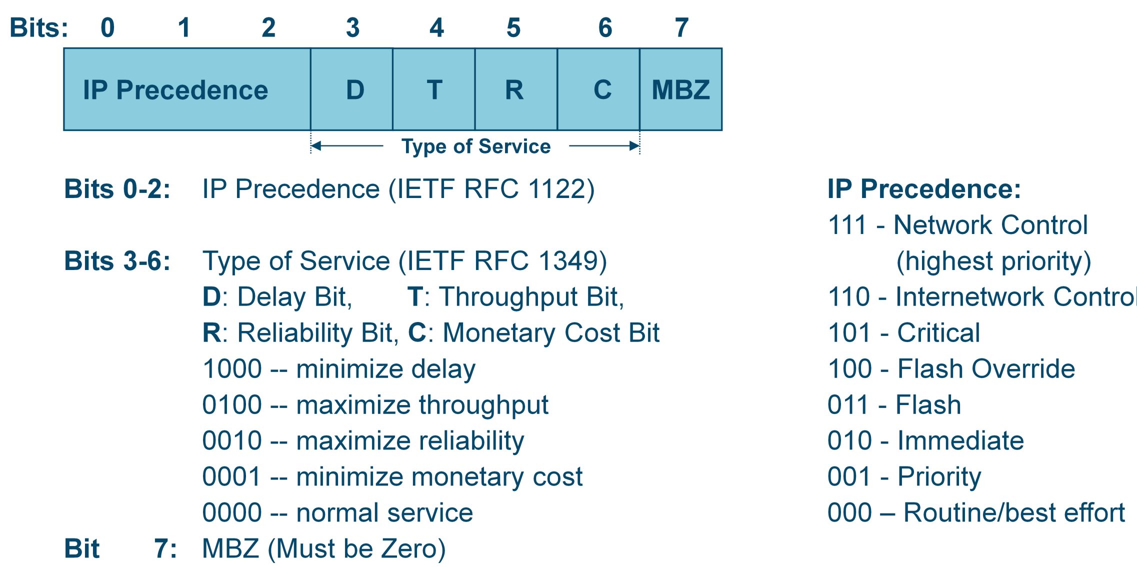
[dw_SW_ethernet_IPv4_TCP_UDP, 3, --_--]

6.3 TOS or DSCP based traffic class marking of IPv4 packets

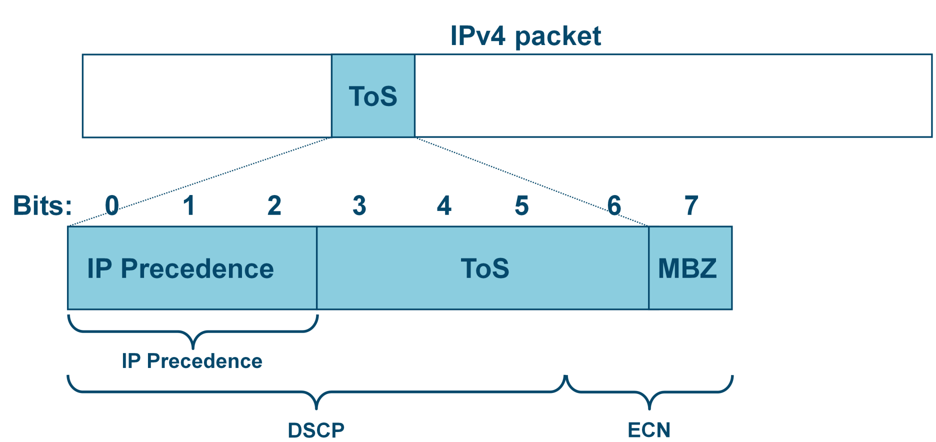
TOS or DSCP (Differentiated Service Code Points) are efficient IPv4 packet header traffic class marking techniques, which allow end-to-end Quality of Service processing in utilities heterogeneous Ethernet and IPv4 private WAN network. **Wherever edge devices support TOS or DSCP IPv4 header marking, this method should be the preferred choice among all possible traffic classification options.**

Type of Service Byte was defined in original IPv4 specification for QoS packet marking and is already deprecated by IETF, only legacy devices might still use it. PowerLink IP supports only the mapping of IP Precedence (Bits: 0, 1, 2) to eight traffic priorities and then to four traffic classes (TC: Critical, High, Medium and Normal). For backward compatibility IP Precedence maps to eight possible DSCP values so called Class Selector code points (CS0, CS1, CS2, CS3, CS4, CS5, CS6 and CS7, which are of the form "xxx000") by using the IP Precedence as the three high-order bits and padding the lower-order bits with 0.

Table below shows the correspondence of DSCP Class Selector code points to the eight decimal IP Precedence values.



[dw_tos_based_traffic_class_marking, 1, --_--]

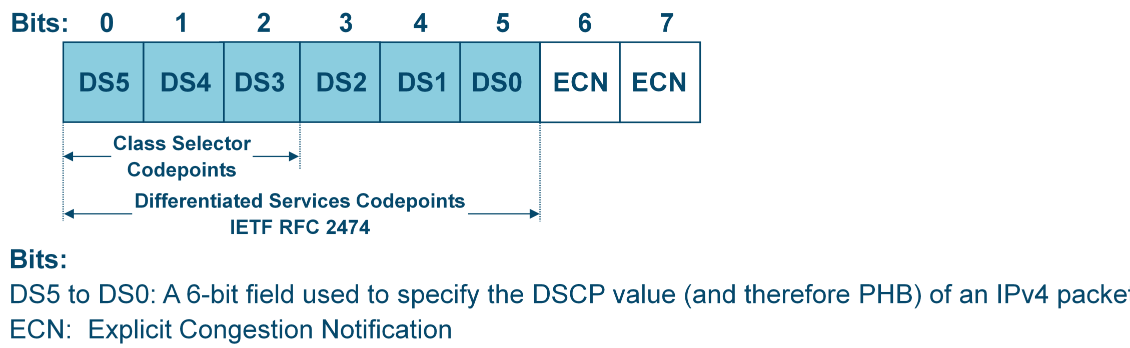


IP Precedence	0	1	2	3	4	5	6	7
DSCP	0 CS0	8 CS1	16 CS2	24 CS3	32 CS4	40 CS5	48 CS6	56 CS7

[dw_tos_ip_precedence_based_traffic_class_marking, 1, --_--]

Differentiated Services (DiffServ) is a newer extension and has successively replaced ToS. It defines in several RFCs for IPv4 QoS marking so called Differentiated Services Codepoint (DSCP) values between 0 – 63 (6 bits) to maintain relative levels of priority. By means of DSCP, IPv4 packets can get a particular per-hop forwarding behavior (PHB) on networking nodes along their path from the source to the destination. On the network edge, the IP DSCP is assigned by the edge device or the router so that each subsequent network element can provide per packet based priorisation if configured by the user on that network device.

The other 2 bits are defined in RFC 3168 for Explicit Congestion Notification (ECN). PowerLink IP supports DSCP QoS 6-bit mapping to eight traffic priorities and then to four traffic classes (TC: Critical, High, Medium and Normal).



[dw_dscp_based_traffic_class_marking, 1, --_--]

When configuring an IPv4 network device to mark or recognize a DSCP value, decimal numbers or the name of a specific DSCP value can be used.

In PowerLink IP decimal numbers as DSCP values are used to recognize edge device DSCP QoS IPv4 packet marking inside the HW switch chip on DMB. Higher decimal DSCP values represent higher priority traffic than lower DSCP values.

The four different DiffServ PHBs are as follows:

- Class Selector (CS): Used for backward compatibility with legacy network devices and applications that uses IP Precedence priority Bits 0, 1, 2. When using this PHB, the last 3 bits of the DSCP field are 0.
- Assured forwarding (AF): Specifies four AF PHBs grouped into four classes. When using AF, the first 3 bits of the DS field define the queuing class (1 to 4), and next 2 bits define the drop probability (1 to 3). The 6th bit is always zero. AF therefore has 12 different classes.
- Expedited forwarding (EF): States a low-delay, low-loss and low-jitter QoS treatment with guaranteed bandwidth.
- Best effort (BE): Specified when all 6 bits of the DS field are 0, that is (equal to CS0); the packet does not need any specific QoS treatment or does not meet the requirements of any of the other defined classes. BE is also known as default PHB.

IPv4 DSCP (DiffServ)			IPv4 IP Precedence
Name	Binary value	Decimal value	Decimal value
CS0 / BE	000000	0	0
CS1	001000	8	1
CS2	010000	16	2
CS3	011000	24	3
CS4	100000	32	4
CS5	101000	40	5
CS6	110000	48	6
CS7	111000	56	7
AF11	001010	10	NA
AF12	001100	12	NA
AF13	001110	14	NA
AF21	010010	18	NA
AF22	010100	20	NA
AF23	010110	22	NA
AF31	011010	26	NA
AF32	011100	28	NA
AF33	011110	30	NA
AF41	100010	34	NA
AF42	100100	36	NA
AF43	100110	38	NA
VOICE-ADMIT	101100	44	NA
EF PHB	101110	46	NA

[dw_dscp_ip_precedence_based_traffic_class_marking_table, 1, --_--]

IEC 61850-90-12 Edition 1.0 shows in Table 49 an example for assignment of different utility applications to 8 priority levels. This yields a simple mapping to 802.1Q and DSCP priority fields.

Traffic Class	Application	802.1Q PCP, MPLS EXP	DSCP
Network Control	Network Management IS/IS, LDS, RSVP-TE, BGP	7	NC, CS7
Expedited	Teleprotection IEC TR 61850-90-1 (SS-SS) operational voice	6	EF, CS6
Real-Time	Telecontrol, WAMPACs IEC TR 61850-90-5 (SS-CC)	5	EF, CS5
Streaming	IP telephony, Video surveillance	4	AF41, AF42, AF43, CS4
Operation	SCADA, DNP-3, IEC TR 61850-90-2 IEC 61850-8-1	3	AF31, AF32, AF33, CS3
Support	EMS (CC-CC), CIM, OAM	2	AF21, AF22, AF23, CS2
Business	Mail, File Exchange	1	AF11,AF12,AF13, CS1
Internet	Browsing, downloads, videos, webinars, web learning	0	CS0 / Best Effort

6.4 VoIP planning

VoIP planning topics

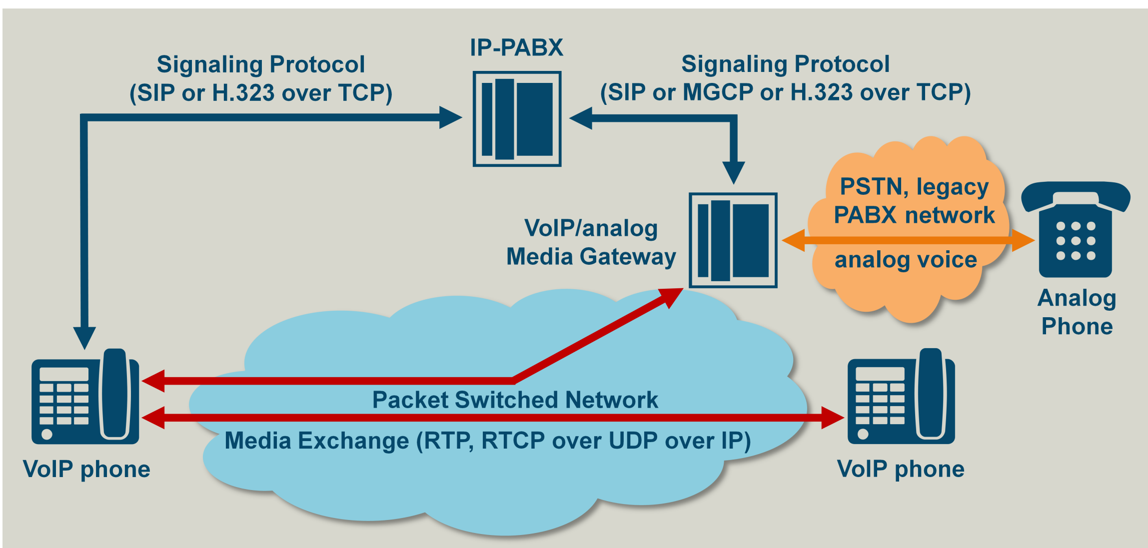
Typical utility will use below corporate VoIP infrastructure with central IP-PABX(s) and Media Gateway(s) to PSTN or legacy PABX network islands. Due to their hard real time characteristics, VoIP packets require higher QoS priorisation compared to VoIP signaling protocols and all other traffic types, except network control protocol inside the packet switched network.

Only selective VoIP phone models support peer-to-peer signaling mode (sometimes called direct signaling or direct IP call without Gatekeeper or SIP proxy). Dialing is done by IP address, telephone number or email-like aliases, known as uniform resource identifier – URI (with a locally configured resolution table of destination IP address to the destination call number/identifier inside each telephone set) to reach the called party.

NOTE

Only phone sets supporting peer-to-peer signaling mode are suitable as service telephone for simple substation to substation hotline function.

H.323 is an older standard, SIP is a newer substitute, and Media Gateway Control Protocol (MGCP) controls digital VoIP to analog Media Gateways.



[dw_voip_call_signalling_and_media_paths, 1, --_--]

Packet delay can cause voice quality degradation. Understanding and accounting for the delay of network components is essential when designing networks for voice communication. Correctly accounting for all potential delays ensures that overall network performance is acceptable for the users. As delays increase, the communication between two humans falls out of natural voice synchronization (for example, they speak at the same time or both wait for the other to speak). This condition is called talker overlap. In networks with very high one-way mouth-to-ear delay communications needs stringent rules like in a walky-talky communication, where each user in an active conversation is only allowed to talk or to listen. Such communication is not perceived as natural for human.

One PowerLink IP link causes typically a one-way end-to-end delay of max. 20ms depending on frame length and currently used transmission scheme.

The ITU-T G.114 (05/2003) defines three bands of one-way mouth-to-ear delay time (latency).

While **it is recommended that a one-way delay of 400 ms should not be exceeded for general network planning**, it is important to appreciate that highly interactive tasks (e.g. many voice calls, interactive data applications, video conferencing) can be affected by much lower delays.

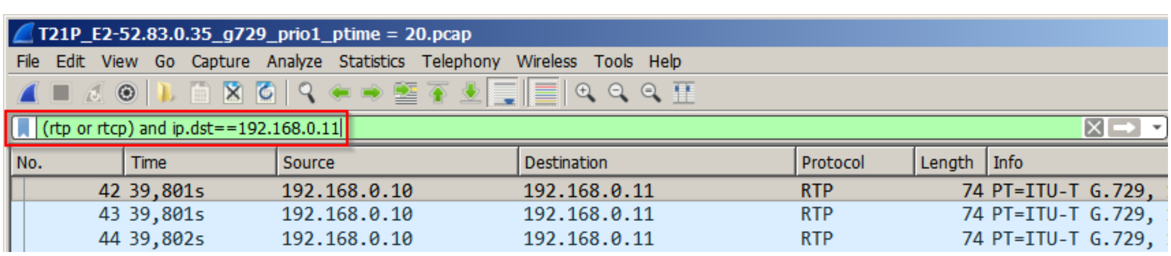
Delay	Effect on Voice Quality
0 to 150 ms	Acceptable, for most user applications. Users will be very satisfied
151 to 400 ms	Acceptable provided that the organization is aware of the transmission time and its impact on the transmission quality of user applications. Note that this is the expected range for a satellite link. Users will be satisfied and some dissatisfied
> 401 ms	Unacceptable for general network planning purposes. However this limit is exceeded in some exceptional cases e.g. unavoidable double satellite hop for a hard-to-reach location. Many users will be dissatisfied.

Mean Opinion Score (MOS) is a common benchmark to define sound quality. MOS scales from 1 (bad) to 5 (excellent).

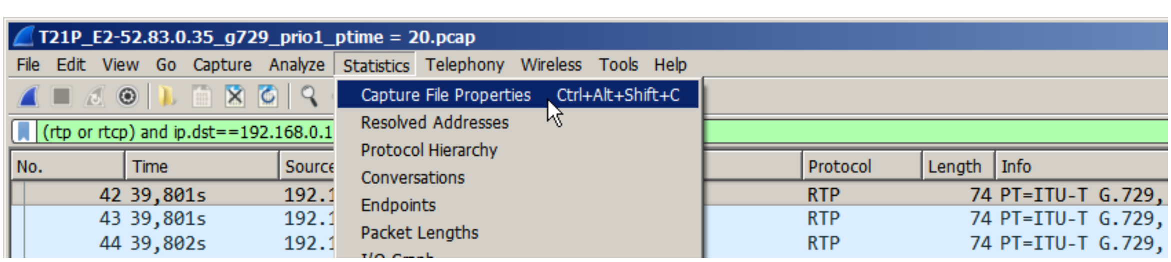
Selection of an optimum VoIP voice codec is based on a compromise between the best possible MOS Score (G.722 or opus), least bandwidth consumption (G.729 / G.729B or G.723.1), and robustness against packet loss and jitter (iLBC 20/ iLBC 30) in packet switched networks (especially in case of difficult PLC link conditions). Optional Voice Activity Detection (VAD) and Silence Suppression (e.g. G.729B) in VoIP endpoints and Robust Header Compression (ROHC RFC 3095) in PowerLink IP can significantly reduce the bitrate of a VoIP call on PLC WAN links.

VoIP bitrate requirements per voice packet stream include RTP (12 Byte), UDP (8 Byte), IPv4 (20 Byte) and Ethernet II (18 Byte incl. Frame Check Sequence (FCS)) headers. ROHC compresses at maximum compression rate condition RTP+UDP+IPv4 headers to 3 Bytes. Codec bandwidth also depends on the sampling rate (pps - packets per second) and the packetization time in the VoIP endpoints. Below bitrates per codec are given for reference and guidance for correct traffic control QoS configuration in PowerLink IP.

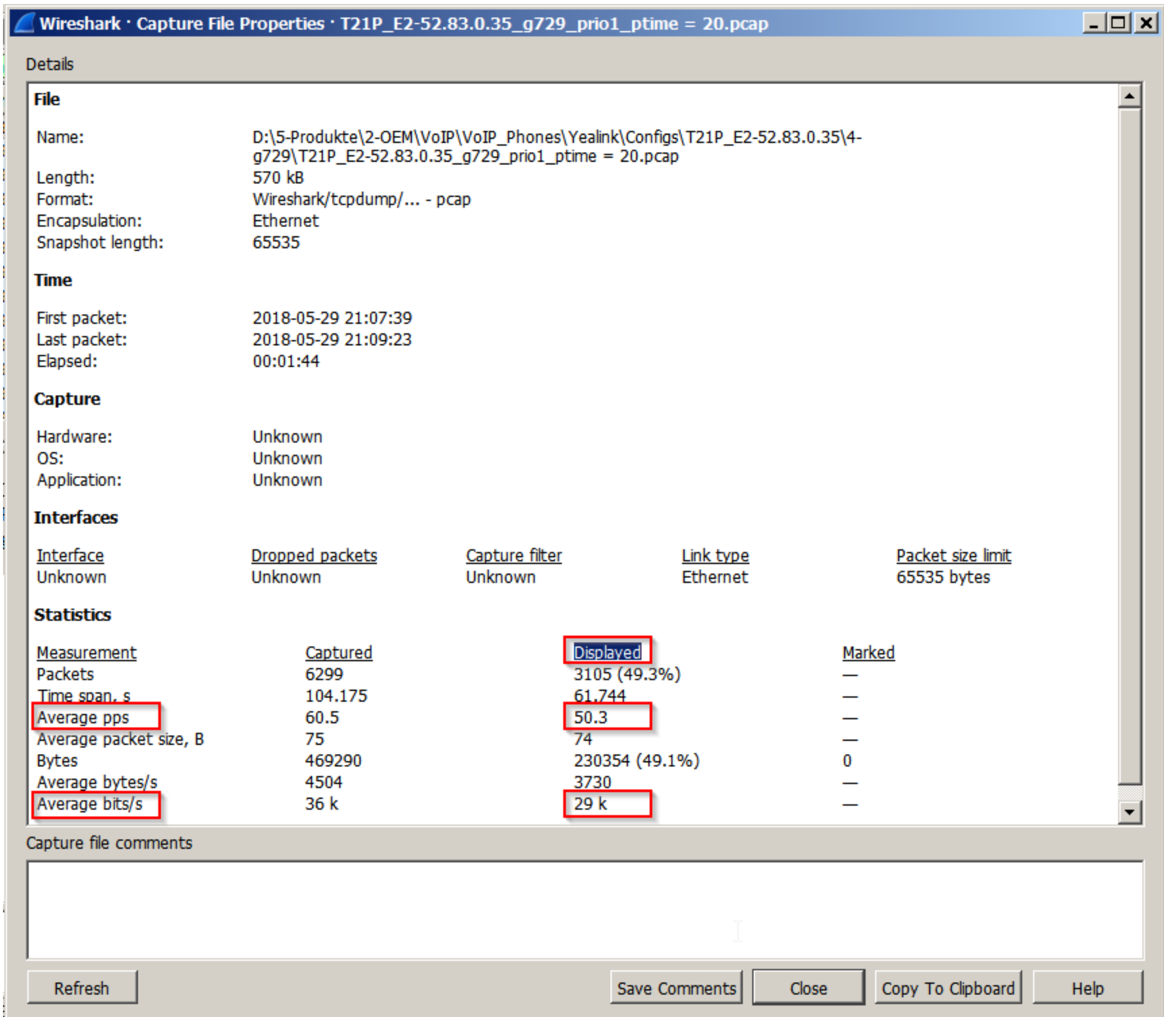
It is generally recommended to use a network sniffer program like Wireshark (https://www.wireshark.org) to record one VoIP call and filter captured data for voice packets in one direction with *(rtp or rtcp) and ip.dst== <VoIP phone IP address> display filter* analyze the bitrate of the Real-Time Transport Protocol (RTP) stream using the menu *Statistics - Capture File Properties (column Displayed)*. It gives a realistic measurement of the average constant bitrate for respective VoIP codec and VoIP phone configuration. Please add [Average pps * 4 * 8 bit/Byte] / 1000 to the average Displayed bits/s rate in Wireshark to account for Ethernet Frame Check Sequence (FCS) (4 Byte), which is not captured by Wireshark (is stripped by the service PC NIC).



[dw_wirkeshark_voip_bitrate_mesurement_display_filter, 1, --_--]



[dw_wirkeshark_voip_bitrate_mesurement_statistics_capture_file_properties, 1, --_--]



[dw_wirkeshark_voip_bitrate_mesurement_statistics_capture_file_properties_average_bits_per_s, 1, --_--]

G.722 and opus provide improved speech quality due to a wider speech bandwidth of 50–7000 Hz compared to G.711, opus codec consumes only half of G.722 bitrate. Both G.722 and opus provide the best possible audio quality.

Recommended VoIP codecs are marked in bold below.

Voice Codec / Standard	Voice Payload Size (ms)	Packets Per Second (PPS)	Max. one-way voice bitrate over Ethernet II without ROHC(kbps)	Max. one-way voice bitrate over Ethernet II with ROHC (kbps)	Audio Band-width	MOS Score
G.722 (wide-band)	20	50	88	66	8 kHz	4.13
opus (wide-band)	20	50	**43**	**22**	8 kHz	**4.13**
G.711 (64 kbps)	20	50	88	66	4 kHz	4.1
G.726 (40 kbps)	20	50	67	42	4 kHz	3.85
G.726 (32 kbps)	20	50	59	36	4kHz	3.85
G.726 (24 kbps)	20	50	49	24	4 kHz	3.85
G.726 (16 kbps)	20	50	41	18	4 kHz	3.85

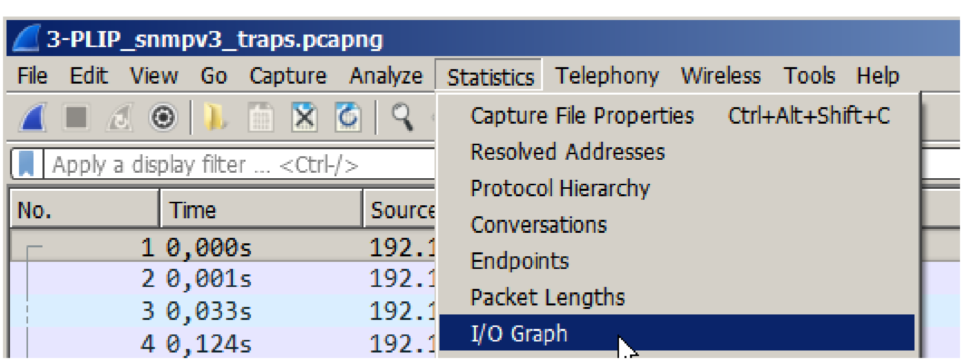
Voice Codec / Standard	Voice Payload Size (ms)	Packets Per Second (PPS)	Max. one-way voice bitrate over Ethernet II without ROHC(kbps)	Max. one-way voice bitrate over Ethernet II with ROHC (kbps)	Audio Band-width	MOS Score
G.728 (16 kbps)	30	33.3	32	18	4 kHz	3.61
G.729 (8kbps)	20	50	**33**	**10**	4 kHz	**3.92**
G.723.1 (6.3 kbps)	30	33.3	22	8	4 kHz	3.9
G.723.1 (5.3 kbps)	30	33.3	21	7	4 kHz	3.8
iLBC 20 (15.2 kbps)	20	50	**40**	**18**	4 kHz	**4.1**
iLBC 30 (13.33 kbps)	30	33.3	**30**	**15**	4 kHz	**4.0**

QoS and traffic control example

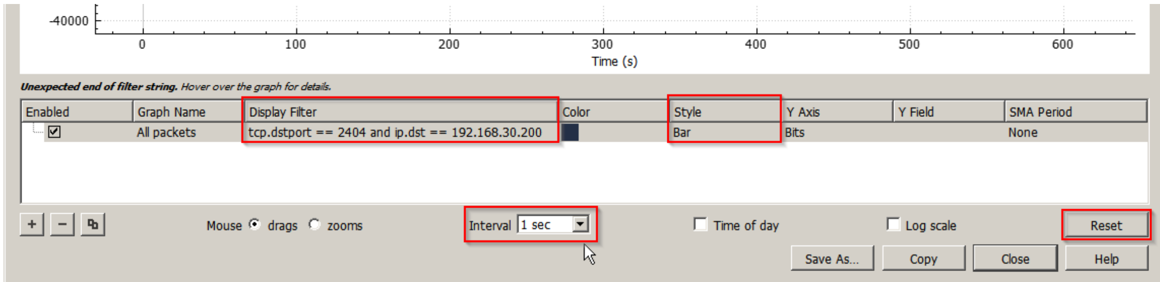
In below example two PowerLink IP links are shown, with two VoIP phones in Substation A and B, two IEC 60870-5-104 RTUs and one Business PC connected to PowerLink IP terminals. PowerLink IP allows QoS traffic control on Layer 4 for VoIP, IEC 60870-5-104 and other configured UDP/TCP based application protocol traffic. It is assumed that two VoIP calls and two RTU connections should be guaranteed per substation. For IEC 60870-5-104 RTUs, the given bitrate is just an average example and depends highly on the RTU substation network and RTU configuration. Please consult with a RTU expert for the required min. and max. data rates for worst case communication conditions required by SCADA, e.g. if SCADA loses communication to all RTUs and starts to poll all its data at once.

It is generally recommended to use a network sniffer program like Wireshark (https://www.wireshark.org) to record one IEC 60870-5-104 RTU session (in average and worst case situations), use *Wireshark menu: Statistics – I/O Graph* filter captured data for IEC 60870-5-104 packets in **one direction** towards SCADA with

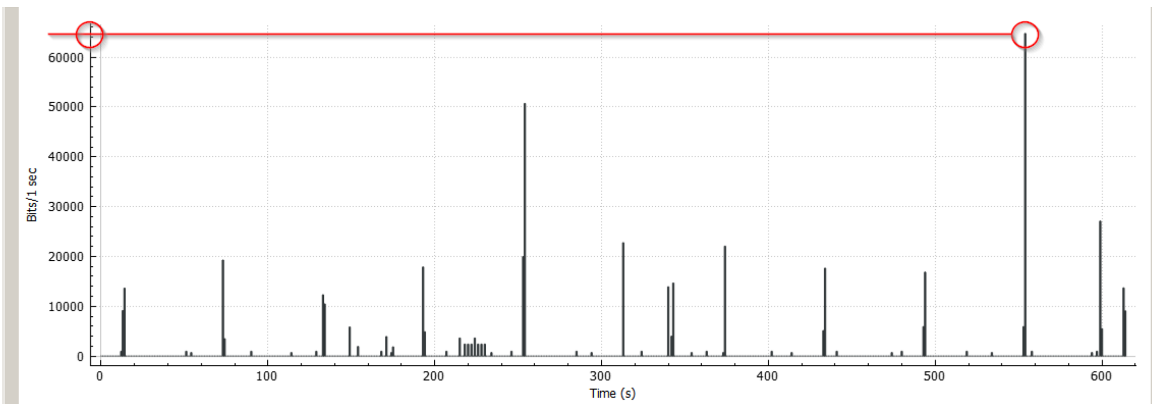
Display filter: tcp.dstport == 2404 and ip.dst==<SCADA IP address>; Style drop down box: Bar; Y Axis: Bits; Y Field: empty; SMA Period: None; Mouse: drags; Interval: 1 sec and find and note the peak bitrate for respective captured IEC 60870-5-104 session. To account for Ethernet Frame Check Sequence FCS (4 Byte), which is not captured by Wireshark (is stripped by the service PC NIC), apply first the display filter: *tcp.dstport == 2404 and ip.dst==<SCADA IP address>* in Wireshark main window and use now the menu *Statistics – Capture File Proper-ties (column Displayed)*, it gives a realistic measurement of the **average packet per second (pps) rate**. Please add [Average pps * 4 * 8 bit/Byte] / 1000 to the peak bitrate.



[dw_wirkeshark_rtu_scada_bitrate_mesurement_statistics_io_graph, 1, --_--]



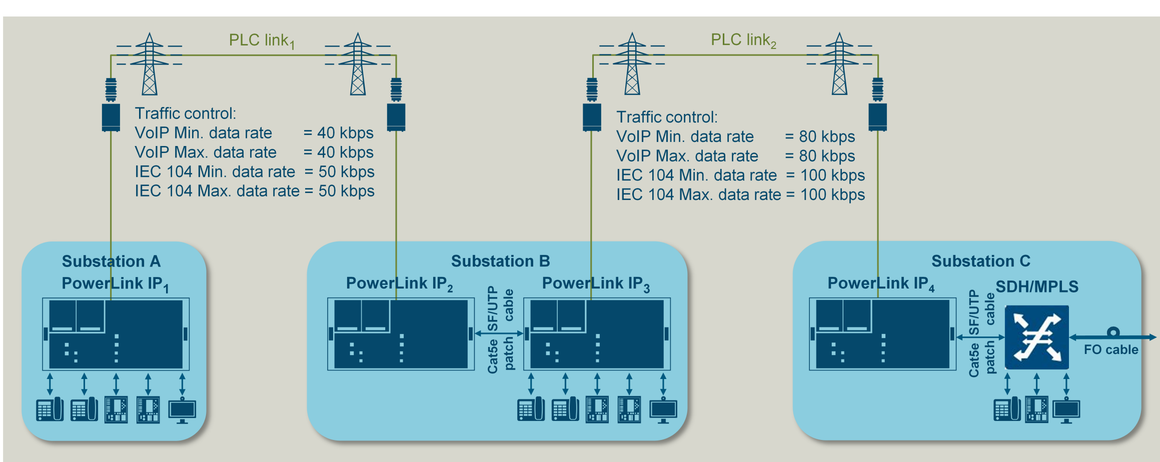
[dw_wirkeshark_rtu_scada_bitrate_mesurement_statistics_io_graph_settings, 1, --_--]



[dw_wirkeshark_rtu_scada_bitrate_mesurement_statistics_io_graph_peak_bitrate, 1, --_--]

A min. and max. data rate (kbps) for the important traffic classes can be set individually. The range between the min. and the max. value is guaranteed for the enabled service and only if PL IP has free resources. This reservation is only active if those traffic classes are detected by SW QoS according to the UDP and TCP source or destination ports. Otherwise the reserved data rate can be used by other Ethernet data (e.g. Business PC in below example). If the data rate of enabled VoIP or IEC 60870-5-104 traffic class exceeds the given max. value, then the exceeding data will be dropped. The max. data rate of other data frames (except VoIP and IEC 60870-5-104) is the total current bit rate achieved by PLCDSP Modem minus current VoIP data rate minus current IEC 104 data rate; it is not configurable explicitly in Web UI.

Other data can use the remaining PLCDSP Modem WAN bitrate if available. Otherwise it will be buffered or dropped. VoIP packets, complying with UDP ports configured in Web UI under Configuration > Ethernet > QoS > Configuration will be sent per default via the SW QoS High Priority queue to PLCDSP Modem! It is also possible to enable in Web UI the transmission of IEC 60870-5-104 and other enabled application protocol messages via the SW QoS High Priority Queue to PLCDSP Modem.



[dw_qos_and_traffic_control_example, 2, --_--]

User Application	VoIP phone	IEC 60870-5-104 RTU	Business PC
Amount	2	2	1
QoS Method	802.1p QoS = Disabled **TOS/DCSP based QoS = Enabled** **Traffic control = Enabled** $DSCP_{RTP}$ = 48 / CS6 $DSCP_{Signaling}$ = 32 / CS4	802.1p QoS = Disabled **TOS/DCSP based QoS = Enabled** **Traffic control = Enabled** DSCP = 24 / CS3	802.1p QoS = Disabled **TOS/DCSP based QoS = Enabled** **Traffic control = Enabled** DSCP = 8 / CS1 (if supported by OS, otherwise DSCP = 0 / CS0 (Best Effort)
VoIP Codec	G.729	NA	NA
Bitrate	20 kbps one-way (with ROHC enabled)	appr. 25 kbps one-way	variable
Layer 4 ports	Dst. UDP $port_{RTP}$ = e.g. 5004 (from range 5004 to 5018) Dst. UDP $port_{RTCP}$ = e.g. 5005 (auto assigned by VoIP phone) Dst UDP/TCP $port_{Signaling}$ = default	Dst. TCP $port_{IEC\ 104}$ = 2404	Various UDP/TCP ports
Header Compression	ROHC + TCP/IP header Compression = Enabled	ROHC + TCP/IP header Compression = Enabled	ROHC + TCP/IP header Compression= Enabled

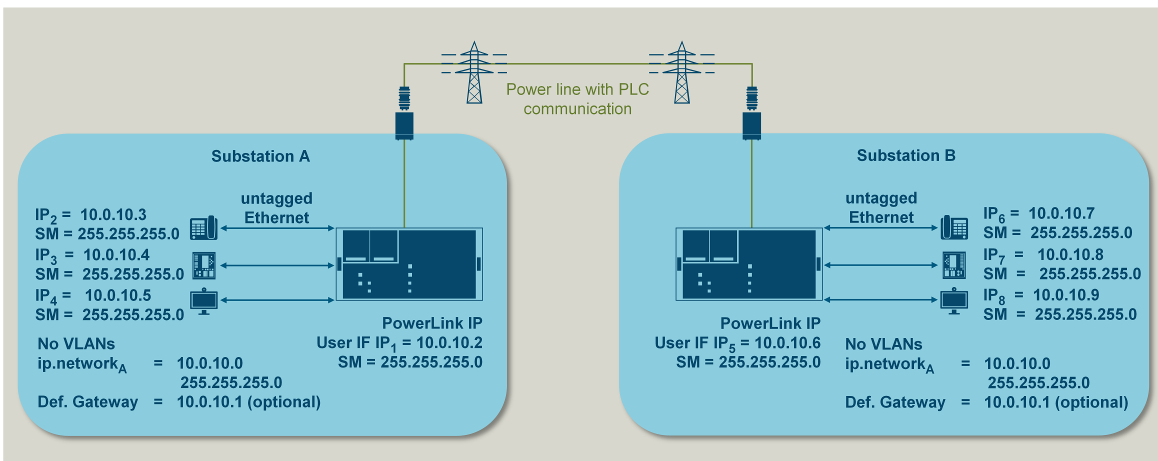
Layer 4 Traffic control in PowerLink IP	Min. data rate (kbps)	Max. data rate (kbps)	Enabled
PLC Link		1	
VoIP	40	40	Yes
IEC 60870-5-104	50	50	Yes
Business PC	NA	NA	NA
PLC Link		2	
VoIP	80	80	Yes
IEC 60870-5-104 100 100 Yes	100	100	Yes
Business PC	NA	NA	NA

6.5 IP address planning topics for customer edge devices

Scenario without external network devices

In a private IPv4 network it is recommended best practice to use the previously **class A IP network 10.x.x.x / 255.0.0.0** for IP address planning of PowerLink IP user interface and connected edge devices due to the highest address space flexibility (24 bits freely available for subnetting and host addressing) and future IP network growth. Service interface (LCT port) can be left as factory default in ip.network = 192.168.20.x / 255.255.255.0 or even with same default ip address of 192.168.20.20 / 255.255.255.0.

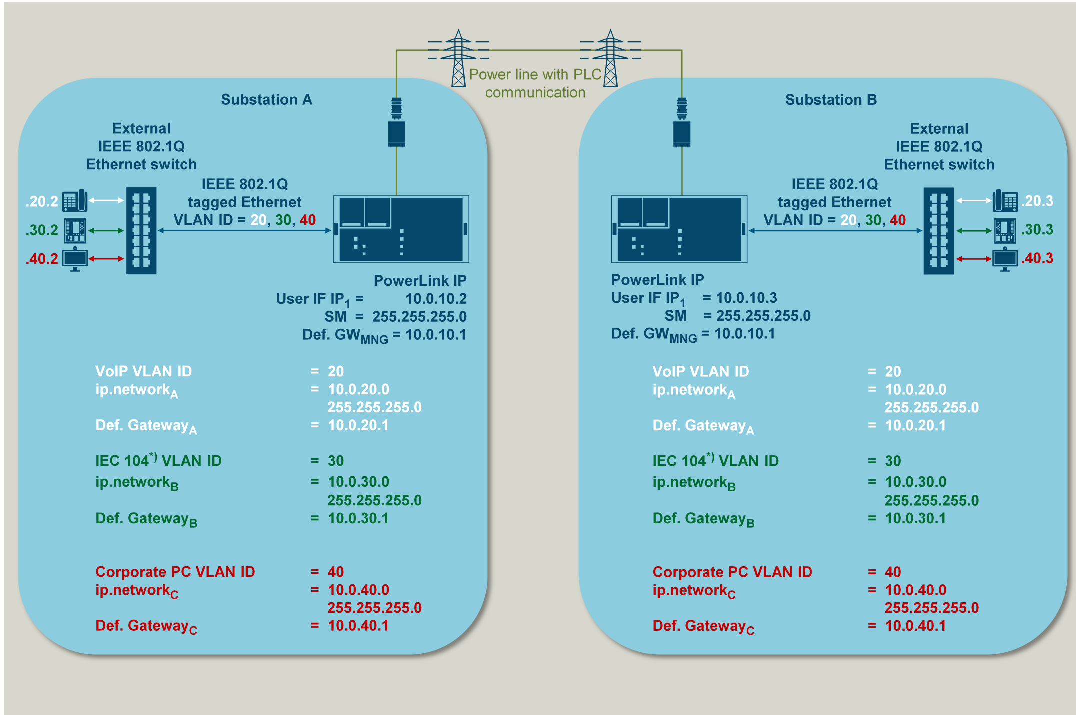
PowerLink IP cannot route IPv4 packets, but only bridges them transparently inside the Ethernet frames. Device connected to the same PowerLink IP chains (same Layer 2 broadcast domain) must use the same IP network. Default gateway IP address is optional if IPv4 routing to another IP networks is required. In this case also an external IPv4 router must be provisioned. Advantage of this scenario is its cost benefit and easy IP address planning; disadvantage is that all user services and PL IP devices are member of the same broadcast domain.



[dw_ip_address_wo_external_network_devices, 1, --_--]

Scenario with external IEE 802.1Q Ethernet switch

An external IEEE 802.1Q switch can be connected via trunks to the ETH1 to 5 ports in cases where the five integrated switch user interfaces are not sufficient or separation of the different user services in own isolated VLANs for higher network stability are required. As each VLAN is an own isolated broadcast domain, individual IP networks must be used per each VLAN / user service type. In cases where inter VLAN routing or ip connectivity with other IP networks is required (e.g. IP-PABXs, SCADA or business servers located in other IP networks), external IPv4 routers as default Gateways for each VLAN IP network must be provisioned e.g. in central Control Center site.

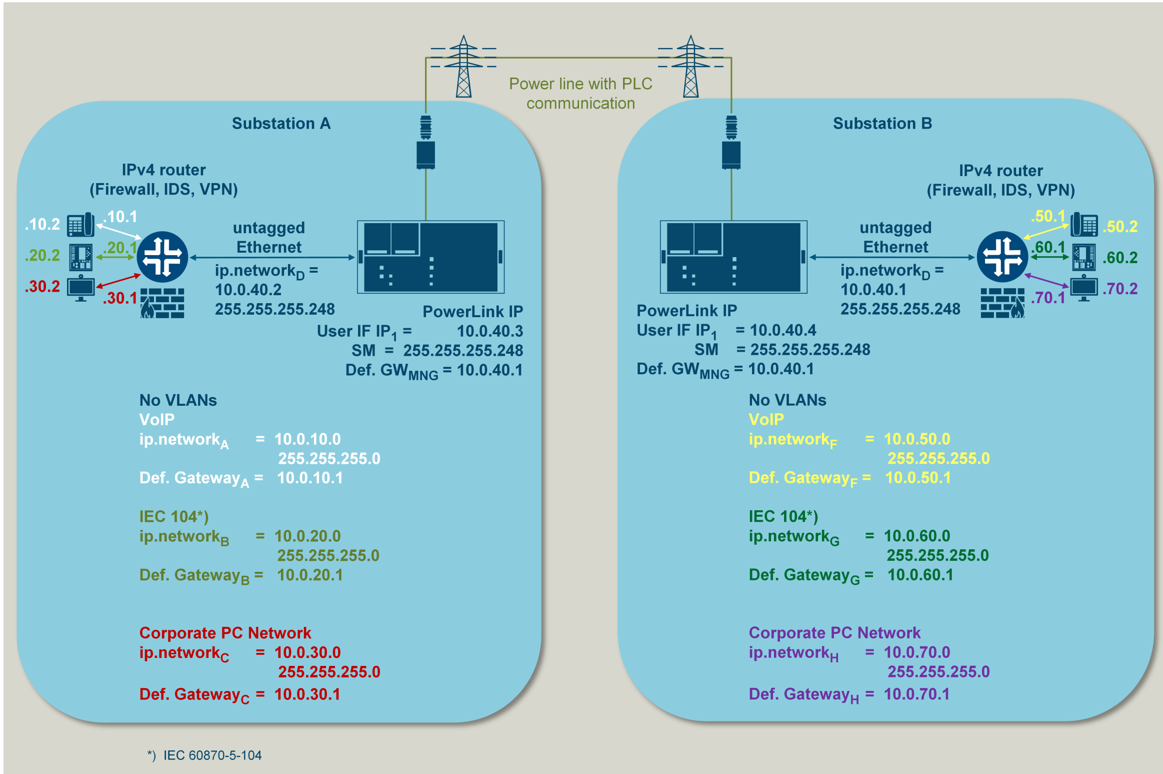


[dw_ip_address_external_ethernet_switch, 1, --_--]

Scenario with external IPv4 router

Advantage of using IPv4 routers at substation level is the isolation of Ethernet broadcast domains (IPv4 Routers do not forward Ethernet broadcasts into the WAN), faster convergence times of IGP routing protocols (e.g. OSPF, IS-IS, EIGRP) and higher network availability in case of physical topology changes or loops compared to the slower Rapid Spanning Tree protocol. Advanced Firewall, Intrusion Detection (IDS) and Virtual Private Network Gateways (e.g. IPsec or OpenVPN for authentication and encryption of user traffic) are exclusively implemented on IP routers to provide absolute protection if cyber security requirements of the utility are very high.

In routers, each of its interfaces must be configured in an own different IP network, which forms the default Gateway for the user edge devices in different VLAN or LAN.



[dw_ip_address_external_ipv4_router, 1, --_--]

Scenario with external legacy interface to IPv4 gateways

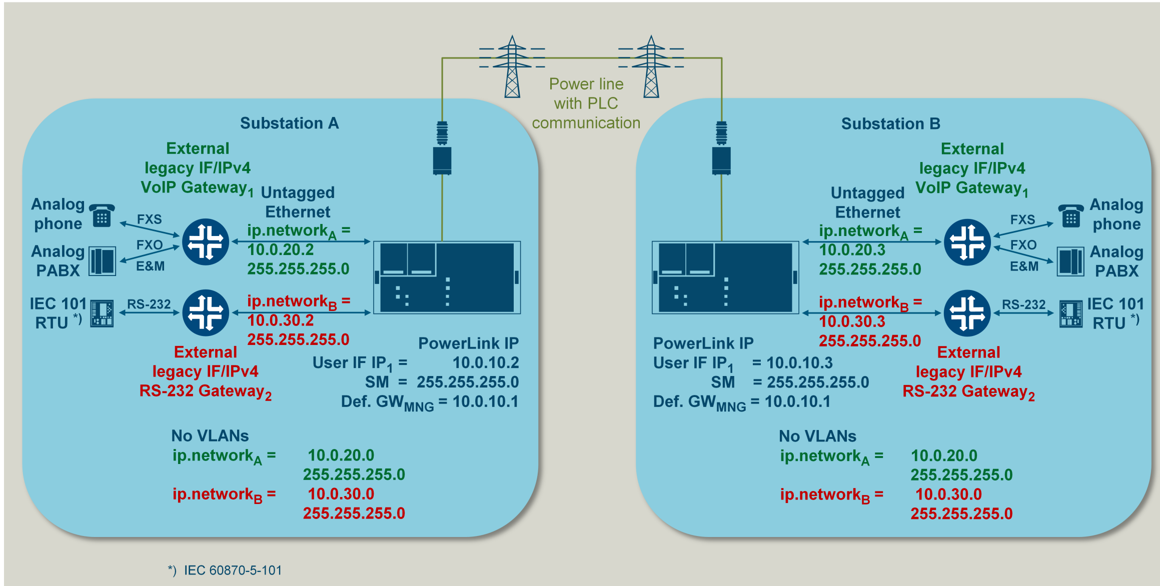
In substations where legacy devices like analog phones (FXS), analog PABX (FXO or E&M) or IEC 60870-5-101 RTUs need to be connected to PowerLink IP, external Gateways must be used in a point-to-point mode.

VoIP gateways must support peer-to-peer signaling or direct IP call without H.323 Gatekeeper or SIP Server. VoIP codecs like G.729 / G.729B / G.729AB or G.723.1 provide a very high compression efficiency. Newer iLBC codec provides additionally high robustness against packet loss and jitter in case of difficult PLC link conditions. VoIP gateways are available on the market with one to N FXS/FXO/E&M interfaces per unit. Central FXO or E&M / IPv4 converter must provide N x FXO or E&M interfaces in one chassis to aggregate the N x remote FXS interfaces of the analog phones.

IEC 60870-5-101 RTU / SCADA telegrams via serial RS-232 interface can be transparently tunneled via Serial Encapsulation protocols over TCP to SCADA. Central RS-232 / IPv4 converter must provide N x RS-232 interfaces in one chassis to aggregate the N x remote IEC 101 traffic from several RTUs.

If external VoIP gateways support Quality of Service (QoS) on its LAN/WAN Ethernet Interfaces, other Ethernet based customer edge devices requiring QoS should be connected to the external gateways and not to PowerLink IP. In PowerLink IP no 802.1p nor TOS/DSCP QoS nor Traffic Control should be used. PowerLink IP will act just as a transparent Ethernet bridge (“virtual Ethernet Patch cable”).

WAN interfaces for analog Voice and IEC 60870-5-101 gateways should preferably be assigned to different IP networks to isolate both service types in own broadcast domains.



[dw_ip_address_external_legacy_IF_IPv4_gateway, 1, --_--]

Scenario with external Carrier Ethernet IEEE 802.1ad Provider Bridge

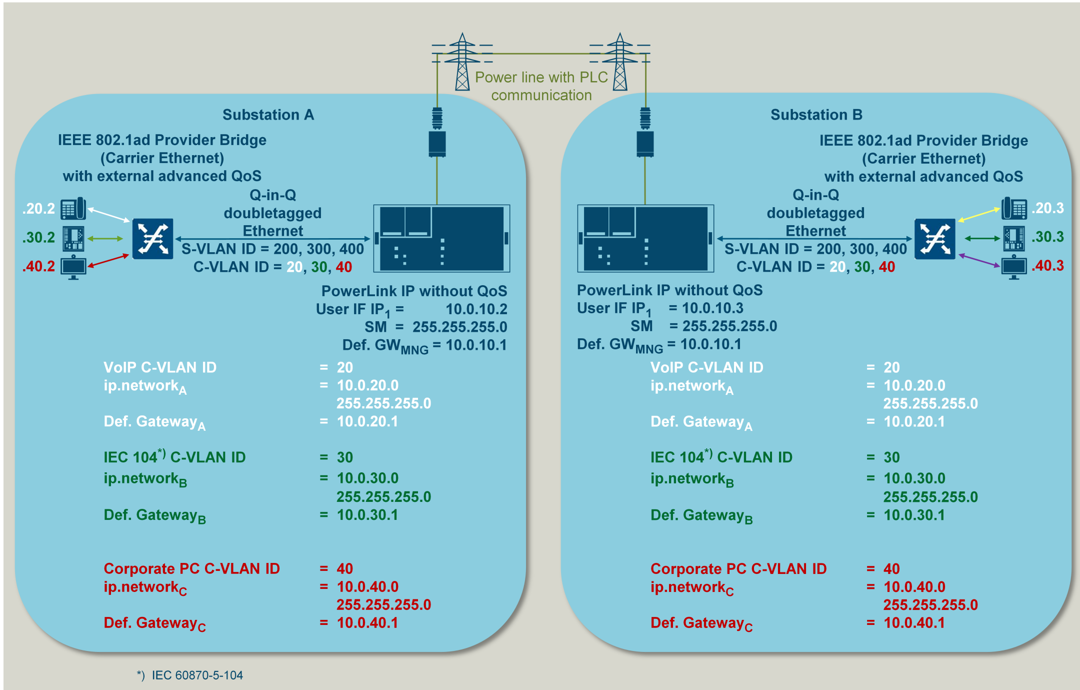
As PowerLink IP can transparently bridge tagged Ethernet frames up to a maximum Jumbo frame size of 2000 byte (without counting the Ethernet Inter-frame gap (12 Byte) Preamble (8 Byte)) via the five user interfaces, it is possible to connect external IEEE 802.1ad Provider Bridges between substations where fiber optic cables are not available.

NOTE

Due to double tagging of the Ethernet frames with a S-VLAN (Service VLAN ID) and C-VLAN (Customer VLAN ID) **all QoS functions and Traffic Control in PowerLink IP must be disabled and Carrier Ethernet switch advanced QoS features be used instead**.

Power Link IP will act just as a transparent Ethernet bridge ("virtual Ethernet Patch cable").

IEEE 802.1ad Provider Bridges can provide only Layer 2 VPNs (L2VPN). So same rules apply for IP address planning of edge devices as for traditional single tag IEEE 802.1Q switches.



[dw_ip_address_w_external_carrier_ethernet_switch, 1, --_--]

Scenario with external MPLS-TP switch or IP/MPLS router

As PowerLink IP can transparently bridge tagged Ethernet frames up to a maximum Jumbo frame size of 2000 byte (without counting the Ethernet Inter-frame gap (12 Byte) and Preamble (8 Byte)) via the five user interfaces, it is possible to connect external MPLS-TP switches or IP/MPLS routers between substations where fiber optic cables are not available.

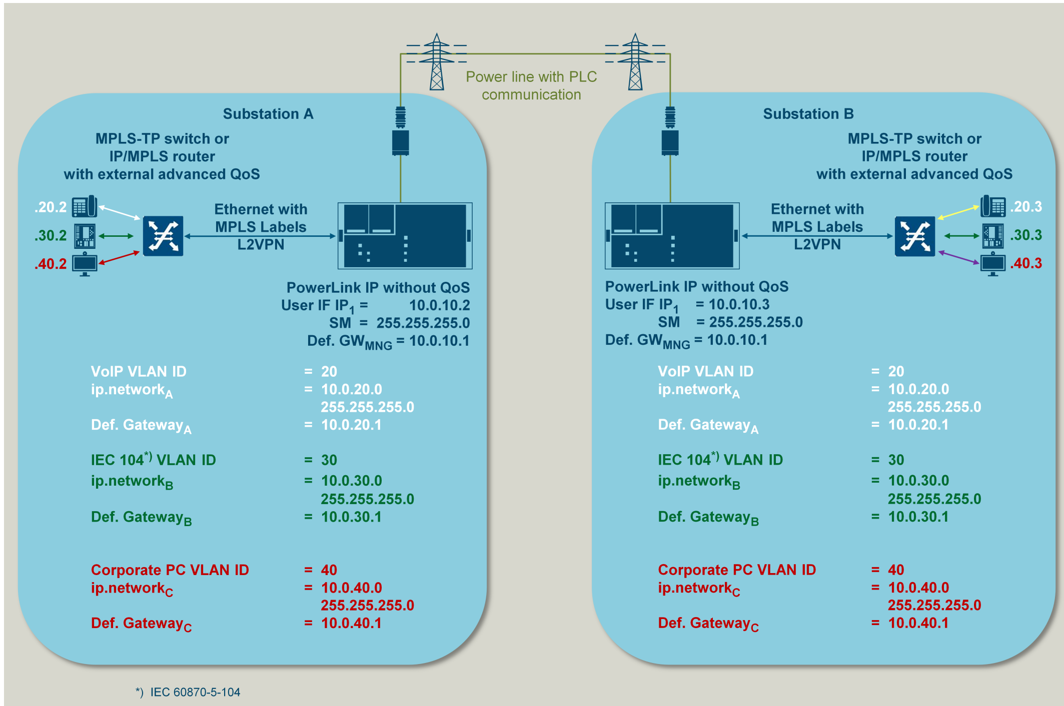
NOTE

Due to the MPLS label stack (one MPLS label for Label Switched Path and another for the Pseudo Wire) between transport Ethernet and user Ethernet frames in case of L2VPNs **all QoS and Traffic Control functions in PowerLink IP must be disabled and MPLS advanced QoS features be used instead**.

Power Link IP will act just as a transparent Ethernet bridge (“virtual Ethernet Patch cable”) in this scenario.

MPLS-TP switches can provide only Layer 2 VPNs (L2VPN). So for IP addresses planning of edge devices same rules apply as for traditional single tag IEEE 802.1Q switches.

IP/MPLS routers can provide L2VPNs (Ethernet connectivity on Layer 2) or L3VPNs (IP connectivity on Layer 3). For L2VPN same IP address planning rules apply as for traditional single tag IEEE 802.1Q switches. For L3VPN the rules for external IPv4 routers apply.

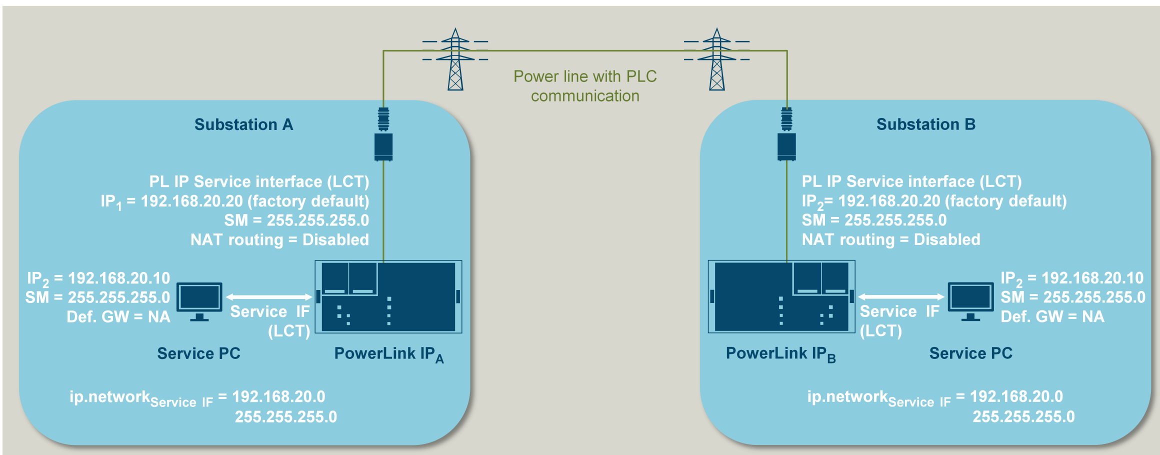


[dw_ip_address_w_external_mpls-tp_or_ip-mpls, 1, --_--]

6.6 IP address planning topics for PowerLink IP management

Local management via service interface (LCT port)

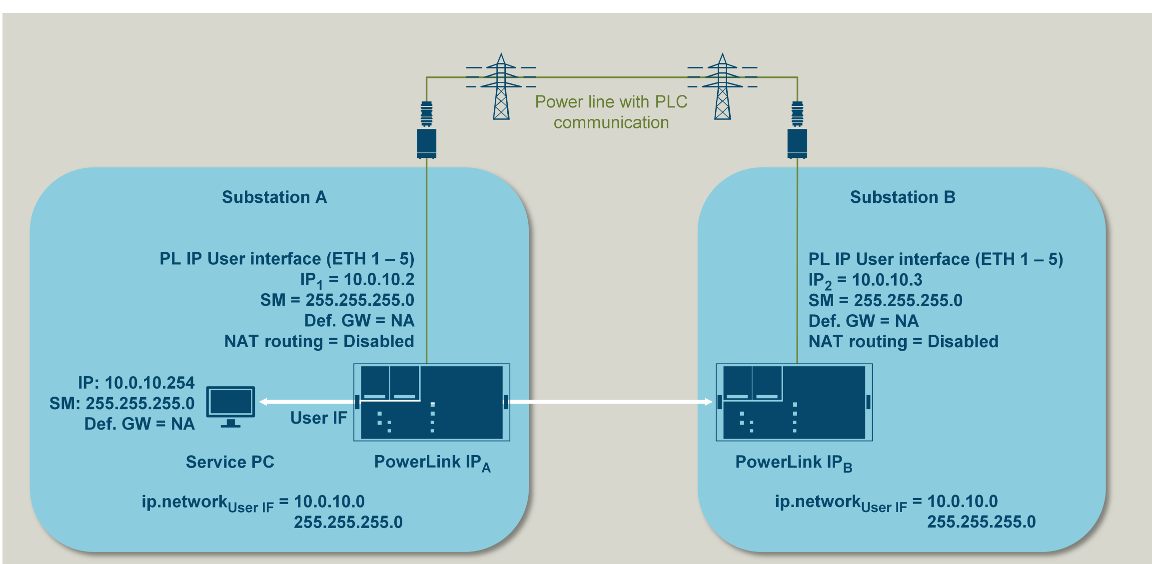
It is possible to manage PowerLink IP via the same factory default IP address 192.168.20.20 / 255.255.255.0 at each device and at the same time. This is typically the case during commissioning with two service engineers located in substation A and B when the PLC link via OHVL is not established yet, in maintenance or disturbed. The IP address of the service interface can of course be changed to any other private IPv4 address if required, but should then be labeled outside on the device and documented appropriately in the project documentation.



[dw_local_management_via_service_if, 1, --_--]

Local or remote management via user interface (ETH1 to 5 port)

The preferred remote management option during the commission phase is to use inband management over the user interface. Prerequisite is to configure the IP address of Service PC and all user interfaces (ETH 1 – 5) to be of the same IP network. Configuration of default gateway is not required in Service PC.

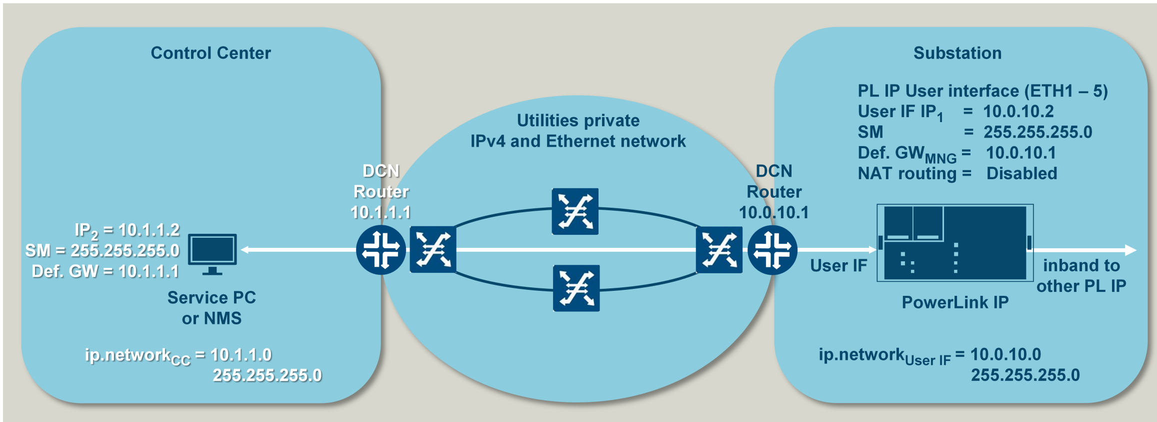


[dw_remote_management_via_user_if, 1, --_--]

Remote management via user interface from Control Center

PowerLink IP can be managed or SNMP supervised remotely from Control Center using inband management channel over the user interface. If Service PC / NMS and PowerLink IP user interfaces are located in different

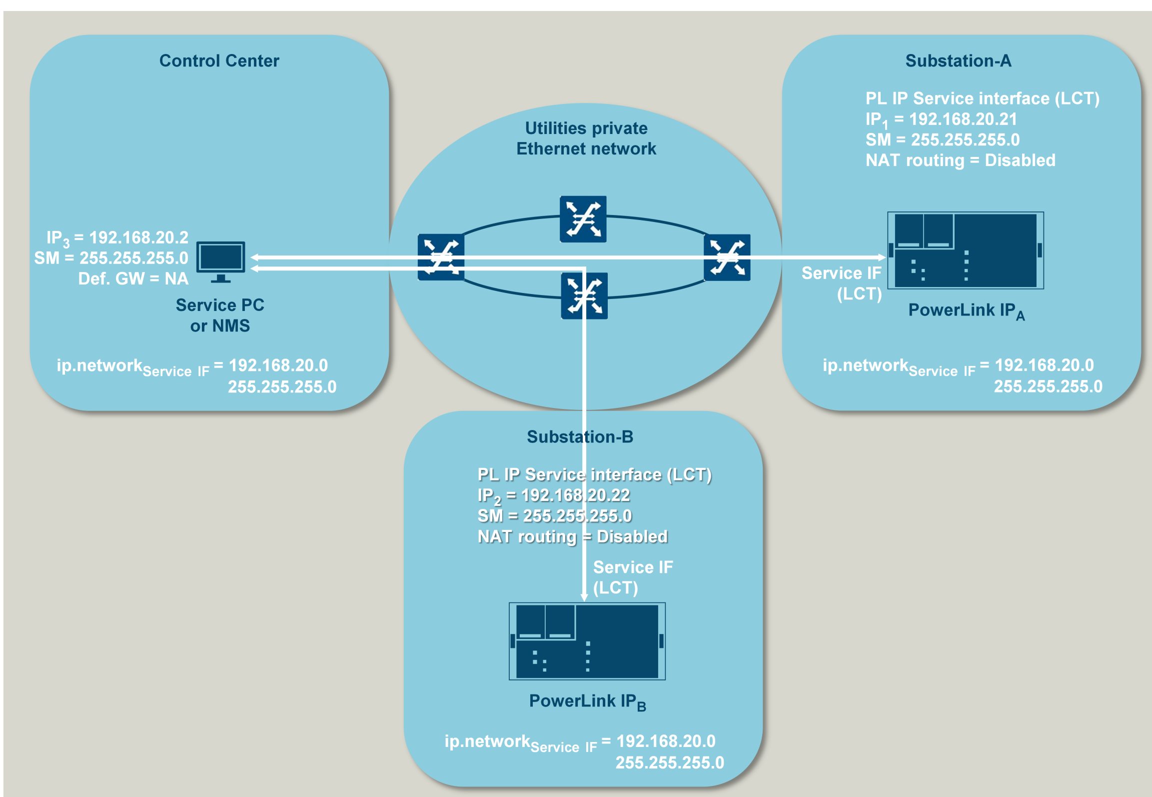
IP networks external IPv4 DCN routers are necessary and default Gateway address must be configured on PowerLink IP user interface connected to utilities private WAN.



[dw_inband_remote_management_from_cc, 1, --_--]

Remote management via service interface and out-of-band channels from Control Center

In case of limited HF bandwidth, PowerLink IP's remote management traffic can be offloaded to utilities, existing private out-of-band Ethernet network (collocated Ethernet over SDH, MPLS, Layer 3 Switches, IP Routers etc. WAN network devices in the same substation). PowerLink IP devices can then be remotely SNMP supervised, configured and monitored with Web UI via their Service interfaces. In this case, all service interfaces must have unique IP addresses. Service PC or NMS must be located in the same IP network as well all PL IP service interfaces. IPv4 routing cannot be used between the Control Center LAN and PowerLink IP devices service interface LAN, plain Ethernet bridging must be used instead.



[dw_out-of-band_remote_management_from_cc, 1, --_--]

7 Cyber Security

7.1 Cyber Security

The device is protected against malicious cyber attacks by following features:

- Web server with certificate based (2048 bit key length) TLSV1.2 authentication and encryption
- Web UI login with username and complex password
- Role based access control with four possible user roles (ADMIN, SECAUD, ENGINEER and VIEWER)
- User authentication via RADIUS
- Selective disabling of user roles
- User blocking after login failure (max. block time and max. retry limit)
- Password policy enforcement (upper case, lower case, number, special character, default password check, min. password length, password expire time)
- SNMP version 3 with User based Security Model and authentication and privacy protocol
- Port security for user interfaces (disable unused ETH1 to 5 ports and configurable source MAC address white list)
- Layer 2 filter based firewall
- HW crypto chip for license feature
- Comply with least privilege principle for system component
- Security log including user actions and security relevant actions
- Ingress broadcast and multicast rate limit for user interface

7.2 TCP/UDP Ports

TCP/UDP ports used depend on service and protocol.

Service	Layer 4 protocol	Layer 7 Protocol	Client	Client Port	Server	Server Port
Web server with SSL encryption	TCP/TLS	HTTPS	Web browser	>1024	PowerLink IP/CM	443
Time synchro-nization	UDP	NTP	PowerLink IP/CM	>1024	NTP Server	123
DHCP Client	UDP	DHCP	PowerLink IP/CM	68	DHCP Server	67
SNMP	UDP	SNMP	NMS	>1024	PowerLink IP/CM	161
SNMP Trap/ Inform	UDP	SNMP	PowerLink IP/CM	>1024	SNMP Trap receiver	162
SNMP Inform ACK	UDP	SNMP	SNMP Trap Receiver	162	PowerLink IP/CM	>1024
OPC UA Pub/Sub MQTT	TCP	MQTT	PowerLink IP/CM	>1024	Broker	8883
RADIUS user authentication	UDP	RADIUS	PowerLink IP/CM	>1024	RADIUS Server	1812
SIP server	UDP	SIP	VoIP phone	>1024	PowerLink IP	5060
Serial IP	TCP / UDP	IEC60870-5-101	SCADA	> 1024	PowerLink IP	30201-30204
IEC 16850 on EN100	TCP	MMS	PC	>1024	PowerLink IP	102
IEC 16850 on DMB	TCP	MMS	PC	>1024	PowerLink IP	102

7.3 Security configuration

The follwing hardening steps have to be carried out during commissioning:

No.	Steps	Settings
1	Enforce password policy	Web UI > Configuration > Ethernet > Web access >> Enable password policy check = Enabled
2	Limit the number of unsuccessful authentication attempts	Web UI > Configuration > Ethernet > Web access >> Block user after login failure = Enabled
3	Change default password after first login	Web UI > Change password >> Change new password with at least one upper case, lower case, digital number and special character, and password length is more than 8 characters
4	Re-create self-signed certificate after device IP address changed	Web UI > Configuration > Ethernet Web access >> Create certificate
5	Install certificate on service PC to enable the trust	Connection service PC to Web UI, install the certificate into Windows Trusted Root Certification Authorities store
6	Switch off unused service port number: SNMP	Web UI > Configuration > Ethernet > SNMP > Configuration >> SNMP version = Disabled Web UI > Configuration > Clock synchronization >> Local clock sync mode = <without NTP> Web UI > Configuration > Ethernet > Service interface Web UI > Configuration > Ethernet > User interface >> DHCP client = Disabled
7	Enable secure protocol	Web UI > Configuration > Ethernet > SNMP > Configuration >> SNMP version = SNMP v3
8	Enable SNMP notification for authentication failure of web access	Web UI > Configuration > Ethernet > SNMP > Trap Severity >> AUTH_FAIL = Enabled
9	Enable L2/L3 protocol	Web UI > Configuration > Ethernet > Firewall >> Firewall = Enabled
10	Disable undesired SNMPv3 user account	Web UI > Configuration > Ethernet > SNMP > User table >> Delete default user after clone new user
11	Disable undesired web user account	Web UI > User management >> Disable or delete undesired user account
12	Disable unused Ethernet user interface	Web UI > Configuration > Ethernet > Port configuration >> ETH1...5 Enabled = Unchecked
13	Enable MAC address white list for user interface	Web UI > Configuration > Ethernet > Port security > Configuration >> Port security = Static MAC Web UI > Configuration > Ethernet > Port security > MAC address white list >> Source MAC address which allow access to Ethernet user interface
14	Enable Ingress broadcast and multicast rate limit for user interface	Web UI > Configuration > Ethernet > Port configuration >> Ingress broadcast and multicast rate limit = 64 kbps

7.4 Security log

The security relevant actions are recorded as below:

Event ID	Event message
201	<Login user>: User logged on
1163	<Login user>: User logon failed
202	<Login user>: User logged off
203	<Login user>: User added [user name]
204	<Login user>: User removed [user name]
205	<Login user>: User enabled [user name]
206	<Login user>: User disabled [user name]
208	<Login user>: User role(s) changed [user name]
209	<Login user>: User password changed [user name]
1154	<Login user>: User blocked [user name]
600	<Login user>: Device restarted
601	<Login user>: Firmware updated
602	<Login user>: Parameter change activated
603	<Login user>: Parameter change activation failed
604	<Login user>: Parameter change cancelled
605	<Login user>: Firewall enabled
606	<Login user>: Firewall disabled
607	<Login user>: Firewall parameter changed
608	<Login user>: MAC address white list enabled
609	<Login user>: MAC address white list disabled
610	<Login user>: MAC address white list changed
611	<Login user>: Block user after login failure enabled
612	<Login user>: Block user after login failure disabled
613	<Login user>: Web access system parameter changed
614	<Login user>: Certificate updated
615	<Login user>: Password policy enabled
616	<Login user>: Password policy disabled
617	<Login user>: Password policy parameter changed
618	<Login user>: SNMP enabled
619	<Login user>: SNMP disabled
620	<Login user>: SNMP read-only community string changed
621	<Login user>: SNMP read-write community string changed
622	<Login user>: SNMPv3 user added [user name]
623	<Login user>: SNMPv3 user removed [user name]
624	<Login user>: SNMPv3 user disabled [user name]
625	<Login user>: SNMPv3 user enabled [user name]
626	<Login user>: SNMPv3 default user restored
627	<Login user>: SNMPv3 auth password changed [user name]
628	<Login user>: SNMPv3 priv password changed [user name]
629	<Login user>: License file updated
630	<Login user>: All settings cleared
631	<Login user>: Measurement data cleared
632	<Login user>: Device date and time changed manually [new date / time]

8 Technical Data

8.1 Transmission Method

Modulation	Multicarrier modulation (windowed OFDM) for data transmission Frequency shift keying for teleprotection
HF-frequency range	24 kHz to 500 kHz
HF-bandwidth	4 kHz to 256 kHz, 250 Hz steps Transmit bandwidth only, see also setting of Tx filter
Frequency management	Dynamic *) and predefined bandwidth allocation Notching of occupied frequencies (up to 20 notches) Adjustable asymmetric traffic Adjacent and non-adjacent Tx/Rx band operation Teleprotection communication via anchor frequencies *) automatic bandwidth adaption within the frequency domain adjacently operating PowerLink IP devices

8.2 HF-Interface

Output power	50 W-amplifier, up to +47 dBm PEP Adjustable 10 W to 50 W 100 W-amplifier, up to +50 dBm PEP Adjustable 20 W to 100 W
Rated output impedance	75 Ohm unbalanced or 150 Ohm balanced
Spurious emission, Return Loss, Tapping Loss, Balance to ground, Receiver sensitivity and Selectivity	In accordance with IEC 60495 IEC 62488-2 IEC 62488-3
Tx Filter	Simple adjustment by jumpers
RX Filter	The Rx filtering is done in digital domain and is adjusted automatically.

8.3 Transmission Characteristics

Transmission Characteristics	Transmission capacity up to 1.5 Mbps Spectral efficiency 0.8 to 10.2 bit/s/Hz Minimum SNR: 42.6 dB for 16,384 QAM 36.6 dB for 4,096 QAM 30.6 dB for 1,024 QAM 24.5 dB for 256 QAM 18.2 dB for 64 QAM 11.4 dB for 16 QAM 3.3 dB for 4 QAM All values rated at 64-kHz bandwidth and BLER 10E-6
Dynamic transmission path adaption	Modulation steps 4/16/64/256/1024/4096/16384-QAM
Latency	Typically 20ms Latency depends on frame length and the currently used transmission scheme

8.4 Ethernet Interface

Ethernet	1 x 100BASE-TX Full Duplex; RJ45 service interface (LCT port) 3 x 10BASE-T or 100BASE-TX Half/Full Duplex/Auto Negotiation; PoE on port 3 acc. to IEEE 802.3af, 15.4 W; RJ45 user interfaces 2 x Ethernet 100BASE-FX; SFP user interfaces
Layer 2 switch	Transparent Layer 2 bridging Ethernet II, IEEE 802.3, IEEE 802.1Q IEEE 802.1ad Provider Bridge/Q-in-Q (Carrier Ethernet) MPLS labeled Layer 2 VPN frames Jumbo frame: max. frame size 2000 bytes (without preamble) on all five user interfaces Maximum Transmit Unit (MTU) for IPv4 over Ethernet: 1500 byte on service interface (LCT)
QoS	Layer 2/3: VLAN ID, IEEE 802.1p, TOS/DSCP Layer 4: VoIP, IEC 60870-5-104, CCTV, SCADA

8.5 Analog Interface

VF- Telephone Channel E&M (2/4 Wire)

Number of channels	1
Signaling	DTMF
Impedance input/output	600 Ohm balanced
Max. input level (4 / 2 wire)	15 dBm
Max. output level (4 / 2 wire)	14 dBm
Control wires	Telephone signaling channel (S2) Compander control

VF- Telephone Channel FXS (2 Wire)

Number of channels	4
Signaling	DTMF / Dial pulse
Impedance	600 Ohm balanced
Infeed current	48 V, 24.1 mA
Max. loop resistance	1690 Ohm
Ringing voltage	25 Hz, 75 Vrms
Max. input level	9 dBm
Max. output level	7 dBm

VF- Telephone Channel FXO (2 Wire)

Number of channels	1
Signaling	DTMF / Dial pulse
Impedance	600 Ohm balanced
Ringing detection	25 Hz, 50 Hz, 60 Hz (> 24 Vrms) The ringing signal must contain polarity reversal to be detected.
Loop resistance	< 500 Ohm
Loop current	15 mA to 112 mA (depending on line feed resistance)
Max. input level	14 dBm
Max. output level	12 dBm

RS-232

Number of channels	4
Data rate	300, 600, 1200, 2400, 4800, 9600, 19 200, 38 400, 57 600, 115 200 bps
Serial mode	7N1, 7N2, 7E1, 7E2, 7O1, 7O2, 8N1, 8N2, 8E1, 8E2, 8O1, 8O2
Port B	Only available in RS-232-2 and RS-232-4

8.6 Integrated Teleprotection System SWT 3000

8.6.1 Overview

Number of systems	One, integrated in the PowerLink IP frame or external via FOM connection
Operation modes	Alternate Multi-Purpose (AMP)
Number of Trip commands Number of Interface modules Number of IEC 61850 modules	Up to 8 Up to 2 1
Modulation	Coded tripping
AMP frequencies	Trip 0.36 – 2.62 kHz when using 4 command option Trip 0.50 – 3.79 kHz when using 8 command option Guard 2.61 kHz

8.6.2 Command Input/Output

Binary Input IFC-P/IFC-D

Rated input voltage	DC 24 V to DC 250 V (tolerance: -20 % to +20 %)
Nominal Input Voltage 24 V 48 V or 60 V 110 V 250 V	**Selectable Threshold Voltage** Low level U_{in} < 15 V, high level U_{in} > 18 V Low level U_{in} < 40 V, high level U_{in} > 47 V Low level U_{in} < 72 V, high level U_{in} > 85 V Low level U_{in} < 167 V, high level U_{in} > 198 V
Polarity independence	Yes
Pulse suppression	1 ms additionally up to 100 ms programmable in steps of 1 ms

Command Output

Interface modules	IFC-P normal contact load	IFC-D high contact load IFC-S for signalling
Contact type	Relay, normally open contact	Relay, IFC-D normally open contact Relay, IFC-S changeover with common root
Switching power	250 W/250 VA	150 W/1,250 VA
Switching voltage	AC/DC 250 V	AC/DC 250 V
Switching current	AC/DC 1.5 A (5A < 2.5 ms)	AC/DC 5 A (30 A ≤ 0.5 ms)
Carry current	AC/DC 1.5 A	AC/DC 5 A for IFC-D AC/DC 1 A for IFC-S
Insulation withstand voltage	2500 VAC	2500 VAC

IEC 61850 Command Input/Output EN100

Electrical interface	RJ45; 100Base-TX; max. range 20 m
Optical interface	SFP; 100Base-FX; 1,300 nm; LC connector; Max. range 1.5 km

8.6.3 Terminals of IFC Modules

Screwed connection

Wire cross section	< 1.5 mm^2 (> AWG 16)
Bare Wire without conductor sleeve Stripping Length L	12 mm (0.47 inch)
Stranded Wire with conductor sleeve Stripping Length L	10 mm (0.39 inch)
Terminal screw tightening torque	0.8 Nm (7.1 lb. inch)
Sleeve length (wire range) / Type	> 10 mm (0.39 inch) e.g. DIN 46228-E1,5-10
Sleeve Type	Acc. EN 60947-7 class 1

Crimped connection

0.5 to 1.0 mm^2 (AWG 20 to 18) Recommended Contact Type	Weidmueller Order. No. 162552 (Tape), 162556 (single contact)
1.5 to 2.5 mm^2 (AWG 15, 14) Recommended Contact Type	Weidmueller Order. No. 162550 (Tape), 162551 (single contact)
Recommended Crimp Tool	Weidmueller Order. No. 9014140000
Recommended Unlocking Tool	Weidmueller Order. No. 1359000000

8.6.4 Command Transmission

Transmission Time TO (SWT 3000 integrated into PowerLink IP)*

Alternate multi purpose	≤ 19 ms

* Values are given for the IFC-P module and permissive tripping. For direct tripping schemes the transmission time increases about 5ms. If the IFC-D module is used for increased contact load, all specified transmission times are prolonged by up to ≤ 4 ms.

Security (Analog Transmission Path)

Probability of unwanted commands	$P_{UC} < 10^{-6}$

Dependability (Analog Transmission Path)

Probability of missing commands	$P_{MC} < 10^{-4}$ at SNR of +6 dB

8.7 Miscellaneous

8.7.1 Maintenance Interfaces

Service-PC	Web UI via Web browser, https secure protocol DHCP client for ETH interface
Service telephone	Via IP telephone or PC app

8.7.2 Network Management

Element Manager	Web browser for local and remote access with username/password for configuration and maintenance
Integration with NMS at higher level	Via SNMP v2/3, Alarm Management (up to 4 destinations for alarm traps), inventory and performance management

8.7.3 Event Recorder

Recording capacity	PowerLink IP 10000 events iSWT: 8000 events
Real-time clock	NTP, IRIG-B, Line clock sync 1-ms resolution

8.7.4 SD Card

File system	FAT32

8.7.5 Alarm Modules Input/Output

Binary Input ALR Module

Binary Input 1 Nominal voltage used for synchronization with	DC 24 V to DC 250 V (tolerance: -20 % to +15 %)
Polarity independence	Yes
IRIG-B Polarity independence	DC 5 V, DC 12 V, DC 24 V (tolerance: ±15%) No, defined polarity required

Output ALR Module (Relay)

Number of alarm outputs	3 relay contacts
Contact type	Change over contact
Switching power	300 W (DC) 1000 VA
Switching voltage	250 V (DC or peak AC)
Switching current	5 A (DC or peak AC)
Carry current	1 A (DC or peak AC)

8.7.6 Power Supply

Input voltage range	
PSPA2-DC	DC 38 V to DC 72 V
PSPA2-AC	AC 93 V to AC 264 V (47 Hz to 63 Hz) DC 85 V to DC 264 V
Power consumption	
50 W Amplifier (AC/DC)	typ. value normal operation 301VA/104W typ. value max operation 394VA/146W
100 W Amplifier (AC/DC)	typ. value normal operation 358VA/131W typ. value max operation 559VA/215W

8.7.7 EMC Immunity

Immunity for industrial environments – Generic standard IEC 61000-6-2, testlevels see table.

Immunity for equipment used in power station and substation environments IEC 61000-6-5; Testlevels see table in ()

Standards	Testlevels
Electrostatic discharge IEC 61000-4-2	direct/indirect contact discharge: 8 kV air discharge: 15 kV
Radiated, immunity IEC 61000-4-3	10 V/m 80...1000 MHz 3 V/m 1...6 GHz
Electrical fast transient (burst) IEC 61000-4-4	AC/DC supply lines: +/- 2 kV HF input/output lines: +/- 1 kV (+/- 4 kV) Data input/output: +/- 1 kV (+/- 2 kV)
Surge Immunity IEC 61000-4-5	1,2/50 us (8/20) pulse Signal/control lines: +/-1 kV line to earth (+/- 1 kV line to earth) HF input/output lines: +/- 1 kV line to earth (+/- 2 kV line to earth) DC supply lines: +/- 0,5 kV line to earth; +/- 0,5 kV line to line (+/- 2 kV line to earth; +/- 1 kV line to line) AC supply lines: +/- 2 kV line to earth; +/- 1 kV line to line
Immunity to conducted disturbances IEC 61000-4-6	0.15 MHz to 80 MHz 10 Vrms (signal lines >3 m and AC/DC power supply lines)
Power frequency magnetic field immunity IEC 61000-4-8	50/60 Hz; 30 A/m (100 A/m; 1000 A/m for 1 s)
Voltage dips AC supply line IEC 61000-4-11	Dip: 0% 20 ms 1 P Dip: 0% 100 ms 5 P Dip: 40% 200 ms 10 P Dip: 40% 1000 ms 50 P Dip: 70% 20 ms 1 P Dip: 70% 500 ms 25 P

Standards	Testlevels
Voltage interruptions AC supply line IEC 61000-4-11	0% 5 s 250/300 P
Ring wave immunity test IEC 61000-4-12	100 kHz 2.5 kV LTG 1 kV LTL
Test for immunity to conducted, common mode disturbances IEC 61000-4-16	(Signal/control lines: 50/60 Hz; 10 V cont., 300 V for 1 s (HF input/output lines: 50/60 Hz; 30V and 300V for 1s) (DC supply lines: 50/60 Hz; 10V cont., 300 V for 1 s)
Ripple on d. c. input power port immunity IEC 61000-4-17	(DC supply lines: 10% Un)
Damped oscillatory wave immunity test IEC 61000-4-18	(HF input/output lines: 1 MHz; 2,5 kV common mode and 1 kV differential mode)
Voltage dips, short interruptions and voltage variations on d.c. input power IEC 61000-4-29	0%, 0.010 s 0%, 0.050 s 40%, 0.100 s 70%, 0.100 s

8.7.8 EMC Emission

Standards	Testlevels
Emission standard for industrial environments IEC 61000-6-4	Class A

8.7.9 International Standards

Single side band power-line carrier terminals	IEC 60495 *) IEC 62488-2 ED1 *)
Climatic conditions	IEC 60870-2-2 Climatic-Storage/Operation: B3 (3k4/1k2); C1 (3k5/1k3) no condensation, no icing Climatic-Transport: Ct1 (2k2) Mechanical-Storage, Installation, Transport: B^m

*) IEC 60495 valid for applicable parameters on digital PLC

8.7.10 Climatic Conditions

Standards	Testlevels
Cold IEC 60068-2-1	-10°C
Dry heat IEC 60068-2-2	+ 55°C
Damp heat, cyclic IEC 60068-2-30	+ 25°C at 95% humidity + 55°C at 93% humidity

8.7.11 Mechanical Conditions

Standards	Testlevels
Degree of protection	IP 20
Vibration stationary use IEC 60068-2-6	Resonance: 5 Hz to 9 Hz: 0,35 mm amplitude 9 Hz to 500 Hz: 1m/s^2 acceleration
	Endurance: 5 Hz to 9 Hz: 3,5 mm amplitude 9 Hz to 200 Hz: 10m/s^2 acceleration 200 Hz to 500 Hz: 15m/s^2 acceleration
Test of dynamical behaviour during mechanical stress (Shocktest) IEC 60068-2-27: test Ea	Half sine; 30g acceleration; duration 18ms

8.7.12 Mechanical Design

19” frame	
Dimensions *)	482 mm x 266 mm x 300 mm (W x H x D)
Weight with 50-W amplifier with 100-W amplifier	 17 kg 19 kg

8.7.13 Statement of Conformity

	The product is in conformity with the regulations of the following European Directives: • • EMC Directive 2014/30/EU • • Low Voltage Directive 2014/35/EU • • RoHS Directive 2011/65/EU

8.7.14 Distributor statement according to WEEE-Guideline 2012/19/EU

	Do not throw the device in the household trash! Please dispose of the device according to the guidelines regarding electronic waste in your country.

9 Appendix

9.1 Abbreviations

Subsequently you find a list with abbreviations which are used in the PowerLink IP equipment manual:

Abbreviation	Signification
A	
ACN	Allocated Channel Number
ADC	Analog Digital Converter
ADJ	Adjacent
AGC	Automatic Gain Control
AKE	Coupling Unit (Ankoppeleinheit)
AL	Alarm wire
ALA	Alarm output
ALR	Alarm Module PowerLink with binary input for IRIG-B synchronization
ALRS	Alarm module PowerLink
AMP	Tele protection mode: Alternate Multi Purpose operation
AMP	Amplifier
ARP	Address Resolution Protocol
aSWT	Stand Alone SWT
ATT	Attenuator
B	
BI	Binary Input
BER	Bit Error Rate
BLER	Block Error Rate
BP	Backplane
bps	bit per second
C	
CB-1	Capacitor bank
CC	Control Center
CDB	Configuration Data Base
CF	Carrier Frequency
CFG	Configuration alarm in the PowerSys service program
CI	Command Input
CO	Command Output
COMCON	Communication Controller
CT	Coded tripping (transmission mode in SWT 3000)
CTS	Clear to send
D	
D/A	Digital Analog Converter
DHCP	Dynamic Host Configuration Protocol
DIAG	Diagnostic
DMB	Digital Modulation Board
DP	Data Pump
dPLC	Digital PLC
DSCP	Differentiated Service Code Points
DSP	Digital Signal Processor
DTT	Direct Transfer Trip
DV	Digital Voice
E	

Abbreviation	Signification
ECN	Explicit Congestion Notification
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
ETC	External Transmit Clock
ETH	Ethernet
EOW	Engineering Order Wire (Service Telephone)
F	
FGND	Frame Ground
FIFO	First in First out
FM	Frequency Modulation
FO	Fiber Optic
FOBox	Fiber Optic Modem Box
FOL	Fiber Optic Modem Long distance
FOM	Fiber Optic Modem
FOS	Fiber Optic Modem Short distance
FPGA	Field Programmable Gate Array
FSK	Frequency Shift Keying
FTP	File Transfer Protocol
FW	Firmware
G	
GAL	Guard Alarm (i)SWT 3000
GENALR	General Alarm
GND	Ground
GOOSE	Generic Object Oriented Substation Events
GSE	Generic Substation Events
H	
HDB3	High Density Bipolar of order 3 code
HF	High Frequency
HV	High Voltage
HVL	High Voltage Line
HW	Hardware
I	
ICC	Internal Communication Control
IFC-D	Interface module for protection signaling system SWT 3000 (Direct tripping)
IFC-P	Interface module for protection signaling system SWT 3000 (Permissive tripping)
IFC-S	Interface module for protection signaling system SWT 3000 (Signaling only)
iLAN	internal Local Area Network
iMUX	integrated Multiplexer for asynchronous data transmission
INC	Impulse Noise Compression
INPLM	Input Limitation Alarm
IP	Internet Protocol
IRIG	Inter Range Instrumentation Group
IRIG-B00x	Message for clock synchronization of the CSPi, iSWT
ISDN	Integrated Services Digital Network
iSWT	integrated protection signaling system SWT 3000
K	

Abbreviation	Signification
kbps	Kilobit per second
L	
LAN	Local Area Network
Layer 2	Synonym for Ethernet
Layer 3	Synonym for Internet Protocol (IP)
Layer 4	Synonym for UDP or TCP
Layer 7	Synonym for application layer protocols
LCT	Service interface at the front cover of CSPi (Local Craft Terminal)
LED	Light Emitting Diode
LIA	Line Interface Analog – analog line interface from (i)SWT
M	
MARC	Medium Access Request Channel
Mbps	Megabit per second
MFC	Multi Frequency Code (multi frequency signaling)
MIB	Management Information Base
MLFB	Siemens ordering number
MMI	Man-machine interface
MMU	Memory Management Unit
N	
NADJ	Non Adjacent
NAT	Network Address Translation
NC	Normally Closed contact, brake contact (alarm relay)
NE	Network Element
NMS	Network Management System
NO	Normally Open contact, make contact (alarm relay)
NTP	Network Time Protocol (clock synchronization of the iSWT resp. PowerLink via internet in case of SNMP)
NU	Non-Urgent alarm, pre-alarm
O	
OFDM	Orthogonal Frequency Division Multiplexing
OID	Object Identifier
OSA	Optimized Sub channel Allocation
P	
PAL	Pilot Alarm / Receive level alarm
PCB	Printed Circuit Board
PCP	Priority Code Point
PD	Present Detect
PEP	Peak Envelope Power
PHB	Per-Hop forwarding Behavior
PLC	Power Line Carrier
PLE	PLC line equipment
PLPA	PowerLink Power Amplifier
PLPAStraps	Program for determining the jumper and straps in the PowerLink PLPA part
PoP	Power over Ethernet
PPP	Point to Point Protocol
PPPOE	PPP Over Ethernet
PS	Power supply

Abbreviation	Signification
PSCF2	Power Supply CF2
PSE	Protection Signaling Equipment
PSPA2	Power Supply Power-Amplifier
PU4	Processing Unit SWT 3000 enhanced necessary for integration in PowerLink
PWL	PowerLink
Q	
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
R	
RARP	Reverse Address Resolution Protocol
RADIUS	Remote Authentication of Dial In User Service
RF	Radio Frequency (High Frequency)
RM	Remote Monitoring
ROHC	Robust Header Compression
RSTP	Rapid Spanning Tree Protocol
RTC	Real Time Clock
RTU	Remote Terminal Unit
RX	Receiver
RXALR	Receiver Alarm
RxD	Receive Data signal
S	
S/N, SNR	Signal to Noise Ratio
SMI	Structure of Management Information
SNALR	Signal/Noise Alarm
SNMP	Simple Network Management Protocol
SSTN	Substation
SV	Sampled Values
SWT	Protection voice frequency transmission
T	
TCP	Transmission Control Protocol
TFLT	Transmit Filter Line Termination
ToS	Type of Service
TP	Teleprotection
TPS	Teleprotection Signal (trip frequency)
Tunbl	Duration of the unblocking impulse of the (i)SWT 3000
TXALR	Transmitter Alarm
U	
UDP	User Datagram Protocol
UNBL	Unblocking
Usync	Clock synchronization for DMB resp. integrated SWT 3000
V	
VF	Voice Frequency
VoIP	Voice over IP
W	
WebUI	Web based User Interface
X	

Abbreviation	Signification
4	
4iC	Operation Mode 3a for the iSWT transmission of 4 independent commands