TC EXTENDER 2001 ETH-2S

Ethernet

DSL

Ethernet extender

Data sheet
106914_en_01

1 Description

The Ethernet extender makes broadband Ethernet applications on existing cables possible. The Ethernet extender can be used for in-house 2 and 4-wire cables but not in the public telephone network.

Point-to-point, line or ring structures can be established, with ranges of up to 20 km.

The Ethernet extender can be used in a network with old generation devices (PSI-MODEM-SHDSL/ETH from firmware version 4.xx, Order No. 2313643).

Furthermore, the Ethernet extender can be combined with the Managed Ethernet extenders
(e.g., TC EXTENDER 6004 ETH-2S, Order No. 2702255).
This enables the central diagnosis of all users and lines via IP.

Features

– Distances up to 20 km
– Automatic SHDSL data rate detection
– Network transparent (no IP configuration required)
– Protocol transparent
– Future proof (IPv4 and IPv6-compatible)
– Automatic detection of network cable type (auto MDI(X))
– Automatic network data rate detection (10/100 Mbps)
– Easy startup, plug and play
– Robust modulation method (SHDSL)
– Two alarm and signal outputs

| **i** | Make sure you always use the latest documentation. It can be downloaded from the product at phoenixcontact.net/products. |

PHŒNIX CONTACT

INSPIRING INNOVATIONS

2   Table of contents

3 Ordering data

Description	Type	Order No.	Pcs./Pkt.
Second generation: Unmanaged Ethernet extender for point-to-point connections, line and ring structures, data rates up to 30 Mbps, distances of up to 20 km on in-house copper cables, diagnostics via USB and LEDs, 2 SHDSL ports, 1 LAN port	TC EXTENDER 2001 ETH-2S	2702409	1

Accessories	Type	Order No.	Pcs./Pkt.
Primary-switched MINI POWER supply for DIN rail mounting, input: 1-phase, output: 24 V DC/1.5 A	MINI-SYS-PS-100-240AC/24DC/1.5	2866983	1
DIN rail connector for DIN rail mounting. Universal for TBUS housing. Gold-plated contacts, 5-pos. Header, Nominal current: 8 A, Number of positions: 5, Pitch: 3.81 mm, Articles with gold-plated contacts, bus connectors for connecting with electronic housings	ME 17,5 TBUS 1,5/ 5-ST-3,81 GN	2709561	10
Attachment plug with surge protection for two SHDSL telecommunications interfaces (ports). Connection: RJ45 (RJ12/RJ11) and plug-in screw terminal block (COMBICON). Alternatively, can be snapped onto a DIN rail.	DT-TELE-SHDSL	2801593	1
USB 2.0 cable, USB A male plug to mini-USB B male plug, length: 1 m	PSI-CA-USB A/MINI B/1METER	2313575	1
USB connecting cable: USB plug type A to USB plug type Mini-B; length: 3 m	CABLE-USB/MINI-USB-3,0M	2986135	1
Security element for FL patch cable	FL PATCH SAFE CLIP	2891246	20
Patch cable, CAT5, assembled, 0.5 m	FL CAT5 PATCH 0,5	2832263	10
Patch cable, CAT5, assembled, 5.0 m	FL CAT5 PATCH 5,0	2832580	10
CAT5-SF/UTP cable (J-02YS(ST)C HP 2 x 2 x 24 AWG), heavy-duty installation cable, 2 x 2 x 0.22 mm², solid conductor, shielded, outer sheath: 7.8 mm diameter, inner sheath: 5.75 mm ± 0.15 mm diameter, preassembled on both sides with RJ45 plug, crossover or line	FL CAT5 HEAVY CONF/	2744827	1

4 Technical data

Supply	
Connection method	COMBICON plug-in screw terminal block
Supply voltage range	18 V DC ... 30 V DC
Nominal supply voltage	24 V DC ±5 % (as an alternative or redundant, via backplane bus contact and system current supply)
Typical current consumption	< 180 mA (24 V DC)
Electrical isolation	DIN EN 50178 (VCC // Ethernet // DSL (A) // DSL (B) // FE)
Test voltage data interface/power supply	1.5 kV$_{rms}$ (50 Hz, 1 min.)
Torque	0.56 Nm ... 0.79 Nm

> ℹ Internal device protection: varistor (voltage limiting), series diode (protection against polarity reversal)

Ethernet interface, 10/100BASE-T(X) in acc. with IEEE 802.3u	
Connection method	RJ45 socket, shielded 1 port 10/100Base-T(X), auto negotiation
Conductor cross section	0.2 mm² ... 2.5 mm² (24 AWG ... 13 AWG)
Serial transmission speed	10/100 Mbps, auto negotiation
Transmission length	< 5 m (shielded twisted pair)
Protocols supported	Protocol-transparent for TCP/IP, IPv4, and IPv6

SHDSL interface according to ITU-T G.991.2.bis

Connection method	2 x 2-pos. COMBICON plug-in screw terminal blocks
Serial transmission speed	4-wire operation: 64 kbps ... 30 Mbps 2-wire operation: 32 kbps ... 15.3 Mbps
Transmission length	< 20 km (Depending on data rate and cable cross section)

USB 2.0

Connection method	Mini-USB type B, 5-pos.
Transmission length	< 5 m (shielded twisted pair)

Digital output

Connection method	2 x 2-pos. COMBICON connector
Number of outputs	2
Voltage output signal	depending on the operating voltage
Current output signal	≤ 150 mA (Short-circuit-proof)

> ⓘ The digital switching outputs must be connected to a load between 220 Ω and 100 kΩ.
>
> In the event of supply by means of DIN rail connectors, the digital switching outputs cannot be used. The function is selected by means of the configuration software.

General data

Management	Plug and play, user-friendly software: Diagnostic functions, log book, individual configuration
Status and diagnostic indicators	LEDs: US (supply voltage), ACT/LINK (Ethernet data traffic), ERR (errors) 2x LINK / 2x STAT (DSL data traffic port A and port B), DIAG (diagnostic messages)
Degree of protection	IP20
Dimensions (W/H/D)	35 mm x 99 mm x 114.5 mm
Housing material	PA 6.6-FR gray
Vibration resistance in acc. with EN 60068-2-6/IEC 60068-2-6	5g, 10-150 Hz, 2.5 h, in XYZ direction
Shock in acc. with EN 60068-2-27/IEC 60068-2-27	15g
MTTF (mean time to failure) SN 29500 standard, temperature 25°C, operating cycle 21 % (5 days a week, 8 hours a day)	711 Years
MTTF (mean time to failure) SN 29500 standard, temperature 40 °C, operating cycle 34.25 % (5 days a week, 12 hours a day)	308 Years
MTTF (mean time to failure) SN 29500 standard, temperature 40°C, operating cycle 100 % (7 days a week, 24 hours a day)	125 Years

Ambient conditions

Ambient temperature (operation)	-20 °C ... 60 °C (Freestanding (40 mm spacing to the right and left), no supply of other modules via the device)
	-20 °C ... 55 °C (Mounted in rows with zero spacing and low power dissipation of aligned modules)
	-20 °C ... 50 °C (Mounted in rows with zero spacing)
Ambient temperature (storage/transport)	-40 °C ... 85 °C
Permissible humidity (operation)	10 % ... 95 % (non-condensing)
Permissible humidity (storage/transport)	10 % ... 95 % (non-condensing)
Altitude	5000 m (For restrictions see manufacturer's declaration)

Approvals / Certificates

Conformance	CE-compliant
Standards/regulations	EN 50121-4

Conformance with EMC Directive 2014/30/EU

Noise immunity according to EN 61000-6-2

Electrostatic discharge	EN 61000-4-2	
	Contact discharge	± 6 kV
	Discharge in air	± 8 kV
	Indirect discharge	± 6 kV
	Comments	Criterion B
Electromagnetic HF field	EN 61000-4-3	
	Frequency range	26 MHz ... 3 GHz
	Field intensity	10 V/m
	Comments	Criterion A
Fast transients (burst)	EN 61000-4-4	
	Input	± 2 kV (Unshielded supply line)
	Signal	± 2 kV (Shielded signal line)
	Comments	Criterion B
Surge current loads (surge)	EN 61000-4-5	
	Input	± 0.5 kV (Symmetrical, unshielded supply line) ± 1 kV (Asymmetrical, unshielded supply line)
	Output	± 1 kV (asymmetrical, unshielded)
	Signal	± 1 kV (asymmetrical, shielded Ethernet cable) ± 4 kV (asymmetrical: line to ground, unshielded SHDSL cable) ± 2 kV (symmetrical: line to line, unshielded SHDSL cable)
	Comments	Criterion B
Conducted interference	EN 61000-4-6	
	Frequency range	0.15 MHz ... 80 MHz
	Voltage	10 V
	Comments	Criterion A

Emitted interference in acc. with EN 61000-6-4

Noise emission	EN 55011 Class A, industrial applications

Criterion A	Normal operating behavior within the specified limits
Criterion B	Temporary impairment of operating behavior that is corrected by the device itself

5 Safety regulations and installation notes

⚠ **CAUTION:**
Observe the following safety notes when using the device.

- Installation, operation, and maintenance may only be carried out by qualified electricians. Follow the installation instructions as described. When installing and operating the device, the applicable regulations and safety directives (including national safety directives), as well as generally approved technical regulations, must be observed. The safety data is provided in the package slip and on the certificates (conformity assessment, additional approvals where applicable).

- The device must not be opened or modified. Do not repair the device yourself, replace it with an equivalent device. Repairs may only be carried out by the manufacturer. The manufacturer is not liable for damage resulting from violation.

- The IP20 protection (IEC 60529/EN 60529) of the device is intended for use in a clean and dry environment. The device must not be subject to mechanical strain and/or thermal loads, which exceed the limits described.

- The device is designed exclusively for SELV operation according to IEC 60950/EN 60950/VDE 0805. The device may only be connected to devices, which meet the requirements of EN 60950.

6   Installation

![ESD warning symbol]

NOTE: electrostatic discharge!

The device contains components that can be damaged or destroyed by electrostatic discharge. When handling the device, observe the necessary safety precautions against electrostatic discharge (ESD) according to EN 61340-5-1 and IEC 61340-5-1.
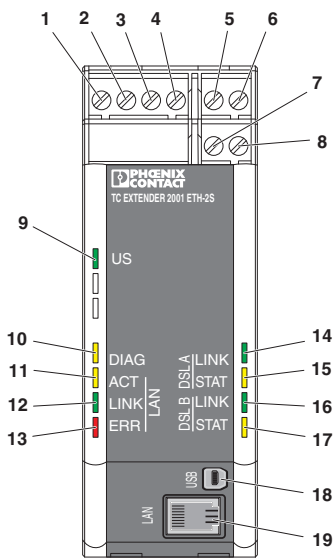
6.1   Structure

Figure 1   Structure

Plug-in screw terminal blocks

1 / 2 Supply voltage

3 / 4 Digital switching outputs

5 - 8 DSL connections: port A (wire pair 1) / port B (wire pair 2)

Interfaces

18 Mini-USB, type B (5-pos.): USB interface for configuration/diagnostics

19 RJ45, Ethernet interface (TP port)

Status and diagnostics indicators

9	US	Supply voltage
	ON	Supply voltage OK
	Flashing (1 Hz)	Supply via USB (only for configuration)
	Flashing (2 Hz)	Error during boot process (ERR also flashes)
10	DIAG (yellow)	Diagnostics
	OFF	No serious errors
	Flashing (1 Hz)	(Duration: 20 s after boot process) device is set to factory configuration
	Flashing (2 Hz)	Remote access from another extender (data transmission during remote configuration, remote diagnostics, firmware update)
	ON	Serious error - reading of diagnostic data is recommended
11	ACT (yellow)	ETH - Ethernet interface
	ON	Data traffic
12	LINK (green)	ETH - Ethernet interface
	ON	Connection established
13	ERR (red)	Error
	Flashing (2 Hz)	Error during boot process (US also flashes)
	ON	Telegram error/installation error

14 LINK DSL A / **16** LINK DSL B (green)

OFF	DSL port not active
Off (pulsating)	(Flashing every 3 s) DSL port is searching for link device
Flashing (1 Hz)	Link partner found
Flashing (2 Hz)	Initializing connection
Flashing (4 Hz)	ERR ON / STAT DSL OFF = Installation error: e.g., line structure configured, but 4-wire point-to-point connection implemented
ON	Connection established

15 STAT DSL A / **17** STAT DSL B (yellow)

OFF	No connection established
Off (pulsating)	(Flashing every 3 s) link quality adequate
On (pulsating)	(Goes out every 3 s) link quality good
ON	Link quality very good

6.2 Mounting and removing

NOTE: device damage

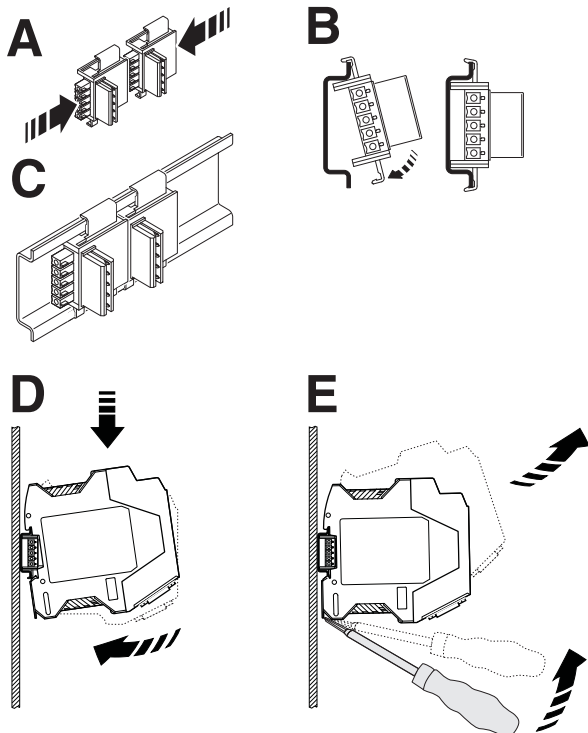**Only mount and remove devices when the power supply is disconnected.**

Figure 2   Mounting and removing

- Use a grounding terminal block to connect a 35 mm EN DIN rail to a protective earth ground. The module is grounded by snapping it onto the DIN rail.

Mounting as a stand-alone device

- Place the device onto the DIN rail from above. Push the module from the front toward the mounting surface until it audibly engages.

Combined assembly

- For one connection station, plug the DIN rail connectors together (order no. 2709561, 2 per device).
- Push the connected DIN rail connectors into the DIN rail.
- Place the device onto the DIN rail from above. Ensure the device and DIN rail connector are aligned correctly.
- Push the front of the device toward the mounting surface until it audibly snaps into place.

Removing

- Push down the locking tab with a screwdriver, needle-nose pliers or similar.
- Pull the device away from the DIN rail.

When you dismantle a connection station, also remove the DIN connectors.
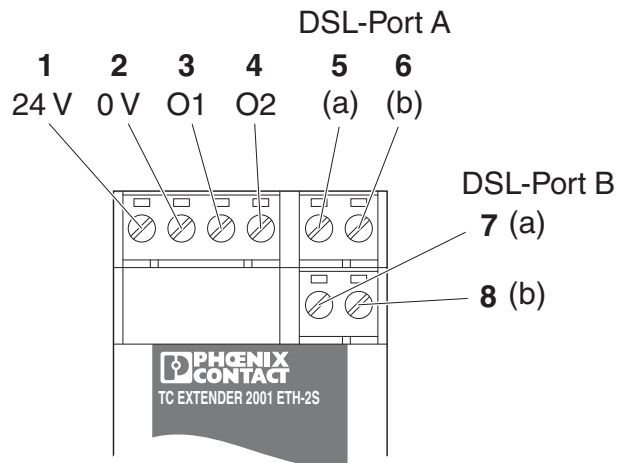
6.3 Power Supply Voltage

Figure 3   Power supply

- Supply voltage to the device via terminal blocks **1** (24 V) and **2** (0 V).

As an alternative, the supply voltage can be provided via the DIN rail connectors (Order No. 2709561) and the system power supply (Order No. 2866983, MINI-SYS-PS-100-240AC/24DC/1.5).

NOTE: device damage

The maximum current load in a connection station must not exceed 2 A.

A connection station must not consist of more than ten devices.

Railway applications according to EN 50121-4 outside the 3 m range: Use QUINT POWER power supply units from Phoenix Contact directly on the device. Supply the supply voltage to the module via terminal blocks **1** (24 V) and **2** (0 V).

6.4 DSL connections

The devices connect automatically. The devices only have to be configured if diagnosis via IP address is required.

- In the case of star-quad twisted cables, use the single wires 1a/1b or 2a/2b on the opposite side to avoid crosstalk.
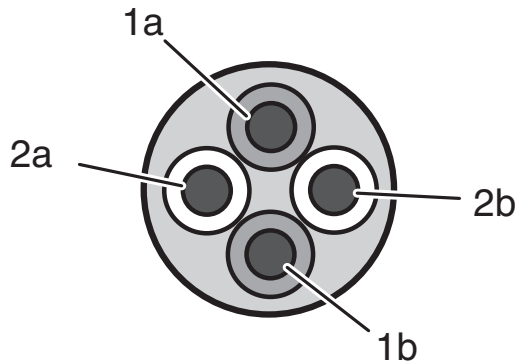

Figure 4   Star quad

- **2-wire connection:** Connect DSL port A at device 1 (client) to DSL port B at device 2 (server). The polarity of the connections is not important: (a)-(a)/(b)-(b) or (a)-(b)/(b)-(a). Establishing the DSL connection automatically can take up to one minute.
- **4-wire connection:** Connect two devices crosswise: DSL port A (device 1) - DSL port B (device 2) and DSL port B (device 1) - DSL port A (device 2). Automatic 4-wire detection needs up to two minutes for establishing the connection. Wait until the green LINK DSL LEDs remain illuminated.
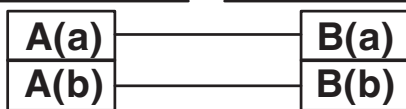
Figure 5   DSL connection

6.5 Ethernet interface (TP port)

The Ethernet extender is provided with an Ethernet interface on the front side.

> **(!) NOTE: Malfunction**
>
> Only use shielded twisted pair cables with an impedance of 100 Ω, e.g., patch cable FL CAT 5 PATCH 0,5 (Order No. 2832263).

7 Configuration

7.1 USB interface

You can configure the Ethernet extender or read diagnostic information via the USB interface. To connect the Ethernet extender to a computer, use the CABLE-USB/MINI-USB-3,0M cable (Order No. 2986135).

When using the supply via USB, you can configure the device without an external power supply.

DSL operation is not possible when power is supplied via USB.

7.2 Immediate startup (Plug and Play)

Observe the default settings. If these apply to your application, software-assisted configuration is not necessary. The Ethernet extender can be immediately started up.

Default settings

Automatic DSL transmission detection is performed between 192 kbps and 5.696 Mbps. The Ethernet interface is adapted to the cable type used (1:1 or crossed) and to the data rate (10 or 100 Mbps).

Default settings of the switching outputs: **O1** = DSL port A / **O2** = DSL port B

24 V	A voltage of 24 V is output
	= good to very good connection
Open	Output is open
	= no or only moderately good connection

7.3 Configuration software

Very low data rates (<192 kbps) or very high data rates (> 5.696 Mbps) as well as the switching output configuration can be manually set via the configuration software.

A PC with a Windows operating system is required for configuration.

> **(i)** You can download the PSI-CONF configuration software free of charge at phoenixcontact.net/products.

8 Range

8.1 DSL technology

In contrast to an analog permanent line modem, DSL (Digital Subscriber Line) uses a greater frequency range, which enables a data rate that is several times higher.

The modulation process is applied to different carrying frequencies for DSL. Modulation is therefore significantly less sensitive to external sources of electromagnetic interference.

SHDSL is a version of this DSL technology. In contrast to other DSL technologies, a greater range can be realized with SHDSL. In addition, the bandwidth for upstream and downstream is equally large (symmetrical data transmission). For this reason, SHDSL is well suited to industrial applications.

SHDSL is standardized in the ITU-T G-991-2. Further technical information can be found there.

Ethernet extenders with SHDSL technology are ideal for retrofitting a system, because the extenders can be used with the system's existing wiring.

8.2 Determining the data rate

A precise prediction of the maximum possible data rate is difficult in practice as many parameters play a role:

– Cable type (design, diameter, capacity, shielding)
– How it is laid (number of transitions, lines laid in parallel)
– EMC influences of neighboring devices on the communication line

For a new installation, we recommend using shielded twisted pair cables.

To gain an initial estimation of the possible data rate, use the following diagram or the SHDSL calculator software. It can be downloaded free of charge at phoenixcontact.net/products.

The actual data rate can only be determined in a practical test. To this end, Phoenix Contact provides test kits with two Ethernet extenders. This enables you to test the paths under realistic conditions.

The maximum possible data rate is dependent on several parameters. Two important parameters are the cable length and cable cross section.
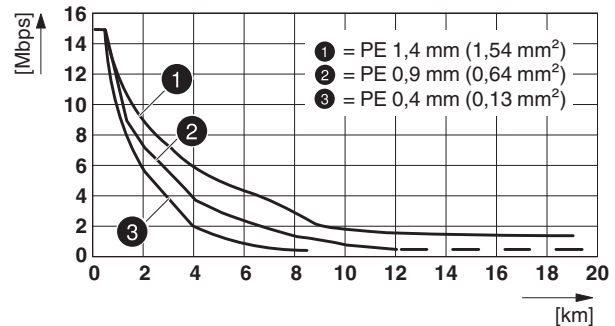

Figure 6   Data rate depending on the distance, 2-wire

The diagram illustrates the dependency of the maximum data rate on the line length with 3 cable types. Longer distances can be achieved using high-quality cables with larger diameters.

The industrial Ethernet extenders support data rates of 32 kbps to 15.3 Mbps in 2-wire operation.

The Ethernet extenders are suitable for in-house cables, not for public telephone networks. Establishing the connection between the devices usually takes around one minute.

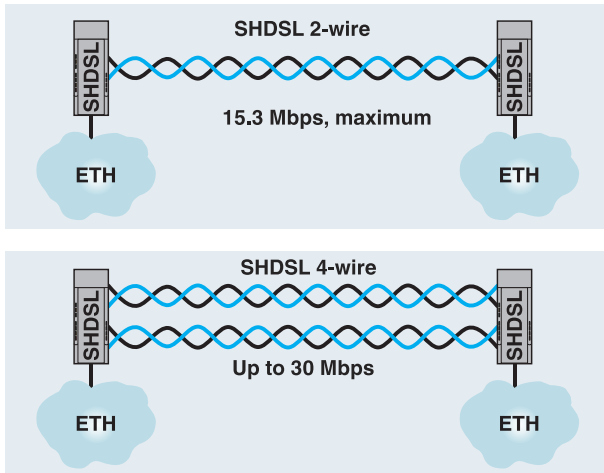# 9 Application examples

9.1 Point-to-point connection

Figure 7   Point-to-point connection

There can be a maximum distance of 20 km between two devices. The Ethernet extender automatically recognizes if the path is constructed on a 2-wire or 4-wire path.

If the devices have detected a 4-wire line, the transmission rate is automatically increased depending on the line quality. It is usually doubled. If one of the connections fails, the data is transmitted via the remaining conductors at single transmission speed. In this way, a reliable redundancy operation is supported.

9.2 Line structure
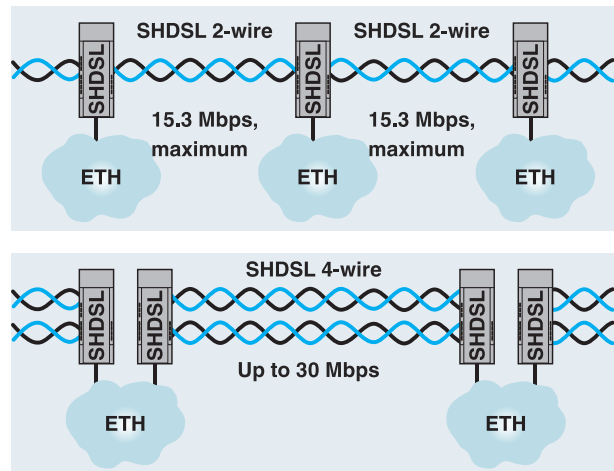
Figure 8   Line structure

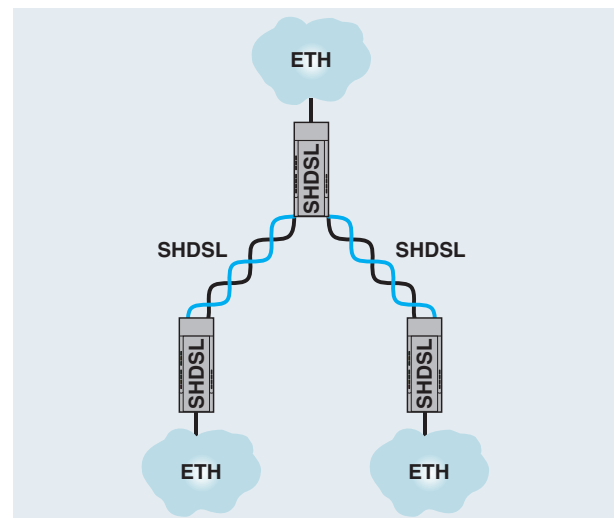There can be a maximum distance of 20 km between two devices.

9.3 Star structure

Figure 9   Star structure

Since each device features two SHDSL ports, you need only three devices.
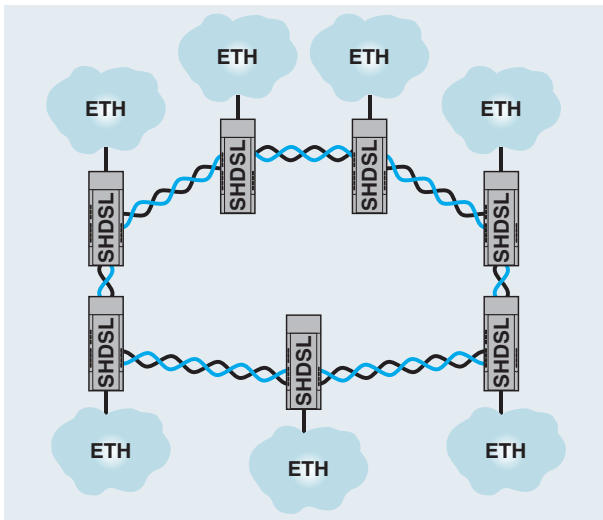
9.4 Ring structure

Figure 10   Redundant ring structure

The overall availability of the system is significantly increased by a redundant ring.

There can be a maximum distance of 20 km between two devices. You can integrate up to 50 devices in a ring.

If there is a ring interruption, Ethernet communication is possible again after the following response time:
$t_{Recovery}$ = 600 ms + number of devices x 100 ms

The paths of the SHDSL ring should show a very high connection quality during normal operation. If that is not the case, the reaction time can deviate from the value calculated above.

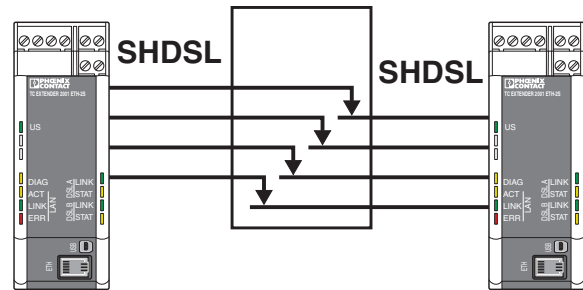## 9.5 Redundant data communication in rotating applications

Figure 11   Slip ring communication

The Ethernet extenders are connected via a 4-wire line. The connection is therefore redundantly established.

Using the two digital outputs on the Ethernet extender, you can monitor the slip ring communication.

Special application: redundant data communication in wind turbine generators
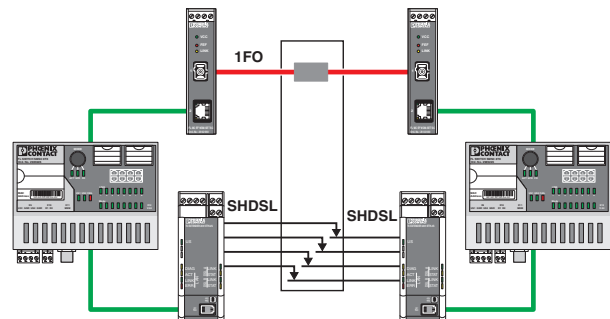

Figure 12   Redundant slip ring communication

In this example, a redundant network ensures data communication between the hub and the nacelle. Independent transmission paths are used for data communication.

With the use of fiber optic technology, standard Ethernet data transmission is based on two WDM media converters (e.g., FL MC EF WDM-SET SC, 2902660). For fiber optic transmission, an optical rotary transformer with a single fiber is used. The rotary transformer is integrated in the axis of the existing copper slip ring.

The redundant path is constructed with the aid of Ethernet extenders. The available copper slip ring is used for the SHDSL connection.

The redundancy management is guaranteed by means of managed switches. Phoenix Contact provides various RSTP-capable switches, e.g., FL SWITCH LM 8TX, 2832632 or FL SWITCH SMCS 8TX, 2989226.