SIEMENS

Information

ULAF+ V4.2

Technical Description

A3118-X300-M100-2-7618

Important Notice on Product Safety

Elevated voltages are inevitably present at specific points in this electrical equipment. Some of the parts can also have elevated operating temperatures.

Non-observance of these conditions and the safety instructions can result in personal injury or in property damage.

Therefore only trained and qualified personnel may install and maintain the system.

The system complies with the standard EN 60950. All equipment connected has to comply with the applicable safety standards.

Copyright (C) Siemens Switzerland Ltd 2008

Issued by Engineering and Innovative Products
Albisriederstrasse 245
CH-8047 Zürich

Technical modifications possible.
Technical specifications and features are binding only insofar as
they are specifically and expressly agreed upon in a written contract.

Issues

Change indications:

N = new; G = modified; 0 = deleted;

Title	Issue	Page(s)	
Administration Section (AD)	2	AD - 1 . . . . AD - 10	G
Chapter 1	2	1 - 1 . . . . . .1 - 44	G
Chapter 2	2	2 - 1 . . . . . .2 - 70	G
Chapter 3	2	3 - 1 . . . . . .3 - 4	G
Chapter 4	2	4 - 1 . . . . . .4 - 10	G
Appendix (AP)	2	AP - 1 . . . . AP - 6	G

This document consists of a total of 144 pages.

Contents

1 Introduction

This Chapter provides an overview of the ULAF+ system and the available customer documentation, with explanations of the structure and use of this documentation.

1.1 Documentation overview

The ULAF+ customer documentation comprises the following manuals:

- **Technical Description (TED)**
  The Technical Description for ULAF+ provides an overview of the composition and function of the system, together with all its components. The descriptions of the subsystems contain detailed information about the individual submodules and the complete product overview, together with comprehensive technical data relating to the system.
- **Installation Manual (IMN)**
  The Installation Manual contains the assembly instructions for the individual system components or submodules. The IMN contains tables and illustrations with the contact PIN assignments for the connectors, the settings for the address switches and operating elements, together with the module-specific alarm tables.
- **User Manual (UMN)**
  The User Manual describes all the procedures for the LCT which are required for operation and administration of a fully functioning system. If malfunctions occur, the Manual contains instructions showing how to restore the system to its normal operating condition.

The ULAF+ documentation is supplemented by the manuals for the AccessIntegrator management system (NMS):

- **Installation Manual (IMN)**
  The Installation Manual is intended for anyone involved in the installation and configuration of the AccessIntegrator. It describes the procedures for installation of a new version of the AccessIntegrator software.
- **Installation and System Administration Manual (ADMN)**
  The Administration Manual is intended to be used by anyone who configures the AccessIntegrator for other users. It describes the tasks which must be performed in order to guarantee trouble-free and reliable management of the network elements using the AccessIntegrator.
- **User Manual (UMN)**
  Intended for use by anyone who uses AccessIntegrators to monitor and maintain network elements.

1.2 Target group and structure of this document

The Technical Description is intended for use by technicians, installation engineers and network specialists who are interested in gaining an overview of the benefits, system requirements and possible applications for the ULAF+.

The topics covered in the Chapters following this Introduction include:

- Introduction and System components of ULAF+ (Chapter 1)
- Function of the system components (Chapter 2)
- Operation and monitoring (Chapter 3)
- Technical Data (Chapter 4)
- References (Chapter 5)
- Abbreviations (Chapter 6)
- Index (Chapter 7)

1.3 Application Scenarios

1.3.1 High Speed Business Class Access Services

ULAF+ is a modular system to provide Business Class Ethernet, 2 Mbps and nx64 kbps services in the access network. The transmission between central office equipment and subscriber modem is based on ETSI and ITU compliant SHDSL technology. Supporting SHDSL.bis standard transmission rates up to 5'696 kbps per copper wire-pair are possible.

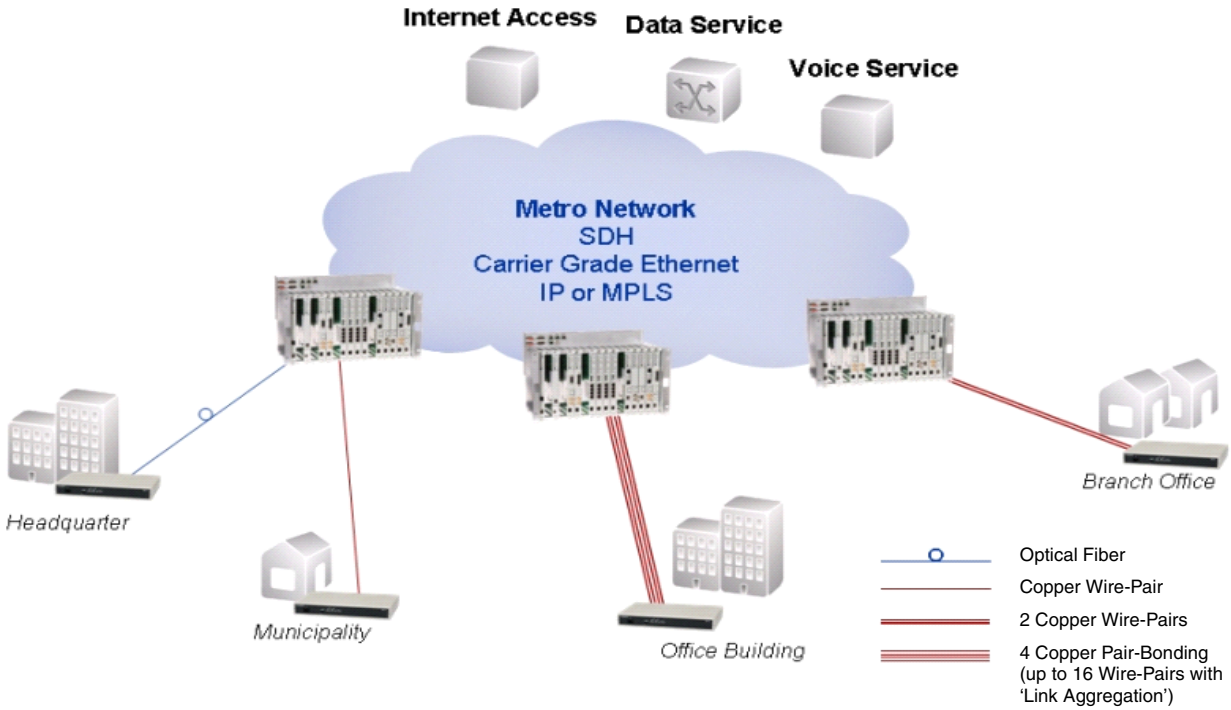


Fig. 1.1 Application scenarios for business class access services

1.3.2 Backhauling

ULAF+ is also suitable for mobile backhauling applications.

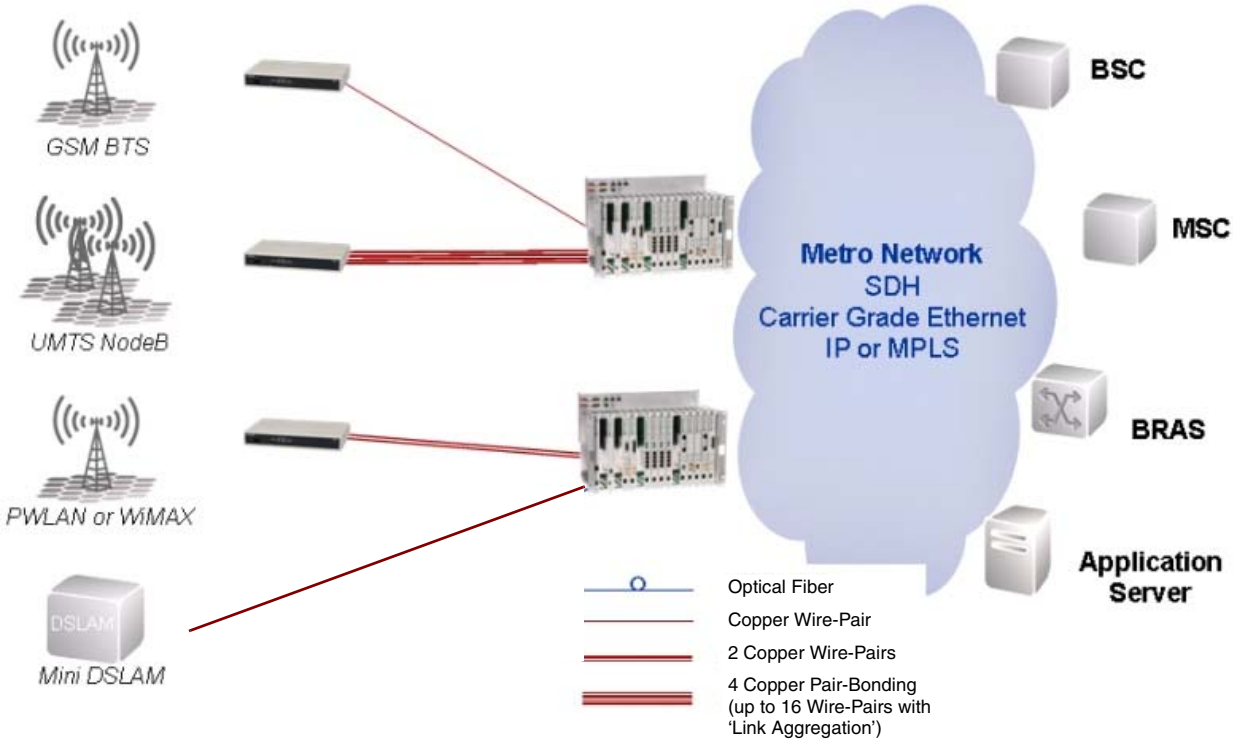


Fig. 1.2 Application scenarios for mobile backhauling

1.3.3 Campus Application

ULAF+ can be used to connect two sites.

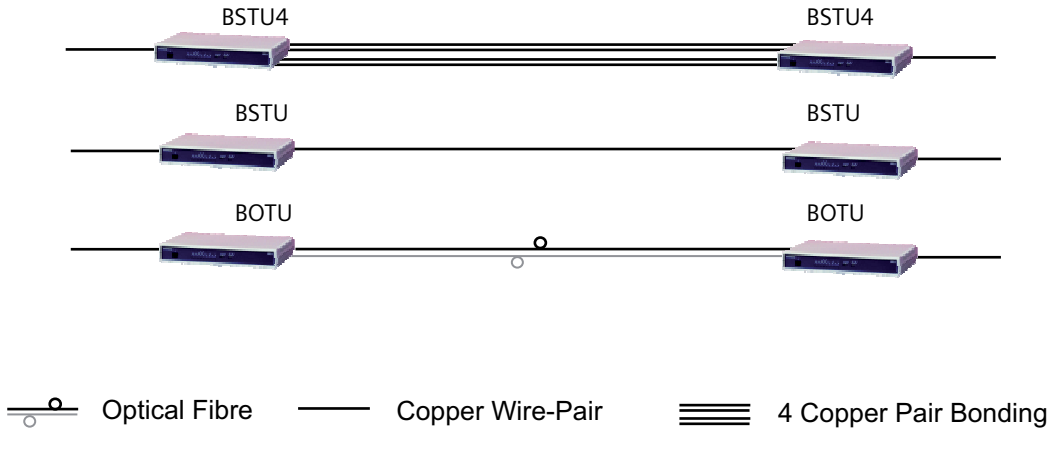


Fig. 1.3 Campus Application

1.4 System components of ULAF+

In detail, the system consists of the following components:

- the subrack
- the Operating & Maintenance Interface unit OMI SNMP
- the SHDSL transmission units BSTU, QSTU, BSTU4
- the Ethernet over TDM Inverse Multiplexer GTU4
- the BOTU and QOTU transmission units for optical transmission
- the G.703 GTU transmission unit (interface converter)
- the SHDSL regenerators BSRU
- a series of plug-in modules (subscriber interfaces for example) for individual configuration of the system.

For local operation and maintenance of ULAF+, the system can be controlled from a Local Craft Terminal (LCT) which is connected to the OMI SNMP or to the desktop units. The AccessIntegrator management software is used for centralized operation and maintenance and this is also connected to the OMI SNMP or to the desktop units.

1.5 Access configurations

The following options are available to the user:

- Ethernet connections up to 22,8 Mbit/s via SHDSL
- Ethernet connections up to 100 Mbit/s via optical transmission
- Ethernet Inverse Multiplexing over E1 connections
- Add/Top 2 Mbit/s and Data
- ‘Add/Drop’ (mixed mode nx64 kbit/s or Ethernet with 2 Mbit/s)
- nx64 kbit/s data connections
- Connecting data equipment (X.21, V.35, V.36)
- Access to local ISDN exchanges via the subscriber access network for subscribers with ISDN Primary Rate Access lines conforming to ITU-T G.704 [8], ITU-T I.431 [14] and ETSI ETS 300 233 [21]
- Configuring frame structured transmission with 2 Mbit/s interfaces conforming to ITU-T G.703 [7] and ITU-T G.704 [8]
- Configuring bit-transparent transmission with 2 Mbit/s interfaces conforming to ITU-T G.703 [7]

1.6 SHDSL line equipment

Transmission is via 1 – 4 copper wire pair as defined in ETS 101 524 [24] and ITU-T G.991.2 [13]. The SHDSL transmission units supports symmetrical PSD Masks (Power Spectrum Density) with TC-PAM 16 and TC-PAM 32 Modulation (Trellis Coded Pulse Amplitude Modulation).

The extension of the standard ETSI TS 101 524, Annex E, enables significantly higher transmission rates on the SHDSL interface:

- TC-PAM 16 (192 kbit/s – 3840 kbit/s) or
- TC-PAM 32 (768 kbit/s – 5696 kbit/s).

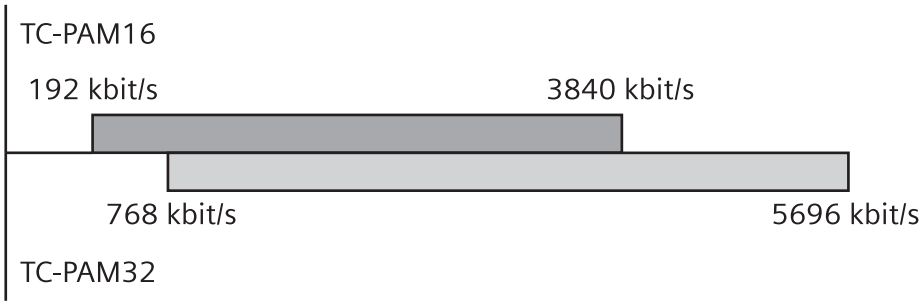


Fig. 1.4 Bitrate range TC-PAM 16 / TC-PAM 32

Transmission range

It is not possible to specify a generally-valid value for the usable range of SHDSL systems, because various cable characteristics, the environmental conditions and the modulation type (TC-PAM 16 / TC-PAM 32) have a critical influence on the transmission range. To enable comparable results to be obtained, the SHDSL transmission modules have been measured by means of a line simulator, on standardized lines with standardized noise interference. However, the usable ranges which are possible in practice can differ greatly from the values determined in this way.

The maximum reachable distances are affected by

- the cable parameters (R', C', L', G')
- the payload bitrate of each wire pair
- type and level of the surrounding noise
- the level of the transmitted signal (adjustable by the PBO (Power Back-Off))
- type of modulation (TC-PAM 16 / TC-PAM 32)

Cable parameters

The cable parameters are defined, in a first approach, by the diameter of the copper wire and the insulation material used in the cable. Also the space between the conductors and the wire twisting have a strong impact on the cable characteristics. The parameters R', C', L' G' are dependent on the frequency and temperature. Considering the parameters, one can estimate the attenuation as a function of the frequency.

The cable parameters for the standardized cables (as simulated in the cable simulator) are defined in ITU-T G.991.2 [13] and ETSI ETS 101 524 [24]. In practice, those values can be investigated on the real cable with the use of special cable tester.

Payload bitrate

The payload bitrate per wire pair depends on the termination unit used. The payload bitrate of each wire pair can be adjusted from 192 kbit/s to 5696 kbit/s in 64 kbit/s steps, according to the application requirements.

As a course value for orientation, one can assume that the maximum transmission distance varies inversely with the square root of the payload bitrate variation.

Example: Lowering the payload bitrate from 2048 kbit/s to 512 kbit/s (4:1) will approximately double the transmission distance (square root of 4).

Noise level and type

The interference signals that have an influence on the SHDSL signal come from many different sources. Alongside with far and near end cross talk (FEXT, NEXT) originated by other signals in the same cable (e.g. POTS, ISDN, HDSL, ADSL, ADSL2, VDSL, VDSL2, etc. or further SHDSL systems), impulsive noise is frequently present. In order to produce (under laboratory conditions) values comparable to those ones in real conditions, various noise models have been defined in G.991.2 [13] and ETSI ETS 101 524 [24]; these models reproduce the situations that are possible in practice. For the measurements in table 1.1, the noise «Type B» as defined G.991.2 [13] and ETSI ETS 101 524 [24] have been used.

"Type B" noises correspond with a mean value of various interference effects (e.g. several wire pairs) in a standard cable, in order to receive the most practical test results.

The measurements were carried out with 0 dB «Type B» noise and with another noise which was increased by 6 dB in comparison with the «Type B» reference noise, and this represents heavily disturbed surroundings.

Transmission level

The maximum transmission level is defined in G.991.2 and ETSI 101 524 [24] and amounts

with TC-PAM 16	13,5 dBm for	< 2048 kbit/s payload bitrates
	14,5 dBm for	≥ 2048 kbit/s – 3848 kbit/s payload bitrates
with TC-PAM 32	13,5 dBm for	≥ 768 kbit/s – 2688 kbit/s payload bitrates
	14,5 dBm for	≥ 2688 kbit/s – 5696 kbit/s payload bitrates

The values correspond with the nominal transmission level with the configuration PBO = 0 dB. For long cables, this default value should be maintained. For shorter cables, the transmission level can be reduced through the PBO according to the application requirements, in order to diminish the crosstalk noise on the other copper pairs.

i

In accordance with the standards G.991.2 [13] and ETSI 101 524 [24], the transmission level must be reduced at line loss ≤ 6 dB (or ≤ 10 dB at TC-PAM 16 and ≤ 8 dB at TC-PAM 32 with ETSI Annex E / ITU-T Annex G). This setting is automatically made in the 'Default PBO' setting (in the LCT). The user must ensure this by manual configuration.

Wire diameter/ Capacity	Noise	Payload Bitrate of each wire pair (TC-PAM 16)									
		192 kbit/s	384 kbit/s	512 kbit/s	768 kbit/s	1024 kbit/s	1536 kbit/s	2048 kbit/s	2304 kbit/s	3072 kbit/s	3840 kbit/s
0,4 mm	Without noise	7800	6900	6500	6200	5700	5600	5200	5100	4500	4000
	with ETSI noise “Typ B”, level = 0 dB	6600[1)]	5200	4800	4200	3700	3100	2700	2500	2000	1900
	with ETSI noise “Typ B”, level = 6 dB	6000[1)]	4600	4100	3400	3100	2500	2200	2000	1550	1450
0,8 mm	Without noise	>15500[2)]	>15500[2)]	>15500[2)]	>15500[2)]	>15500[2)]	15500	14800	14800	11600	10300
	with ETSI noise “Typ B”, level = 0 dB	> 15500[1)2)]	> 15500[2)]	15100	13300	11800	9300	7850	7250	5550	4650
	with ETSI noise “Typ B”, level = 6 dB	> 15500[1)2)]	14400	12900	11400	10000	7700	6200	5700	4100	3400

1) Noise: FSAN BC 384 kbit/s

2) Max. length of the line simulator

Tab. 1.1 SHDSL transmission range for QSTU (FW-ID 633/649), BSTU, BSTU4, BSRU with TC-PAM16 (ETSI Annex E [22] and ITU-T Annex G) links

Wire diameter/ Capacity	Noise	Payload Bitrate of each wire pair (TC-PAM 32)									
		768 kbit/s	1024 kbit/s	1536 kbit/s	2048 kbit/s	2304 kbit/s	3072 kbit/s	3804 kbit/s	4096 kbit/s	5120 kbit/s	5696 kbit/s
0,4 mm	Without noise	5600	5500	5100	5000	4800	4300	3900	3900	3500	3200
	with ETSI noise “Typ B”, level = 0 dB	3800	3500	2900	2500	2300	1800	1600	1450	1200	1100
	with ETSI noise “Typ B”, level = 6 dB	3200	2800	2300	1800	1700	1350	1200	1000	800	600
0,8 mm	Without noise	15500[2)]	15500[2)]	15500[2)]	14800	14000	12000	10800	10200	8900	6900
	with ETSI noise “Typ B”, level = 0 dB	11500	10900	9000	7500	6800	5400	4200	4100	3200	2900
	with ETSI noise “Typ B”, level = 6 dB	10000	8900	7100	5700	5000	3700	2900	2700	1900	1700

2) Max. length of the line simulator

Tab. 1.2 SHDSL transmission range for QSTU (FW-ID 633/649), BSTU, BSTU4, BSRU with TC-PAM32 (ETSI Annex E [22] and ITU-T Annex G) links

1.7 Optical line equipment BOTU/QOTU

The data is transferred optically, full duplex with a nominal bit rate of 155 Mbit/s. Depending on the SFP module used in the device, transfer is either over one optical fiber with two different optical frequencies or over two optical fibers. In addition, the maximum transfer range and the connection technology are also defined by the SPF module used.

The transfer can be protected against failure by using a second optical transfer path and 1+1 line protection.

1.7.1 SFP Modules

The optical transfer device has two/four SFP slots, whereby 155 Mbit/s SFP modules must be used. These are available in different variants from several manufacturers and differ in the following points:

- Range: 15 – 125 km
- Output power and receive sensitivity
- Wavelengths: 1310 nm or 1550 nm
- Transmission over one optical fiber with two optical wavelengths or over two optical fibers
- ‘Monomode’ or ‘multimode fiber’
- Different optical connections

1.7.2 Frame structure

The user data is transferred in a frame structure. The frame is scrambled for the transfer and protected via a CRC32 checksum. The frame transfer takes 125 microseconds.

The following information is transferred in a frame:

- Synchronization information
- 100 Mbit/s for Ethernet transmission
- 4x 2Mbit/s for E1 transmission
- 4.6 Mbit/s for data modules (X.21, V.35, V.36, ABAR)
- EOC for management information
- Checksums

1.7.3 1+1 Line Protection

The optical transmission can optionally be protected via 1+1 line protection. To do this, the data is transferred simultaneously over two optical transfer interfaces and the receiver uses the receive quality to decide which of the two receive lines the data is taken from. If an LOS, LFA or BER3 alarm is pending on the optical transfer line that is currently being used, the system switches immediately to the other optical line, but only if this line is free of alarms.

If the receive quality is the same on both optical transmission lines, one of them can be given priority. The prioritized optical transfer line is used as soon as it has been error-free (LOS, LFA or BER3) for 30 seconds.

1.8 G.703 transmission Unit (GTU)

The G.703 transmission unit GTU is used for the following applications:

- Interface converter (Chapter 1.8.1)
- NT1-Z function for transparent 2 Mbit/s links (Chapter 1.8.2)
- Inband management for AccessIntegrator (Chapter 1.8.4)

1.8.1 Interface converter

The GTU is used to connect terminals operating at nx64 kbit/s or Ethernet interfaces to transmission equipment with G.703 interfaces. In this application the data is packed by the GTU into a G.704 frame.

It is also possible to operate the unit in Add/Drop mode. In this situation equipment with fractional E1 and nx64 kbit/s or Ethernet interfaces can be connected at the same time to the terminal side. The data of the nx64 kbit/s interface is inserted into the unoccupied time slots of the fractional E1 signal in such cases.

Fig. 1.5 shows a typical application of the GTU as an interface converter.

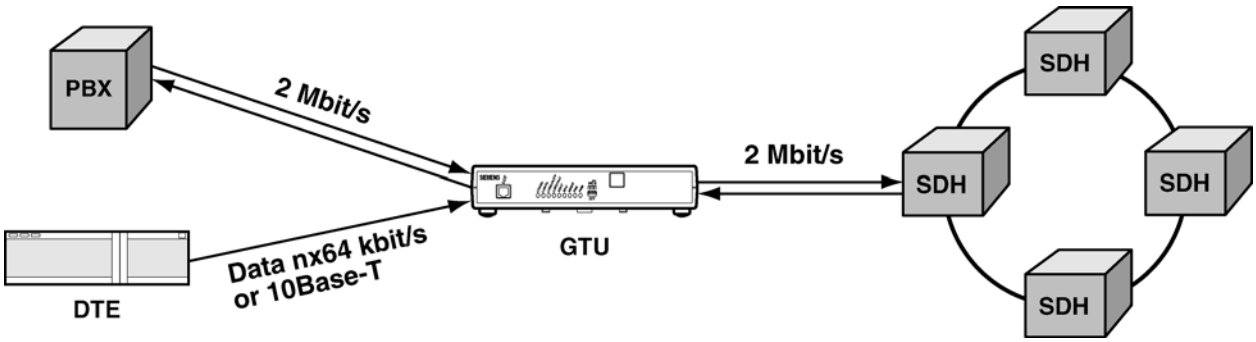


Fig. 1.5 Interface converter application

1.8.2 NT1-Z function for transparent 2 Mbit/s links

The GTU can also be used as an ISDN PRA termination (ETSI ETS 300 233 [21]) for transparent 2 Mbit/s links. It completely replaces the function of the NT1-Z module.

Fig. 1.6 shows a typical application of the GTU as an interface converter.

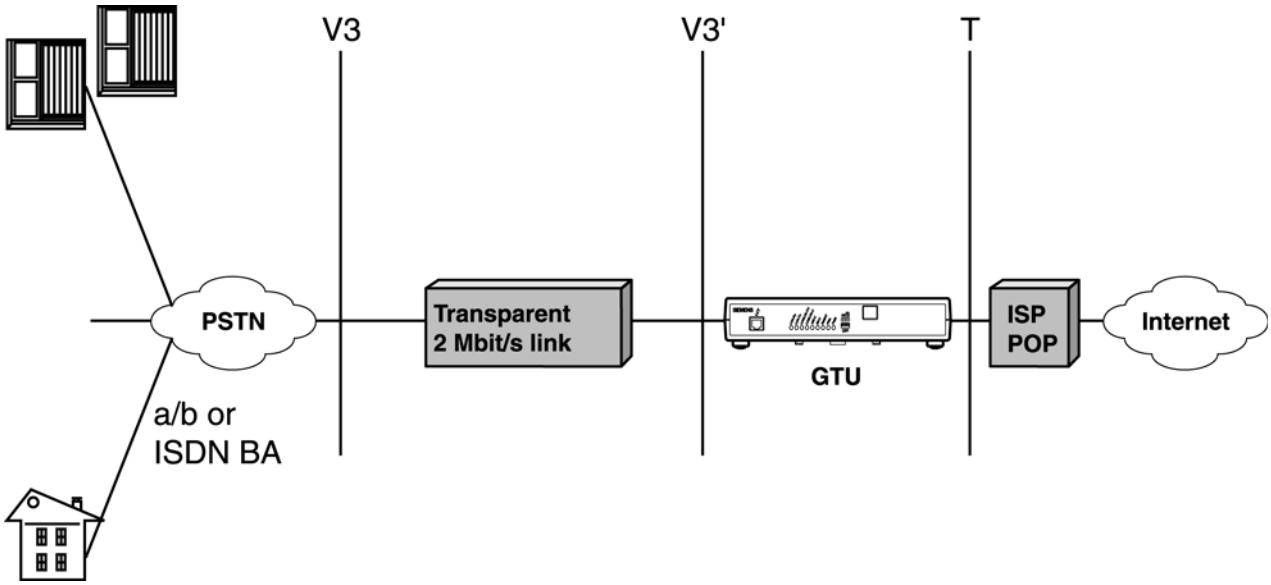


Fig. 1.6 Application NT1-Z function

1.8.3 GTU remote

The GTU can be configured as master/slave. In 'GTU remote' mode the GTU reports triggered alarms via the free Sabits (Sa7 and Sa8). To use a GTU in 'remote' mode, the plug-in must be configured with appropriate DIP switches (see the ULAF+ Installation Manual for this [1]). Fig. 1.7 shows a possible case of using a 'GTU remote'.

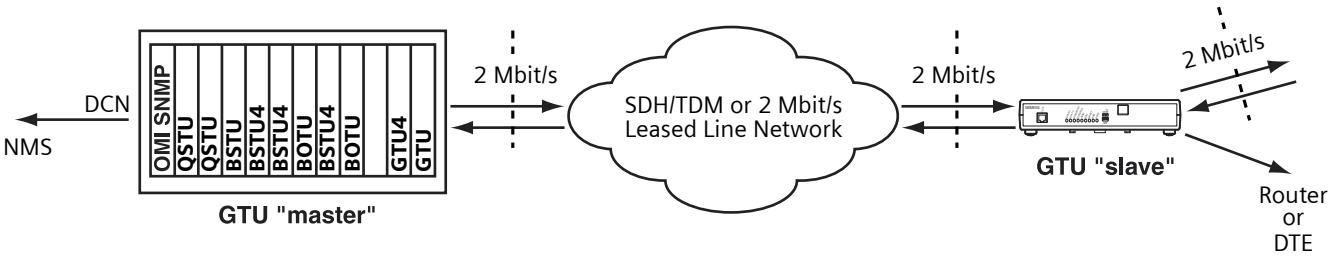


Fig. 1.7 Application GTU remote

1.8.4 Inband management for AccessIntegrator

If a site does not provide facilities for connecting a ULAF+ device directly to the Management DCN, you can use the GTU to help transfer the management data over one or several free timeslots of a 2 Mbit/s transmission link.

Fig. 1.8 shows a typical application of the GTU as Inband Management for AccessIntegrator.

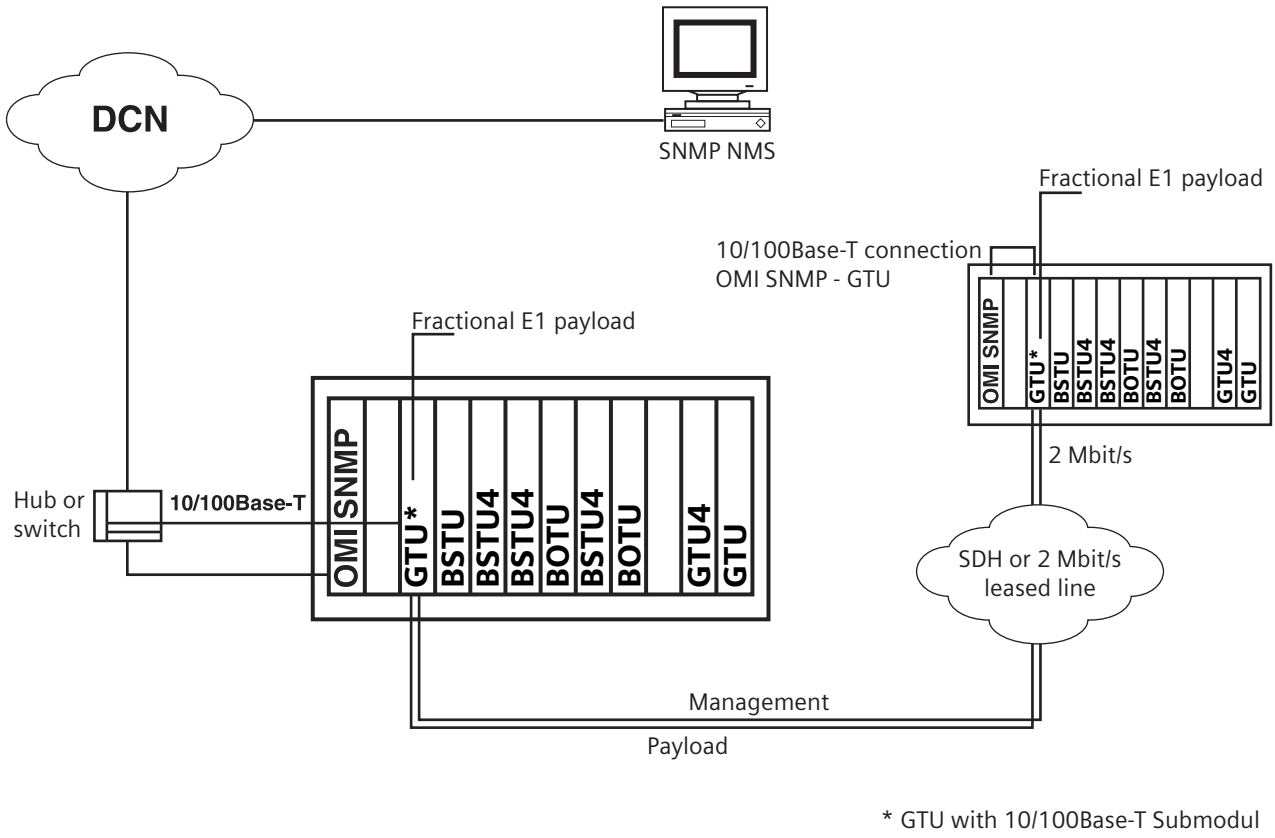


Fig. 1.8 Inband manager for AccessIntegrator application

1.9 Standard modes of operation of ULAF+

The possible modes of operation are listed below.

1.9.1 2 Mbit/s mode

Fig. 1.9 Standard mode 2 Mbit/s

Standard mode 2 Mbit/s
In this operating mode, the signal injected at the G.703 interface is transmitted using SHDSL or optical transmission. The payload bitrate is 2 Mbit/s.

Transparent 2 Mbit/s
The subscriber interface data is transmitted transparently, i.e. the data stream is not checked for the presence of a frame signal.

Structured 2 Mbit/s (G.704)
In this operating mode a check is made for the presence of a frame as per G.704 [8].

ISDN-PRA 2 Mbit/s
In this operating mode Sa-bit signalling, maintenance functions and alarm codes are checked in accordance with [21].

1.9.2 Data mode

Fig. 1.10 Data mode

nx64 kbit/s, Ethernet Bridging
In this operating mode the data signal (nx64 kbit/s) is adapted to the transmission bit rate (Payload Bitrate).

nx64 kbit/s - 2 Mbit/s (G.704)
For this operating mode use LT and NT-side data terminals.

Fig. 1.11 nx64 kbit/s - 2 Mbit/s (G.704)

You use this configuration for connection to a higher-ranking network. (Fig. 1.12).

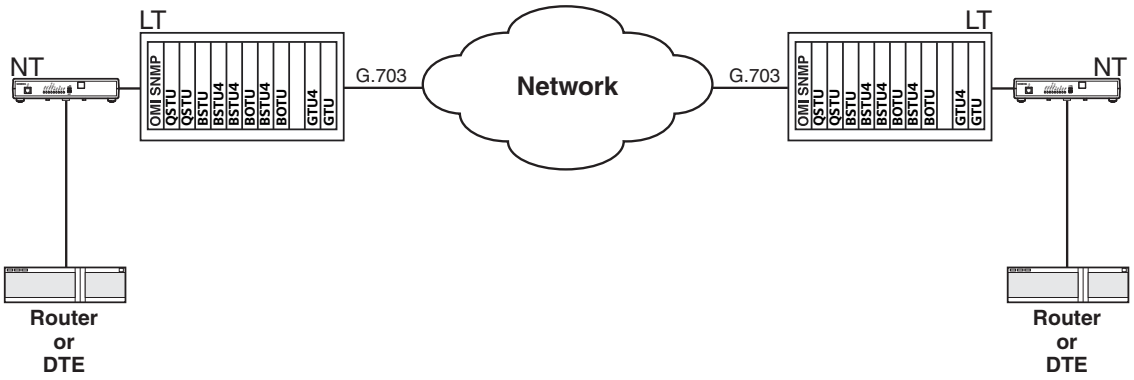


Fig. 1.12 Integration into higher-ranking network

1.9.3 'Add/Drop' mode

'Add/Drop' mode

In 'Add/Drop mode', unused timeslots of the G.704 frame can be used for the transmission of data via the Data interface. In this case, the maximum data rate of the Data interface is 960 kbit/s.

For 'Add/Drop mode', the G.704 frame must be terminated both the LT and the NT. This causes a CRC4 checksum to be calculated and entered in Timeslot 0. In this way, the G.704 frame is recalculated in the transmit and receive direction.

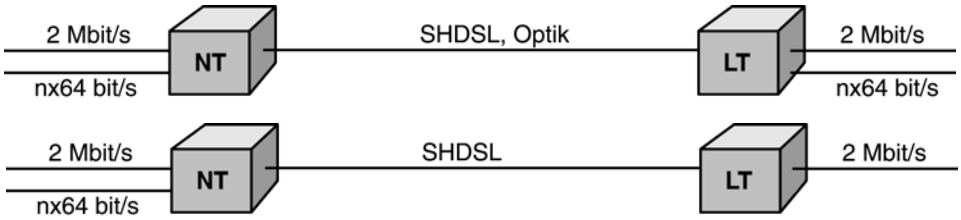


Fig. 1.13 Add/Drop mode

'Add/Drop' cannot be used in ISDN Primary Rate Access mode.

1.9.4 'Add/Top' mode

'Add/Top' is an additional function for the following modes of operation:

- Transparent 2 Mbit/s (G.703)
- Structured 2 Mbit/s (G.703)
- ISDN PRA
- Mapped

The 'Add/Top' function replaces the 'Add/Drop' mode with use of the BSTU.

With 'Add/Top' additional data of the V.35, V.36, X.21 or Ethernet interfaces is transmitted in addition of the G.703 interface. 'Add/Top' is automatically switched as soon as the data interface of the LT and the NT is activated in one of the four modes mentioned above.

The maximum data rate is 5696 kbit/s for a 1 wire pair system and 11392 kbit/s for a 2 wire pair system, whereby the data rate for the V.35, V.36 or X.21 interface is restricted to 4608 kbit/s.

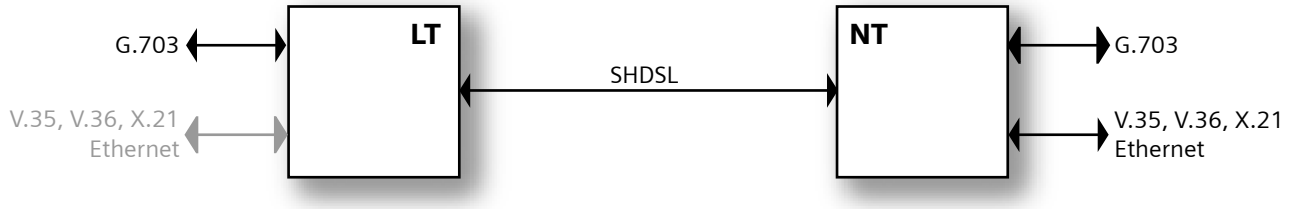


Fig. 1.14 ‘Add/Top’

Example 1: SHDSL Mapping ‘Add/Top’ mode with Transparent 2 Mbit/s

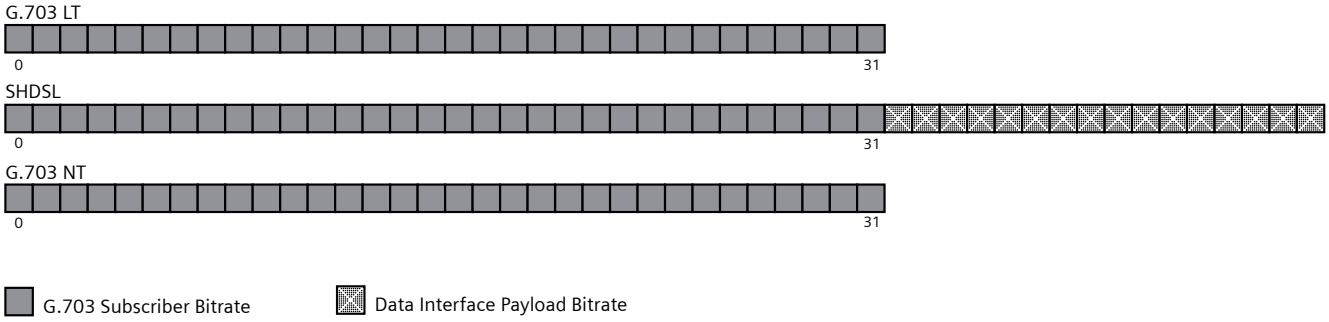


Fig. 1.15 Example 1: SHDSL Mapping ‘Add/Top’ mode with Transparent 2 Mbit/s

– Subscriber Bitrate at G.703: 2048 kbit/s
– Bitrate at Data interface: 1024 kbit/s
– SHDSL Payload Bitrate: 3072 kbit/s (2048 kbit/s (32TS) + 1024 kbit/s (16TS))

Example 2: SHDSL Mapping ‘Add/Top’ mode with Structured 2 Mbit/s (G.704)

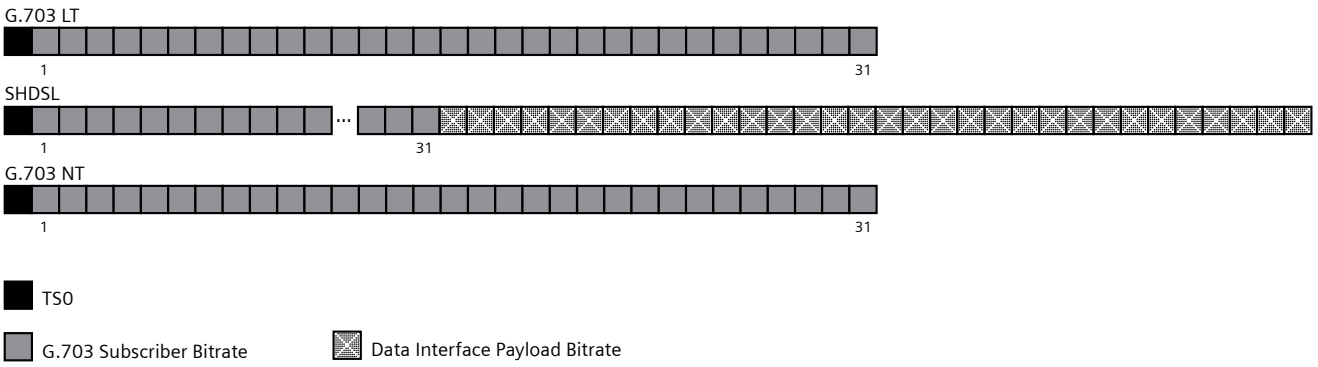


Fig. 1.16 Example 2: SHDSL Mapping ‘Add/Top’ mode with Structured 2 Mbit/s (G.704)

- Subscriber Bitrate at G.703: 1984 kbit/s
- Transmit TS0: Enabled
- Bitrate at Data interface: 2048 kbit/s
- SHDSL Payload Bitrate: 4096 kbit/s (1984 kbit/s (31TS) + 64 kbit/s (TS0) + 2048 kbit/s (32TS))

Example 3: SHDSL Mapping ‘Add/Top’ mode with Mapped Mode

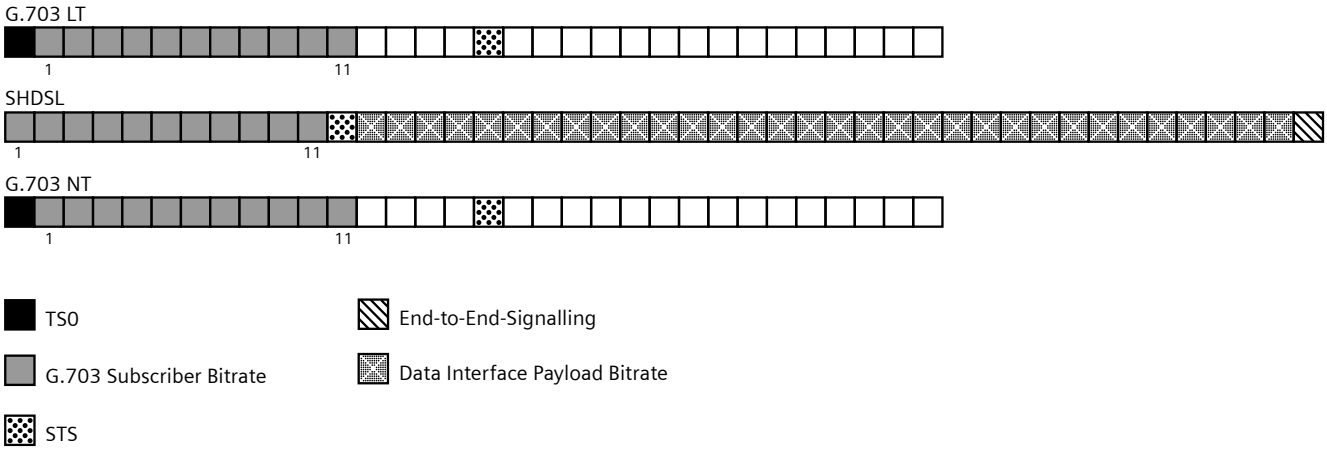


Fig. 1.17 Example 3: SHDSL Mapping ‘Add/Top’ mode with Mapped Mode

- Subscriber Bitrate an G.703: 704 kbit/s
- G.703 STS Position: TS16
- Remove STS: Disabled
- End-to-End-Signalling: Fast
- Transmit TS0: Enabled
- Bitrate at Data interface: 2048 kbit/s
- SHDSL Payload Bitrate: 2880 kbit/s (704 kbit/s (11TS) + 64 kbit/s (STS) + 2048 kbit/s (32TS) + 64 kbit/s (1TS))

1.10 TDM / Ethernet mode

This mode of operation is always used when you want to transmit data rates > 2 Mbit/s via a TDM network. The 'Multi Channel Synchronization' (MCS) procedure enables up to four E1 to be used for the data transmission. A channel can have the bandwidth in the range 1…32x64 kbit/s. The 'Inverse Multiplexer' (IMUX) merges the data of the channels and forwards it to the 4-port Ethernet Switch.

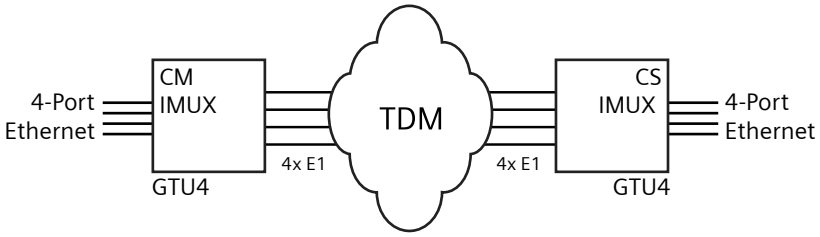


Fig. 1.18 TDM / Ethernet mode in conjunction with a GTU4

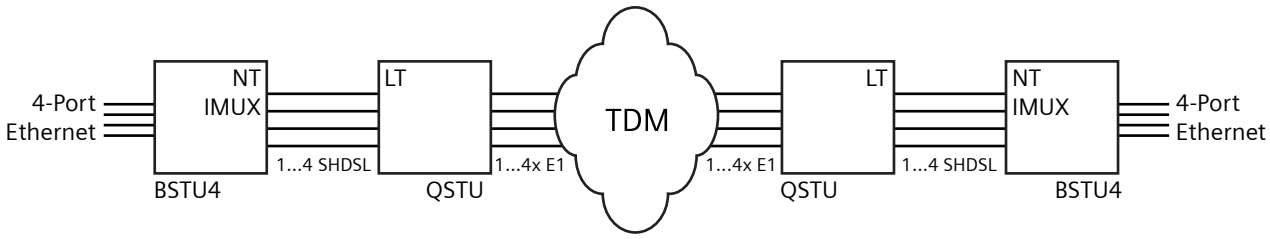


Fig. 1.19 TDM / Ethernet mode with QSTU – BSTU4

1.11 Ethernet / Ethernet mode

This mode of operation is used to connect two Ethernet networks with one another. The bitrate of the individual MCS channels is limited by the transmission medium. Up to 22.8 Mbit/s (5.7 Mbit/s per channel) are possible with SHDSL. An inverse multiplexer that distributes the data to the individual channels is available on both devices.

Fig. 1.20 Ethernet / Ethernet mode with BSTU4 – BSTU4

1.12 Clock concept

The ULAF+ timing pulse concept uses two different operating modes: 2 Mbit/s mode and data interface mode. In 2 Mbit/s mode, the transmission module can be operated synchronously as well as plesiochronously, while in nx64 kbit/s / Ethernet mode it can only be operated synchronously.

As a general rule, ULAF+ modules derive the necessary timing information from the following interfaces (see Fig. 1.21):

- from the subscriber interface,
- from the external clock input,
- from the internal oscillator or
- from the U interface.

The priority and availability of the timing sources is configured via the LCT. The highest priority timing source available is always used as the system clock. If a timing source fails, the system automatically switches over to the timing source with the next lower priority. During AIS/ES signalling, if a transmission direction fails the timing pulse for all the devices is derived from the internal oscillator. Incoming AIS/ES signalling is relayed using the signal clock.

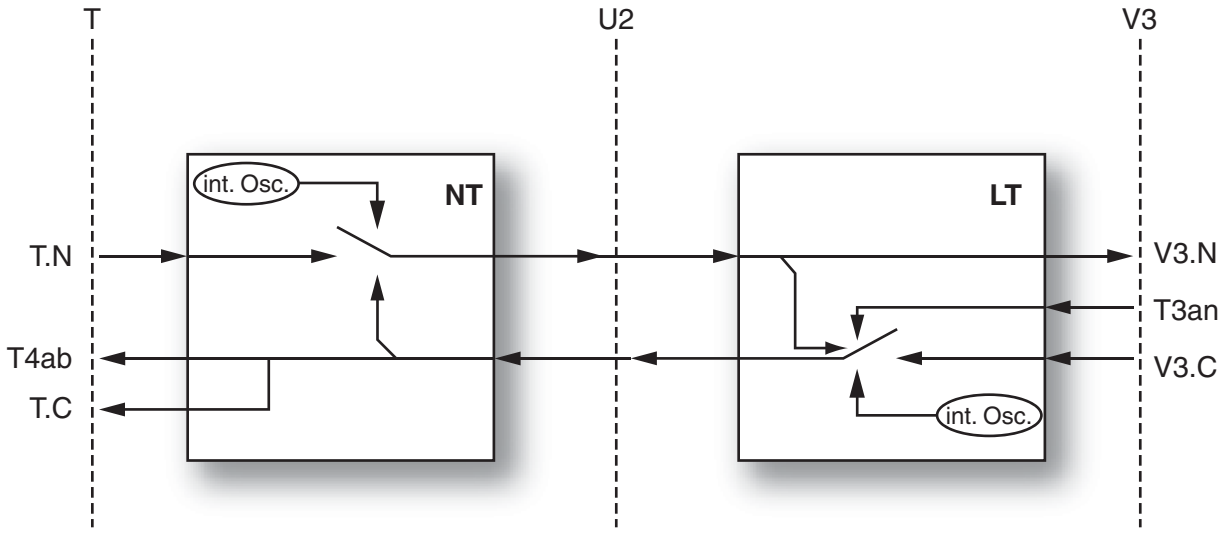


Fig. 1.21 Clock concept

2 Mbit/s mode

Plesiochronous operation

In this mode, the signals from the ‘V3.C’ interface of the LT are used for the downstream timing pulse and the signals from the ‘T.N’ interface of the NT are used for the upstream timing pulse (Fig. 1.21).

Operation with data interfaces

Operation with data interfaces

If the data is transferred with nx64 Kbits/s / Ethernet, it must be ensured that the clock on the LT is derived from the same source as the clock on the NT. The NT should derive the clock from the transfer interface for this. With the LT, either V3.C, T3an or the internal oscillator can be used.

Clock interface on the subrack

Clock interface on the subrack

The timing pulse to the individual modules is routed via the backplane circuit board. The impedance of the clock input is 75 Ω (BNC connector) or 120 Ω (RJ45 connector). If the transmission module obtains an external timing pulse via the backplane circuit board, the signal (T3an) is monitored. An alarm is emitted if the signal fails.

A clock priority can be assigned for clock synchronization. If the current timing source fails, the system switches over to the clock with the next lower priority.

Clock interface on the Desktop

Clock interface on the Desktop

The clock signal will be output or injected via the appropriate optional interface module. The 75/120 Ω impedance is configured with the aid of jumpers. The activity of the external clock is monitored by the software. An alarm is emitted if the clock fails.

1.12.1 Clock concept of the SHDSL termination units

In addition to the clock configurations described above (application), there is an optional possibility with the SHDSL modules to derive the SHDSL Symbol Clock from the Local Oscillator, from the T3an interface (reference clock) or from the application clock.

This choice for the SHDSL clock pulse is not available to the same extent for all ULAF+ modules. Details of this will be found in Tab. 1.3.

SHDSL Mode No.	LT symbol clock source	NT symbol clock source	Mode	Supported by
1	Local Oscillator	Receive symbol clock	Plesiochron	QSTU FW ID 633, 649, BSTU, BSTU4(NT), BSRU
2	Network Reference	Receive symbol clock	Plesiochron with Reference clock ‘Embedded Clock’	QSTU FW ID 633, 649, BSTU, BSTU4(NT), BSRU
3a	Transmit data clock	Receive symbol clock	Synchron (Up- and Downstream)	QSTU FW ID 633, 649, BSTU, BSTU4, BSRU

Tab. 1.3 SHDSL clock concept

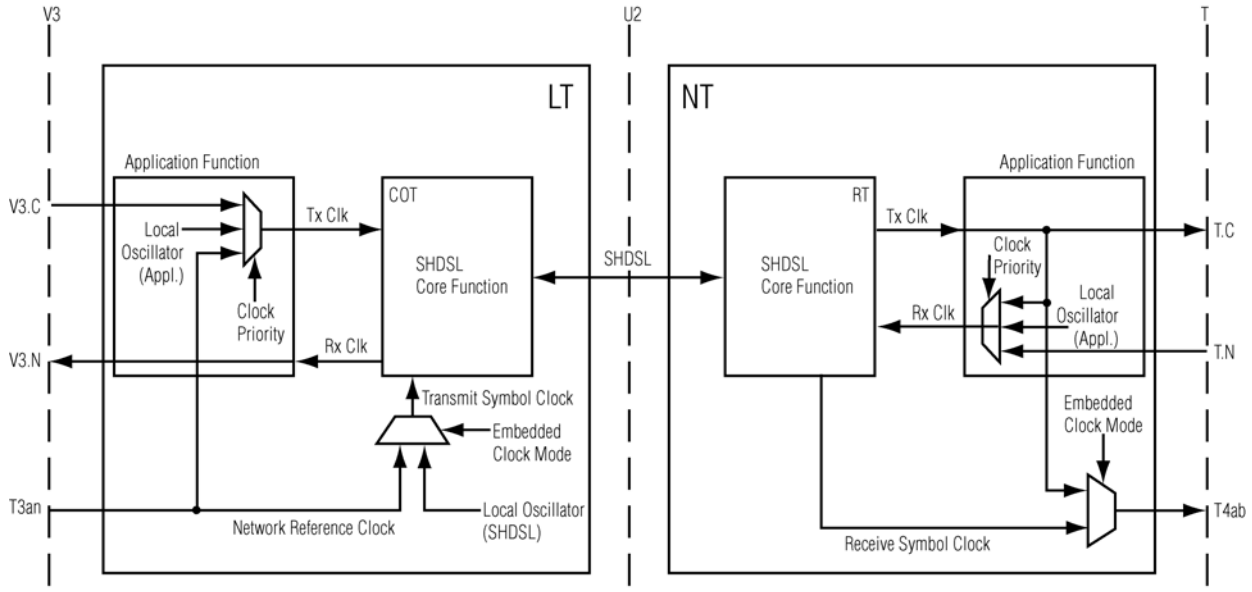


Fig. 1.22 ULAF+ SHDSL clock concept

Fig. 1.22 shows the clock concept for the ULAF+ SHDSL modules. The diagram shows the two functional blocks 'Application Function' and 'SHDSL Core Function'. For all the transmission modules, the clock source can be set with the configuration 'Clock Priority'. It must be noted here that this is a setting in the 'Application Function', i.e. the clock data and data items are adjusted to the SHDSL frame by means of a stop method (exception: SHDSL Clock Mode 3a).
The SHDSL clock settings are used to select the clock configuration for the "SHDSL Core Function in Fig. 1.4. In doing this the following clock masters are available, depending on the module (see Tab. 1.3):

SHDSL Clock Mode 1 (Plesiochronous)

The clock for the SHDSL link is derived from a "Local Oscillator" and is thus independent of the application clock. The data items are introduced into the SHDSL frame in the up- and down-stream directions by stop methods, and are thus transmitted plesiochronously.

The clock at the data and clock output from the NT corresponds to the payload's clock.

SHDSL Clock Mode 2 (Embedded Reference)

In this SHDSL clock configuration, the SHDSL symbol clock is derived from a reference clock. Hence it is possible, in addition to the data transmission, to transmit a high-quality clock and output it at the NT clock output (T4ab).

The data clock is not affected by this setting. As for clock mode 1, the data items are transmitted plesiochronously in the up- and down-stream directions by stop methods.

The following points should be noted when operating in the 'Embedded Clock Mode':

- Configuration requires an (automatic) restart of all the module's SHDSL links, because the basis for the clock is reset.
- T4ab is output on the NT as soon as the first of the SHDSL links for the module is in error-free operation. In each case, the available wire-pair with the lowest ordinal number is automatically selected.
- If no SHDSL link has synchronized up, then no T4ab will be available.

i T3an/T4ab can be an independent clock, not synchronous with the data clock.

SHDSL Clock Mode 3a (Synchronous)

In the synchronous SHDSL clock mode, the SHDSL clock is derived directly from the application's transmitting clock. In this case a stop method is no longer applied in the up- and down-stream, i.e. the system is synchronous.

The data and clock outputs on the NT are thus directly linked to the LT's transmitting clock. By this means, the wander at the data and clock outputs of the NT is significantly reduced.

The configuration is suitable for all applications which require a very high clock quality. In addition the system latency time is shortened, because in the synchronous mode the buffer sizes can be reduced.

Clock mode 3a can be used for all applications where it is possible to forego plesiochronicity.

The following points must be noted when operating in the 'synchronous mode':

- Configuration requires an (automatic) restart of all the module's SHDSL links, because the basis for the clock is reset.
- In the case of multi-system modules, T4ab is output on the NT as soon as the first of the SHDSL links for the module is in error-free operation. In each case, the available wire-pair with the lowest ordinal number is automatically selected.
- If no SHDSL link has synchronized up, then no T4ab will be available.

1.12.2 Clock concept of the BSTU4 and GTU4

The clock concept of the BSTU4 and the GTU4 is different to the rest of the devices of the ULAF+ family. The BSTU4 and the GTU4 can be operated plesiochronously, i.e. the clock master must not be identical in the transmission and receive directions.

In the following you will find various setting options for the clock in conjunction with the QSTU, BSTU4 and GTU4.

BSTU4 (LT) – BSTU4 (NT) application

SHDSL clock mode 3a is always configured for BSTU4(LT) - BSTU4(NT) connections. On the LT side, you can configure the SHDSL symbol clock on the clock input. If the LT clock is set to "external" and an external clock is present, a clock is output on the NT.

QSTU (COT) – BSTU4 (RT) application

The QSTU (FW-ID 649) and BSTU4 together support all three SHDSL clock modes. This allows a QSTU - BSTU4 link to be used as the transfer medium for a high quality clock.

In SHDSL clock modes 1 und 2, the data path can operated either synchronously or plesiochronously .

GTU4 – GTU4 application

With the GTU4, there is no difference in the clock setting between the Configuration Master (CM) and the Configuration Slave (CS). The outgoing signal can be synchronized to the incoming G.703 signal, the clock input or the internal oscillator.

1.12.3 Clock concept of the BOTU and QOTU

The optical module can derive the required clock information for each 2 Mbit/s interface as well as for the optical interface from another clock source. This allows all interfaces to be operated plesiochronously to each other. To prevent bit losses caused by different clock sources, bit stuffing must be used on the 2 Mbit/s signal for transfer over the optical interface.

It is also possible to operate the G.703 interfaces synchronously to the optical interface (without bit stuffing). The optical clock is used as the clock source for the 2Mbit/s signal in this case. Transfer to the Ethernet and the data interface is synchronous, with the optical symbol clock.

The following clock sources are available for optical transmission:

- External clock input
- Subscriber interface VA, VB, VC, VD (the first available interface is used in synchronous operation (without bit stuffing))
- Internal oscillator

The following clock sources are available for the G.703 interface:

- External clock input (only LT)
- Subscriber interface VA, VB, VC, VD (separate for each interface)
- Clock of the U interface
- Internal oscillator

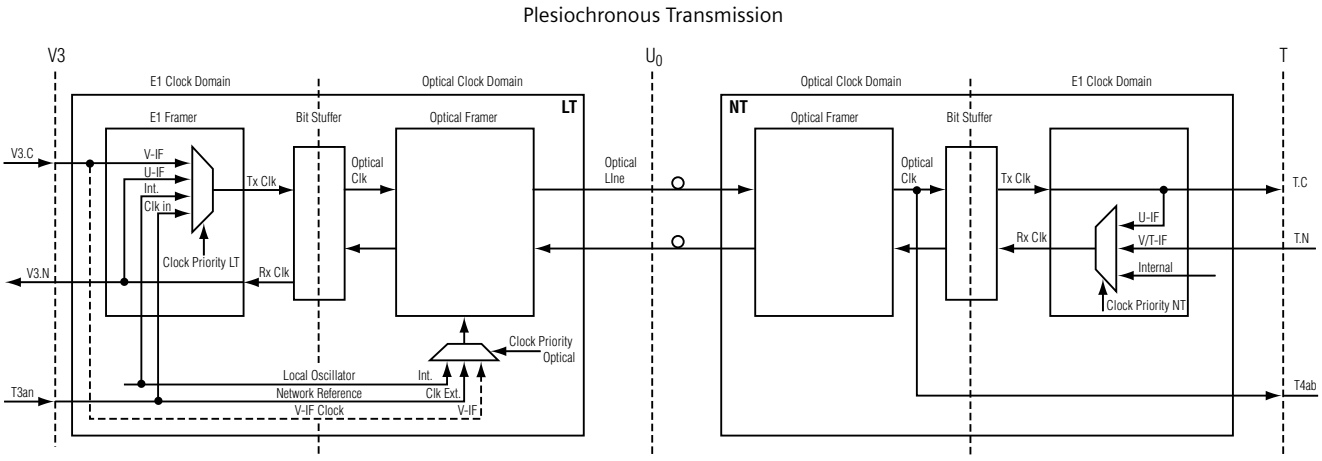


Fig. 1.23 Clock concept of the BOTU and QOTU (Plesiochronous Transmission)

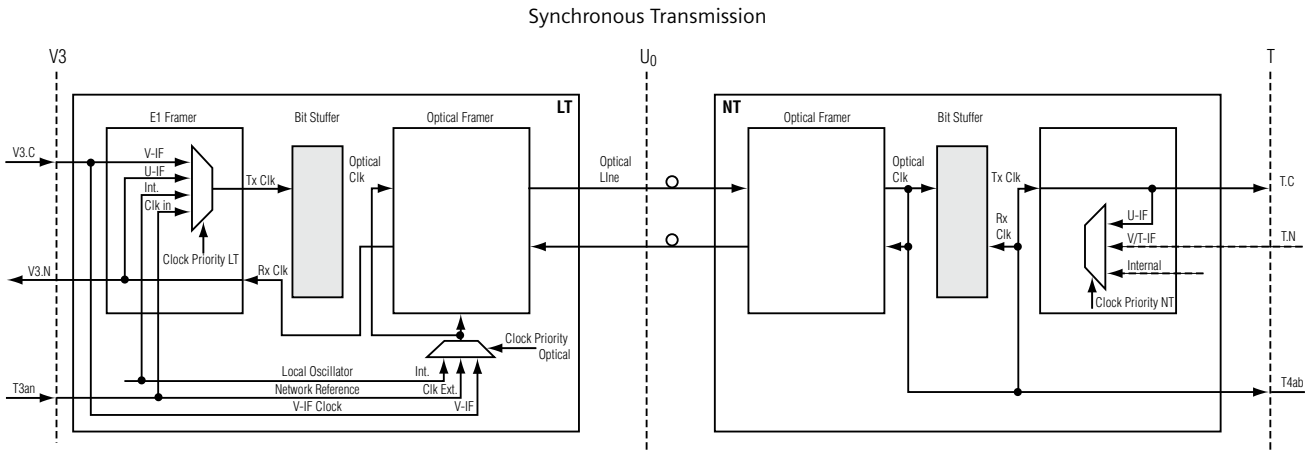


Fig. 1.24 Clock concept of the BOTU and QOTU (Synchronous Transmission)

1.12.3.1 Clock transmission of the BOTU/QOTU

The BOTU/QOTU is suitable for transferring a high quality clock signal, e.g. for synchronizing UMTS base stations.

The device fulfills the requirements for PDH synchronization interfaces as per G.823 [11], chapter 6.2.4.

The clock is always transferred from LT to NT and is available on the clock output of a desktop unit or on the G.703 interface.

If the external clock or the top-prioritized clock of a V interface is present on the LT side, the clock signal is output on the NT side. Otherwise, the clock signal is suppressed (squelched).

1.13 Structuring of the payload signal

1.13.1 Framings of the BSTU/QSTU (FW-ID 633)

Transparent 2 Mbit/s (G.703)

In this mode of operation, the signal injected at the G.703 interface is transmitted via an SHDSL interface. The bitrate for the G.703 signal is 2048 kbit/s. The data at the subscriber interface is transmitted transparently, i.e. the data stream is not checked for the presence of a frame signal. As an option, 'AIS Detection' can be enabled.

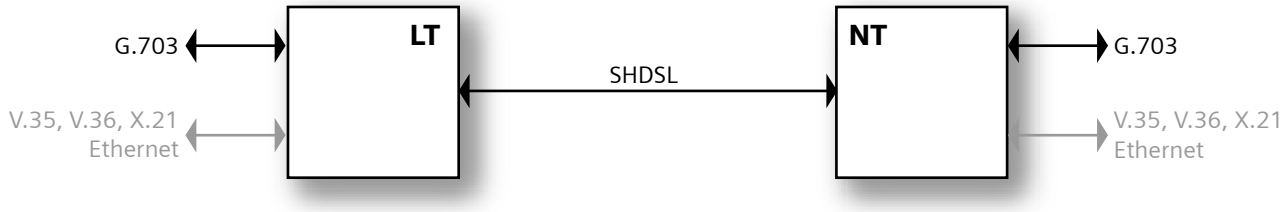


Fig. 1.25 Transparent 2 Mbit/s (G.703)

Fig. 1.26 SHDSL Mapping Transparent 2 Mbit/s (G.703)

– Subscriber Bitrate at G.703: 2048 kbit/s
– SHDSL Payload Bitrate: 2048 kbit/s (2048 kbit/s (32 TS))

Structured 2 Mbit/s (G.704)

In this operating mode, the signal is checked for the presence of a frame in accordance with G.704. If the option 'CRC4' is enabled, the signal quality is checked by means of CRC4 multiframe in bit 1 of the G.704 frame. The bitrate including the G.704 frame is 2048 kbit/s.

If the 'Termination' option is enabled, the incoming G.704 frame is terminated and a new frame generated. In doing this the CRC4 values are also recalculated.

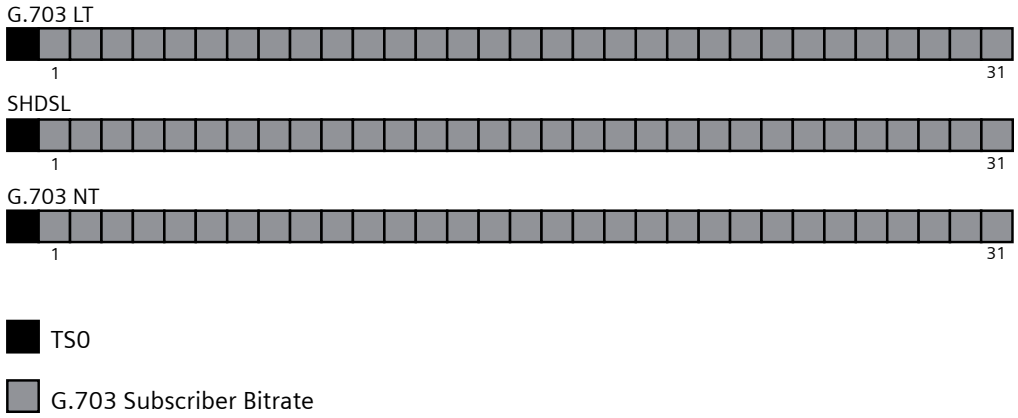


Fig. 1.27 SHDSL Mapping Structured 2 Mbit/s (G.704) and ISDN PRA Mode

– Subscriber Bitrate at G.703: 1984 kbit/s (31 TS)
– SHDSL Payload Bitrate: 2048 kbit/s (32 TS)

ISDN PRA

In this operating mode, the 'Sa bit' signalling, the maintenance functions and the alarm codes are checked and set in accordance with ETS 300 233. The bitrate including the G.704 frame is 2048 kbit/s.

Mapped Mode

This operating mode is used if it is not required to transmit the full 2048 kbit/s bitrate of the G.703 interface over the SHDSL interface. To increase the transmission range, the SHDSL links are started up at the minimum possible bitrate (≥ 192 kbit/s) (Trading Speed for Distance).

For the 'Mapped' operating mode to function, the option 'G.704 Framing' must be configured as <Termination>, because the content of the data stream is altered.

The following 'DSL Mapping' options are possible:

- **G.703 STS Position**
  Here, any arbitrary position can be selected for the signalling timeslot (STS) at the G.703 interface of the LT and the NT.
  With <STS Mapping disabled>, all the time slots apart from time slot 0 (TS0) are handled the same. If a time slot is selected, this selection specifies the position of the STS. Normally this will be time slot 16 (TS16). If the option <Remove STS> is disabled, the STS will always be transmitted. The 'Signalling Timeslot' is not part of the subscriber bitrate for the G.703 interface.
- **Remove STS**
  If the option <Remove STS> is enabled, there will be no transmission of the 'Signalling Timeslot'. This is logical if the systems connected to the LT and the NT use, for example, TS1 to TS15 and TS17 to TS31, but no 'Signalling' signal is present in TS16.
- **Transmit TS0**
  This setting is used to specify whether the time slot 0 (TS0) is transmitted on the SHDSL link. Time slot 0 (TS0) is required, among other things, for transmitting the Sa bits.
  If 'Transmit TS0' is disabled, time slot 0 (TS0) is regenerated for the G.703 interface in the LT and the NT.

Three examples of the 'Mapped' operating mode will be found below.

Example 1: SHDSL Mapping with Mapped Mode

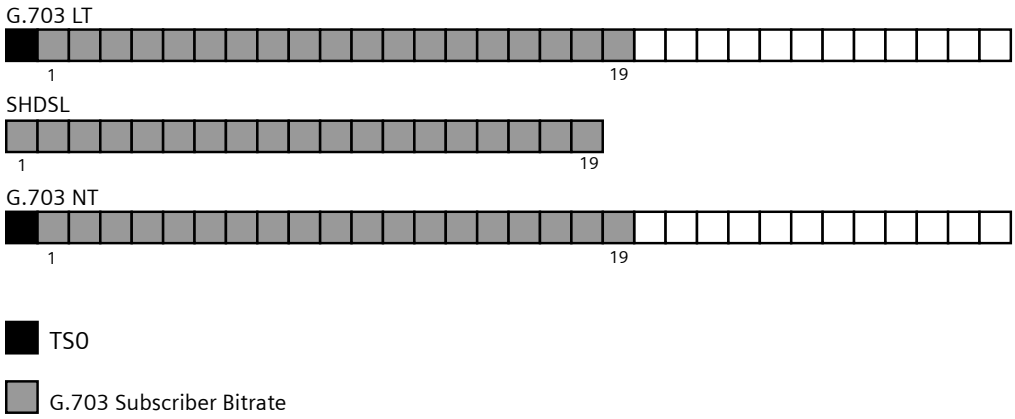


Fig. 1.28 Example 1: SHDSL Mapping with Mapped Mode

– Subscriber Bitrate at G.703: 1216 kbit/s
– G.703 STS Position: Unchanged
– Transmit TS0: Disabled
– SHDSL Payload Bitrate: 1216 kbit/s (1216 kbit/s (19TS))

Example 2: SHDSL Mapping with Mapped Mode

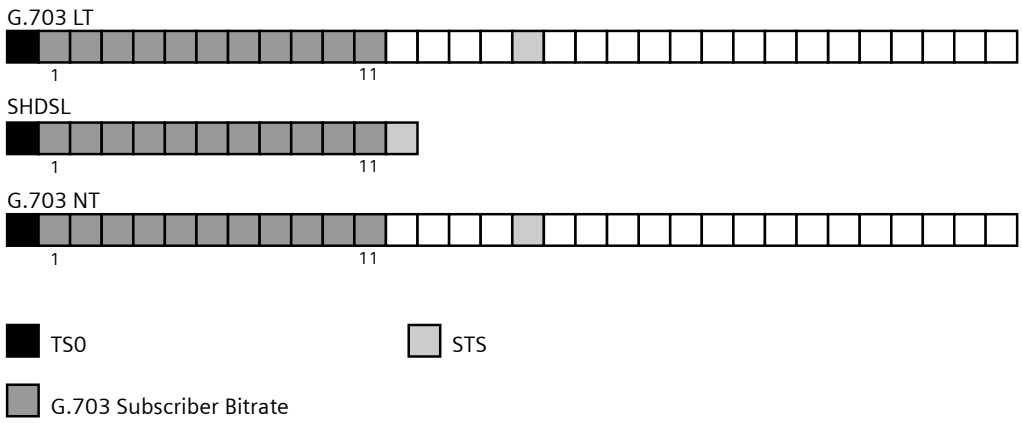


Fig. 1.29 Example 2: SHDSL Mapping with Mapped Mode

– Subscriber Bitrate at G.703: 704 kbit/s
– G.703 STS Position: TS16
– Remove STS: Disabled
– Transmit TS0: Enabled
– SHDSL Payload Bitrate: 832 kbit/s (704 kbit/s (11TS) + 64 kbit/s (TS0) + 64 kbit/s (STS))

Example 3: SHDSL Mapping with Mapped Mode

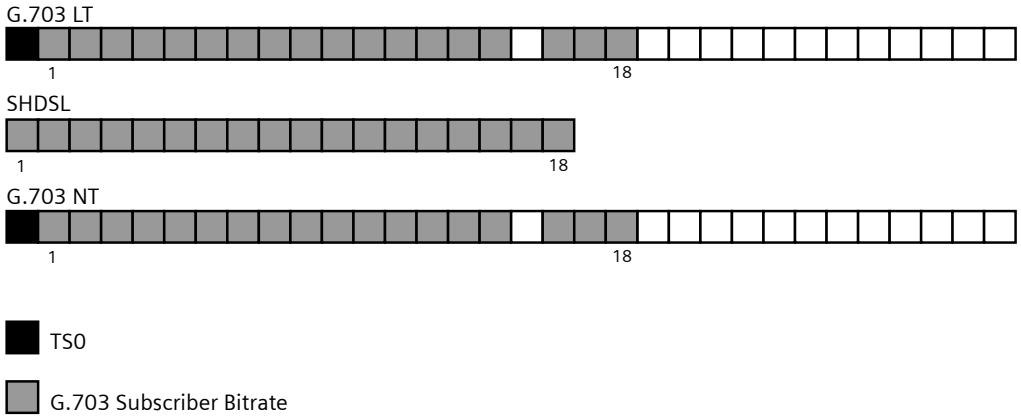


Fig. 1.30 Example 3: SHDSL Mapping with Mapped Mode

– Subscriber Bitrate at G.703: 1152 kbit/s
– G.703 STS Position: TS16
– Remove STS: Enabled
– Transmit TS0: Disabled
– SHDSL Payload Bitrate: 1152 kbit/s (1152 kbit/s (18TS))

Data nx64 kbit/s

In this operating mode, a V.35, V.36, X.21 data interface or an Ethernet interface is enabled on the LT/NT side.

The Bitrate amounts:

- 64 kbit/s to 4608 kbit/s with V.35, V36 and X.21 interfaces
- 64 kbit/s to 5696 kbit/s with Ethernet on 1 wire pair systems
- 64 kbit/s to 11392 kbit/s with Ethernet on 2 wire pair systems.

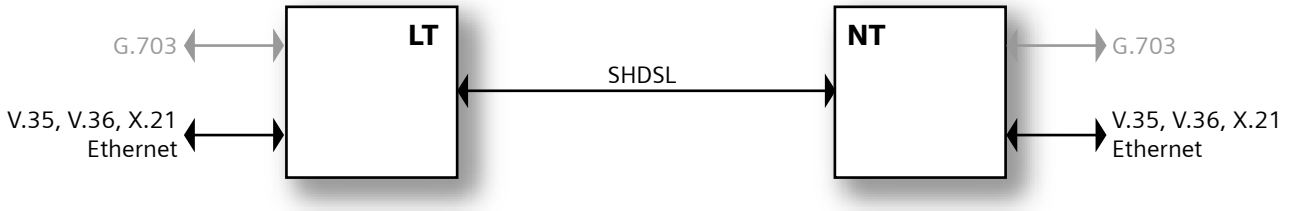


Fig. 1.31 Data nx64 kbit/s

G.703(LT)-Data(NT)

In this operating mode the G.703 interface is active on the LT side and the data interface is active on the NT side. On the NT, the data stream is mapped into a G.704 frame.

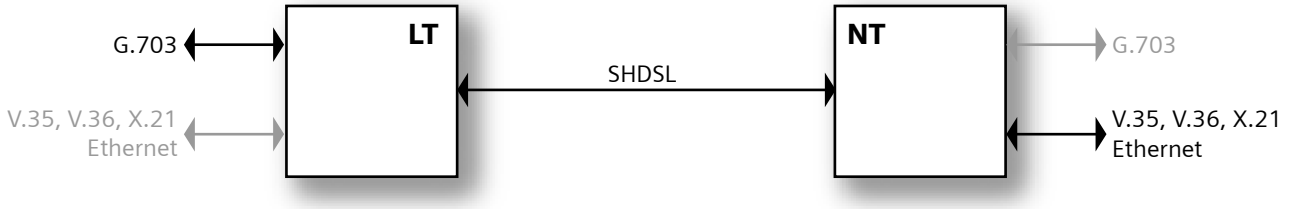


Fig. 1.32 G.703(LT)-Data(NT)

Two examples of the 'G.703(LT)-Data(NT)' operating mode will be found below.

Example 1: SHDSL Mapping with G.703(LT)–Data(NT) mode

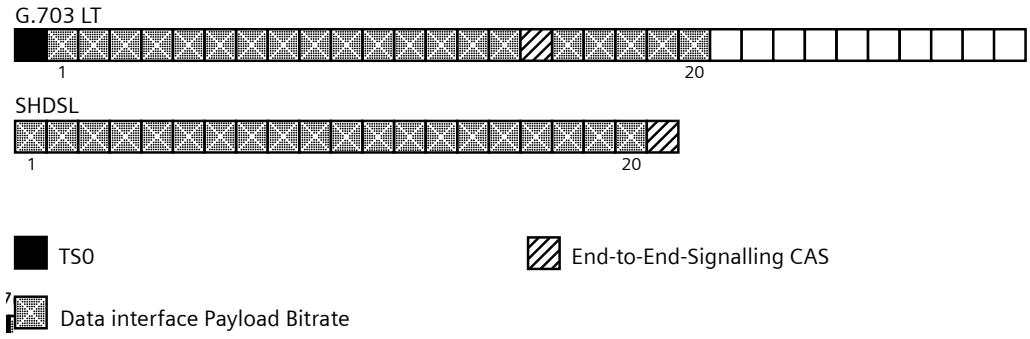


Fig. 1.33 Example 1: SHDSL Mapping withG.703(LT)-Data(NT) mode

– Bitrate at Data interface: 1280 kbit/s
– End-to-End-Signalling: CAS
– G.703 STS Position: TS16
– Remove STS: Disabled
– Transmit TS0: Disabled
– SHDSL Payload Bitrate: 1344 kbit/s (1280 kbit/s (20TS) + 64 kbit/s (CAS))

Example 2: SHDSL Mapping with G.703(LT)-Data(NT) mode

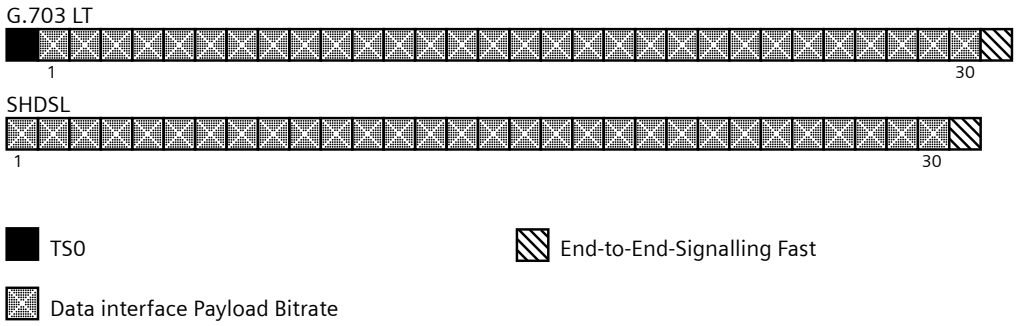


Fig. 1.34 Example 2: SHDSL Mapping with G.703(LT)-Data(NT) mode

- Bitrate at Data interface: 1920 kbit/s
- End-to-End-Signalling: Fast
- G.703 STS Position: Unchanged
- Transmit TS0: Disabled
- SHDSL Payload Bitrate: 1984 kbit/s (1920 kbit/s (30TS) + 64 kbit/s (Fast))

G.703(LT)-'Add/Drop'(NT)

On the NT side, a data stream from the data interface is mapped into the G.704 frame. On the LT side, both partial data streams are output jointly via the G.703 interface. By this means, two different data streams can be transmitted over one network connection.

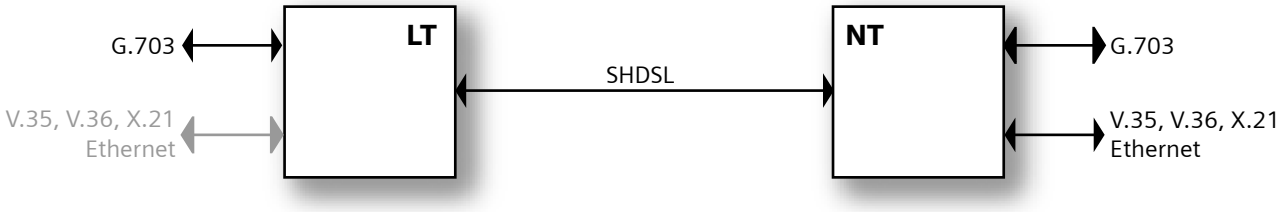


Fig. 1.35 G.703(LT)-'Add/Drop'(NT)

Two examples of the 'Add/Drop' operating mode will be found below.

Example 1: SHDSL Mapping with G.703(LT)-'Add/Drop'(NT) mode

Fig. 1.36 Example 1: SHDSL Mapping with G.703(LT)-'Add/Drop'(NT) mode

– Subscriber Bitrate at G.703: 1216 kbit/s
– Bitrate at Data interface: 704 kbit/s
– End-to-End-Signalling: Fast
– G.703 STS Position: Unchanged
– Transmit TS0: Disabled
– SHDSL Payload Bitrate: 1984 kbit/s (1216 kbit/s (19TS) + 704 kbit/s (11TS) + 64 kbit/s (1TS))

Example 2: SHDSL Mapping with G.703(LT)-'Add/Drop'(NT) mode

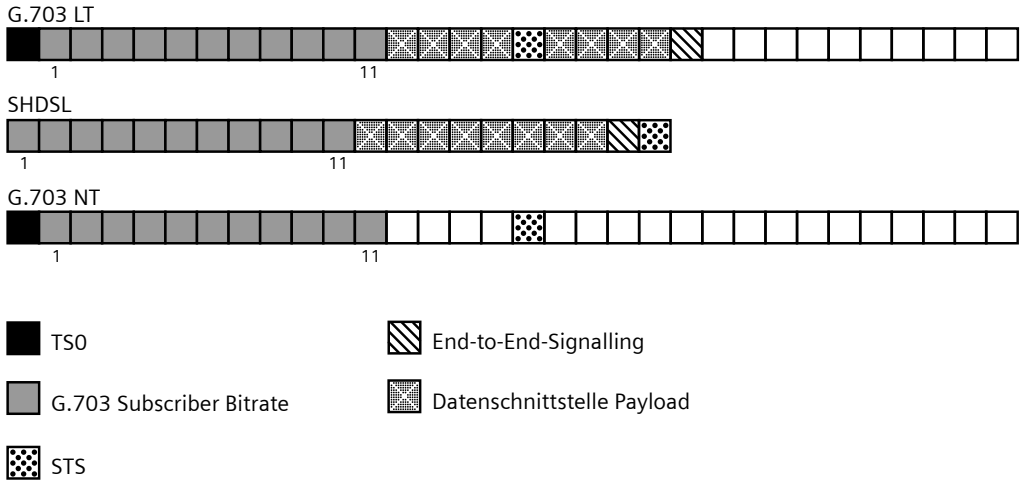


Fig. 1.37 Example 2: SHDSL Mapping with G.703(LT)-'Add/Drop'(NT) mode

– Subscriber Bitrate at G.703: 704 kbit/s
– Bitrate at Data interface: 512 kbit/s
– End-to-End-Signalling: Fast
– G.703 STS Position: TS16
– Remove STS: Disabled
– Transmit TS0: Disabled
– SHDSL Payload Bitrate: 1344 kbit/s (704 kbit/s (11TS) + 512 kbit/s (8TS) + 64 kbit/s (STS) + 64 kbit/s (1TS))
– Subscriber Bitrate at G.703: 1216 kbit/s
– G.703 STS Position: Unchanged
– Transmit TS0: Disabled
– SHDSL Payload Bitrate: 1216 kbit/s (1216 kbit/s (19TS))

1.13.2 Supported Framings of the application QSTU with BSTU4, GTU4

In conjunction with an BSTU4 or GTU4, the QSTU supports 'Transparent Transmission', 'Structured Transmission' and 'Structured Transmission Fractional E1'.

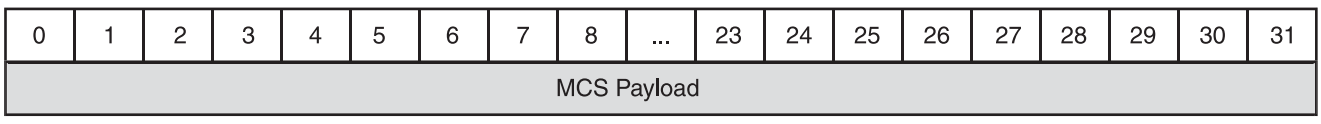


Fig. 1.38 Transparent transmission

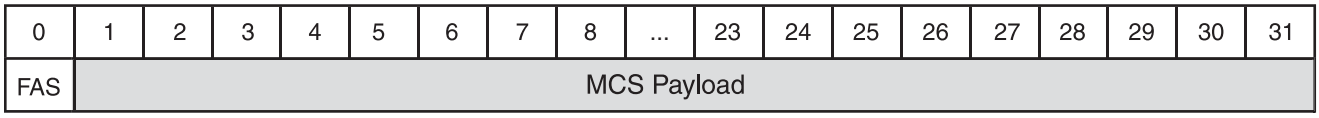


Fig. 1.39 Structured mode with or without CRC4

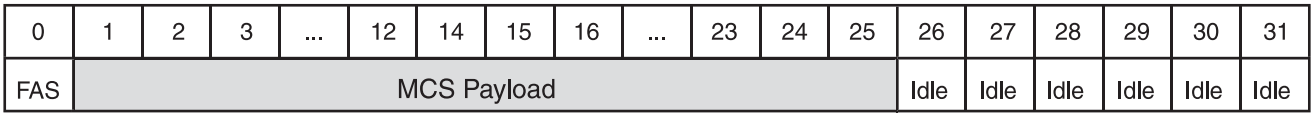


Fig. 1.40 Structured mode “Fractional E1” for example

1.13.3 Framings of the BOTU/QOTU

Transparent 2 Mbit/s (G.703)

In this operating mode, the signal fed in at the G.703 interface is transferred in the optical frame. The bit rate of the G.703 signal is 2048 Kbits/s. The data on the subscriber interface is transferred transparently, i.e. the data stream is not checked for the presence of a frame signal. 'AIS detection' can be enabled optionally.

Structured mode 2 Mbit/s (G.704)

In this operating mode, the signal is checked for the presence of a frame as per G.704. If the 'CRC4' option is enabled, the signal quality is checked via CRC4 multiframe in bit 1 of the G.704 frame. The bit rate, including the G.704 frame, is 2048 kbits/s. If the 'termination' option is enabled, the incoming G.704 frame is terminated and a new frame is generated. The CRC4 values are thereby also recalculated.

ISDN PRA

In this operating mode, the 'Sa bit' signalling, the maintenance functions and the alarm codes are checked and used as per ETS 300 233. The bit rate, including the G.704 frame, is 2048 kbits/s.

Mapped Mode

This operating mode is used for flexible positioning of the 'Signalling Timeslot (STS)' or if less than all the G.703 interface time slots are to be used.

The 'G.704 framing' option must be configured to <termination> for the 'Mapped' operating mode to be used since the content of the data stream is modified.

The following 'TS mapping' options are possible:

- **G.703 STS Position**
  The position of the signalling timeslot (STS) at the G.703 interface of the LT and the NT can be selected as required here.
  With <STS mapping disabled>, all timeslots are handled identically apart from timeslot 0 (TS0). If a timeslot is selected, this selection defines the position of the STS. This is normally timeslot 16 (TS16). If the <remove STS> option is disabled, the STS is always transferred. The 'signaling timeslot' is not part of the subscriber bit rate of the G.703 interface.
- **Remove STS**
  If the 'remove STS' option is enabled, the 'signaling timeslot' is not transferred. This is meaningful if the systems connected to LT and NT occupy, for example, TS1 to TS15 and TS17 to TS31 but no 'signaling' signal is present in TS16.

Data nx64 kbit/s

In this operating mode, a V.35, V.36 or X.21 data interface or an Ethernet interface (ABAR) is enabled on the LT/NT side. The maximum bit rate is 4608 Kbits/s.

G.703(LT)-Data(NT) In this operating mode, the G.703 interface is active on the LT side and the data interface is active on the NT side. The data stream is mapped on the NT in a G.704 frame.

Ethernet In this operating mode, 'Ethernet frames' fed into the Ethernet interfaces are transferred as part of the optical frame. The data transfer rate is 100 Mbit/s. The built-in switch allows the Ethernet frames to be prioritized and their bandwidth to be limited. In addition, VLAN tags may be added to the frame or removed from it.

1.14 Loopback concept

The path can be checked for possible transmission errors by inserting loopbacks. Once the loopbacks have been activated, the data should be returned without error.

Loopback can be generated either by means of the software (LCT or TMN) or by means of the DIP switches on the modules.

The different loopbacks are shown in Fig. 1.41 to Fig. 1.57.

Loop 2b can be inserted by means of the DIP switch, either locally at the NT or remotely at the LT (Loop 2bR).

Note

- The Regenerator Loopback can only be inserted at the LT
- In the PRA mode, the '1/3a' loopback is transparent
- With the exception of the loopback '1/3a', all the loopbacks can be configured to be transparent or non-transparent

1.14.1 Loopbacks for the BSTU

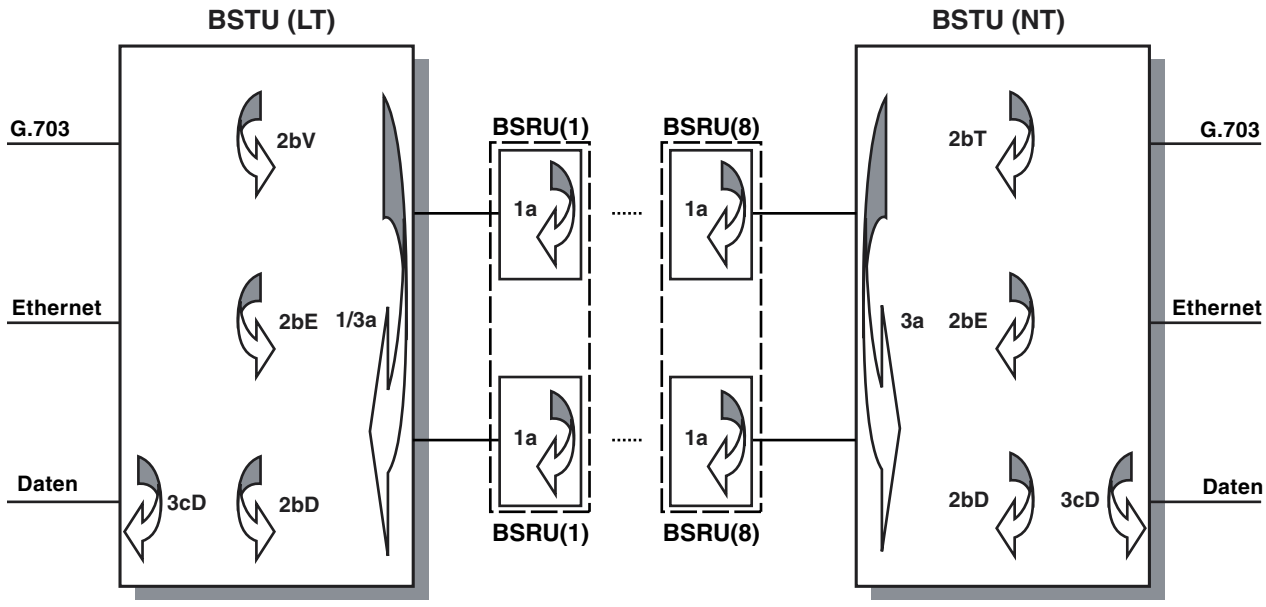


Fig. 1.41 Loopbacks for a BSTU - BSTU link

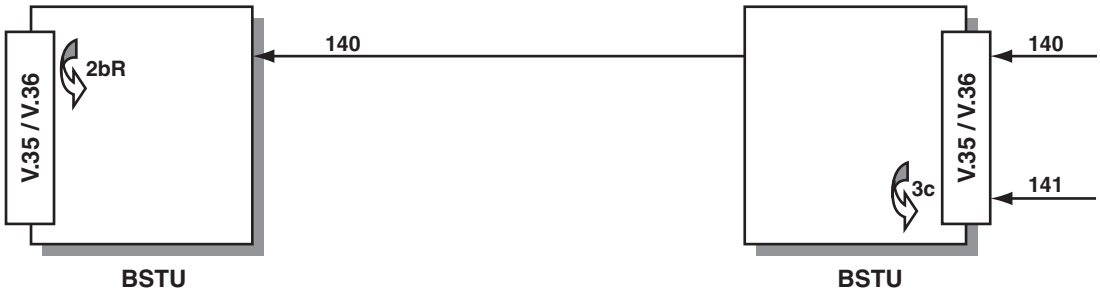


Fig. 1.42 Loopback via control line 140/141 (V.35 / V.36)

For BSTU-BSTU links, the loopbacks 2bD far and 3c local can be inserted via the control lines 140/141.

The loopback 2bDfar is inserted using TMN and is transparent:

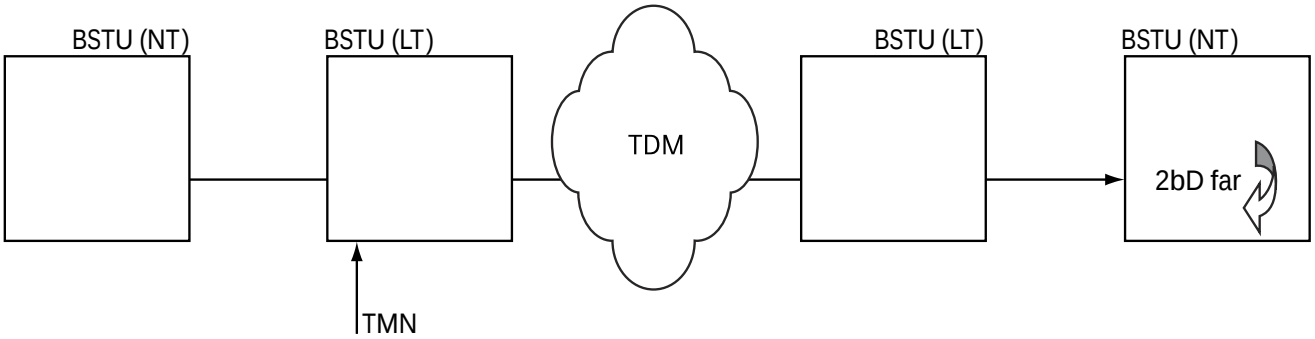


Fig. 1.43 Loopback 2bD far via control line

In addition to the loopbacks indicated above, it is also possible to enable the 'Switch Test Mode' on the BSTU. This makes the Ethernet switch transparent, and thus makes loopbacks on the Ethernet interface possible.

i The loopbacks which are available for a BSTU - BSTU link depend on the hardware fitted and the operating mode. With the exception of loop 3a, all the loopbacks can be configured to be transparent or non-transparent.

1.14.2 Loopbacks for the QSTU

Loopback 1/3a applies simultaneously for all SHDSL transfer interfaces assigned to the G.703 system. Loopback 1a is set up common for all regenerators in the separate sections.

In conjunction with the QSTU (FW-ID 633) and the BSTU the loopbacks, except for loopback 1/3a, can be inserted as transparent or non-transparent.

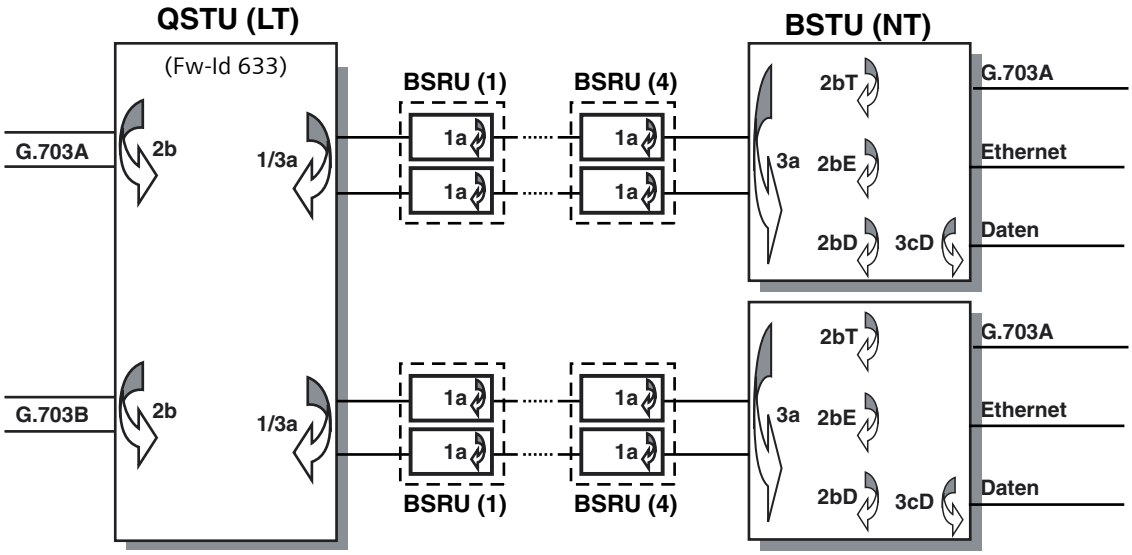


Fig. 1.44 Loopback of a QSTU - BSTU link (e.g.: 2x 2 wire pair mode)

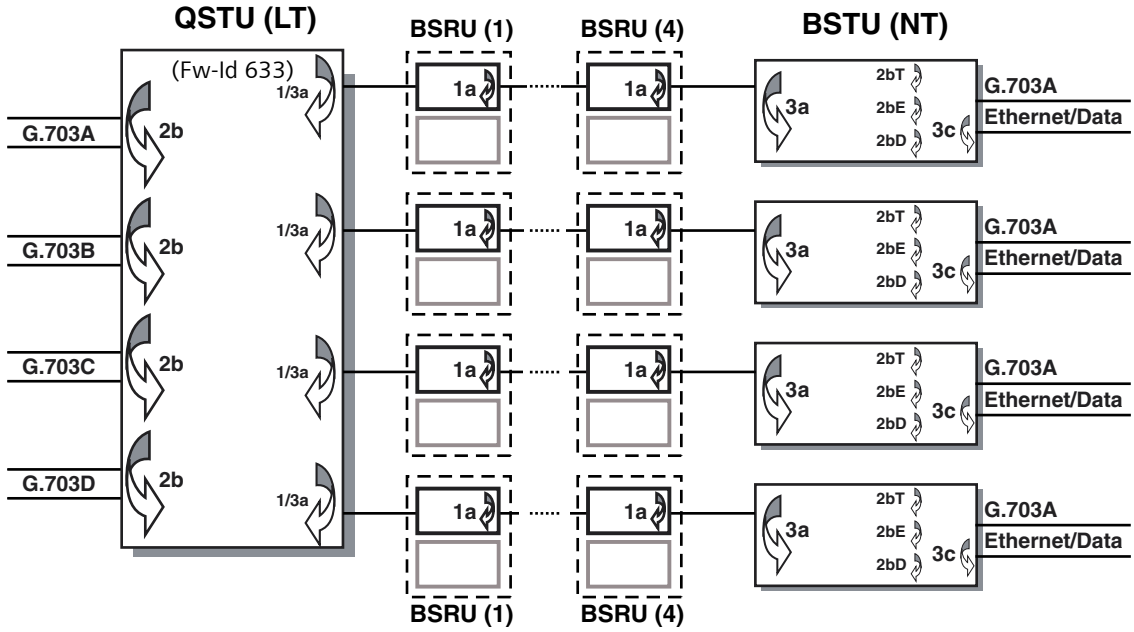


Fig. 1.45 Loopback of a QSTU - BSTU link (4x 1 wire pair mode)

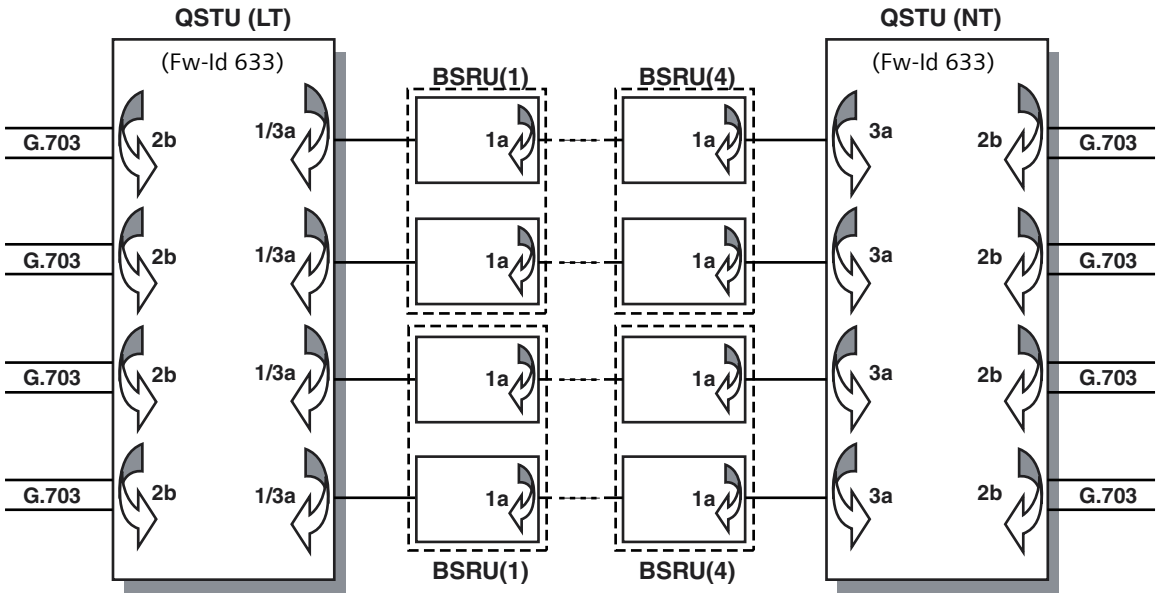


Fig. 1.46 Loopbacks for a QSTU - QSTU link (4 x 1 wire pair mode)

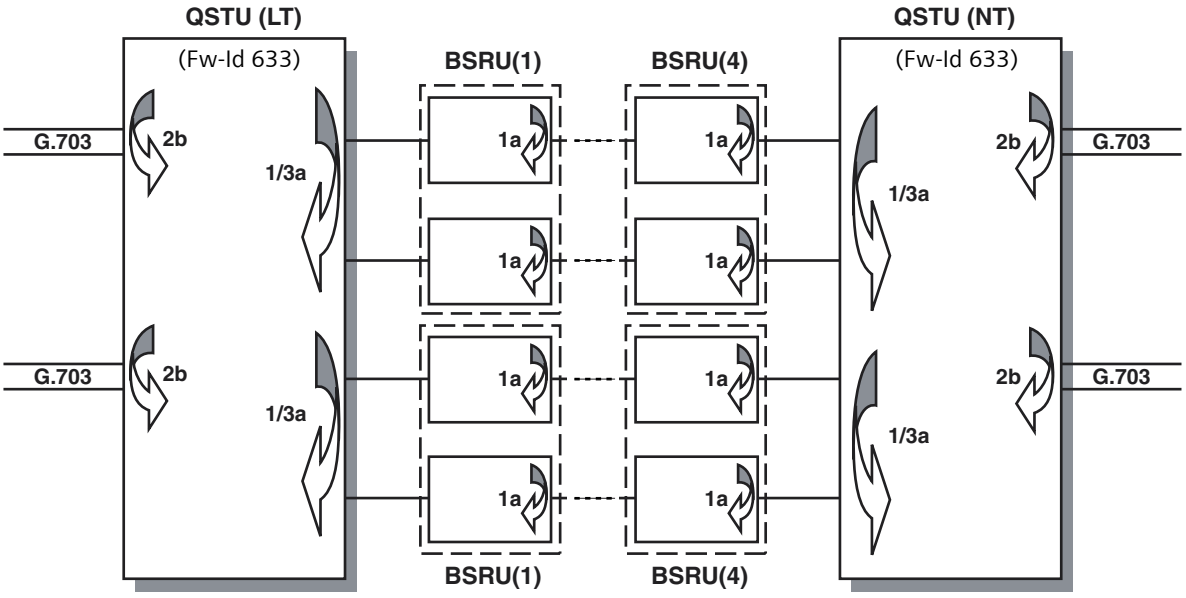


Fig. 1.47 Loopbacks for a QSTU - QSTU link (2 x 2 wire pair m)ode

The loopback are enabled simultaneously for both SHDSL interfaces in the BSRU.

1.14.3 Loopbacks of the BSTU4

The available loopbacks for the BSTU4 depend on whether you use the unit together with a QSTU (as LT) or with another BSTU4.

Loopbacks of a QSTU - BSTU4 link

With a telecom BERT (Bit Error Rate Tester) on the G.703 interface you can insert the 2b loopback individually for each channel.

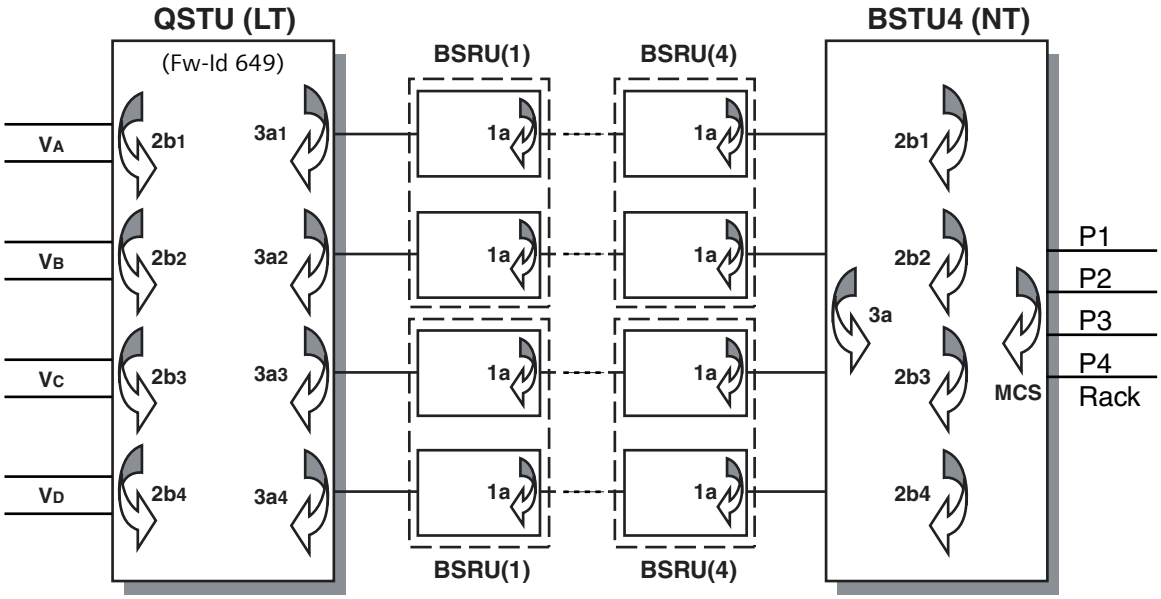


Fig. 1.48 Loopbacks of a QSTU – BSRU – BSTU4 link

i The 2b loopback is only activated on an BSTU4 when there is no valid MCS signal on the corresponding interface, i.e. the alarm 'LOM' must be activated.

Loopbacks of a BSTU4 - BSTU4 link

The MCS loopbacks on the BSTU4 can be inserted together for all activated channels. The test with an external Ethernet test device can be made after the 'L2 Switch Test Mode' has been activated with the BSTU4 that the external test device is connected to (see ULAF+ User Manual [2]).

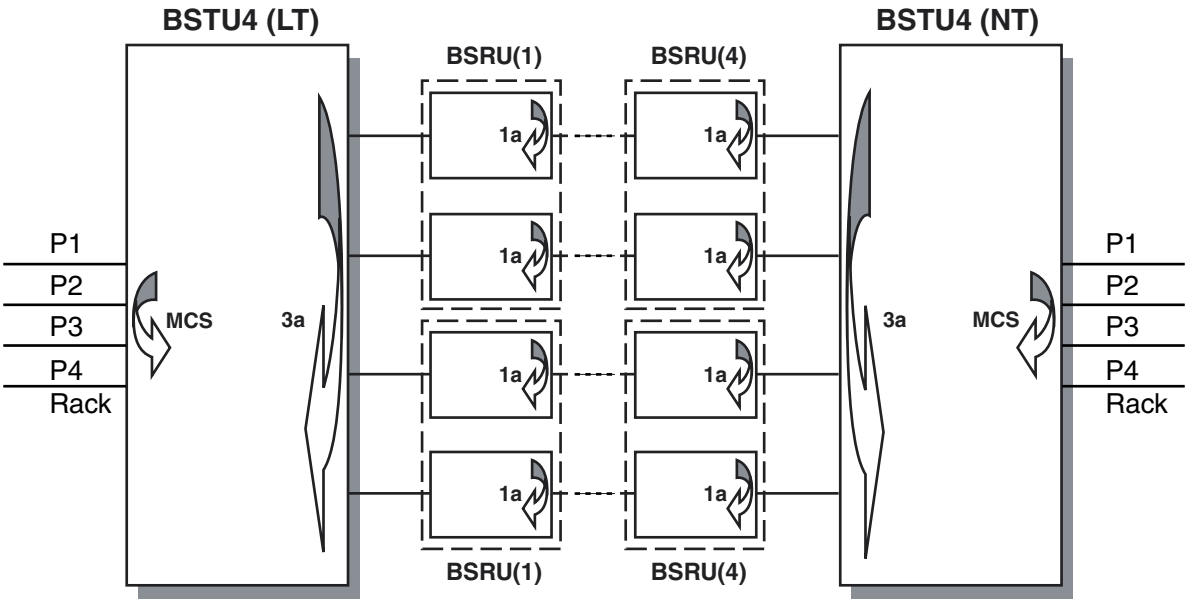


Fig. 1.49 Loopbacks of the BSTU4 – BSRU – BSTU4 link

L2 Test Switch Mode

With the 'L2 Test Switch Mode' function, learning addresses is switched off and all incoming packets are forwarded to all available Ethernet ports. In the 'L2 Switch Test Mode', packets that the Ethernet test device has generated can consequently be split-lot transferred by the switch on the BSTU4 (LT) to the test device again.

i Before inserting the loopback or the 'L2 Switch Test Mode' you should separate the LAN from the BSTU4, as otherwise the data traffic on the LAN is disturbed.

1.14.4 Loopbacks of the GTU4

The available loopbacks for the GTU4 depend on whether you use the unit together with a QSTU (as LT) or with another GTU4.

Loopbacks on a QSTU - GTU4 link

The 2b loopback on a QSTU and GTU4 can be inserted individually for each channel. The quality of an individual line can consequently be checked with a telecom BERT (Bit Error Rate Tester) on the G.703 interface.

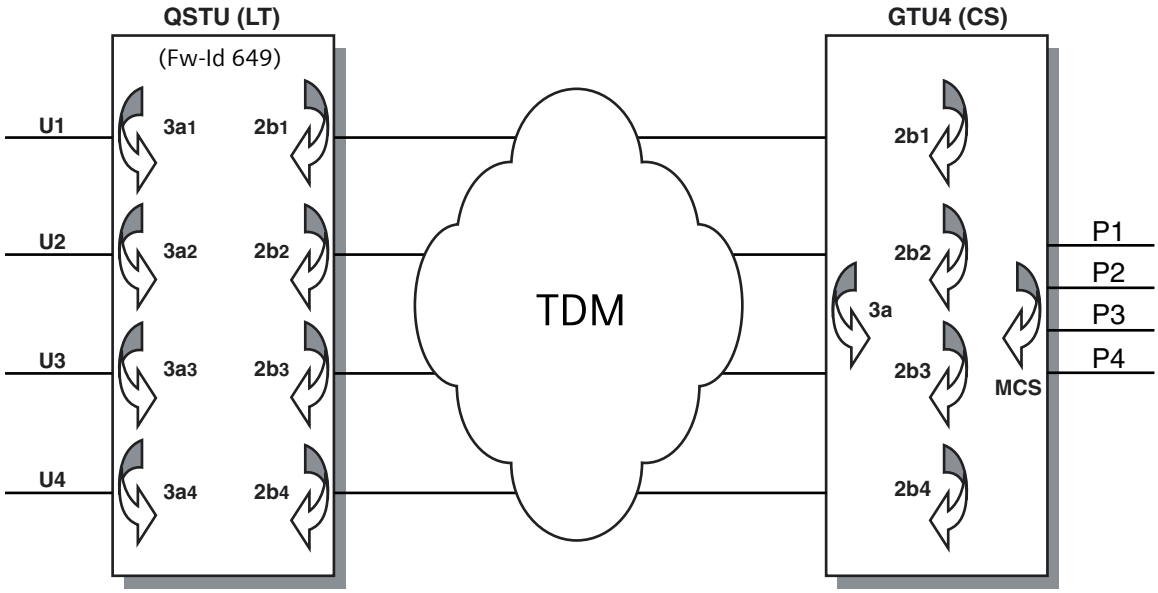


Fig. 1.50 Loopbacks on a QSTU - GTU4 link

i The 2b loopback on a GTU4 is only activated when there is no valid MCS signal on the corresponding interface (alarm 'LOM' must be activated). This attribute ensures that a GTU (CS) is visible again in the management as soon as the test is over.

Loopbacks on a GTU4 - GTU4 link

The MCS loopbacks on the GTU4 can be inserted together for all activated channels. The test with an external Ethernet test device can be made after the 'L2 Switch Test Mode' has been activated with the GTU4 that the external test device is connected to (see ULAF+ User Manual [2]).

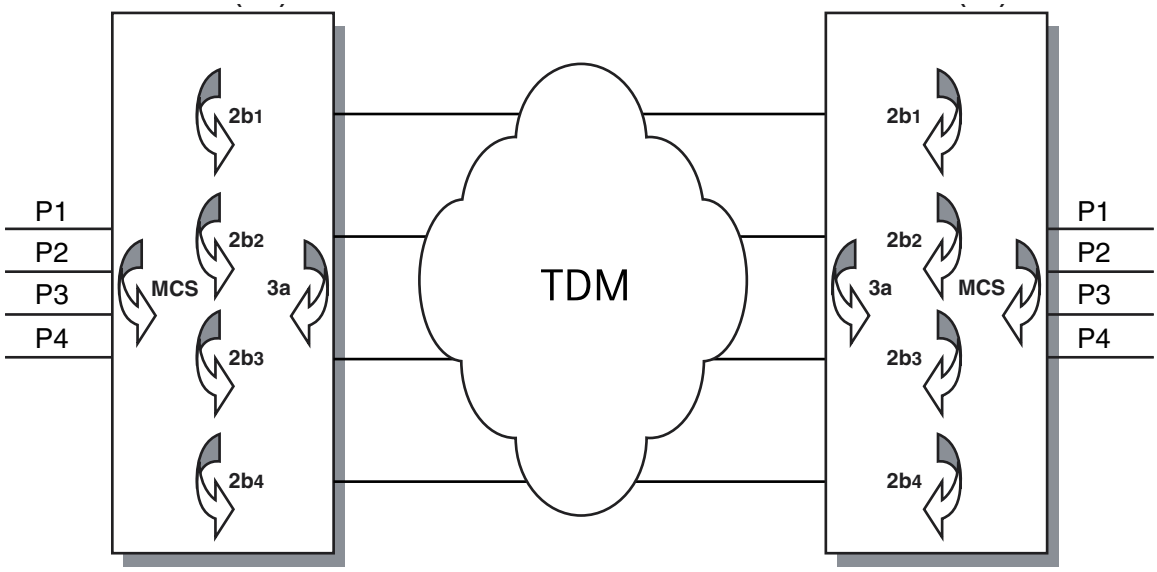


Fig. 1.51 Loopbacks on a GTU4 - GTU4 link

L2 Test Switch Mode

With the 'L2 Test Switch Mode' function, learning addresses is switched off and all incoming packets are forwarded to all available Ethernet ports. In the 'L2 Switch Test Mode', packets that the Ethernet test device has generated can consequently be split-lot transferred by the switch on the GTU4 (CM) to the test device again.

i The 2b loopback on a GTU4 is only activated when there is no valid MCS signal on the corresponding interface (alarm 'LOM' must be activated). This attribute ensures that a GTU (CS) is visible again in the management as soon as the test is over.

i Before inserting the loopback or the 'L2 Switch Test Mode' you should separate the LAN from the GTU4, as otherwise the data traffic on the LAN is disturbed.

1.14.5 Loopback on the BOTU/QOTU

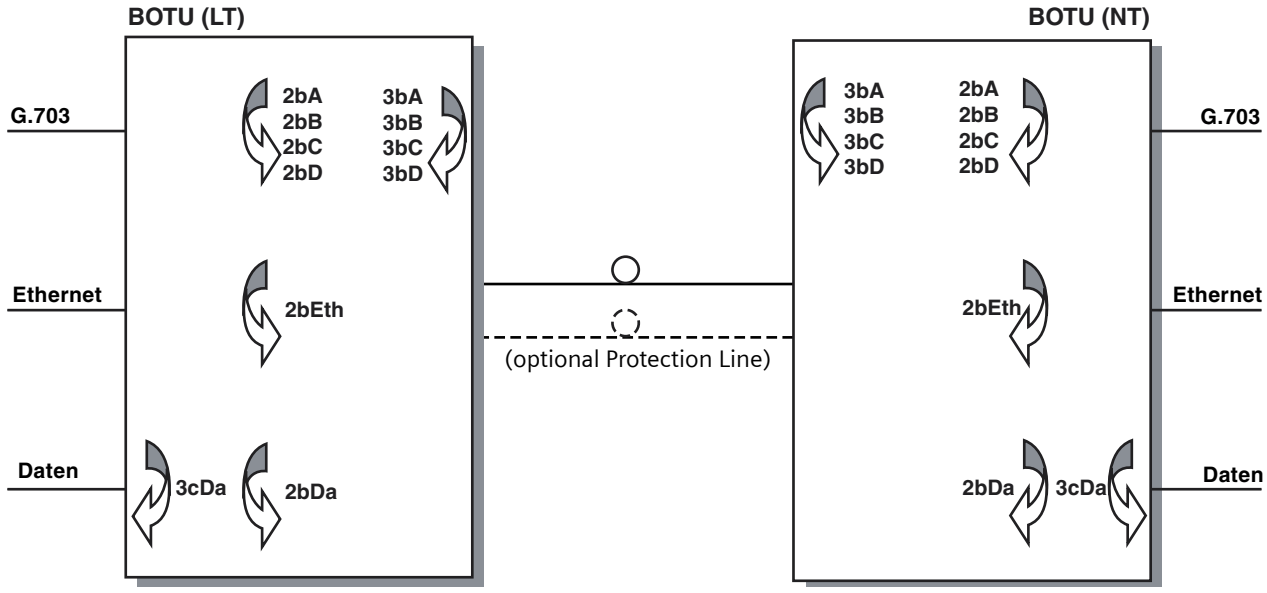


Fig. 1.52 Loopbacks on a BOTU – BOTU link

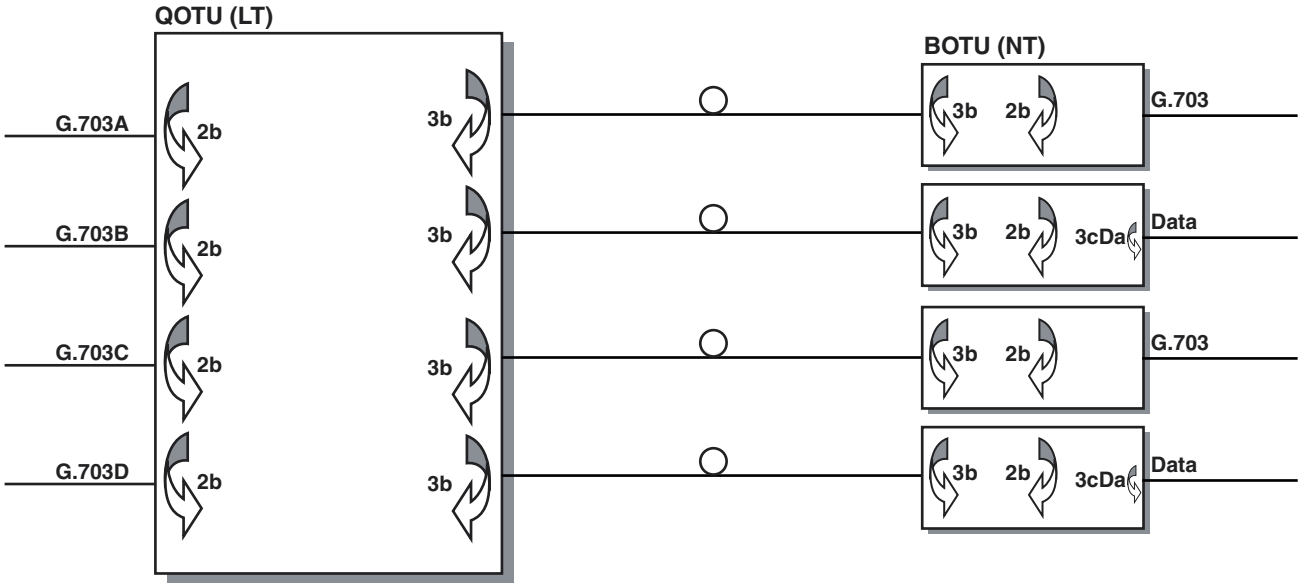


Fig. 1.53 Loopbacks on a QOTU – BOTU link

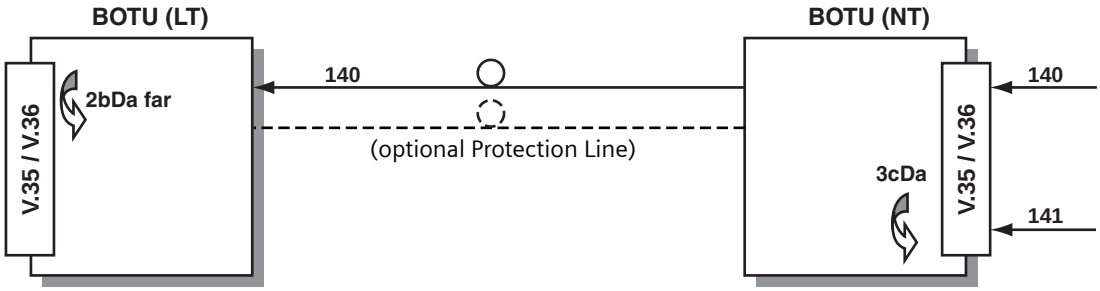


Fig. 1.54 Loopback via control line 140/141 (V.35 / V.36)

For BOTU-BOTU links, the loopbacks 2bDa far can be inserted via the control lines 140/141 and the loopbacks 3c local can be inserted locally.

Additionally the loopback 2bDa far can be inserted via TMN.

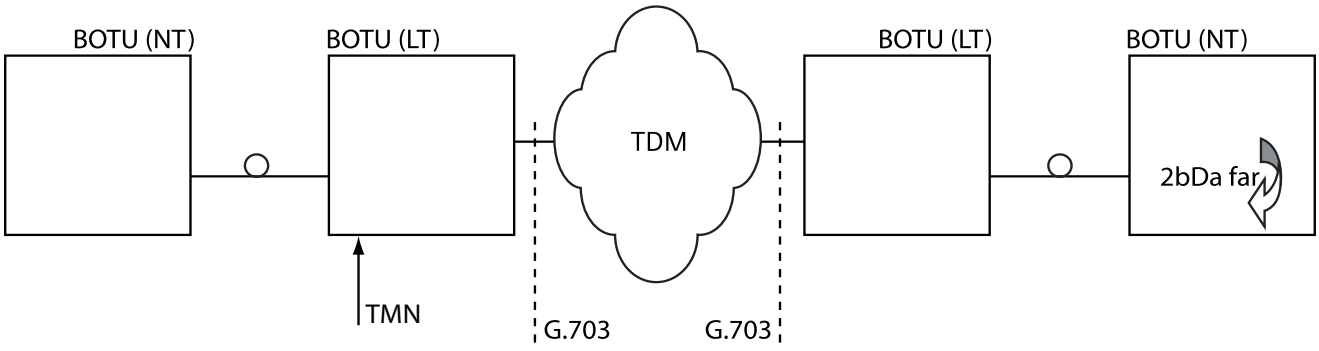


Fig. 1.55 Loopbacks 2bDa far via TMN

In addition to the loopbacks indicated above, it is also possible to enable the 'Switch Test Mode' on the BOTU. This makes the Ethernet switch transparent, and thus makes loopbacks on the Ethernet interface possible.

The loopbacks which are available for a BOTU - BOTU link depend on the hardware fitted and the operating mode. All loopbacks can be configured to be transparent or non-transparent.

1.14.6 Loopback on the GTU

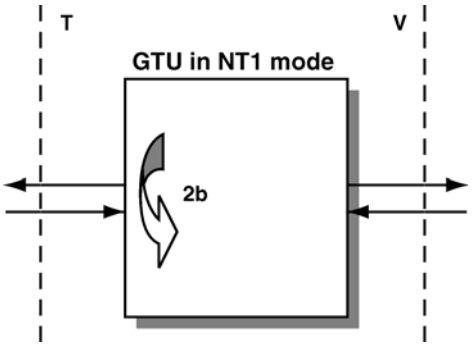


Fig. 1.56 Loopback on the GTU in NT1 mode

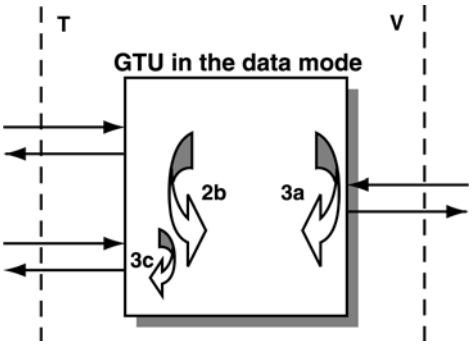


Fig. 1.57 Loopback on the GTU in data mode

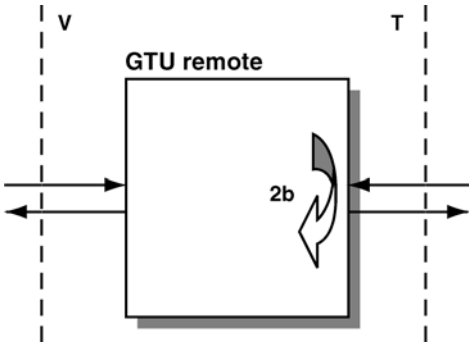


Fig. 1.58 Loopback on the GTU in ‘GTU remote’ mode

1.15 Bit Error Rate Measurement (BER)

You can use Bit Error Measurement to perform true error rate measurement during installation. A bit pattern (PRBS Pseudo Random Bit Sequence) instead of useful data is transmitted from the built-in pattern generator.

In contrast to the CRC4/CRC6 values, when **block** errors from precisely defined line sections are produced (CRC6: HDSL link, CRC4: G.704 link), Bit Error Rate Measurement produces a **bit** error rate.

The length of the test pattern used is 2^{15} -1. The test times that can be set are
– 1 minute
– 10 minutes
– 60 minutes
– 24 hours (only SHDSL termination units).

The following information can be read out:
– Bit Error Rate
– Error Free Seconds
– Number of Errors
– Number of seconds with ‘Pattern Sync Loss’

1.15.1 Bit Error Rate Measurement with QSTU (FW-ID 633), BSTU

When the QSTU (FW-ID 633) and the BSTU are being used, the modes
- G.703 IF (with a G.703 interface) and
- Data IF (with a data- or Ethernet interface)

is available.

Bit Error Rate Measurement can be used
- independently of the interface (G.703/data or Ethernet interface),
- with any bitrate (64 kbit/s to 11392 kbit/s),
- with any operating mode, and
- with all clock settings (except that 'V/T-Interface' may not be configured on the NT as priority 1 Alarm)

One generator per system may be used. The loopbacks are inserted manually for all interfaces.

In the Add/Drop and Add/Top mode, the entire data stream is available on the untested interface.

i In the illustrations below, all the loopbacks concerned are drawn in. For a BER test, it is sufficient to delimit the appropriate sublink by inserting the loopback.

BER Test of a BSTU-BSTU link

Fig. 1.59 shows you the functionality of the BER test of a BSTU-BSTU link.

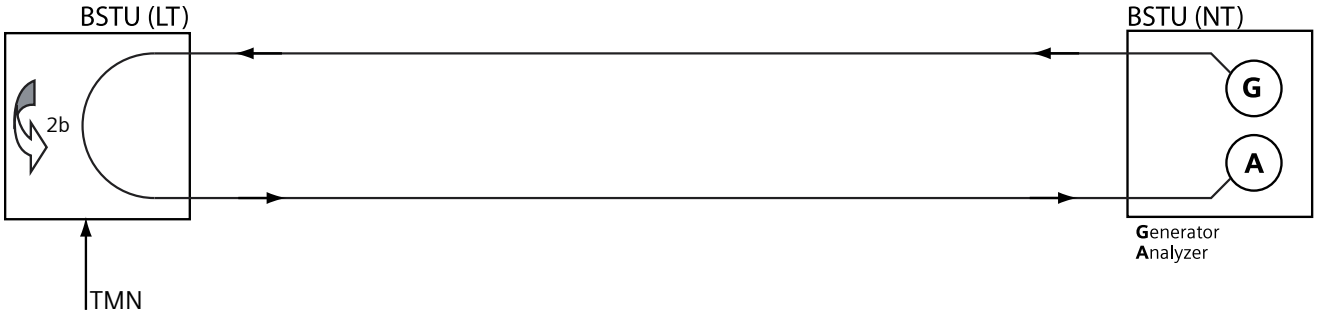


Fig. 1.59 Mode of operation of the BER test of a BSTU-BSTU link

BER Test of a QSTU-BSTU link

Fig. 1.60 shows you the functionality of the BER test of a BSTU-BSTU link resp. a QSTU-BSTU-link.

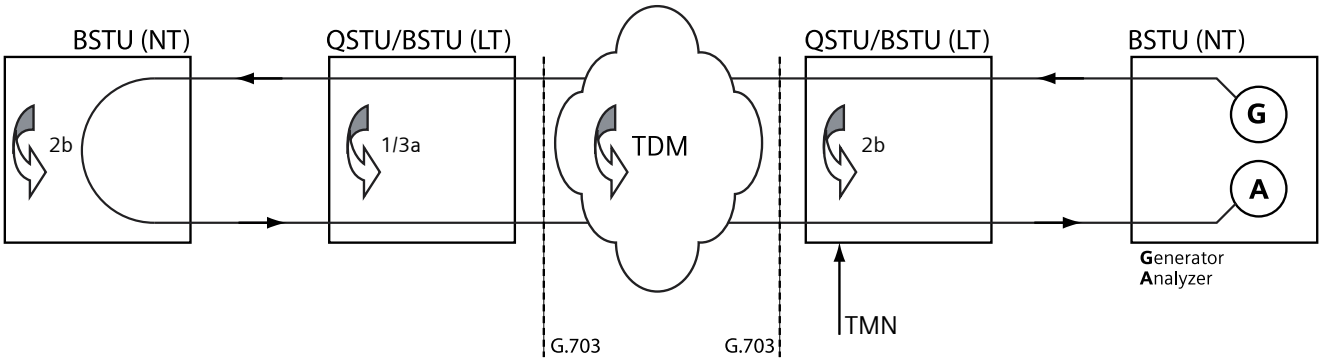


Fig. 1.60 Mode of operation of the BER test of a BSTU-BSTU resp. QSTU-BSTU link

1.15.2 Bit Error Rate Measurement with QSTU, (FW-ID 649), BSTU4, GTU4

The BER test of the BSTU4 or GTU4 checks all activated MCS channels (Multi Channel Synchronization) together. The MCS payload is replaced here by a bit pattern (PRBS/Pseudo Random Bit Sequence).

If the 'Allow automatic BERT Loop' function is not switched on, or you do not want to use the 'MCS' loopback on the remote BSTU4, you can also use the 2b (only on the QSTU) or 3a loopbacks for the BER test. In this case you must activate the loopbacks for all channels used (configured).

The MCS loopback is automatically inserted on the remote BSTU4 by the MCS signal. You can deactivate this function using LCT (see ULAF+ User Manual [2]).

BER test of a QSTU-BSTU4 link

Fig. 1.61 shows you the basic functionality of the BER test of a QSTU-BSTU4 link.

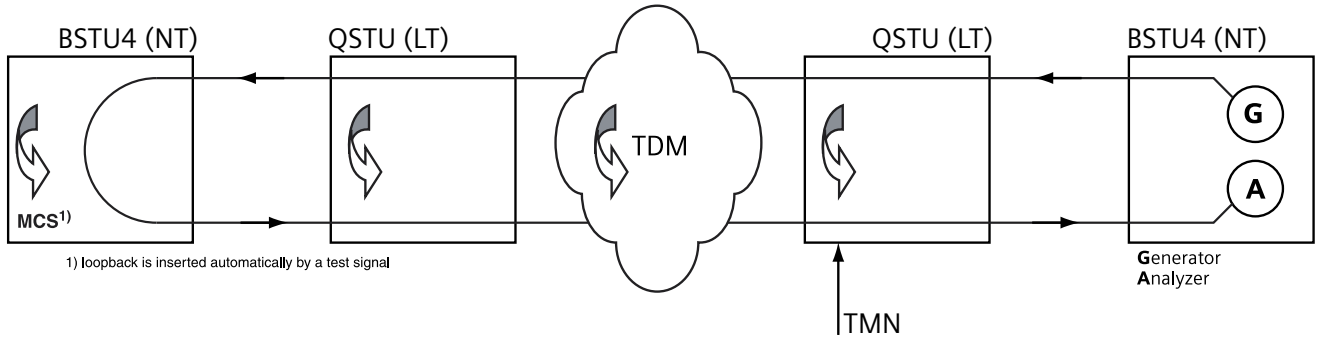


Fig. 1.61 Mode of operation of the BER test of a QSTU - BSTU4 link

BER test of a QSTU-GTU4 link

Fig. 1.62 shows you the basic functionality of the BER test of a QSTU-GTU4 link.

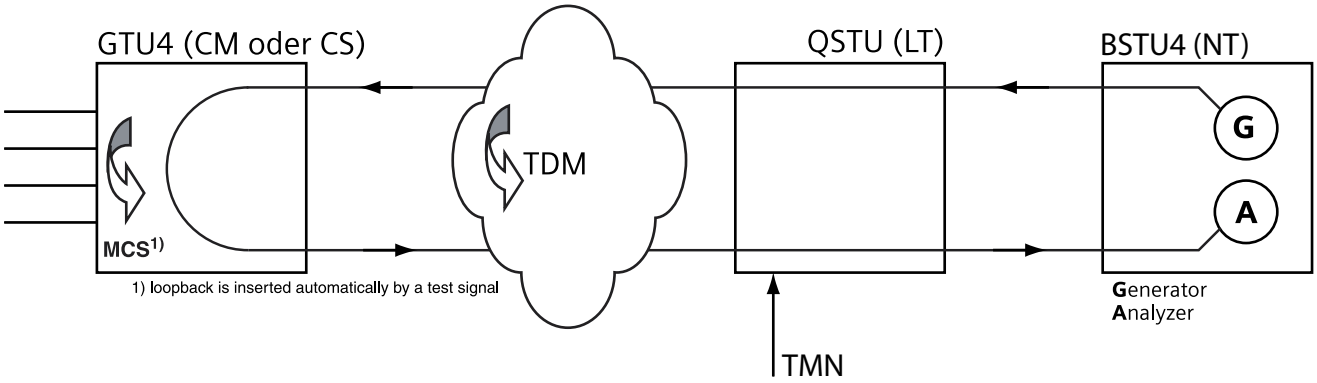


Fig. 1.62 Mode of operation of the BER test of a GTU4 (as CM or CS)

BERT test of a BSTU4-BSTU4 link

Fig. 1.63 shows you the basic functionality of the BER test of a BSTU4-BSTU4 link. The generator is also on the NT with this application.

Fig. 1.63 Mode of operation of the BER test of a BSTU4-BSTU4 link

BERT test of a GTU4- GTU4 link

With a purely GTU4-GTU4 connection the generator is always on the GTU4 configured as master (CM). With a connection with two CM, the local generator is always activated (Fig. 1.64).

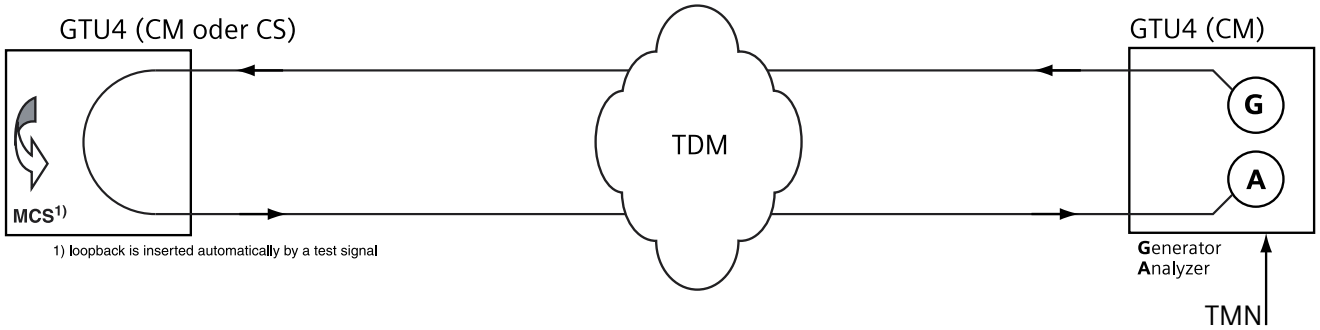


Fig. 1.64 Mode of operation of the BER test of a GTU4-GTU4 link

1.15.3 Bit Error Rate Measurement with BOTU, QOTU

If the BOTU and the QOTU are used, the bit error rate of all possible connections (G.703, data and Ethernet connections) can each be set separately. The remaining connections are not affected by this measurement. The test data generator and bit error counter are on the NT. The test data generated by the generator can be looped back to the bit error counter at various points along the transfer path (Fig. 1.65). The loopback must be set up manually using the TMN.

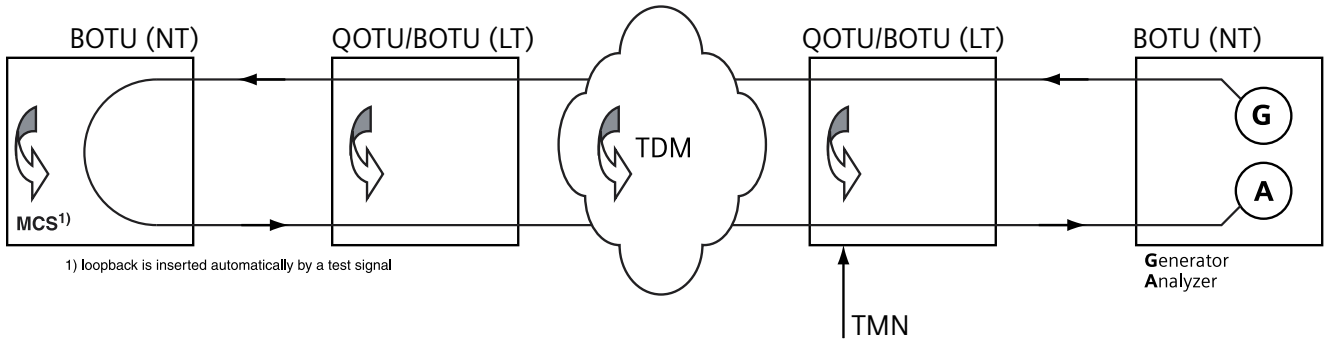


Fig. 1.65 Mode of operation of the BER test of a BOTU–BOTU link

i The bit error rate measurement cannot be started if the V/T interface on the NT belonging to the measurement is supplying the clock as the 'top' prioritized clock source.

2 Function of the system components

This Chapter describes the function of the system components:

- ULAF+ subrack (Chapter 2.1),
- Operating and Maintenance Interface OMI SNMP (Chapter 2.2),
- BSTU termination unit (Chapter 2.3)
- QSTU termination unit (Chapter 2.4)
- BSTU4 termination unit (Chapter 2.5)
- Ethernet over TDM Inverse Multiplexer GTU4 (Chapter 2.6)
- Optical termination unit BOTU/QOTU (Chapter 2.7),
- G.703 termination unit GTU (Chapter 2.8),
- Interface modules to the plug-in units and desktop models (Chapter 2.9),
- Module for the clock and alarm interface (Chapter 2.9.3) and
- SHDSL regenerator BSRU (Chapter 2.10)

2.1 ULAF+ subrack

2.1.1 Overview

The subrack accepts plug-in units in double eurocard format. Slot 0 is reserved for the OMI SNMP in each case. The remaining 16 slots can be equipped with either BSTU, QSTU, BSTU4, GTU4, BOTU, QOTU or GTU transmission units.

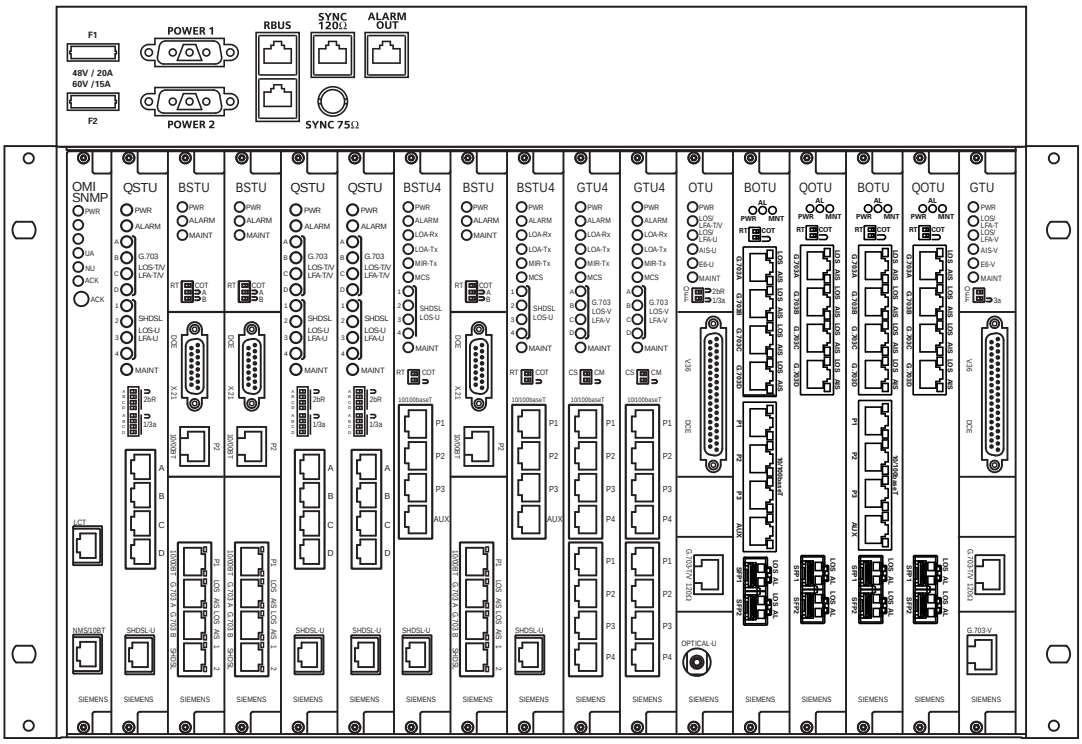


Fig. 2.1 Typical configuration of a ULAF+ subrack (S3105-B128-C211)

The ULAF+ subrack can be used at the exchange as well as at the subscriber side.

The backplane circuit board

The backplane circuit board
- supplies the timing pulse
- delivers the 48 V_{DC} / 60 V_{DC} supply voltage to the termination plug-in unit
- links the termination plug-in units with the OMI SNMP.

Timing pulse injection

The timing pulse is injected via a BNC female connector with an input impedance of 75 Ω or via a RJ45 connector with an input impedance of 120 Ω. For further details of the ULAF+ timing concept, see Chapter 1.12.

Cascading via the OMI bus

One OMI SNMP can control up to 64 termination plug-in units, which are distributed in a maximum of 4 subracks and linked via the OMI bus. In this case, the subrack in which the OMI SNMP is inserted is the master and, as such, it is connected to the management system (LCT or AccessIntegrator).

i

You cannot cascade subracks equipped with QSTU/QOTU plug-in units. The reason for this is that the QSTU/QOTU occupies up to four slot addresses.

Addressing

The subracks are addressed by means of DIP switches on the backplane circuit board. For further information, refer to the ULAF+ Installation Manual [1].

2.1.2 Interfaces

The following interfaces are located on the frontpanel of the subrack:
- the 48 V_{DC} / 60 V_{DC} operating voltage interface (Power 1 and Power 2)
- the clock supply interface (BNC female connector, 75 Ω)
- the clock supply interface (RJ45 female connector, 120 Ω)
- the collective alarm message (one RJ45 female connector)
- the cascader interface for cascading subracks with the aid of the OMI bus (two RJ45 female connectors)

All those interfaces which need to be accessed after assembly of the subrack are located on the termination plug-in unit and are accessible from the front. For further details of these interfaces, see Chapter 2.2 and the following text.

2.2 Operating and Maintenance Interface OMI SNMP

2.2.1 Overview

The Operating and Maintenance interface unit (OMI SNMP) is the link between the termination plug-in units and the LCT or AccessIntegrator. One OMI SNMP can control up to 64 termination plug-in units in 4 subracks.

Since the functionality of the OMI and the OMI SNMP are largely identical, only the term OMI is used hereafter in this manual. Where there are specific differences between the two modules, these will be pointed out.

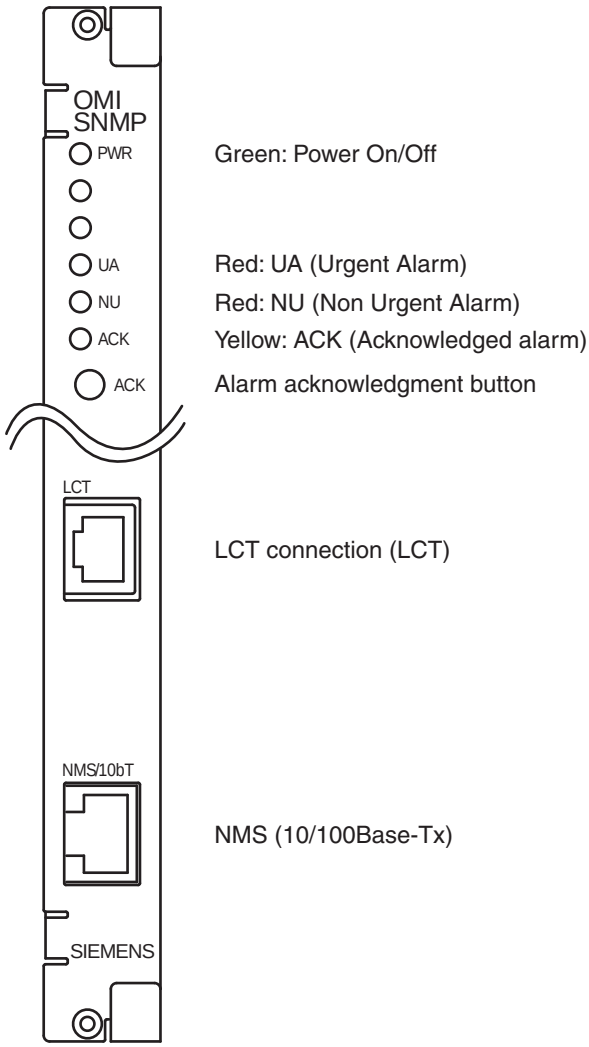


Fig. 2.2 Front panel of the OMI SNMP

In the subrack the OMI SNMP is linked with the termination plug-in units via the backplane circuit board. The termination plug-in units in the other subracks are connected via the OMI bus. For further details about cascading the subracks, see ULAF+ Installation Manual (IMN) [1].

2.2.2 Indicators and operating elements

Four LEDs for status indication are located on the front panel of the module; see Fig. 2.2:

Collective alarms

The OMI SNMP collects the alarms from all the associated modules and indicates any faults by means of the corresponding LEDs on the front panel.

Alarm acknowledgment

It is possible to acknowledge an alarm (urgent/non-urgent) with the alarm acknowledgment button (ACK) on the front panel of the OMI SNMP. An alarm acknowledged in this way is indicated by a yellow LED on the OMI SNMP. The LED of the urgent or non-urgent alarm is canceled and the alarm output of the corresponding plug-in unit blocked.

If a new alarm occurs after you have clicked on the alarm acknowledgment button, the 'urgent alarm (UA)' or 'non-urgent alarm (ND)' LED is reactivated. After the acknowledged alarms have disappeared, the yellow LED goes out.

Indicator (LED)	Designation	Description
Green	PWR	Power ON
Red	UA	Urgent Alarm
Red	NU	Non Urgent alarm
Yellow	ACK	Acknowledged alarm

Tab. 2.1 Visual indications on the OMI SNMP

2.2.3 Interfaces

The OMI SNMP is connected to the LCT via the LCT interface (RS232) and the NMS AccessIntegrator via the 10Base-T interface (Fig. 2.3).

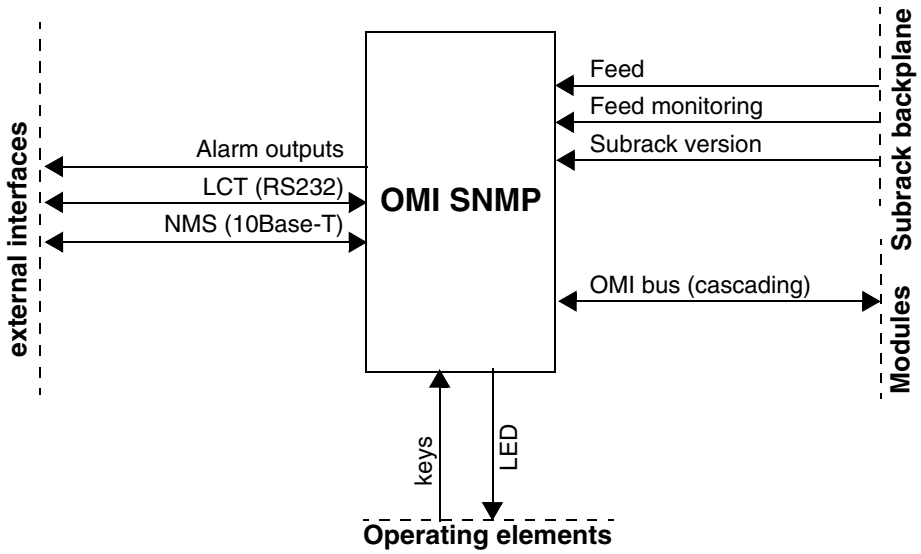


Fig. 2.3 Interfaces of the OMI SNMP

RS232 interface

The interface is in the form of an RJ45 female connector. The baud rate is 9600 baud.

Ethernet interface

The Ethernet interface (10Base-T) is implemented using an RJ45 female connector.

Alarm outputs

The OMI SNMP is equipped with three mutually independent non-grounded alarm contacts. The urgent alarm is designed as a normally-closed contact in order to be able to emit an alarm in the event of a power failure. In a non-grounded type of alarm current circuit, the maximum load is 60 V / 0.2 A. If the alarm current circuit incorporates a ground connection, the maximum load is 100 V / 0.2 A. The alarm contacts are isolated from the remainder of the circuit by means of operational insulation. The alarm outputs are routed to an RJ45 connector on the backplane circuit board.

Subrack version

The OMI SNMP is automatically notified, via the ‘Subrack version’ input, of the version and address of the subrack.

OMI bus

The OMI bus links the management plug-in unit with the termination plug-in unit in the other subracks (cascading). The signal level conforms to Standard V.11. The bit rate is 38.4 kbit/s.

The precise contact PIN assignment for the interfaces is described in the ULAF+ Installation Manual [1].

2.2.4 Power supply

Supply

Power is supplied to the OMI SNMP via the backplane circuit board of the subrack. The supply consists of a non-grounded voltage on 48 V_{DC} / 60 V_{DC}.

Supply failure

If the voltage at one of the supply inputs is less than -40 V, the OMI SNMP emits a non urgent alarm. In the event of a total failure of the supply, it emits an urgent alarm.

2.3 BSTU termination unit

2.3.1 Overview

The BSTU termination unit is an universal SHDSL module for 1 or 2 wire-pair connections. The latest SHDSL transmission technology permits high bandwidths and the maximum range in the access network.

The BSTU supports SHDSL bitrates of 192 kbit/s - 5696 kbit/s per wire-pair. Variants with 1 or 2 SHDSL interfaces, and with or without remote power feed (RPS) onboard offer an optimal configuration for every application situation.

A large selection of different subscriber interfaces are available to the user. Thus, G.703, X.21 and Ethernet interfaces are available "on-board", and a slot for ULAF+ data modules permits the use of X.21, V.35, V.36, Advanced Bridge and Advanced Bridge and Router modules.

BSTU variants can be supplied with the following equipment fitted:

Siemens Part No.:	Variants	SHDSL Interface(s)	G.703 (RJ45) onboard	Slot for Data module	Ethernet-Interface	RPS onboard	Slot for Alarm- and Clock-module
S3118-H631-E111	Desktop unit	1	– –	– –	1	– –	– –
S3118-H631-B110	Desktop unit	1	1	– –	– –	– –	– –
S3118-H631-B210	Desktop unit	1	– –	Ja	– –	– –	– –
S3118-H631-E310	Desktop unit	1	– –	No (X.21 onboard)	– –	– –	– –
S3118-H632-E111	Desktop unit	2	– –	– –	1	– –	– –
S3118-H632-D110	Desktop unit	2	2	– –	– –	– –	– –
S3118-H632-D210	Desktop unit	2	2	Yes	– –	– –	Yes
S3118-H632-D211	Desktop unit	2	2	Yes	1	– –	– –
S331-H632-D220	Desktop unit	2	2	Yes	– –	2	Yes
S3118-H632-D221	Desktop unit	2	2	Yes	1	2	Yes
S3118-J632-E111	Plug-In unit	2	– –	– –	1	– –	– –
S3118-J632-D210	Plug-In unit	2	2	Yes	– –	– –	– –
S3118.H632.D220	Plug-In unit	2	2	Yes	– –	2	– –
S3118-J632-D221	Plug-In unit	2	2	Yes	1	2	– –

Tab. 2.2 Mounting variants of the BSTU

Together with the BSRU (Regenerator) and the QSTU (with FW-ID 633), the BSTU makes up a system family. When operated with the BSTU, the QSTU must always be used as an LT, and on the exchange side serves the purpose of concentrating up to 4 links. The BSTU supports up to 8 SHDSL regenerator stages (with the BSRU).

The following operating modes are supported by the BSTU:

- Bit-transparent transmission with 2 Mbit/s interfaces, conforming to ITU-T G.703 [7]
- Frame structured transmission with 2 Mbit/s interfaces, conforming to ITU-T G.704 [8]
- ISDN Primary Rate access, conforming ITU-T I.431 [14], ETSI ETS 300 011 [20] / ETSI ETS 300 233 [21]
- Connection of data equipment (X.21, V.35, V.36), granularity nx64 kbit/s, 10/100Base-Tx (Ethernet)
- 2 Mbit/s 'Add/Drop' (Mixed mode Fractional E1 and Data)

'Add/Top' If sufficient transmission bandwidth is available it is possible, in addition to the G.703 interfaces (transparent, structured, ISDN-PRA), to realize a data connection in the same system (1 or 2 wire-pair operation) via Ethernet, X.21, V.35 or V.36 (Add/Top mode). With this application, the optimal SHDSL bitrate is calculated automatically. Further details about the Add/Top mode will be found in chapter 1.9.4.

‘Mapped Mode’ For the purpose of matching to the terminal devices used, and for optimizing the SHDSL bandwidths (=range), the mapping of the CAS and the control lines, together with the transmission of time slot 0 (TS0) can be flexibly configured in the 'Mapped Mode'. As a result, the restrictions of a fixed allocation for CAS (TS16) and the 2 Mbit/s limit (TS32) are eliminated. With this operating mode, the SHDSL payload bitrate of the system is automatically calculated by reference to the subscriber interface configurations, so that the link is activated with the required SHDSL payload bitrate.

As an alternative to this, it is also possible for the user to prescribe the SHDSL payload bitrate by configuration.

2.3.2 Operating modes of the BSTU

When the BSTU is used in 1 wire-pair operation, system configuration is not required.

BSTUs with 2 SHDSL interfaces can be used as

- '1-system modules' with SHDSL transmission over 2 wire-pairs, so as to increase the range,
  or as
- ‘2-system modules', with 1 wire-pair per system.

The systems can be activated or deactivated via the LCT or AcI (see ULAF+ User Manual [2]).

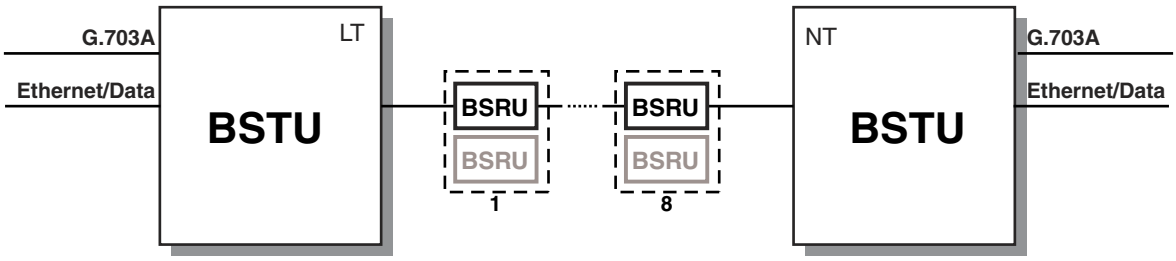


Fig. 2.4 BSTU(LT) – BSTU(NT); 1x 1 wire pair mode

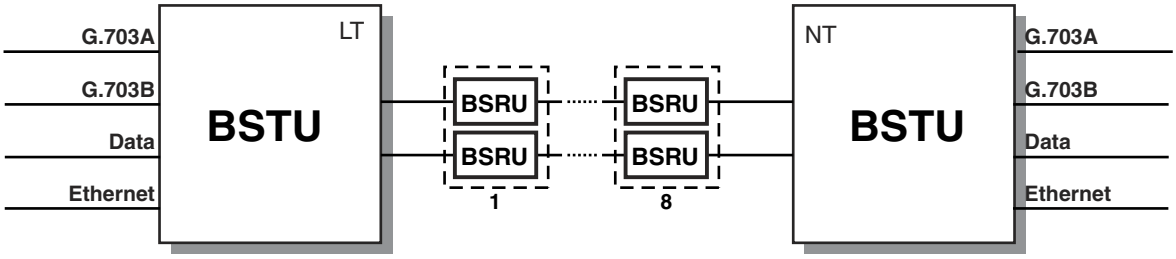


Fig. 2.5 BSTU(LT) – BSTU(NT); 2x 1 wire pair mode

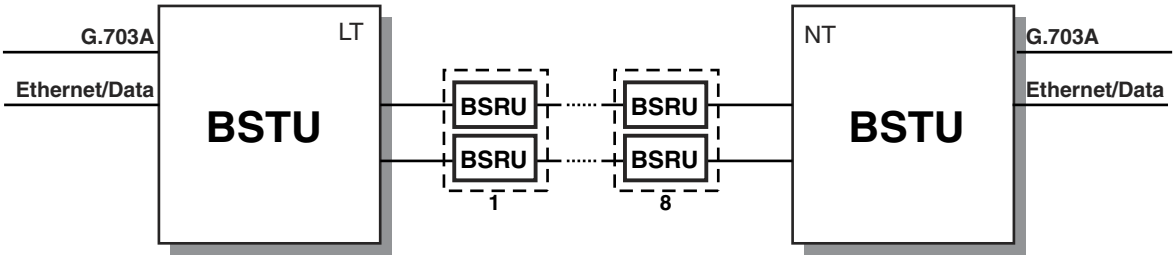


Fig. 2.6 BSTU(LT) – BSTU(NT); 1x 2 wire pair mode

For BSTUs in the 2x 1 wire-pair mode, the standard assignment is

- the data interface to 'System A' and
- the Ethernet interface to 'System B'.

Using the LCT (see ULAF+ User Manual [2]) the Ethernet interface can be assigned to 'System A'. In this case 'System A' can no longer use the data interface

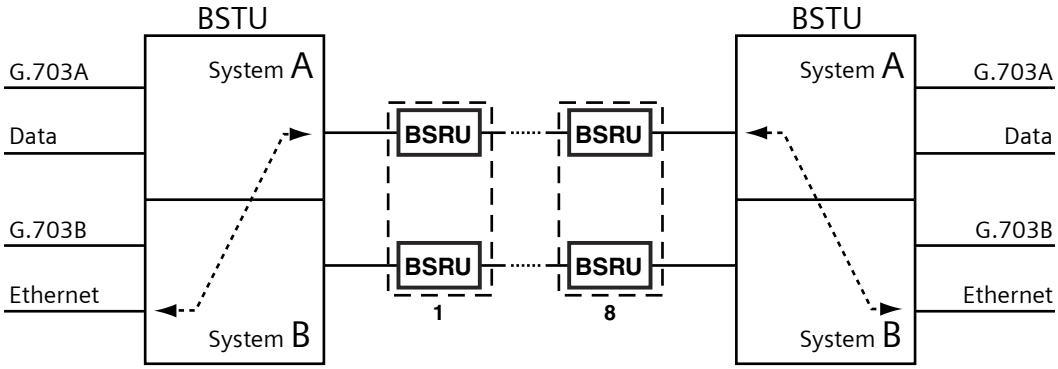


Fig. 2.7 Ethernet interface assigned to ‘System A’

The operating modes of the BSTU in conjunction with the QSTU are described in chapter 2.4.1.1.

2.3.3 Interfaces of the BSTU

2.3.3.1 SHDSL interface(s)

Depending on the equipment variant, the BSTU is fitted with one or two SHDSL interfaces. The interfaces support the extended SHDSL standards (ETSI Annex E and ITU Annex G), so that in a BSTU - BSTU application bitrates of up to 5696 kbit/s per wire-pair can be achieved.

2.3.3.2 G.703 interfaces

The BSTU has two independent G.703 subscriber interfaces. These interfaces are of identical design.

The G.703 interface can be operated at 120 Ω or 75 Ω. The impedance switchover is effected by LCT/AcI and is individually configurable for each interface. In the 75 Ω case, connection is made via an adapter cable which can be purchased separately.

2.3.3.3 Ethernet interface

The Ethernet interface of the BSTU has the following features:

- 10/100 Base-Tx in accordance with IEEE 802.3u
- Full Duplex / Half Duplex
  With Half Duplex as opposed to Full Duplex, simultaneous sending and receiving is not possible.
- Auto negotiating in accordance with IEEE 802.3u for
  – Full-/Half Duplex mode
  – 10/100 Base-Tx
  – Flow Control
- Automatic MDI/MDI-X
  Auto-MDI/MDI-X enables the automatic adjustment of the transmission and reception line of a port, i.e. on the connected Ethernet cable (crossed or not crossed) and the configuration of the opposite terminal.
- Flow Control
  – 'Pause frames' are sent (as per IEEE 802.3x) in full duplex operation
  – The backpressure method is used in half duplex operation
- Bandwidth limiting
  The maximum ingress data rate of the Ethernet interface can be limited in steps of 32 Kbits/s (policing).
- Link status information is available for the Ethernet interface (link up / 10/100 BASE-Tx / full duplex / half duplex)
- Link Failure Propagation
  'Link failure propagation' (LFP) disables the ports on the switch if the synchronization is lost on the U interface. This allows devices connected to the BSTU, such as a switch with 'spanning tree' or 'link aggregation', to react faster to a connection interrupt. A connection interrupt is indicated via 'LFP alarm' for all connected Ethernet interfaces.

2.3.3.4 LCT interface

The desktop variant is fitted with an RJ45 connector on the front panel, for connecting the LCT.

2.3.3.5 Clock and alarm module interface

The fully equipped variants of the desktop unit (with and without RPS) can be equipped in addition with a clock and alarm module. An overview of the equipment fitting variants will be found in Tab. 2.2. Further details of the clock and alarm module will be found in chapter 2.9.3.

2.3.3.6 Slot for Data interface modules

The BSTU can be expanded with additional data interface modules. An overview of the equipment fitting variants will be found in Tab. 2.2. Further details of the interface modules will be found in chapter 2.9.

2.3.4 Service functions

Loopback circuits and CRC checksums can be used for fault localization.

Loopback curcuits are activated either by software command (via the LCT for example) or by means of switches.

See chapter 1.14.1 for further information about loopback circuits.

2.3.5 Using the BSTU as a plug-in unit

2.3.5.1 Mechanical construction

The plug-in unit is produced to double eurocard format. The BSTU is equipped with a front panel for insertion into the subrack. The BSTU plug-in unit can be supplied with various equipment variants (see Tab. 2.2)

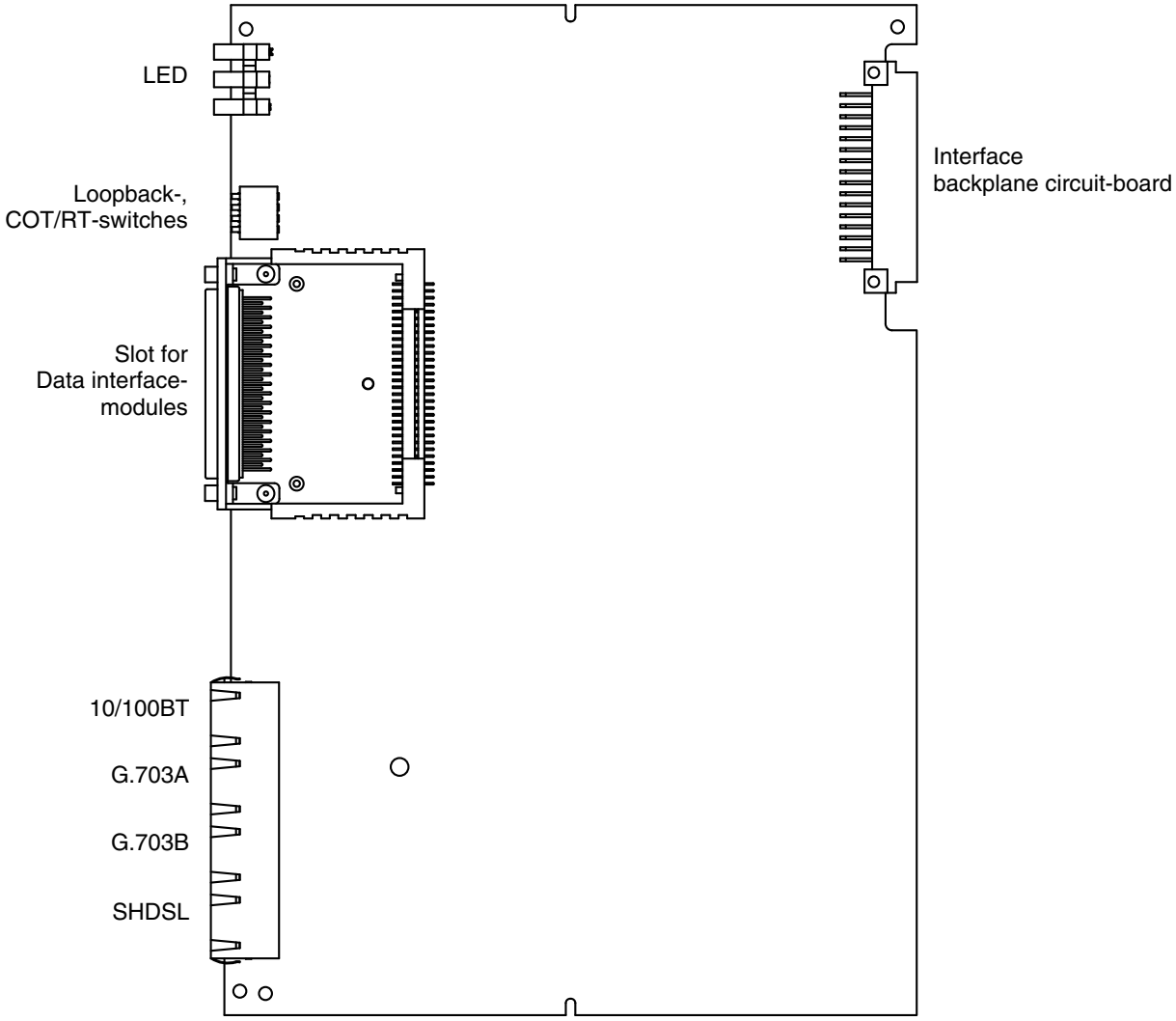


Fig. 2.8 BSTU plug-in unit

2.3.5.2 Display and operating elements

Status display

As a plug-in unit, the BSTU has 3 separate LEDs on its front panel. Integrated into each of the connectors for the Ethernet, G.703 and SHDSL interfaces, are 2 LEDs.

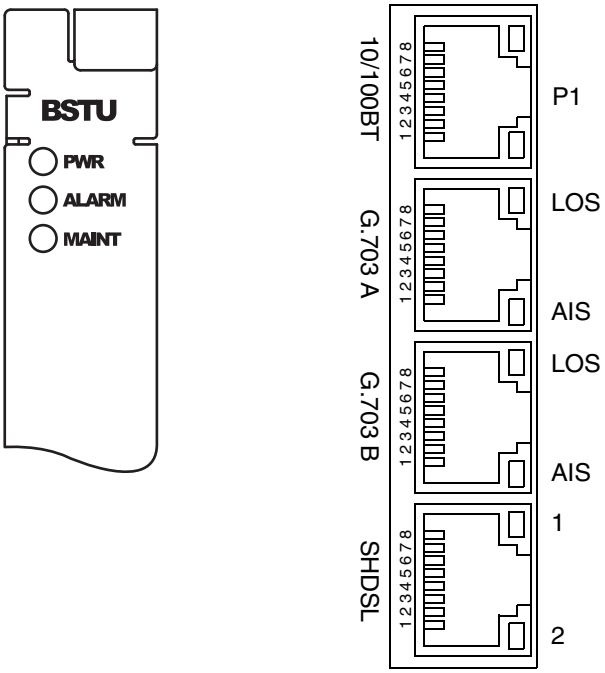


Fig. 2.9 Visual signalling of the BSTU plug-in unit

LED	Color	Status	
		Off	**On**
PWR	green	No power supply	Power supply o.k.
Alarm	red	No alarm	Urgent alarm[2)]
	yellow	No alarm	Non-urgent alarm[2)]
MAINT	yellow	No maintenance function	**on:** Loopback active, traps deactivated, BERT activated, layer 2 switch test mode activated **flashing:** Firmware on LT and NT are not compatible or configuration is not supported by NT
10/100BT (P1)	yellow	Half Duplex	**on:** Full Duplex **flashing:** Collision with Half Duplex
10/100BT (P1)	green	no connection/ no Traffic	**on:** Link Up **flashing:** Traffic
LFA/LOS-T/V (G.703 A)	red	No alarm	**on:** LOS **flashing:** LFA [1)]
AIS (G.703 A)	yellow	No alarm	AIS

Tab. 2.3 Visual signalling of the BSTU plug-in unit

LED	Color	Status	
		Off	On
LFA/LOS-T/V (G.703 B)	red	No alarm	**on:** LOS **flashing:** LFA [1)]
AIS (G.703 B)	yellow	No alarm	AIS
1 (SHDSL-Schnittstelle 1)	red	No alarm	**on:** LOS **flashing:** LFA, LOSW, (Training) [1)]
2 (SHDSL-Schnittstelle 2)	red	No alarm	**on:** LOS **flashing:** LFA, LOSW, (Training) [1)]

1) Visual signalling according Fig. 2.10

2) Priority of the alarm messages (urgent/non-urgent) ist made with the LCT

Tab. 2.3 Visual signalling of the BSTU plug-in unit

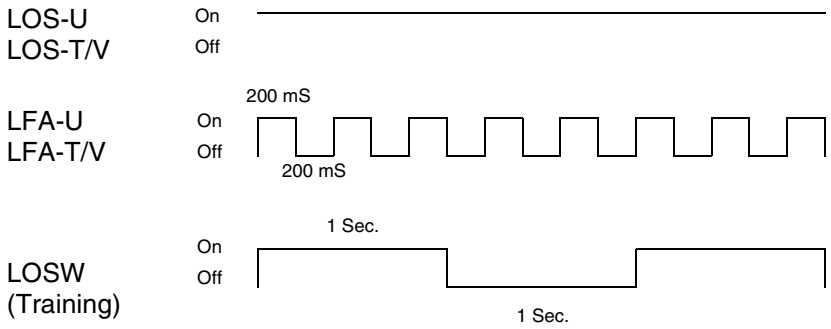


Fig. 2.10 Visual signalling of the BSTU

2.3.5.3 Power supply

Power is supplied to the BSTU via the backplane circuit board of the subrack. The plug-in unit is equipped with a DC/DC converter and the input voltage is 48 V_{DC} / 60 V_{DC}.

2.3.5.4 BSTU remote power supply

One equipment variant of the BSTU which can be supplied has a remote power feed. This enables the remote feeding of a desktop unit or SHDSL regenerators. The ground-free supply voltage is either 120 V_{DC} or 180 V_{DC}, the adjustable current is either 50 mA or 60 mA.

The remote power feeding voltage

- 120 V meets the requirements for TNV supply circuits in accordance to EN60950,
- 180 V also fulfils the requirements defined in ITU-T K.50 [18] and ITU-T K.51 [19] for an RFT-Circuit.

The settings are made via LCT and via DIP-Switches. You will find more information about DIP-Switches in the ULAF+ Installation Manual [1].

Monitoring

A monitoring circuit controls the voltage and the current control.

The output voltage is monitored for earth leakage at 180 V and is switched off in case of fault. In case of a disturbance the BSTU tries to reestablish the remote feed.

The BSTU detects the following states with the remote feed:

- Remote feeding current too deep (line interruption))
- Output voltage too deep (short circuit)
- Earth leakage

Out of this signals the BSTU generates the following alarms for each wire pair:

Alarm	Status	Description
UC	Line break	Remote feeding current too deep (line interruption)
UNBAL	Earth leakage	Earth leakage (Unbalanced)
OC	Short circuit	Output voltage too deep (short circuit)

Tab. 2.4 BSTU remote feed alarm signalling

2.3.6 Using the BSTU as desktop unit

2.3.6.1 Mechanical construction

When the BSTU is used in the desktop unit, it is installed in a plastic casing. The casing can also be wall mounted. The overall dimensions are 175 mm x 272 mm x 47 mm. The desktop unit can be used in the exchange as well as on the subscriber's premises.

The possible operating modes are identical with those for the plug-in unit; see Chapter 2.3.2.

The indicators and operating elements and the RS232 connection for the local LCT are located on the front panel.

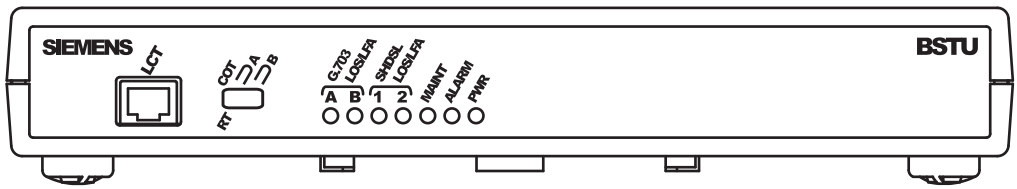


Fig. 2.11 Front panel of the desktop unit

On the rear are the various interfaces, depending on the equipment variant.

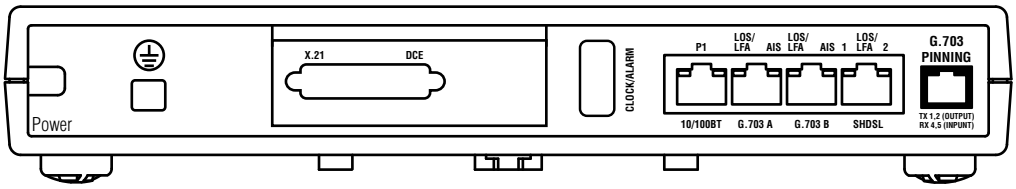


Fig. 2.12 Rear panel of the desktop unit (possible equipment variant)

2.3.6.2 Display and operating elements

The visual signalling of the desktop unit is the same as for the plug-in unit. In addition, the LEDs for the G.703 and SHDSL interfaces are visible from the front side of the desktop unit. The meanings of the LEDs are explained in Tab. 2.3.

2.3.6.3 Power supply

The following alternative types of power supply are available for the desktop unit:

- Local power supply with 110 V_{AC} or 230 V_{AC} (permitted range 95 – 260 V_{AC})
- Local power supply with 48 V_{DC} or 60 V_{DC} (permitted range 40 – 72 V_{DC})
- Remote power supply via the SHDSL interface ($\leq$ 180 V_{DC})
- Redundancy feeding (please find more information in the ULAF+ Installation Manual [1])

2.4 QSTU termination unit

2.4.1 Overview

The QSTU is an SHDSL transmission module with four SHDSL interfaces and (depending on the operating mode) up to four G.703 subscriber interfaces which are independent of each other. As a result, up to 64 systems can be operated in one ULAF+ subrack. In the configuration '2 wire-pair SHDSL', the same module can be used for long subscriber lines. In the '4 wire-pair SHDSL' mode, the maximum range can even be doubled by comparison with the '1 wire-pair SHDSL' mode. Consequently, it is possible to forego the use of regenerators for many applications.

The QSTU hardware can be operated with four different types of firmware (FW-IDs). In combination with other ULAF+ SHDSL modules, the QSTU must always be used on the LT side.

Tab. 2.5 shows an overview of the application possibilities of the QSTU and the required FW-ID:

Application possibilities	Siemens Part No.	FW-ID	Reg.	Max. Reg.steps
QSTU with STU/STU2	S3118-K333-* S3118-Q333-*	333	SRU	2
QSTU with STU4/GTU4	S3118-K333-* 1) S3118-Q333-* 1)	349	SRU	2
QSTU with BSTU/QSTU	S3118-J633-* S3118-H633-*	633	BSRU	4
QSTU with BSTU4/GTU4	S3118-J633-* 1) S3118-J633-* 1)	649	BSRU	4

1) Fw stored in the passive Bank

Tab. 2.5 Modes of operation of the QSTU

The QSTU is available as a plug-in module (with or without RPS) or as a desktop unit. The desktop unit can in addition be equipped with an alarm and clock module, which are available separately.

Chapter 2.4.4 describes the use of the QSTU as plug-in unit, chapter 2.4.5 describes the use as desktop unit.

2.4.1.1 QSTU with FW-ID 633

The QSTU with the FW-ID 633 (QSTU–QSTU / QSTU–BSTU) can be operated in three different system configurations. Settings are made via LCT:

a) Four 1 wire-pair SHDSL systems which are independent of each other
The payload bitrate is configurable in the range 192 kbit/s – 2048 kbit/s.
b) Two 2 wire-pair SHDSL systems which are independent of each other.
The payload bitrate is configurable in the range 384 kbit/s – 2048 kbit/s.
c) One 4 wire-pair SHDSL system (QSTU–QSTU only)
The payload bitrate is configurable in the range 768 kbit/s – 2048 kbit/s.

The QSTU (FW-ID 633) supports up to four regenerator stages (SRU) per SHDSL wire-pair.

i In combination with the BSTU the QSTU (FW-ID 633) must always be used on the LT side.

The following operating modes are supported by the QSTU:

- Bit-transparent transmission with 2 Mbit/s interfaces, conforming to ITU-T G.703 [7]
- Frame structured transmission with 2 Mbit/s interfaces, conforming to ITU-T G.704 [8]
- ISDN Primary Rate access, conforming to ITU-T I.431 [14], ETSI ETS 300 011 [20] / ETSI ETS 300 233 [21]
- Connection of data equipment (X.21, V.35, V.36), granularity nx64 kbit/s, (10/100Base-Tx) Ethernet

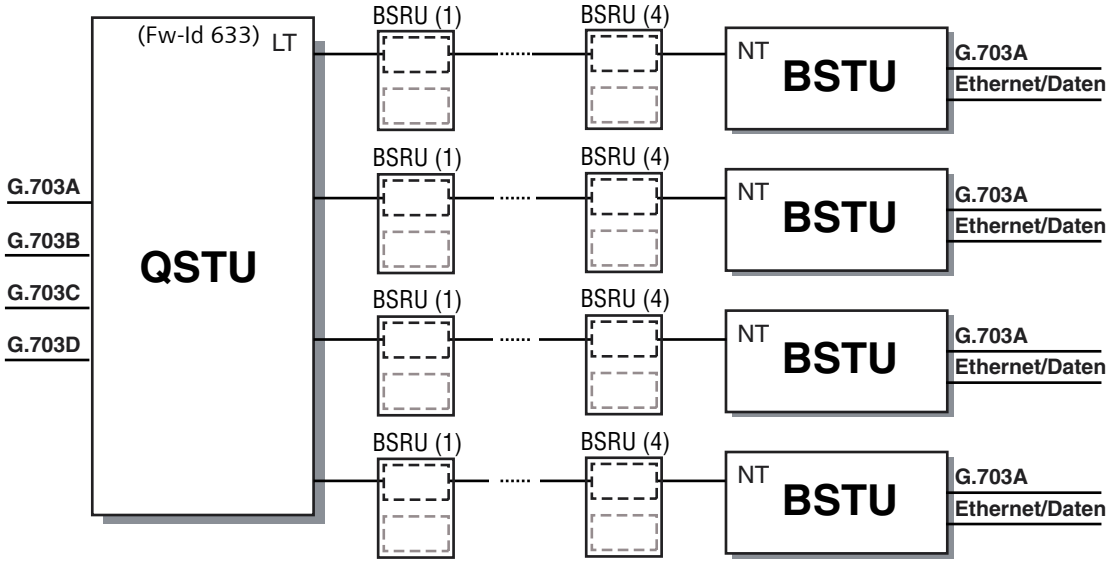


Fig. 2.13 QSTU(LT) – 4x BSTU(NT); 4x 1 wire pair mode

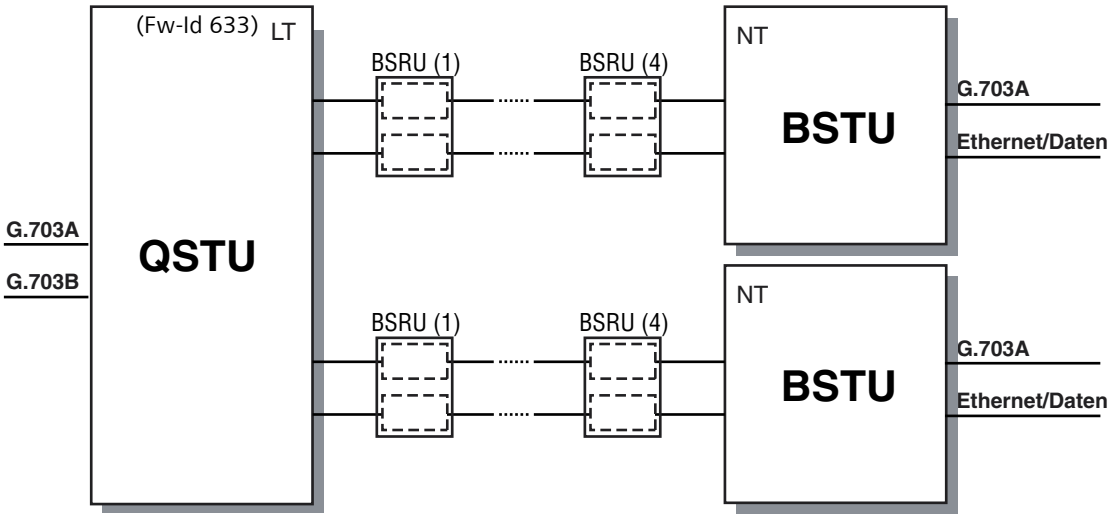


Fig. 2.14 QSTU(LT) – 2x BSTU(NT); 2x 2 wire pairs mode

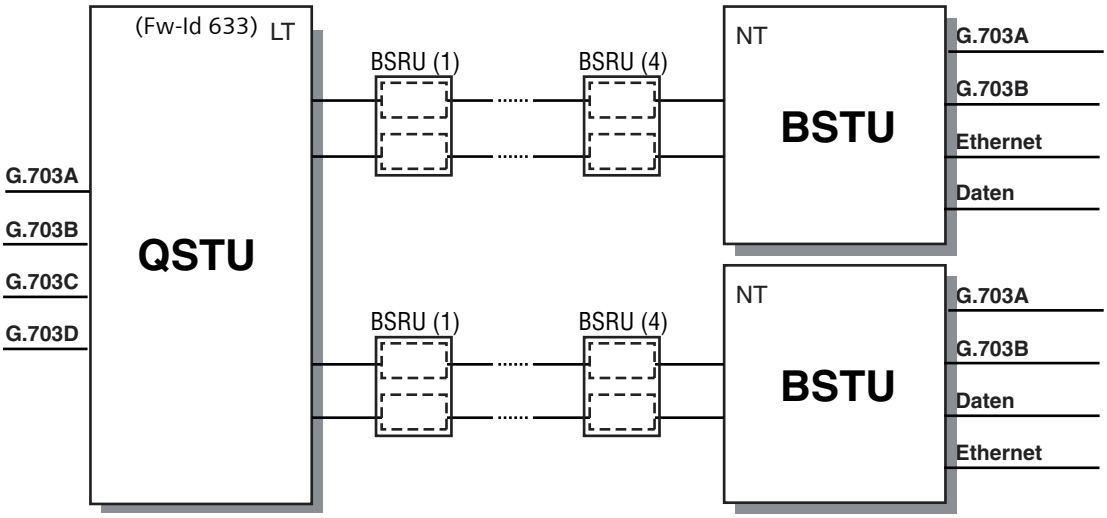


Fig. 2.15 QSTU(LT) – 2x BSTU(NT); 4x 1 wire pair mode

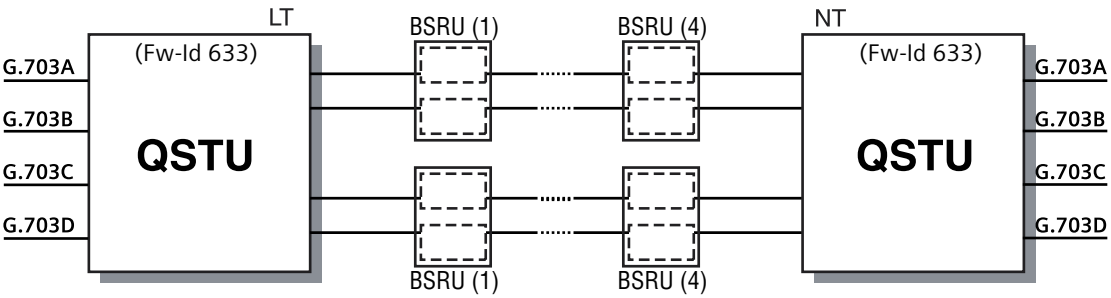


Fig. 2.16 QSTU(LT) – QSTU(NT); 4x 1 wire pair mode

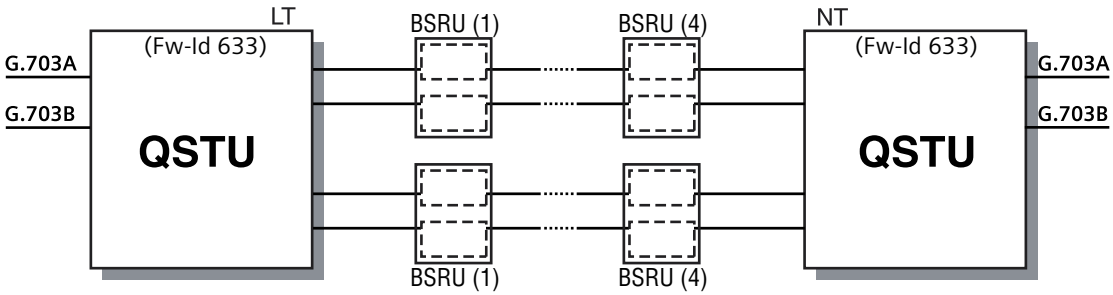


Fig. 2.17 QSTU(LT) – QSTU(NT); 2x 2 wire pairs mode

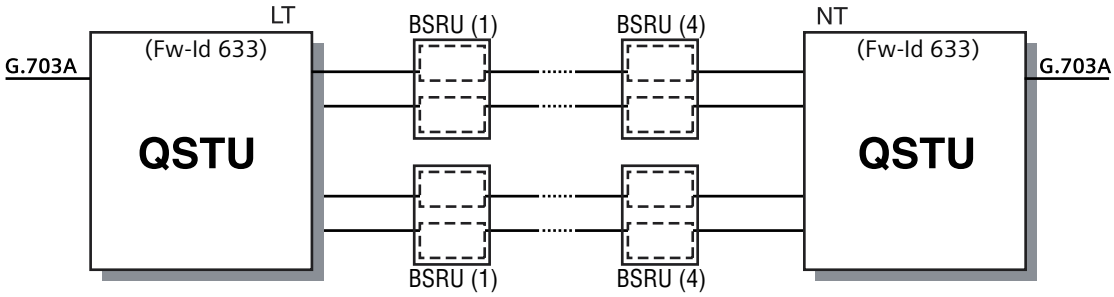


Fig. 2.18 QSTU(LT) – QSTU(NT); 1x 4 wire pairs mode

2.4.1.2 QSTU with FW-ID 649

The QSTU requires the FW ID 649 in combination with the BSTU4/GTU4.

i In connection with a BSTU4/GTU4 you must always use the QSTU (FW-ID 649) on the LT-side.

The QSTU (FW-ID 649) supports up to four regenerator stages (BSRU) per SHDSL wire-pair.

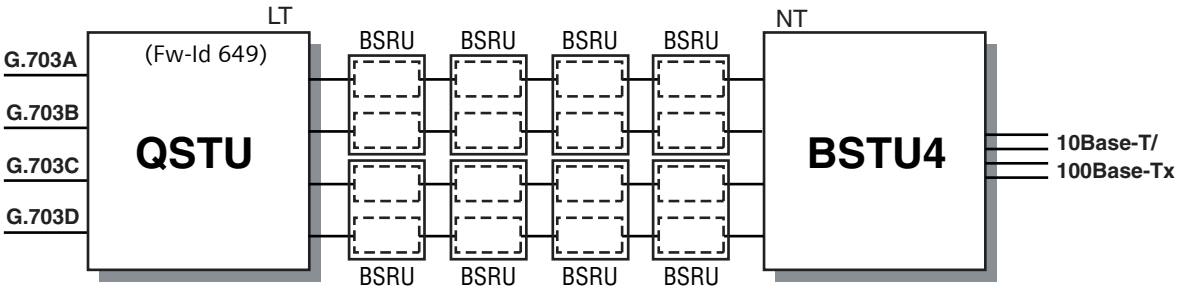


Bild 2.19 QSTU(LT) – BSTU4(NT) (1, 2, 3, 4 Adernpaar-Betrieb)

The QSTU can also be operated as the configuration master together with the GTU4. Further information on the GTU4 can be found in chapter 2.6.

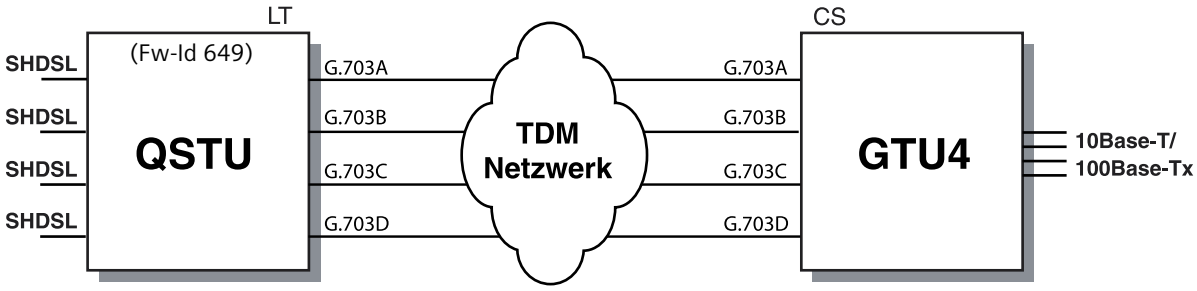


Bild 2.20 QSTU(LT) – GTU4(CS); 1, 2, 3, 4 Adernpaarbetrieb

2.4.2 Interfaces

The basic unit of the QSTU is assembled with four G.703 T/V interfaces. The desktop model can additionally equipped with a clock and alarm interface (see chapter 2.9).

2.4.3 Service functions

Loopback circuits and CRC checksums can be used for fault localization.

Loopback curcuits are activated either by software command (via the LCT for example) or by means of switches. With ISDN PRA, the command to activate the loopback circuit can be transmitted via Sa6 bits in the service word of the 2 Mbit/s frame by the ISDN exchange.

See Chapter 1.14.2 for further information about loopback circuits.

2.4.4 Using the plug-in unit QSTU

2.4.4.1 Mechanical construction

The plug-in unit is produced to double eurocard format. The QSTU is equipped with a front panel for insertion into the subrack.

The front of the plug-in unit incorporates

- the display and operating elements
- the subscriber interfaces and
- the transmission interface.

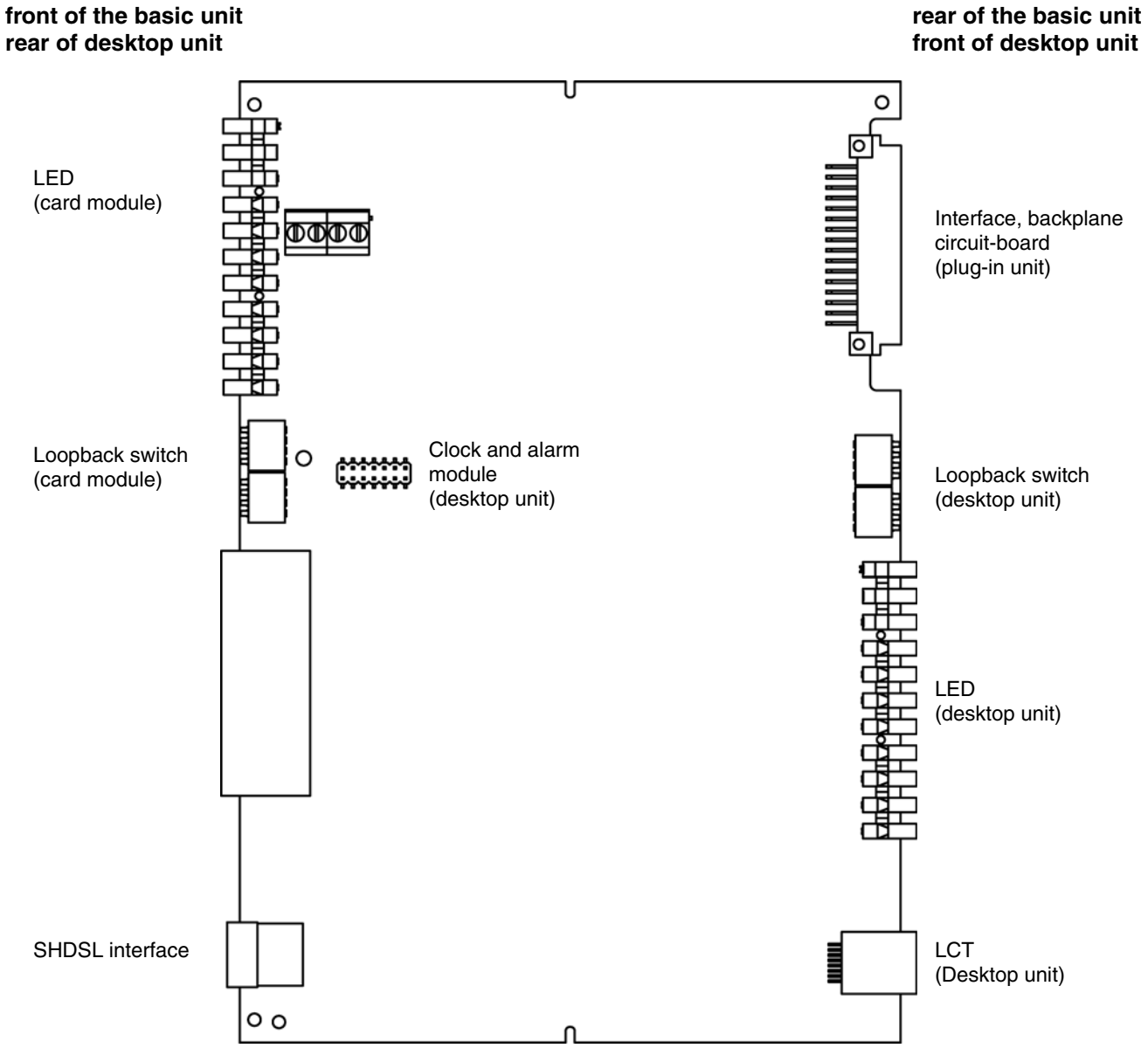


Fig. 2.21 QSTU termination unit

2.4.4.2 Display and operating elements

Status display

When the QSTU is inserted into subrack, the operating state and alarm signalling are indicated by 11 LEDs on the front of the plug-in unit.

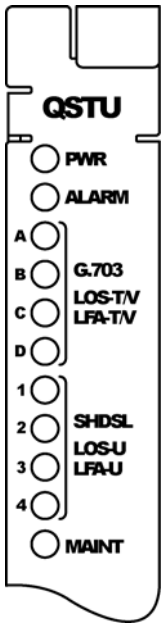


Fig. 2.22 Indicators and operating elements on the plug-in unit

LED	Color	Status	
		Off	On
PWR	Green	No power supply	Power supply OK
Alarm	Red	No alarm	Urgent Alarm [2)]
	Yellow	No alarm	Nonurgent alarm [2)]
LOS/LFA-T/V A[1)]	Red	No alarm	Loss of signal/frame at G.703 A
LOS/LFA-T/V B[1)]	Red	No alarm	Loss of signal/frame at G.703 B
LOS/LFA-T/V C[1)]	Red	No alarm	Loss of signal/frame at G.703 C
LOS/LFA-T/V D[1)]	Red	No alarm	Loss of signal/frame at G.703 D
LOS/LFA-U 1[1)]	Red	No alarm	Loss of signal/frame, Training[3)]
LOS/LFA-U 2[1)]	Red	No alarm	Loss of signal/frame, Training[3)]
LOS/LFA-U 3[1)]	Red	No alarm	Loss of signal/frame, Training[3)]

Tab. 2.6 Visual indications on the plug-in unit

LED	Color	Status	
		Off	On
LOS/LFA-U 4[1)]	Red	No alarm	Loss of signal/frame, Training[3)]
MAINT	Yellow	No maintenance function	**on:** Loopback active, traps deactivated, BERT activated, layer 2 switch test mode activated **blinking 1:** Firmware on LT and NT are not compatible or configuration is not supported by NT

1) Visual signalling according Fig. 2.22

2) Alarm message depends of the configuration made with the LCT

3) The continuous flashing shows the non-successful training

Tab. 2.6 Visual indications on the plug-in unit

DIP switches on the QSTU

The configuration possibilities using DIP switches depend on the QSTU's FW-ID. Below are the settings for all systems.

- **QSTU with FW-ID 633**
  - Use as LT or as NT
  - Current limitation 50 mA / 60 mA for the RPS
  - Switch over from normal operation to PSD test mode (SHDSL No Retraining)
- **QSTU with FW-ID 649**
  - Current limitation 50 mA / 60 mA for the RPS
  - Switch over from normal operation to PSD test mode (SHDSL No Retraining)

External operating elements

From the front side accessible DIP switch on the QSTU can be used to insert either

- one Loopback 1/3a, or alternatively
- one Loopback 2bR.

The loopbacks are each set up for the complete system.

For details of the settings using the internal and external operating elements, refer to the ULAF+ Installation Manual [1].

2.4.4.3 Power supply

Power is supplied to the QSTU via the backplane circuit board of the subrack. The plug-in unit is equipped with a DC/DC converter and the input voltage is 48 V_{DC} / 60 V_{DC}.

2.4.4.4 QSTU remote power supply

The QSTU plug-in unit can be used with an integrated remote power feeding circuit. This enables the remote feeding of a desktop unit or regenerators. The supply voltage is 120 V, the adjustable current is either 50 mA or 60 mA each wire pair.

Settings are made via DIP switch on the QSTU. Detailed information on the DIP switches can be found in the ULAF+ Installation Manual [1].

Monitoring

A monitoring circuit controls the voltage and the current control. The settings are done using DIP switches.

The QSTU detects the following states:

- Remote feeding current too deep (line interruption)

- Output voltage too deep (short circuit)

Out of this signals the QSTU generates the following alarms:

Alarm	State	Description
UC1/2/3/4	Line break	Remote feeding current too deep (under current)
OC1/2/3/4	Short circuit	Output voltage too deep (over current)

Tab. 2.7 QSTU remote feed alarm signalling

2.4.5 Using the QSTU desktop unit

When the QSTU is used in the desktop unit, it is installed in a plastic casing. The casing can also be wall mounted. The overall dimensions are 175 mm x 272 mm x 47 mm. The desktop unit can be used in the exchange as well as on the subscriber's premises.

The desktop unit features the same functionality as the plug-in unit and can be extended with an additional alarm and clock module.

The possible operating modes are identical with those for the plug-in unit; see Chapter 2.4.1.1.

2.4.5.1 Mechanical construction

The indicators and operating elements and the RS232 connection for the local LCT are located on the front panel.

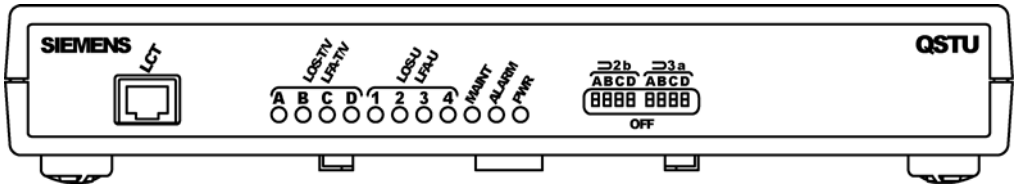


Fig. 2.23 Front panel of the desktop unit

The four transmission and the four G.703 interfaces, the clock and alarm interface and the power supply connection are located on the rear panel.

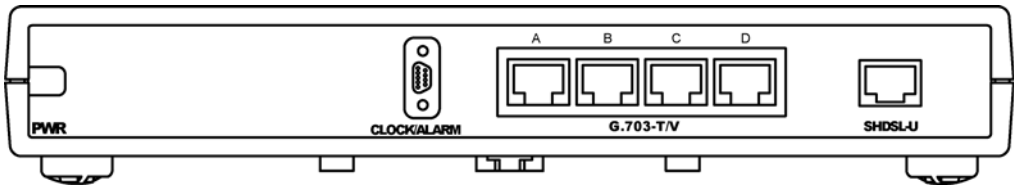


Fig. 2.24 Rear panel of the desktop unit

2.4.5.2 Display and operating elements

Eleven LEDs for operation and monitoring are located on the front panel; see Fig. 2.23.

LED	Color	Status	
		Off	On
PWR	Green	No power supply	Power supply OK
Alarm	Red	No alarm	Urgent Alarm [2]
	Yellow	No alarm	Nonurgent alarm [2]
LOS/LFA-T/V A[1]	Red	No alarm	Loss of signal/frame at G.703 A
LOS/LFA-T/V B[1]	Red	No alarm	Loss of signal/frame at G.703 B
LOS/LFA-T/V C[1]	Red	No alarm	Loss of signal/frame at G.703 C
LOS/LFA-T/V D[1]	Red	No alarm	Loss of signal/frame at G.703 D
LOS/LFA-U 1[1]	Red	No alarm	Loss of signal/frame, Training[3]
LOS/LFA-U 2[1]	Red	No alarm	Loss of signal/frame, Training[3]
LOS/LFA-U 3[1]	Red	No alarm	Loss of signal/frame, Training[3]
LOS/LFA-U 4[1]	Red	No alarm	Loss of signal/frame, Training[3]
MAINT	Yellow	No maintenance function	**on:** Loopback active, traps deactivated, BERT activated, layer 2 switch test mode activated **blinking 1:** Firmware on LT and NT are not compatible or configuration is not supported by NT

1) Visual signalling according Fig. 2.22
2) Alarm message depends of the configuration made with the LCT
3) The continuous flashing shows the non-successful training

Tab. 2.8 Visual indications on the desktop unit

The internal operating elements are the same as those on the plug-in unit; see Chapter 2.4.4.2

DIP switches located on the front panel can be used to make the following adjustments on the desktop unit:

- Insertion of Loopback 1/3a
- Insertion of Loopback 2b/2bR (NT/LT)

For details of the DIP switch settings, refer to the ULAF+ Installation Manual [1].

2.4.5.3 Power supply

The following alternative types of power supply are available for the desktop unit:

- Local power supply with 110 V_{AC} / 230 V_{AC} via a permanently connected mains cable
- Local power supply with 48 V_{DC} / 60 V_{DC} via a permanently connected battery cable
- Local power supply with 230 V_{AC} with redundancy feed via the U interface
  In this case, for local power supply with 230 V_{AC} you must use an external power brick (NTU)
- Remote power supply via the U interface (see Chapter 2.4.4.4 QSTU remote power supply).

A default voltage of 230 V_{AC} is supplied to the desktop unit via a mains cable which is permanently connected to the unit. As an alternative, a voltage of 48 V_{DC} / 60 V_{DC} can be supplied via a permanently connected battery cable. The battery cable is also permanently screwed to the module; for further information refer to the ULAF+ Installation Manual [1].

2.5 BSTU4 termination unit

2.5.1 Overview

The BSTU4 can be used to deploy carrier grade Ethernet services with high bandwidth.

The BSTU4 is a 4 wire pair SHDSL termination unit with integrated 4-port 10/100BaseTx Ethernet Switch. Channel bundling enables bit rates of up to 8 Mbit/s via TDM networks (1/2/3/4 x 2Mbit/s multi-channel system with resiliency); in BSTU4 - BSTU4 applications (Fig. 2.27), bit rates of up to 22.8 Mbit/s are possible via 4 wire pairs, using ‘Link Aggregation’, bit rates of up to 91,2 Mbit/s are possible via 16 wire pairs. The bit rate of each SHDSL path can be configured individually, thereby optimizing it to the physical conditions of the line.

The BSTU4 is available as:

- Plug-in unit with or without RPS
- Desktop unit with or without RPS

The BSTU4 can be operated either with another BSTU4 or with a QSTU (LT) (see chapter 2.5.2). The following modes of operation are possible with use of the BSTU4:

- Ethernet - Ethernet connection (BSTU4 - BSTU4)
- TDM - Ethernet connection (QSTU - BSTU4)

Together with the QSTU, the BSTU4 supports the following networks:

- Bit-transparent transmission with 1...4x 2 Mbit/s,
  conforming to ITU-T G.703 [7]
- Frame structured transmission with 1...4x 2 Mbit/s
  conforming to ITU-T G.704 [8]
- Frame structured transmission with 1...4x 64 kbit/s – 1984 kbit/s (Fractional E1)

The configuration (incl. Ethernet interfaces) is made either via LCT or via TMN. Further information on the configuration can be found in the corresponding user manuals.

2.5.2 Modes of operation of BSTU4

This chapter describes the BSTU4's modes of operation. The following types of use are possible:

- BSTU4(LT) – BSTU4(NT)
- QSTU(LT) – BSTU4(NT)

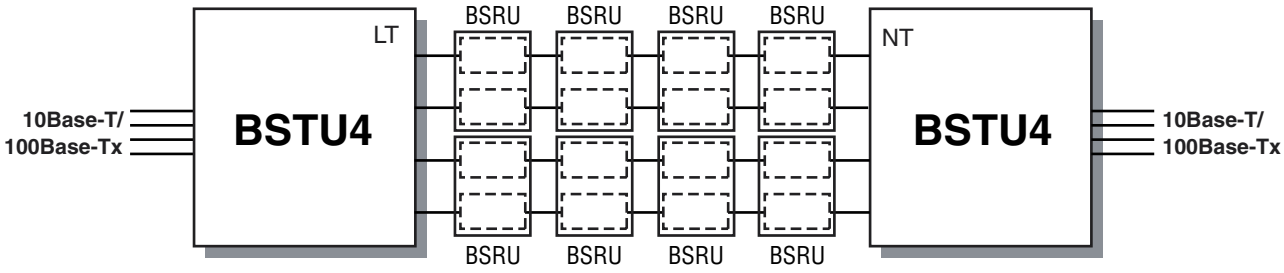


Fig. 2.25 BSTU4(LT) – BSTU4(NT) (1, 2, 3, 4 wire pairs)

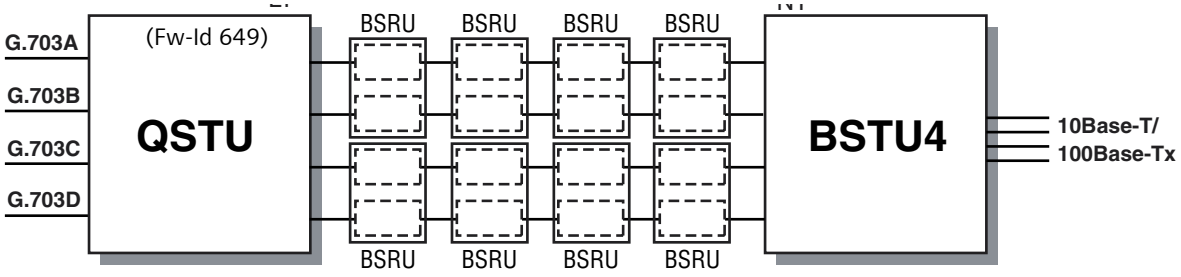


Fig. 2.26 QSTU(LT) – BSTU4(NT) (1, 2, 3, 4 wire pairs)

i

In QSTU – BSTU4/GTU4 connections you must always use the QSTU on the LT-side. Each QSTU is delivered with two different firmware variants. Depending on the use you must activate the corresponding firmware using 'Bank Switch' (see ULAF+ User Manual, LCT for this [2]):
- Variants with Fw-Id 633 for operation with the QSTU/BSTU[1)]
- Variants with Fw-Id 649 for operation with the BSTU4/GTU4.

1) Default setting

2.5.2.1 Application examples for the BSTU4

You will find two application examples for the BSTU4 in the following.

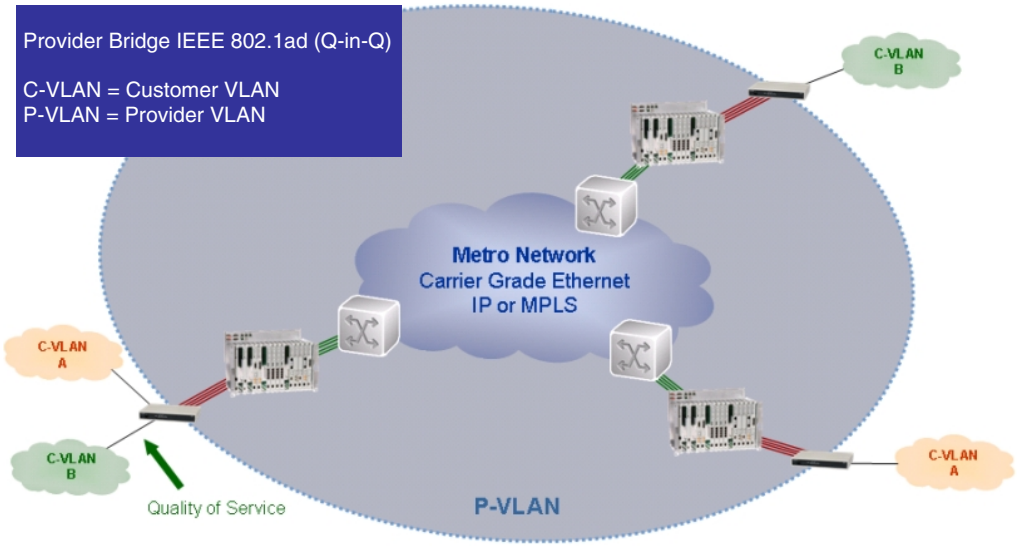


Fig. 2.27 Ethernet via ‘Packet Backbone’ (Carrier Network) up to 22, 8 Mbit/s (up to 91,2 Mbit/s by using ‘Link Aggregation’)

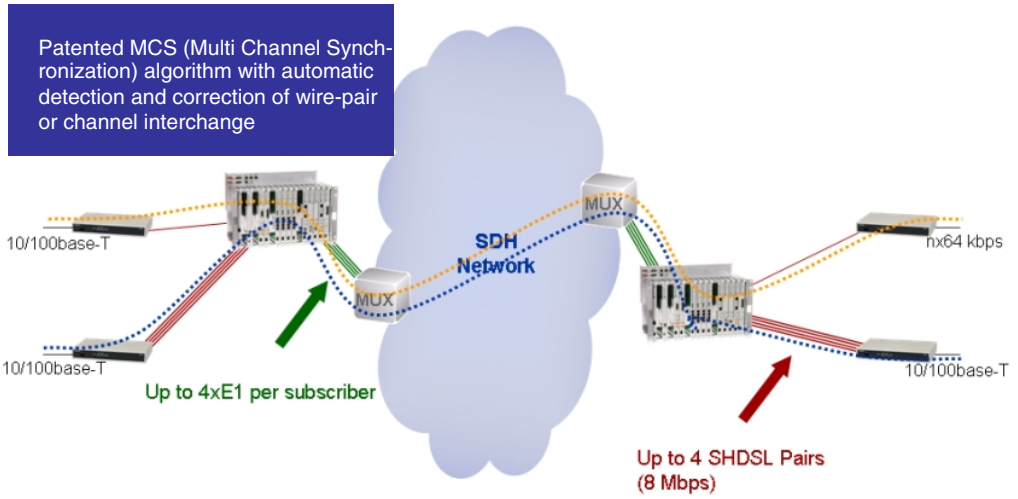


Fig. 2.28 QSTU - BSTU4 over TDM Network (1...4x E1)

2.5.3 BSTU4 function

The BSTU4 is equipped with four Ethernet (10/100Base-Tx) and four SHDSL interfaces. Fig. 2.29 shows you the BSTU4's functional circuit diagram. The individual blocks (1-4) are described in the following chapters.

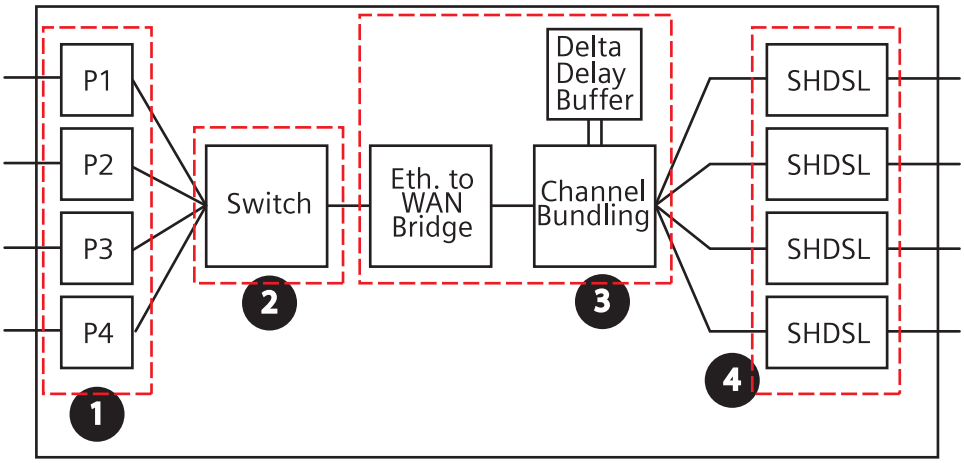


Fig. 2.29 Functional circuit diagram of the BSTU4

- ❶ Ethernet interfaces, see chapter 2.5.3.1
- ❷ Layer 2 Switch, see chapter 2.5.3.2
- ❸ Channel Bundling, see chapter 2.5.3.3
- ❹ SHDSL interfaces, see chapter 2.5.3.4

2.5.3.1 Ethernet interfaces

The Ethernet interfaces of the BSTU4 have the following features:

- 10/100 Base-Tx in accordance with IEEE 802.3u
- Full Duplex / Half Duplex
  With Half Duplex as opposed to Full Duplex, simultaneous sending and receiving is not possible.
- Auto negotiating in accordance with IEEE 802.3u for
  – Full-/Half Duplex mode
  – 10/100 Base-Tx
  – Flow Control
- Automatic MDI/MDI-X
  Auto-MDI/MDI-X enables the automatic adjustment of the transmission and reception line of a port, i.e. on the connected Ethernet cable (crossed or not crossed) and the configuration of the opposite terminal.
- Flow Control
  – 'Pause frames' are sent (as per IEEE 802.3x) in full duplex operation
  – The backpressure method is used in half duplex operation

- Bandwidth limiting
  The maximum ingress data rate of each LAN port can be limited (policing). Up to 1 Mbit/s, the ingress data rate can be set in 64 Kbits/s steps. Above this speed, in steps of 1 Mbit/s.
  In addition, the egress data rate of all LAN and the WAN ports can be limited between 1 Mbit/s and 100 Mbit/s. The following egress data rates can be selected (where x is a value between 2 and 200):

  $$\frac{200'000\ \text{kbit/s}}{x}$$

- Link status information is available for each Ethernet interface
  (link up / 10/100Base-Tx / full duplex / half duplex)
- PHY Power saving mode
  The Ethernet interfaces can be switched on or off separately to reduce the power consumption
- Link Failure Propagation
  'Link Failure Propagation (LFP)' disables the ports on the switch if the synchronization is lost on the U interface. This allows devices connected to the BSTU4, such as a switch with 'spanning tree' or 'link aggregation', to react faster to a connection interrupt. A connection interrupt is indicated via 'LFP alarm' for all connected Ethernet interfaces.

2.5.3.2 Layer 2 Switch

The Ethernet switch of the BSTU4 has the following features:

- 'Store and forward switch'
  The Ethernet packets are checked completely before they are forwarded to the destination address.
- 'Non-blocking'
  All Ethernet interfaces can be processed with full line speed.
- 'Wire speed address learning'
  MAC addresses can be learnt with full line speed
- Up to 1024 MAC addresses can be administered
- The 'Aging time' is 300 seconds
- 'Broadcast storm protection'
  The forwarding of 'Broadcast packets' is limited to max. 5 % of the data rate
- 'Ethernet Frame Size'
  Packets of up to 1518 bytes are supported by default (or 1522 bytes incl. VLAN)
- 'Oversized Frames Option'
  For Ethernet frames that do not comply with standards you can optionally increase the maximum packet size to 2048 bytes. This setting is the same for all ports.
- Packet counters are available for all Ethernet interfaces to facilitate error localizing.

- ‘Link Aggregation’
  'Link aggregation' (LAG) enables you to interconnect 'switch-to-switch' applications used in parallel and therefore to increase the maximum data rate. BSTU4 lets you bundle up to four BSTU4 - BSTU4 links so that you can transmit at up to 91.2 Mbit/s over 16 wire-pairs.
  Fig. 2.30 illustrates the application principle of 'Link Aggregation'. The ports connected in parallel form a 'Port Channel'. The port that bundles the traffic of this channel is known as a 'Bond Port'. The 'Bond Port' of the BSTU4 can be connected either to port P1 (**Bonded to Port 1**) or to the rack port (**Bonded to Rack**). All other available switch ports, including the WAN port, are automatically assigned to this channel.

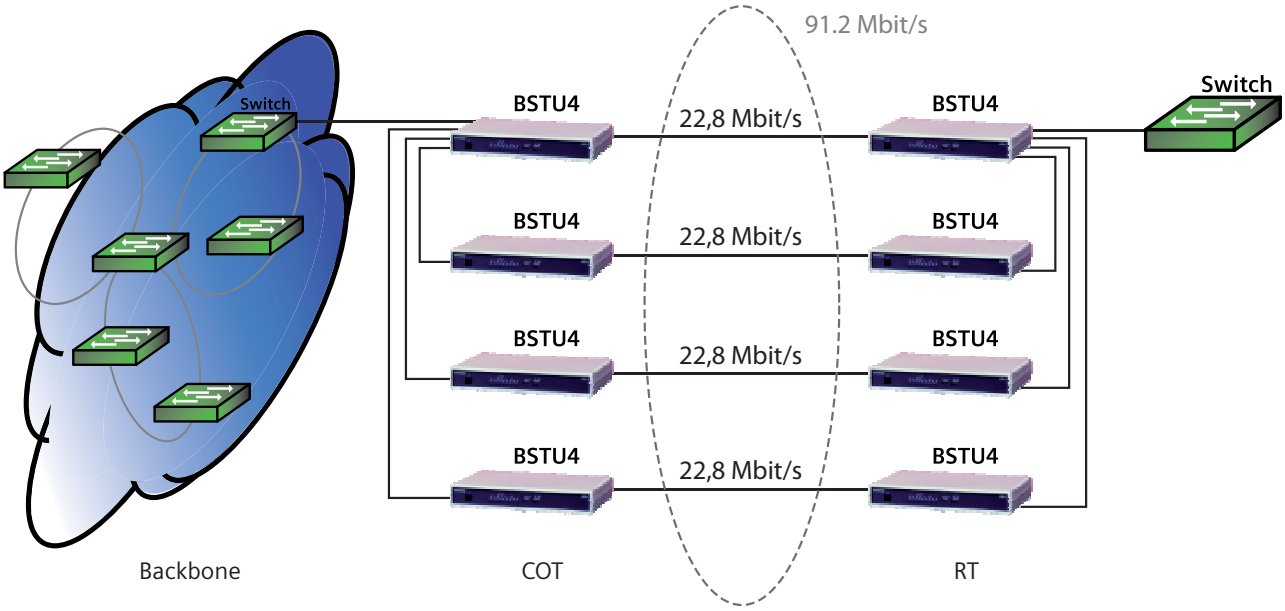


Fig. 2.30 Example scheme of ‘Link Aggregation’

Flow Control

The 'flow control mechanism' controls the data rate between the terminal device and the ULAF+ modem by allowing the sender to only send as much data as the transfer path can transport. If this transport capacity is exceeded, packets are discarded.

The following flow control mechanism are supported:
– ‘Back Pressure Flow Control’ in half duplex mode
– Creating ‘Pause Frames’ in full duplex Mode

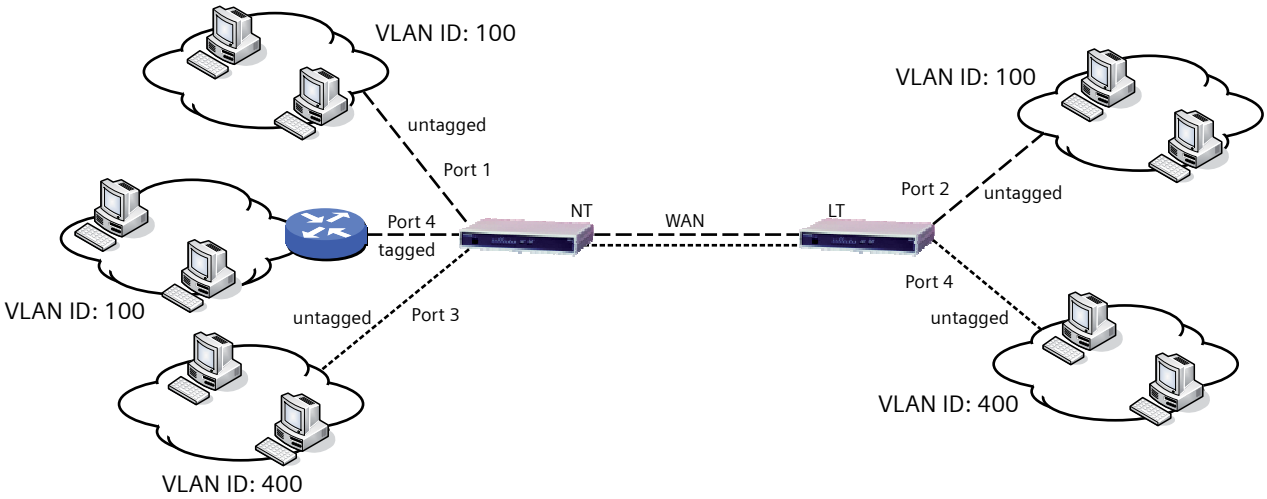
i 'Flow control' must be enabled on both the terminal device and ULAF+ to allow the flow control to function.

VLAN Support (IEEE 802.1Q)

The BSTU4 supports VLANs according IEEE 802.1Q. 16 different VLANs can be identified and handled simultaneously based on the 12-bit VLAN identifier.

Each Ethernet port can be assigned to one ore more VLAN. All ports are assigned to VLAN 1 per default.

The BSTU4 switch can handle tagged and untagged frames at each of its ingress ports. Configuring a port to 'untagged' means, that all Ethernet packets arriving at this ingress port don't have VLAN-Headers according IEEE 802.1Q. Therefore a 'Native VLAN ID' has to be assigned to such a port. The switch will than add this VLAN ID to the packets.



Corresponding VLAN filter table:

NT						
VLAN Number	**VLAN ID**	**Port 1 Member**	**Port 2 Member**	**Port 3 Member**	**Port 4 Member**	**Port 5 Member**
1	1	–	un-tagged	–	un-tagged	un-tagged
2	400	–	–	un-tagged	–	tagged
3	100	un-tagged	–	–	tagged	tagged
:	:	:	:	:	:	:
16	–	–	–	–	–	–

LT						
VLAN Number	**VLAN ID**	**Port 1 Member**	**Port 2 Member**	**Port 3 Member**	**Port 4 Member**	**Port 5 Member**
1	1	un-tagged	–	un-tagged	–	un-tagged
2	400	–	–	–	un-tagged	tagged
3	100	–	un-tagged	–	–	tagged
:	:	:	:	:	:	:
16	–	–	–	–	–	–

Tab. 2.9 Example for VLAN support of BSTU4

Q-in-Q (IEEE 802.1ad)

'Q-in-Q' is known by various names such as 'Double VLAN tagging', 'Double Tagging', '802.1ad' and 'Provider Bridge' but the functionality is always the same.

The IEEE 802.1ad provider bridge mode allows service providers to use a layer 2 tunnel. Customers are able to route freely definable Ethernet traffic through this tunnel (e.g. native frames, VLAN, etc.). The advantage of this standard is that the configuration of the network components need not be changed even if the network topology is modified. The reason is that, in contrast to the P-VLAN frame format, the 802.1Q frame format has remained unchanged and backward compatibility to existing 802.1Q networks is therefore guaranteed.

With 'Double Tagging' a distinction is made between 'Customer Ports' and 'Provider Ports'. Specific 'Ethertype' values can be defined for 'Provider Ports'. The values serve to differentiate between 'Provider Tagged Frames' and normal 'Tagged Frames'.

'Provider Ports' send 'Double Tagged Frames' if 'Single Tagged Frames' arrive at the 'Customer Port'. However, if 'untagged frames' arrive at the 'Customer Port', the 'Provider Port' sends 'single tagged frames' but uses the configurable 'Ethertype'.

An example of an 802.1ad frame format with "Tagged Frames" and an example of an 802.1d provider bridge topology are given below.

When the 'Customer Frame' arrives at the provider bridge, it can have one or more 'VLAN tags'. In the example below, the frame has one 'VLAN tag (C-VLAN)'. A further 'tag' is added at the port input of the provider. Configuration of the 'provider VLAN-ID' and the 'provider Ethertype' is performed by the BSTU4.

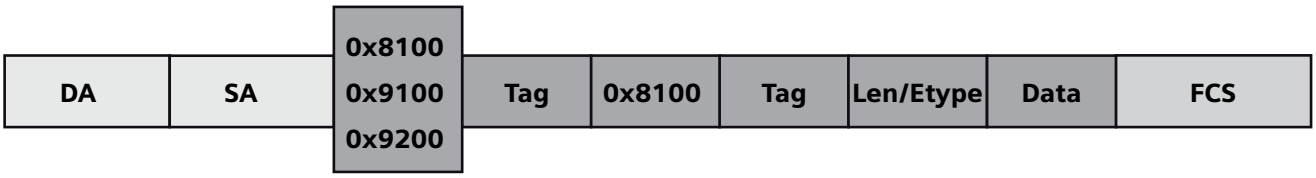


Fig. 2.31 Frame format of '802.1ad Provider Tagged Frames'

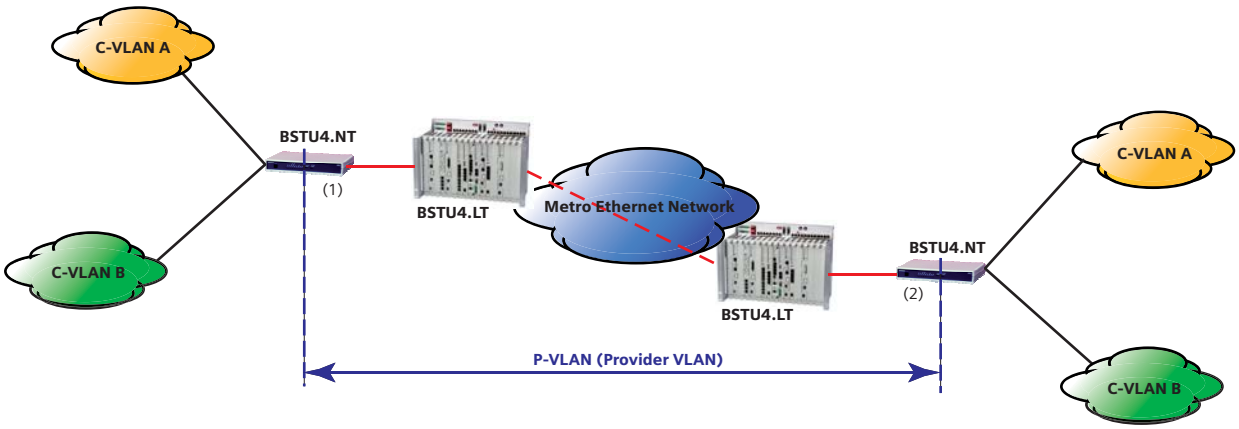


Fig. 2.32 Example of a 802.1ad Provider VLAN topology

Class of Service

Network service providers accommodate quality of service to their customers through a service contract which is called service level agreement (SLA). Classes of Service (CoS) describe the set of features and other characteristics associated with a specific service level. Thus, it must be possible to distinguish between traffic classes and ensure that traffic belonging to a certain class is treated according to the features of this class.

The BSTU4 has four queues per interface to enable network providers to deliver and guarantee these 'Classes of Services'. The following prioritization algorithms are available:

– **WFQ (Weighted** (fair queueing)**)**: The queues of the separate ports are processed accordingly in the ratio 8:4:2:1, where the queue with the lowest priority can use 1/15 of the available bandwidth.
– **PQ (Strict)**: The queues with lower priority are only processed after the queues with higher priority have been fully processed.

Traffic policing at the Ethernet interface

The data flow of the individual inbound interfaces can be restricted with the following granularity:

- in 64 kbit/s steps from 64 kbit/s to 1 Mbit/s
- in 1 Mbit/s steps upwards of 2 Mbit/s

The captured bytes correspond to the standard layer 2Bytes (Ethernet frame of the destination address for CRC).

2.5.3.3 Channel Bundling

In this function the Ethernet packets are packed in HDLC and divided over the available number of transfer channels (Inverse Multiplexing). The following features are realized with the help of the proprietary, patented multi-channel synchronization algorithm (MCS).

- Efficient inverse multiplexing with less than 3 % overhead with 4x 2 Mbit/s
- Bundling of 1...4 TDM channels
- Bundling of 1...4 SHDSL channels up to 4x 5696 kbit/s
- Individually configurable bit rates for each transfer channel
- Resilience
  With the failure of one or more channels, the transfer continues to be made via the functioning channels. If the downed channel is available again, the data rate is increased again accordingly
- Resilience functions independently in the transmission and reception directions.
- Different latency times of the transfer channels of up to 125 ms can be compensated
- The additional latency time caused by the MCS function is minimal (<100 µs)
- Wire pair and path exchange is corrected automatically
- 'End-to-End' monitoring and alarming using MCS alarms and error counters via the network

2.5.3.4 SHDSL interfaces

The BSTU4 has four SHDSL interfaces. All interfaces can be operated with separately configurable bit rates. 1...4 interfaces can be enabled, depending on the applications. The interfaces support the extended SHDSL standards (ETSI Annex E and ITU Annex G, see chapter 1.6), so that in the case of BSTU4 - BSTU4 application, bit rates of up to 5696 kbit/s per wire pair can be reached.

2.5.4 Service functions

Loopback circuits and CRC checksums can be used for fault localization.

Loopback curcuits are activated either by software command (via the LCT for example) or by means of switches.

See Chapter 1.14.3 for further information about loopback circuits.

2.5.5 BSTU4 plug-in unit

2.5.5.1 Mechanical construction

The plug-in unit is produced to double eurocard format. The BSTU4 is equipped with a front panel for insertion into the subrack.

The front of the plug-in unit incorporates

- the display and operating elements
- the subscriber interfaces and
- the transmission interfaces.

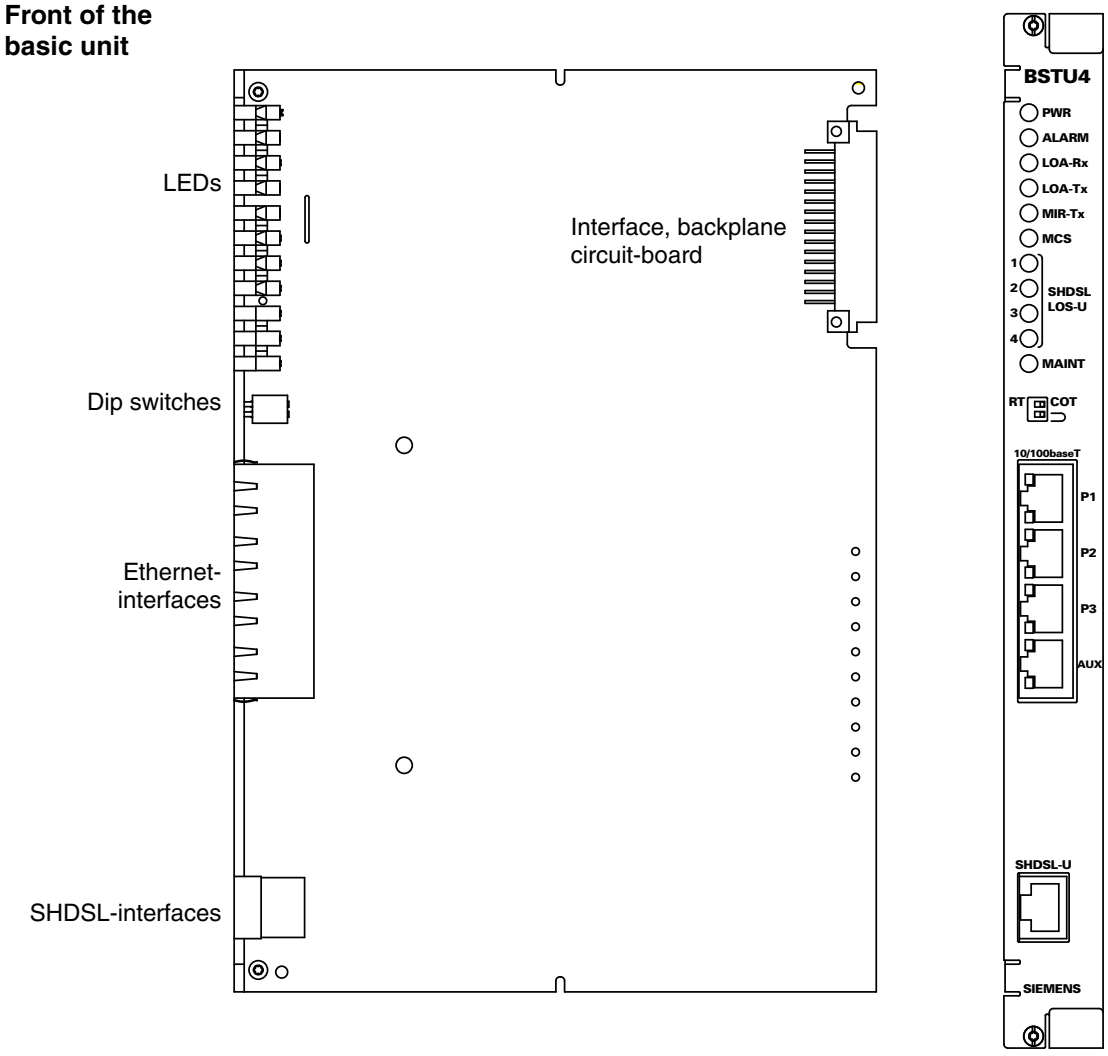


Fig. 2.33 BSTU4 termination unit

2.5.5.2 Display and operating elements

Status display

The operating state and alarm signalling of the BSTU4 are indicated by 11 LEDs on the front of the plug-in unit.

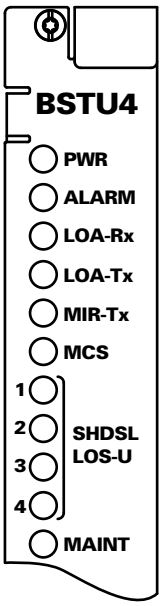


Fig. 2.34 Indicators and operating elements on the plug-in unit BSTU4

LED	Color	Status	
		Off	On
PWR	green	No power supply	Power supply o.k.
Alarm	red	No alarm	Urgent alarm [1)]
	yellow	No alarm	Non-urgent alarm [1)]
LOA-Rx	yellow	No alarm	No WAN activity in reception direction
LOA-Tx	yellow	No alarm	No WAN activity in transmission direction.
MIR-Tx	yellow	No alarm	WAN capacity in the send direction > 70 % utilization
MCS	red	No alarm	**on:** all paths downed **blinking 1:** on or more paths downed
SHDSL LOS-U1	red	No alarm	**on:** LOS **blinking:** LOSW, Training
SHDSL LOS-U2	red	No alarm	**on:** LOS **blinking:** LOSW, Training
SHDSL LOS-U3	red	No alarm	**on:** LOS **blinking:** LOSW, Training

Tab. 2.10 Indicators and operating elements on the plug-in unit BSTU4

LED	Color	Status	
		Off	On
SHDSL LOS-U4	red	No alarm	**on:** LOS **blinking:** LOSW, Training
MAINT	yellow	No maintenance function	**on:** Loopback active, traps deactivated, BERT activated, layer 2 switch test mode activated **blinking 1:** Firmware on LT and NT are not compatible or configuration is not supported by NT

1) Alarm message depends of the configuration

Tab. 2.10 Indicators and operating elements on the plug-in unit BSTU4

Visual signalling of the Ethernet interfaces

A green and a yellow LED are integrated in the sockets of the Ethernet interfaces (P1, P2, P3).

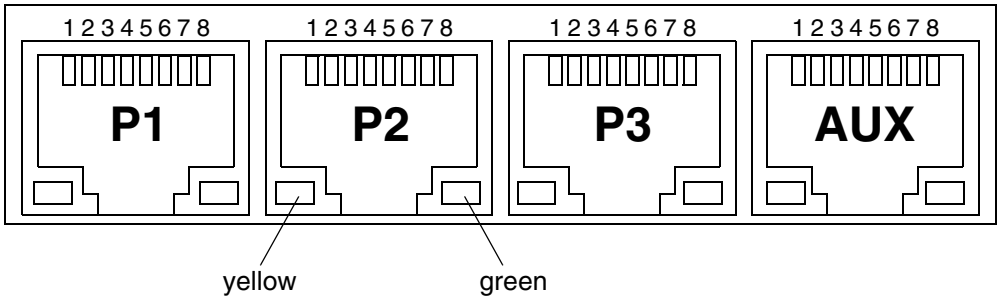


Fig. 2.35 Visual signalling of the Ethernet interfaces

LED	LED Mode 10/100Base-Tx
yellow	**off:** Half Duplex **on**: Full Duplex **blinking**: Collision with Half Duplex
green	**off:** No connection/ no traffic **on**: Link Up **blinking**: Traffic

Tab. 2.11 Visual signalling of the Ethernet interfaces

External operating elements

Using front-mounted DIP Switches you can
- set the BSTU4's operating mode and (Tab. 2.12), and
- insert the loopback.

Setting	Description
RT	NT mode[1)]
COT	LT mode[2)]
⊃	MCS loopback inserted

1) Default setting desktop unit
2) Default setting plug-in unit

Tab. 2.12 Front side DIP switches of the BSTU4

2.5.5.3 Power supply

Power is supplied to the BSTU4 via the backplane circuit board of the subrack. The plug-in unit is equipped with a DC/DC converter and the input voltage is 48 V_{DC} / 60 V_{DC}.

2.5.5.4 BSTU4 remote power supply

With the integrated remote power feeding circuit of the BSTU4 plug-in unit you can remote feeding desktop units. The supply voltage is 120 V, the adjustable current is either 50 mA or 60 mA each wire pair.

Monitoring

A monitoring circuit controls the voltage and the current control. The settings are done the ULAF+ LCT. For details of the settings, refer to the ULAF+ User Manual [2].

The BSTU4 detects the following states with the remote feed:
- Remote feeding current too deep (line interruption)
- Output voltage too deep (short circuit)

Out of this signals the BSTU4 generates the following alarms:

Alarm	State	Description
UC1/2/3/4	Line break	Remote feeding current too deep (line interruption) - wire pairs 1/2/3/4
OC1/2/3/4	Short circuit	Output voltage too deep (short circuit) - wire pairs 1/2/3/4

Tab. 2.13 BSTU4 remote feed alarm signalling

2.5.6 BSTU4 desktop unit

When the BSTU4 is used in the desktop unit, it is installed in a plastic casing. The casing can also be wall mounted. The overall dimensions are 175 mm x 272 mm x 47 mm. The desktop unit can be used in the exchange as well as on the subscriber's premises.

The possible operating modes are identical with those for the plug-in unit; see Chapter 2.5.2.

2.5.6.1 Mechanical construction

The indicators and operating elements and the RS232 connection for the local LCT are located on the front panel.

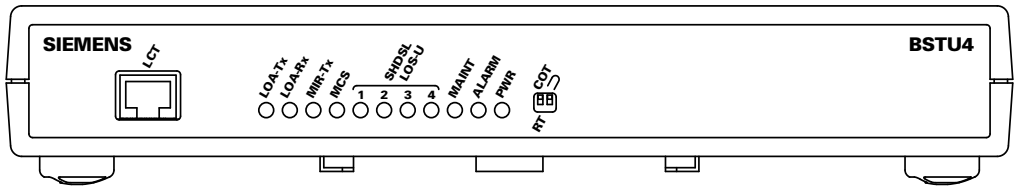


Fig. 2.36 Front panel of the desktop unit

The four Ethernet ports, SHDSL interface, clock input/output and power connector are arranged at the rear. The clock interface is defined as clock input on the LT and as clock output on the NT. The desktop unit with integrated remote power supply comes without a power cable.

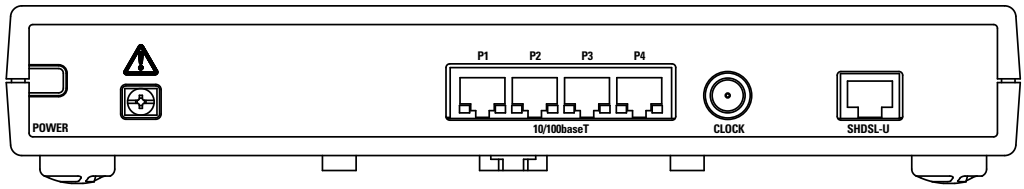


Fig. 2.37 Rear panel of the desktop unit without remote power supply

At the rear of the desktop device with remote power supply there is also a socket for connecting the battery cable (C107-A214-C734) or adapter SNP-A08T-S.

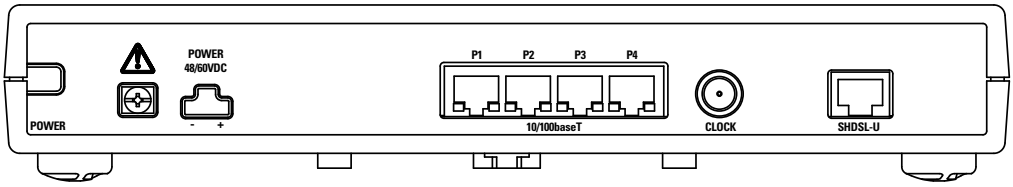


Fig. 2.38 Rear panel of the desktop unit with remote power supply

2.5.6.2 Display and operating elements

Visual signalling of the Ethernet interfaces

One green and one yellow LED is integrated in each of the four Ethernet port interfaces (P1, P2, P3, P4) on the rear of the desktop device.

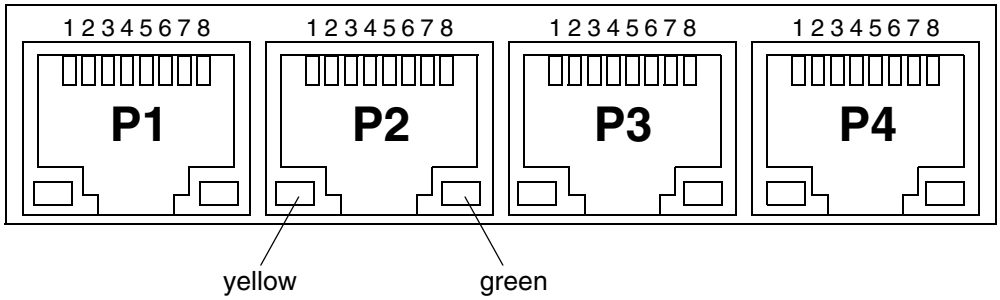


Fig. 2.39 Visual signalling of the Ethernet interfaces

The visual signalling of the desktop unit is the same as for the plug-in unit. The meaning of the LED is described in Tab. 2.10.

2.5.6.3 Power supply of the desktop unit without remote power supply

The following alternative types of power supply are available for the desktop unit without remote power supply:

- Local power supply with 110 V_{AC} or 230 V_{AC} (permitted range 95 – 260 V_{AC})
- Local power supply with 48 V_{DC} or 60 V_{DC} (permitted range 40 – 72 V_{DC})
- Remote power supply via the SHDSL interface ($\leq$ 120 V_{AC})
- Redundancy feeding (local power supply and in case of breakdown remotely fed)

2.5.6.4 Power supply of the desktop unit with remote power supply

The following alternative types of power supply are available for the desktop unit with remote power supply:

- Local power supply with 48 V_{DC} or 60 V_{DC} (permitted range 40 – 72 V_{DC})
- Local power supply with the external power brick SNP-A08T-S (permitted range 40 – 72 V_{DC})
- Redundancy feeding (local power supply via external power brick SNP-A08T-S and in case of breakdown via battery cable C107-A214-C734)

Monitoring and alarming of the desktop unit with remote feed corresponds to that of the plug-in module, see chapter 2.5.5.4.

2.6 Ethernet over TDM Inverse Multiplexer GTU4

2.6.1 Overview

The Ethernet via TDM Inverse Multiplexer GTU4 enables the transfer of up to 8 Mbit/s via four E1 channels. The GTU4 has a 4-port, self-learning VLAN transparent layer-2 switch. With the use of the GTU4 you can extend existing SDH networks with Ethernet interfaces or connect LANs with one another.

The GTU4 is available as
- plug-in unit or as
- desktop unit.

You can use the GTU4 either together with another GTU4, or via an SDH network on a QSTU - BSTU4 line. The following modes of operation are possible with use of the GTU4:
- Ethernet - Ethernet connection (GTU4 - TDM - GTU4)
- TDM - Ethernet connection (QSTU - TDM - GTU4)

The GTU4 supports the following networks:
- Bit-transparent transmission with 1...4x 2 Mbit/s, conforming to ITU-T G.703 [7]
- Frame structured transmission with 1...4x 2 Mbit/s conforming to ITU-T G.704 [8]
- Frame structured transmission with 1..4x 64 kbit/s – 1984 kbit/s (Fractional E1)

The configuration is made either via LCT or via AccessIntegrator. Further information on the configuration can be found in the corresponding user manuals.

2.6.2 Modes of operation of GTU4

This chapter describes the GTU4's modes of operation. The following types of use are possible:
- GTU4(LT) – TDM– GTU4(NT)
- STU4/BSTU4 – QSTU(LT) – TDM – GTU4(CS)

2.6.2.1 GTU4 configured local (Master)

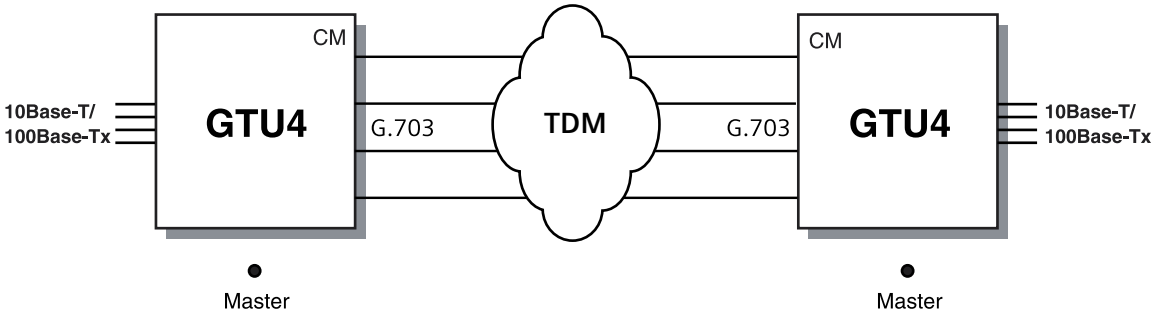


Fig. 2.40 Example of a configuration of a GTU4

The GTU4 is delivered configured by default as master.

2.6.2.2 GTU4 remotely configured (Master/Slave)

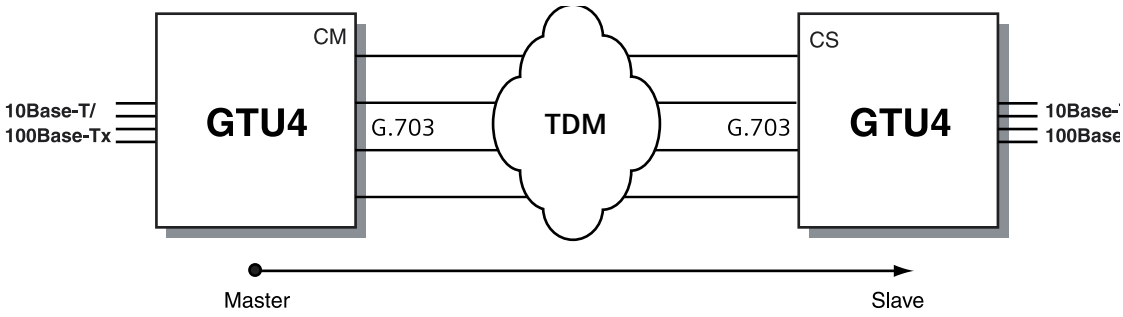


Fig. 2.41 Example of a configuration of a GTU4

The GTU4 is delivered configured by default as master.

2.6.2.3 GTU4 with QSTU locally configured (Master)

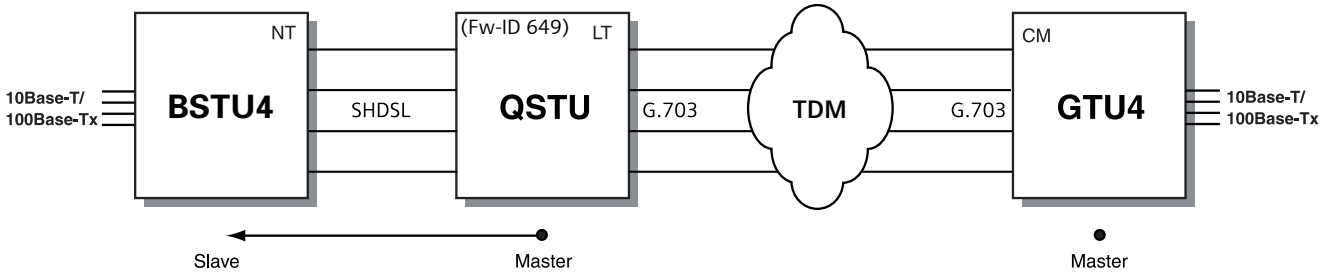


Fig. 2.42 Example of a configuration of a GTU4 in connection with a QSTU

The GTU4 is delivered configured by default as master.

2.6.2.4 GTU4 with QSTU remotely configured (Slave)

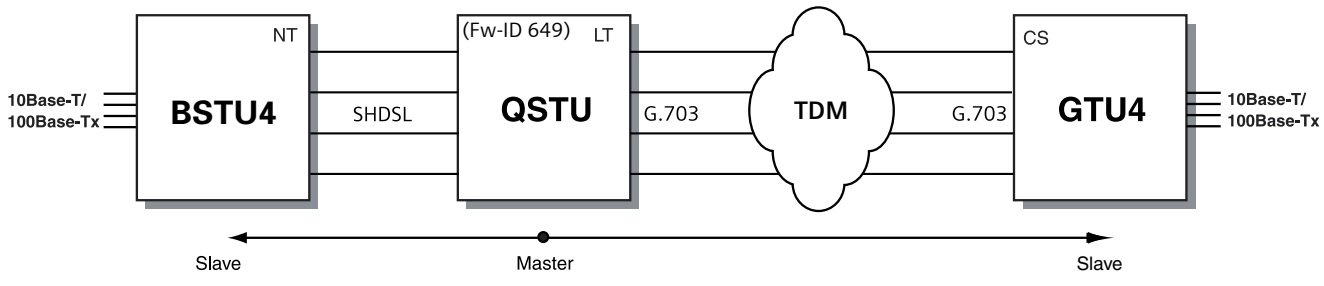


Fig. 2.43 Example of a configuration of a GTU4 in connection with a QSTU

The GTU4 is delivered configured by default as master.

i In BSTU4 – QSTU connections you must always use the QSTU on the LT-side. You can find more information about the FW-ID in Tab. 2.5

2.6.2.5 Application examples for the GTU4

You will find three application examples for the GTU4 in the following.

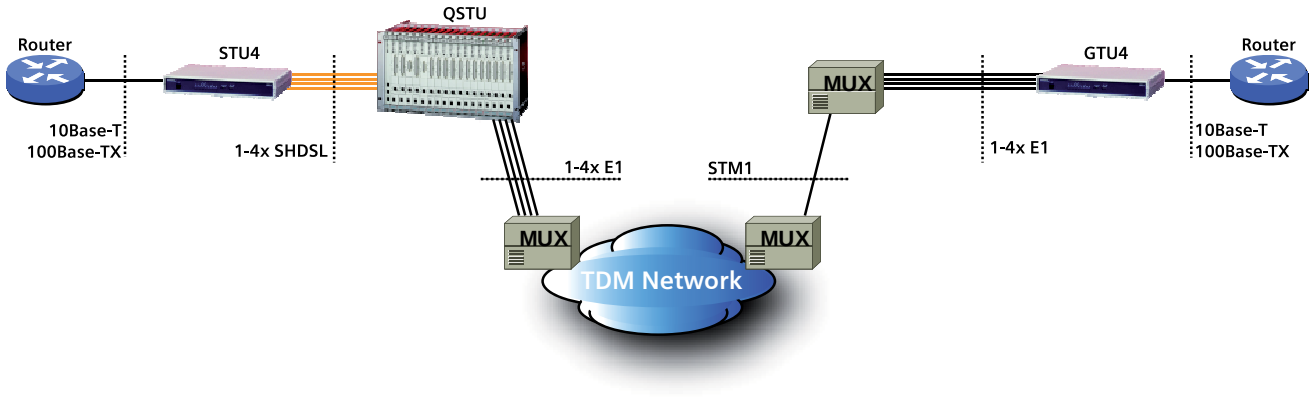


Fig. 2.44 Application GTU4 – BSTU4

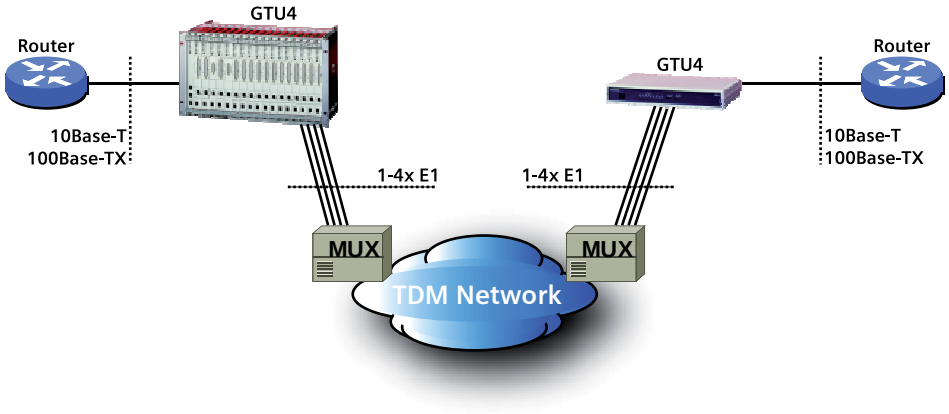


Fig. 2.45 Application GTU4 – GTU4

2.6.3 GTU4 function

The GTU4 is equipped with four Ethernet (10/100Base-Tx) and four G.703 interfaces. Fig. 2.46 shows you the GTU4's functional circuit diagram. The individual blocks (1-4) are described in the following chapters.

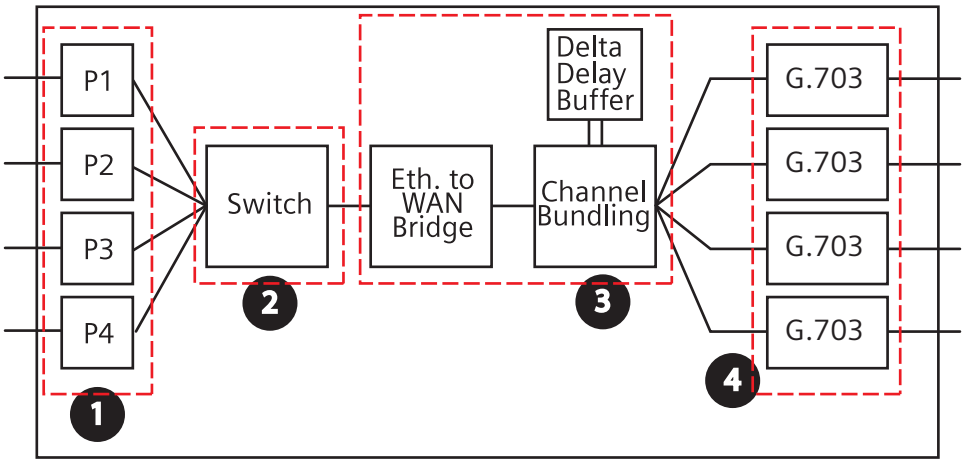


Fig. 2.46 Functional circuit diagram of the GTU4

- ❶ Ethernet interfaces, see chapter 2.6.3.1
- ❷ Layer 2 Switch, see chapter 2.6.3.2
- ❸ Channel Bundling, see chapter 2.6.3.3
- ❹ G.703 interfaces, siehe Kapitel 2.6.3.4

2.6.3.1 Ethernet interfaces

The Ethernet interfaces of the GTU4 have the following features:

- 10/100 Base-Tx in accordance with IEEE 802.3u
- Full Duplex / Half Duplex
  With Half Duplex as opposed to Full Duplex, simultaneous sending and receiving is not possible.
- Auto negotiating in accordance with IEEE 802.3u for
  – Full-/Half Duplex mode
  – 10/100 Base-Tx
  – Flow Control
- Automatic MDI/MDI-X
  Auto-MDI/MDI-X enables the automatic adjustment of the transmission and reception line of a port, i.e. on the connected Ethernet cable (crossed or not crossed) and the configuration of the opposite terminal.
- Flow Control
  – In Full Duplex operation 'Pause Frames' are sent (in accordance with IEEE 802.3x)
  – In Half Duplex operation the back pressure procedure is applied
- Bandwidth limiting
  The maximum input data rate of each Ethernet interface can be limited in steps of 32 kbit/s (policing).
- Link status information (Link up / 10/100 Base-Tx / Full Duplex/Half Duplex) is available for each Ethernet interface.

2.6.3.2 Layer 2 Switch

The Ethernet switch of the GTU4 has the following features:

- ‘Store and forward switch’
  The Ethernet packets are checked completely before they are forwarded to the destination address.
- ‘Non-blocking’
  All Ethernet interfaces can be processed with full line speed.
- ‘Wire speed address learning’
  MAC addresses can be learnt with full line speed
- Up to 1024 MAC addresses can be administered
- The ‘Aging time’ is 300 seconds
- ‘Broadcast storm protection’
  The forwarding of 'Broadcast packets' is limited to max. 1% of the data rate
- ‘Ethernet Frame Size’
  Packets of up to 1518 bytes are supported by default (or 1522 bytes incl. VLAN)
- ‘Oversized Frames Option’
  For Ethernet frames that do not comply with standards you can optionally increase the maximum packet size to 1916 bytes. This setting is the same for all ports.
- Packet counters for all Ethernet interfaces are available for error limitation
- ‘Adaptive Flow Control’
  With 'Adaptive Flow Control' the packet loss with overload can be prevented (overload happens when the Ethernet data rate exceeds the WAN data rate). With activation the 'Flow Control' between the switch and the 'Ethernet to WAN Bridge' is activated.

Flow Control

'Flow Control' depends on the bandwidth limitation on the individual Ethernet interfaces (see Bandwidth Limiting in chapter 2.6.3.1) and the outflow speed of the data on the WAN interface (see 'Adaptive Flow Control' in chapter 2.6.3.2).

- In the case of operation without 'Adaptive Flow Control' the 'Flow Control' mechanism is only controlled by the 'Bandwidth Limiting' function (individual for each interface).
- In the case of operation with 'Adaptive Flow Control' the 'Flow Control' mechanisms of all Ethernet interfaces are controlled together depending on the WAN data rate. The input data rate per Ethernet interface can also be limited in this configuration. The 'Flow Control' of each individual port is then controlled by both criteria.

'Adaptive Flow Control' also ensures an optimum delay.

i The Ethernet interfaces of the terminal devices must also support the 'Flow Control' function.

2.6.3.3 Channel Bundling

In this function the Ethernet packets are packed in HDLC and divided over the available number of transfer channels (Inverse Multiplexing). The following features are realized with the help of the proprietary, patented multi-channel synchronization algorithm (MCS).

- Efficient inverse multiplexing with less than 4% overhead with 4 x 2 Mbit/s
- Bundling of 1...4 TDM channels
- Resilience
  With the failure of one or more channels, the transfer continues to be made via the functioning channels. If the downed channel is available again, the data rate is increased again accordingly
  Resilience functions independently in the transmission and reception directions
- Resilience functions independently in the transmission and reception directions.
- Different latency times of the transfer channels of up to 125 ms can be compensated
- The additional latency time caused by the MCS function is minimal (<100 µs)
- Wire pair and path exchange is corrected automatically
- 'End-to-End' monitoring and alarming using MCS alarms and error counters via the network

2.6.3.4 G.703 interfaces

The GTU4 has four G.703 interfaces that can be operated with 120 Ω or 75 Ω. The interfaces can be configured for 'transparent operation' or 'partially filled G.704'. This makes an individually configurable payload bit rate possible.

2.6.4 Service functions

Loopback circuits and CRC checksums can be used for fault localization.

Loopback curcuits are activated either by software command (via the LCT for example) or by means of switches.

See chapter 1.14.4 for further information about loopback circuits.

2.6.5 GTU4 plug-in unit

2.6.5.1 Mechanical construction

The plug-in unit is produced to double eurocard format. The GTU4 is equipped with a front panel for insertion into the subrack.

The front of the plug-in unit incorporates

- the display and operating elements
- the subscriber interfaces and
- the transmission interface.

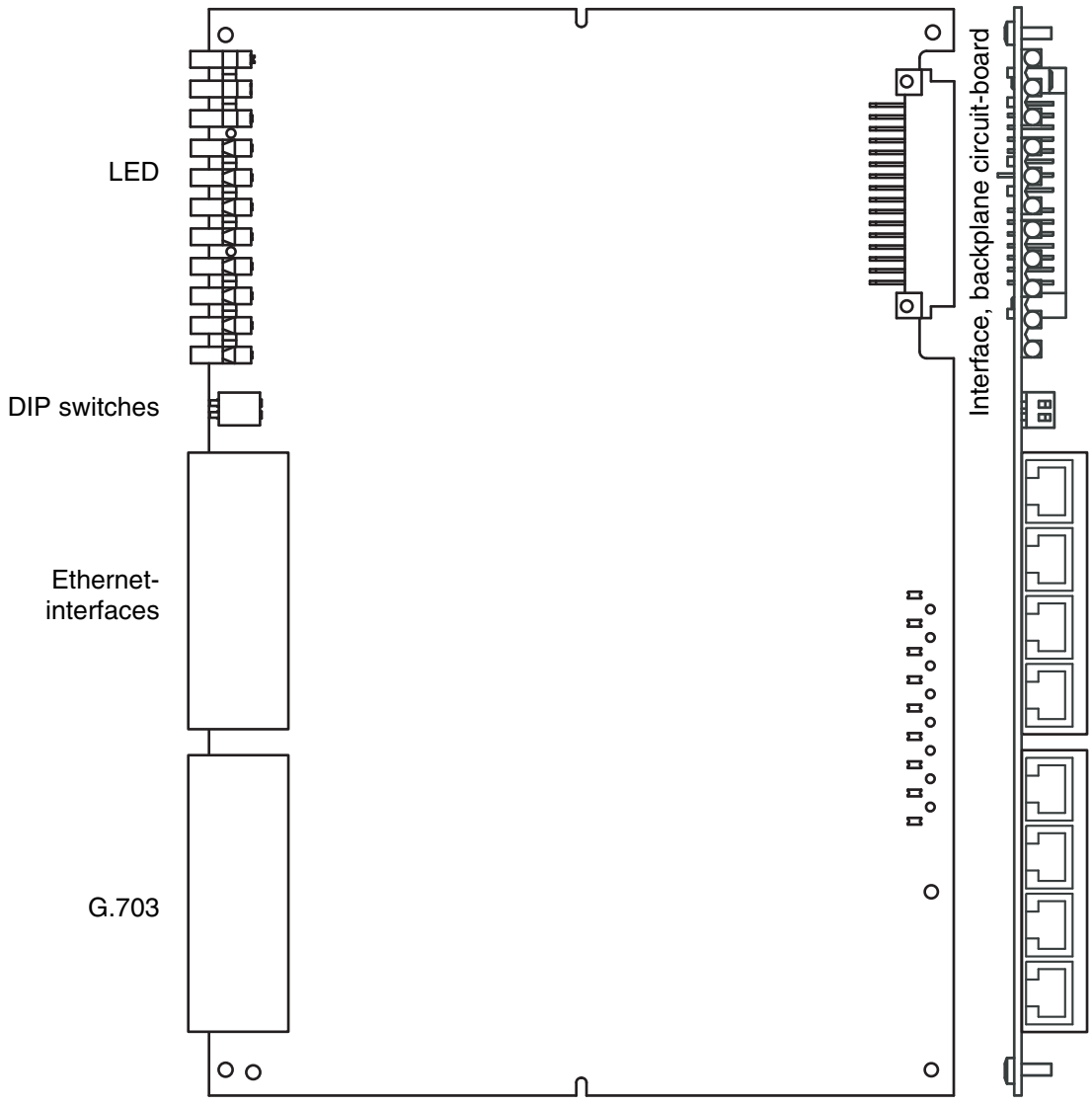


Fig. 2.47 GTU4 termination unit

2.6.5.2 Display and operating elements

Status display

The operating state and alarm signalling of the GTU4 are indicated by 11 LEDs on the front of the plug-in unit (Fig. 2.48).

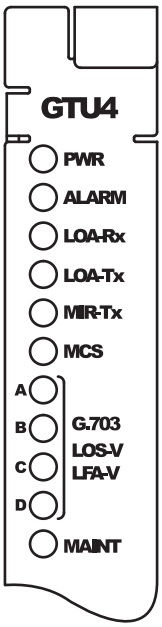


Fig. 2.48 Visual signalling of the GTU4 plug-in unit

LED	Color	State	
		off	on
PWR	green	No power supply	Power supply o.k.
Alarm	red	No alarm	Urgent alarm [1)]
	yellow	No alarm	Non-urgent alarm [1)]
LOA-Rx	yellow	No alarm	No WAN activity in reception direction
LOA-Tx	yellow	No alarm	No WAN activity in transmission direction
MIR-Tx	yellow	No alarm	WAN capacity in the send direction > 70 % utilization
MCS	red	No alarm	**on:** all paths downed **blinking 1:** on or more paths downed
LOS/LFA-V A	red	No alarm	**on:** Loss of signal at V **blinking:** Loss of frame alignment at V
LOS/LFA-V B	red	No alarm	**on:** Loss of signal at V **blinking:** Loss of frame alignment at V
LOS/LFA-V C	red	No alarm	**on:** Loss of signal at V **blinking:** Loss of frame alignment at V
LOS/LFA-V D	red	No alarm	**on:** Loss of signal at V **blinking:** Loss of frame alignment at V

Tab. 2.14 Indicators and operating elements on the plug-in unit GTU4

LED	Color	State	
		off	on
MAINT	yellow	No maintenance function	**on:** Loopback active, traps deactivated, BERT activated, layer 2 switch test mode activated

1) Alarm message depends of the configuration

Tab. 2.14 Indicators and operating elements on the plug-in unit GTU4

Visual signalling of the Ethernet interface

A green and a yellow LED are integrated in the sockets of the four Ethernet interfaces.

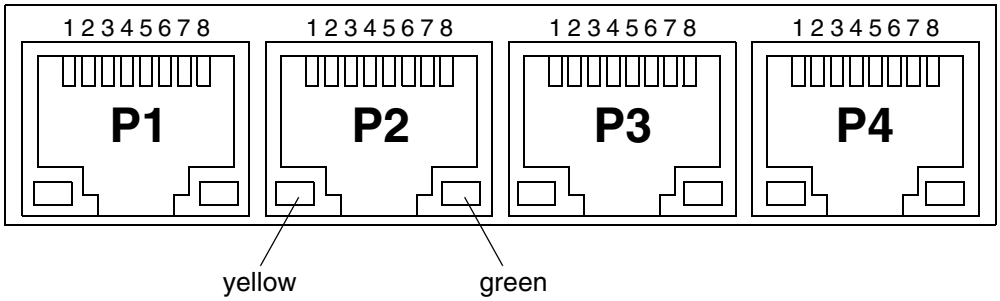


Fig. 2.49 Visual signalling of the Ethernet interface

LED	LED Mode 10/100Base-Tx
yellow	**Off:** Half Duplex **On**: Full Duplex **Blinking**: Collision with Half Duplex
green	**Off:** No connection/no Traffic **On**: Link Up **Blinking**: Traffic

Tab. 2.15 Visual signalling of the Ethernet interface

External operating elements

Using front-mounted DIP switches you can

- set the GTU4's operating mode (Tab. 2.16) and
- insert the loopback.

Settling	Description
CM	Configuration Master [1)]
CS	Configuration Slave
⊃	MCS loobpack inserted

1) Default setting

Tab. 2.16 Front-mounted DIP switches of the GTU4

2.6.5.3 Power supply

Power is supplied to the QSTU via the backplane circuit board of the subrack. The plug-in unit is equipped with a DC/DC converter and the input voltage is 48 V_{DC} / 60 V_{DC}.

2.6.6 GTU4 desktop unit

When the GTU4 is used in the desktop unit, it is installed in a plastic casing. The casing can also be wall mounted. The overall dimensions are 175 mm x 272 mm x 47 mm. The desktop unit can be used in the exchange as well as on the subscriber's premises.

The possible operating modes are identical with those for the plug-in unit, see chapter 2.6.2.

2.6.6.1 Mechanical construction

The indicators and operating elements and the RS232 connection for the local LCT are located on the front panel.

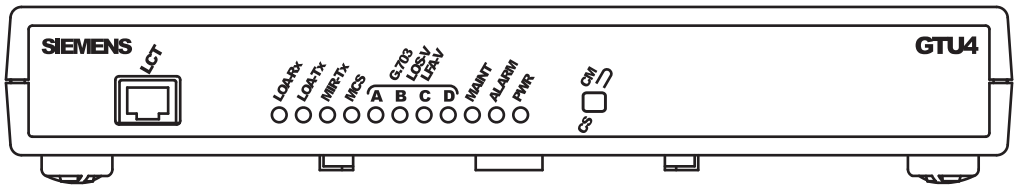


Fig. 2.50 Front panel of the desktop unit

The four Ethernet interfaces, the G.703 interfaces and the power supply connection are located on the rear panel. An alarm and clock module for transferring a high quality clock signal and outputting alarms can optionally be installed.

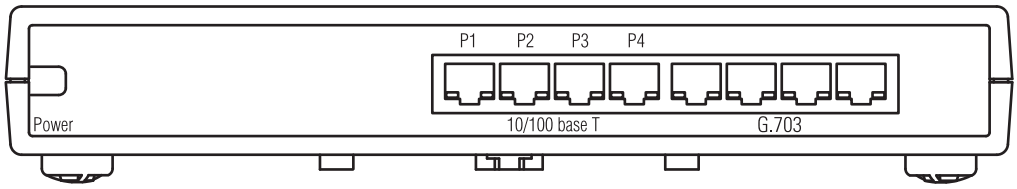


Fig. 2.51 Rear panel of the desktop unit

2.6.6.2 Display and operating elements

The visual signalling of the desktop unit is the same as for the plug-in unit. The meaning of the LED is described in Tab. 2.14.

2.6.6.3 Power supply

The following alternative types of power supply are available for the desktop unit:

- Local power supply with 110 V_{AC} or 230 V_{AC} (permitted range 95 – 260 V_{AC})
- Local power supply with 48 V_{DC} or 60 V_{DC} (permitted range 40 – 72 V_{DC})

2.7 Optical termination unit BOTU/QOTU

2.7.1 Overview

The BOTU and QOTU termination units are universal modules for optical connections and allow provision of 'carrier grade services' with high transfer bandwidths.

Several services can be transferred simultaneously, depending on the population variant:

- 1...4x 2 Mbit/s
- 100 Mbit/s Ethernet
- Data interfaces nx64 kbit/s (up to 4608 kbit/s)
- Clock

Using standard SFP modules for the optical transfer provides maximum flexibility of range and the optical wavelengths used. The BOTU can secure your services with '1+1 line protection' against failures.

There are a large number of different subscriber interfaces available for selection. G.703 and Ethernet interfaces are thereby available 'onboard'. A slot for ULAF+ data modules allows X.21, V.35 and V.36 data modules to be used.

The BOTU/QOTU is available in the following population variants:

Part No. S3118-.....	Description	Variant: Desktop Plug-in	Optical interfaces	G.703 onboard	Ethernet Ports onboard	Data module slots	Power
H612-F111	BOTU desktop 1+1 SFP slot (4 x G.703 + Ethernet)	D	1+1	4	4	–	AC/DC
H612-B210	BOTU desktop 1+1 SFP slot (1 x G.703 + Data)	D	1+1	1	–	1	AC/DC
J612-F111	BOTU plug-in 1+1 SFP slot (4 x G.703 + Ethernet)	P	1+1	4	4	–	DC
J613-F110	QOTU plug-in 4 SFP slot (4 x G.703)	P	4	4	–	–	DC

Tab. 2.17 Population variants of the BOTU/QOTU

The BOTU and the QOTU form a system family. The QOTU is always used as the LT and can only be operated together with a BOTU with a slot for data modules. You can operate the BOTU with a built-in Ethernet switch together with a BOTU with Ethernet switch or a BOTU with a slot for data modules.

The following operating modes are supported by the system family:

- Bit-transparent transmission with 2 Mbit/s interfaces, according to ITU-T G.703 [7]
- Frame structured transmission with 2 Mbit/s interfaces, according to ITU-T G.704 [8]
- ISDN Primary Rate access, conforming ITU-T I.431 [14], ETSI ETS 300 011 [20]/ ETSI ETS 300 233 [21]
- Connection of data equipment (X.21, V.35, V.36), granularity nx64 kbit/s, 10/100Base-Tx (Advanced Bridge-/Advanced Bridge and Router Modul)
- Mapped Mode: The mapping of CAS and control lines as well as the transfer of timeslot 0 (TS0) can be flexibly configured in 'mapped mode' to allow matching to the terminal device used
- G.703(LT) data(NT): For transferring data services over 2Mbits/s networks
- Ethernet: for transferring Ethernet packets at 100Mbits/s

2.7.2 Modes of operation of BOTU/QOTU

In BOTU – BOTU connections the following modes of operation are possible:

- BOTU (4x G.703; Ethernet) (LT) – BOTU (4x G.703; Ethernet) (NT)
- BOTU (4x G.703; Ethernet) (LT) – BOTU (1x G.703; data module slot) (NT)
- BOTU (1x G.703; data module slot) (LT) – BOTU (1x G.703; data module slot) (NT)

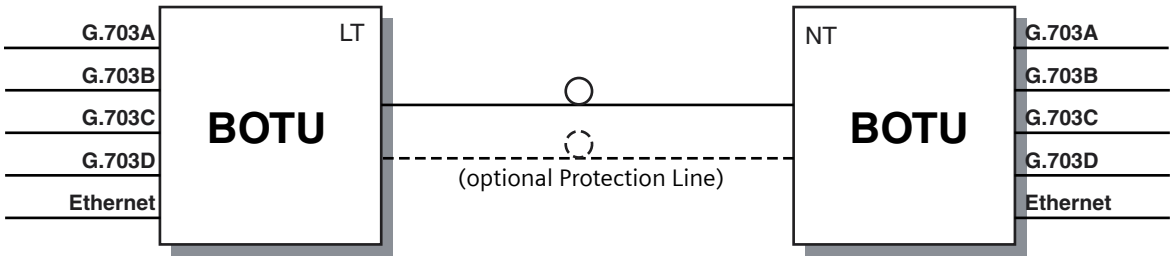


Fig. 2.52 Mode of operation: BOTU (4x G.703; Ethernet) (LT) – BOTU (4x G.703; Ethernet) (NT)

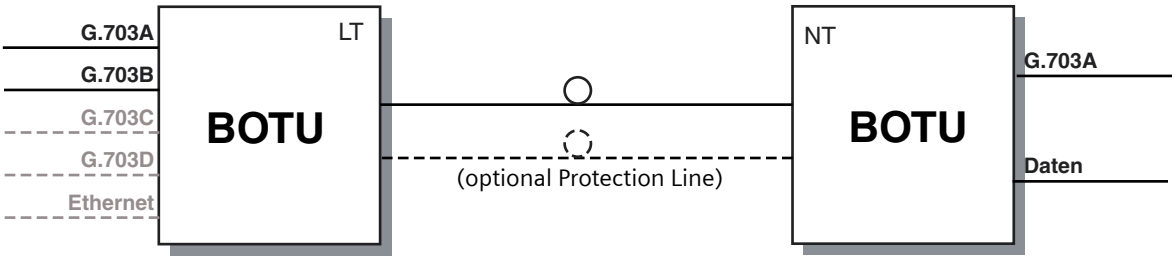


Fig. 2.53 Mode of operation: BOTU (4x G.703; Ethernet) (LT) – BOTU (1x G.703; data module slot) (NT)

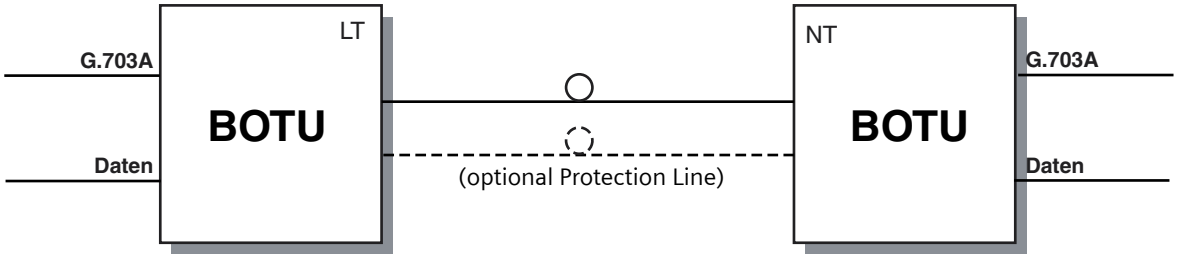


Fig. 2.54 Mode of operation: BOTU (1x G.703; data module slot) (LT) – BOTU (1x G.703; data module slot) (NT)

In QOTU – BOTU connections the following modes of operation are possible:

- QOTU (4x G.703) (LT) – BOTU (1x G.703; Datenmodul Slot) (NT)

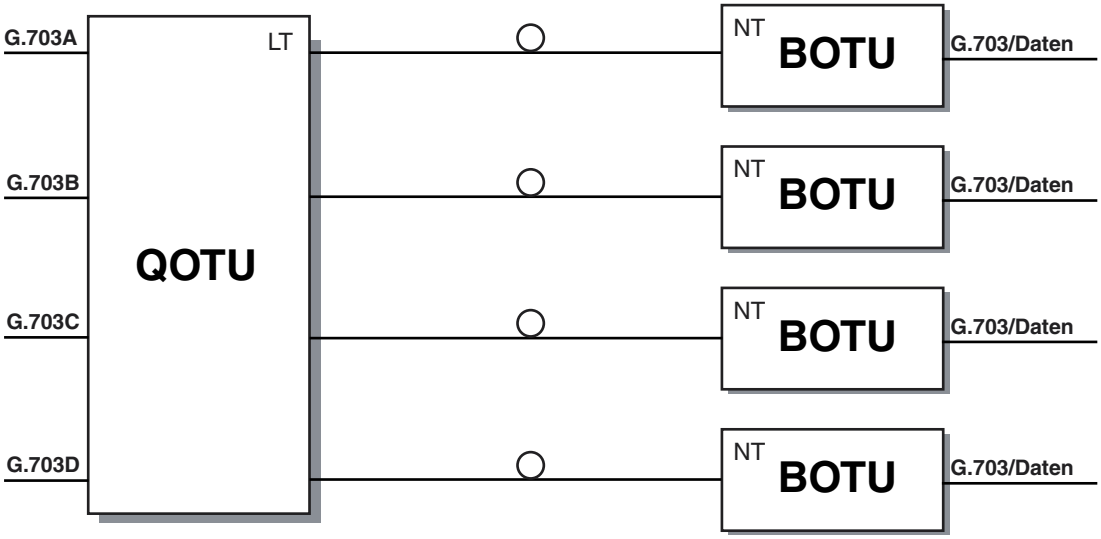


Fig. 2.55 Mode of operation: QOTU(LT) – 4x BOTU (1x G.703; data module slot) (NT)

i In QOTU – BOTU connections you must always use the QSTU on the LT-side.

2.7.3 BOTU/QOTU function

2.7.3.1 Optical interface

The optical transfer device has two/four SFP slots, whereby 155 Mbit/s SFP modules must be used. These are available in different variants from several manufacturers.

2.7.3.2 Data interfaces

The BOTU can be equipped with additional data interface modules. An overview of the population variants of the BOTU can be found in table Tab. 2.17 . Further information on the interface modules can be found in chapter 2.9.

2.7.3.3 G.703 interfaces

The module has four independent G.703 subscriber interfaces. The interfaces are built up identically. The G.703 interface can be operated with 120 Ω or 75 Ω. Impedance switchover is via LCT/ACI and is separately configurable for each interface. Connection with 75 Ω is via a separately available adapter cable.

2.7.3.4 Ethernet interfaces

The Ethernet interfaces of the BOTU have the following features:

- 10/100 Base-Tx in accordance with IEEE 802.3u
- Full Duplex / Half Duplex
- Auto negotiating in accordance with IEEE 802.3u for
  - Full-/Half Duplex mode
  - 10/100 Base-Tx
  - Flow Control
- Automatic MDI/MDI-X (Auto Cross-Over)
  Auto-MDI/MDI-X enables the automatic adjustment of the transmission and reception line of a port, i.e. on the connected Ethernet cable (crossed or not crossed)
- The 'flow control mechanism controls the data rate between the terminal device and the ULAF+ modem by allowing the sender to only send as much data as the transfer path can transport. If this transport capacity is exceeded, packets are discarded.
  - 'Pause frames' are sent (as per IEEE 802.3x) in full duplex operation
  - The backpressure method is used in half duplex operation

  The following flow control mechanisms are supported:
  - ‘Back Pressure Flow Control’ im Half-Duplex Mode
  - Erzeugen von ‘Pause Frames’ im Full-Duplex Mode

i 'Flow control' must be enabled on both the terminal device and ULAF+ to allow the flow control to function.

- Bandwidth limiting
  The maximum ingress data rate of each LAN port can be limited (policing). Up to 1 Mbit/s, the ingress data rate can be set in 64 Kbits/s steps. Above this speed, in steps of 1 Mbit/s.
  In addition, the egress data rate of all LAN and the WAN ports can be limited between 1 Mbit/s and 100 Mbit/s. The following egress data rates can be selected (where x is a value between 2 and 200):

  $$\frac{200'000\ \text{kbit/s}}{x}$$

- Link status information is available for each Ethernet interface
  (link up / 10/100Base-Tx / full duplex / half duplex)
- PHY Power saving mode
  The Ethernet interfaces can be switched on or off separately to reduce the power consumption

- Link Failure Propagation
  'Link failure propagation' (LFP) disables the ports on the switch if the synchronization is lost on the U interface. This allows devices connected to the BSTU4, such as a switch with 'spanning tree' or 'link aggregation', to react faster to a connection interrupt. A connection interrupt is indicated via 'LFP alarm' for all connected Ethernet interfaces.

2.7.3.5 LCT interface

The desktop unit variant is equipped with an RJ45 connector (RS232) on the front for connecting the LCT.

2.7.3.6 Clock interface

The desktop units are equipped with a BNC 75 Ω clock interface. This interface is configured on the LT as a clock input and on the NT as a clock output.

2.7.3.7 Layer 2 Switch

The Ethernet switch of the BOTU has the following features:

- 'Store and forward switch'
  The Ethernet packets are checked completely before they are forwarded to the destination address
- 'Non-blocking'
  All Ethernet interfaces can be processed with full line speed
- 'Wire speed address learning'
  MAC addresses can be learnt with full line speed
- Up to 1024 MAC addresses can be administered
- The 'Aging time' of the MAC table is 300 seconds
- 'Broadcast storm protection'
  The forwarding of 'Broadcast packets' is limited to max. 5 % of the data rate
- 'Ethernet Frame Size'
  Packets of up to 1518 bytes are supported by default (or 1522 bytes incl. VLAN)
- 'Oversized Frames Option'
  For Ethernet frames that do not comply with standards you can optionally increase the maximum packet size to 2048 bytes. This setting is the same for all ports.

Flow Control

'Flow Control' depends on the bandwidth limitation on the individual Ethernet interfaces (see Bandwidth Limiting in chapter 2.7.3.4) and the outflow speed of the data on the WAN interface.

i The Ethernet interfaces of the terminal devices must also support the 'Flow Control' function.

VLAN Support (IEEE 802.1Q)

The BOTU supports VLANs according IEEE 802.1Q. 16 different VLANs can be identified and handled simultaneously based on the 12-bit VLAN identifier.

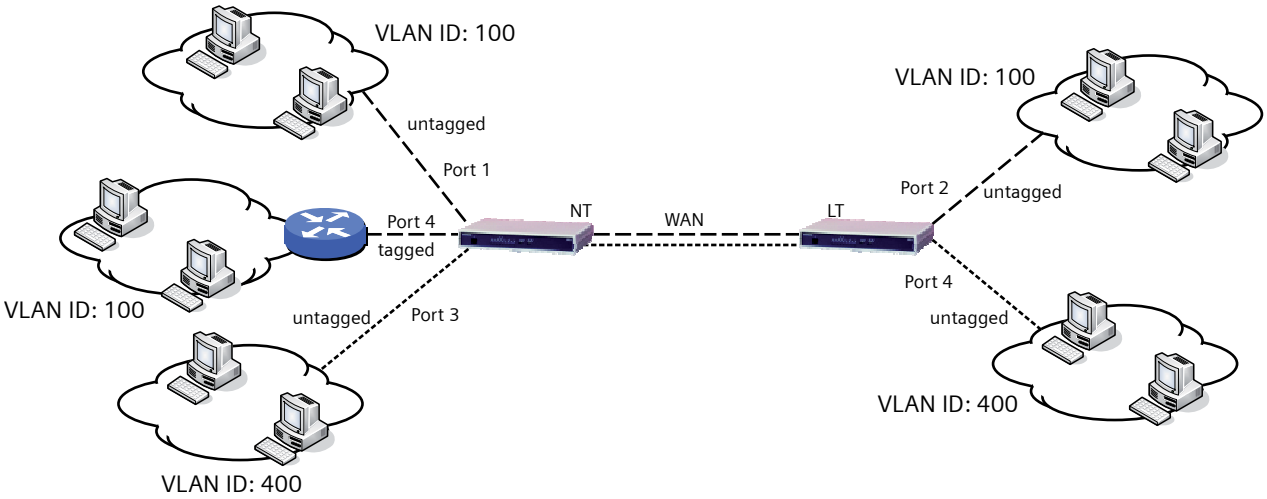


Fig. 2.56 Example for VLAN support

Corresponding VLAN filter table:

NT						
VLAN Number	VLAN ID	Port 1 Member	Port 2 Member	Port 3 Member	Port 4 Member	WAN Member
1	1	–	un-tagged	–	un-tagged	un-tagged
2	400	–	–	un-tagged	–	tagged
3	100	un-tagged	–	–	tagged	tagged
:	:	:	:	:	:	:
16	–	–	–	–	–	–

LT						
VLAN Number	VLAN ID	Port 1 Member	Port 2 Member	Port 3 Member	Port 4 Member	WAN Member
1	1	un-tagged	–	un-tagged	–	un-tagged
2	400	–	–	–	un-tagged	tagged
3	100	–	un-tagged	–	–	tagged
:	:	:	:	:	:	:
16	–	–	–	–	–	–

Tab. 2.18 Example for VLAN support

Q-in-Q (IEEE 802.1ad)

'Q-in-Q' is known by various names such as 'Double VLAN tagging', 'Double Tagging', '802.1ad' and 'Provider Bridge'.

The IEEE 802.1ad provider bridge mode allows service providers to use a layer 2 tunnel. Customers are able to route freely definable Ethernet traffic through this tunnel (e.g. native frames, VLAN, etc.). The advantage of this standard is that the configuration of the network components need not be changed even if the network topology is modified. The reason is that, in contrast to the P-VLAN frame format, the 802.1Q frame format has remained unchanged and backward compatibility to existing 802.1Q networks is therefore guaranteed.

With 'Double Tagging' a distinction is made between 'Customer Ports' and 'Provider Ports'. Specific 'Ethertype' values can be defined for 'Provider Ports'. The values serve to differentiate between 'Provider Tagged Frames' and normal 'Tagged Frames'.

'Provider Ports' send 'Double Tagged Frames' if 'Single Tagged Frames' arrive at the 'Customer Port'. However, if 'untagged frames' arrive at the 'Customer Port', the 'Provider Port' sends 'single tagged frames' but uses the configurable 'Ethertype'.

An example of an 802.1ad frame format with "Tagged Frames" and an example of an 802.1d provider bridge topology are given below.

When the 'Customer Frame' arrives at the provider bridge, it can have one or more 'VLAN tags'. In the example below, the frame has one 'VLAN tag (C-VLAN)'. A further 'tag' is added at the port input of the provider. Configuration of the 'provider VLAN-ID' and the 'provider Ethertype' is performed by the BOTU.

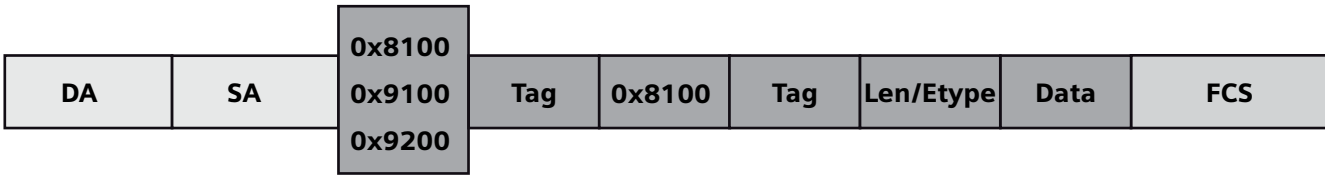


Fig. 2.57 Frame format of '802.1ad Provider Tagged Frames'

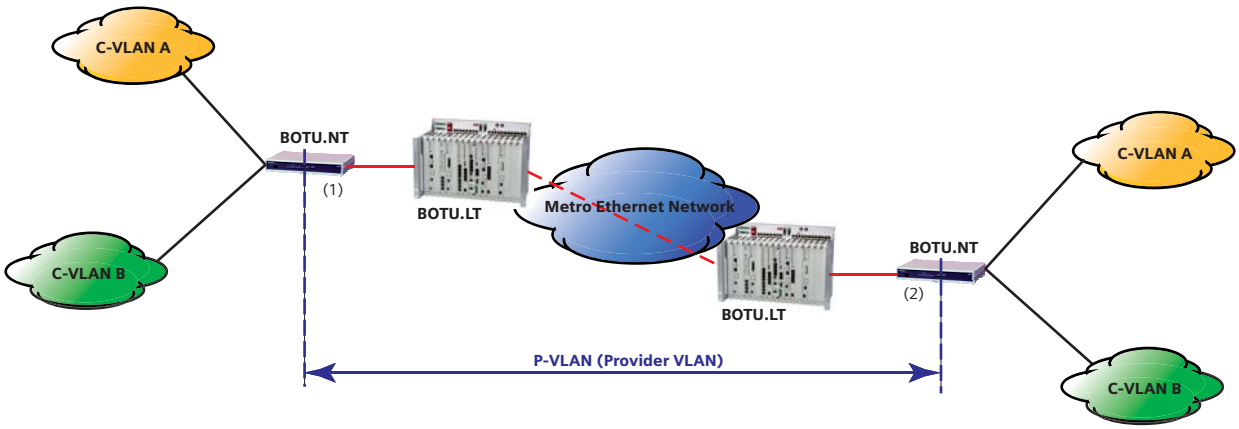


Fig. 2.58 Example of a 802.1ad Provider VLAN topology

Class of Service

Network service providers accommodate quality of service to their customers through a service contract which is called service level agreement (SLA). Classes of Service (CoS) describe the set of features and other characteristics associated with a specific service level. Thus, it must be possible to distinguish between traffic classes and ensure that traffic belonging to a certain class is treated according to the features of this class.

The BOTU has four queues per interface to enable network providers to deliver and guarantee these 'Classes of Services'. The following prioritization algorithms are available:

– **WFQ (Weighted** (fair queueing)**)**: The queues of the separate ports are processed accordingly in the ratio 8:4:2:1, where the queue with the lowest priority can use 1/15 of the available bandwidth.
– **PQ (Strict)**: The queues with lower priority are only processed after the queues with higher priority have been fully processed.

Traffic Policing at the Ethernet interface

The data flow of the individual inbound interfaces can be restricted with the following granularity:

- in 64 kbit/s steps from 64 kbit/s to 1 Mbit/s
- in 1 Mbit/s steps upwards of 2 Mbit/s

The captured bytes correspond to the standard layer 2Bytes (Ethernet frame of the destination address for CRC).

2.7.4 Service functions

Loopback circuits and CRC checksums can be used for fault localization.

Loopback curcuits are activated either by software command (via the LCT for example) or by means of switches. With ISDN-PRA, the control command for activating the loop switching can be transferred from the ISDN exchange via Sa6 bits in the message word of the 2 Mbit/s frame.

See chapter 1.14.5 for further information about loopback circuits.

2.7.5 BOTU/QOTU plug-in unit

2.7.5.1 Mechanical construction

The plug-in unit is implemented in double euro format. The BOTU is equipped with a front panel for use in the subrack. The BOTU/QOTU is deliverable in various population variants, see Tab. 2.17.

The front of the plug-in unit incorporates

- the display and operating elements
- the subscriber interfaces and
- the transmission interface (SFP Slot).

2.7.5.2 Display and operating elements

Status display

As a plug-in unit, the BOTU/QOTU has 3 separate LEDs on the front. 2 LEDs are integrated into each of the connectors for the Ethernet and G.703 interface as well as the SFP slot.

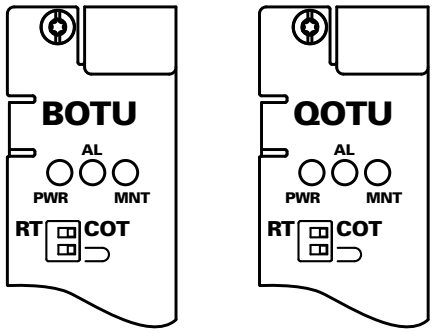


Fig. 2.59 Indicators and operating elements on the plug-in unit

LED	Color	Status	
		Off	On/Blinking
PWR	green	No power supply	Power supply ok
AL	red	No alarm	Urgent alarm 2)
	yellow	No alarm	Non-urgent alarm 2)
MNT	yellow	No maintenance function	**on:** Loopback active, traps deactivated, BERT activated, layer 2 switch test mode activated **blinking 1:** Firmware on LT and NT are not compatible or configuration is not supported by NT
G.703 A-D LOS	red	No alarm	**on:** LOS **blinking:** LFA 1)

1) Visual signalling according Fig. 2.60

2) The priority of the alarm message (urgent / not urgent) can be configured in the LCT

Tab. 2.19 Visual signalling of the plug-in unit BOTU/QOTU

LED	Color	Status	
		Off	On/Blinking
G.703 A-D AIS	yellow	No alarm	AIS
10/100BT P1-3, Aux	green	No connection / No traffic	**on:** Link Up **blinking:** Traffic
	yellow	Half Duplex	**on:** Full Duplex **blinking**: Collision bei Half Duplex
SFP1-4 LOS	red	No alarm	**on:** LOS **blinking:** LFA 1)
SFP1-4 ALARM	yellow	No alarm	**on:** No SFP **blinking:** Invalid SFP 1) **blinking:** Tx Fault1)

1) Visual signalling according Fig. 2.60

2) The priority of the alarm message (urgent / not urgent) can be configured in the LCT

Tab. 2.19 Visual signalling of the plug-in unit BOTU/QOTU

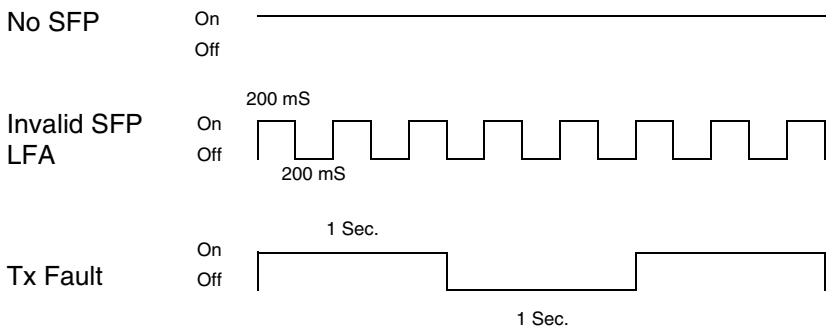


Fig. 2.60 Visual signalling of the BOTU/QOTU

2.7.5.3 Power supply

Power is supplied to the BOTU/QOUT via the backplane circuit board of the subrack. The plug-in unit is equipped with a DC/DC converter and the input voltage is 48 V_{DC} / 60 V_{DC}.

2.7.6 BOTU desktop unit

The indicators and operating elements and the RS232 connection for the local LCT are located on the front panel.

2.7.6.1 Mechanical construction

The BOTU desktop unit has a plastic housing. The casing can also be wall mounted. The overall dimensions are 175 mm x 272 mm x 47 mm. The desktop unit can be used in the exchange as well as on the subscriber's premises. The possible operating modes are identical with those for the plug-in unit, see chapter 2.7.2.

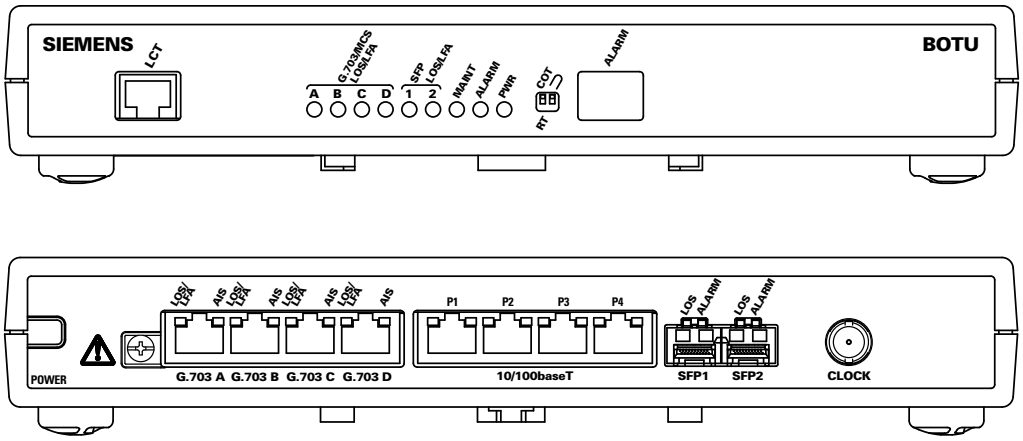


Fig. 2.61 Front and rear panel of the BOTU desktop unit

2.7.6.2 Display and operating elements

The visual signalling of the desktop unit is the same as for the plug-in unit. The LEDs of the G.703 and SHDSL interfaces are additionally fed to the front of the desktop unit. The meaning of the LED is described in Tab. 2.19.

2.7.6.3 Power supply

The following alternative types of power supply are available for the desktop unit:

- Local power supply with 230 V_{AC} via a hard-wired power supply cable
- Local power supply with 48 V_{DC} / 60 V_{DC} via a battery connection cable

The desktop unit is supplied as standard with 230 V_{AC} via a power supply cable that is hard-wired into the unit. The unit can optionally be supplied with 48 V_{DC} / 60 V_{DC} via a battery connection cable.

2.8 G.703 termination unit GTU

2.8.1 Overview

The termination unit GTU is a 2 Mbit/s G.703 termination module which can be used in both the ULAF+ subrack and also in a desktop unit. The information is transmitted by means of two twin copper wires in accordance with ITU-T G.703. Due the modular concept of the ULAF+ allows the GTU to be adapted to the individual user requirements by means of submodules.

The GTU can also be "remotely" managed in a special mode.

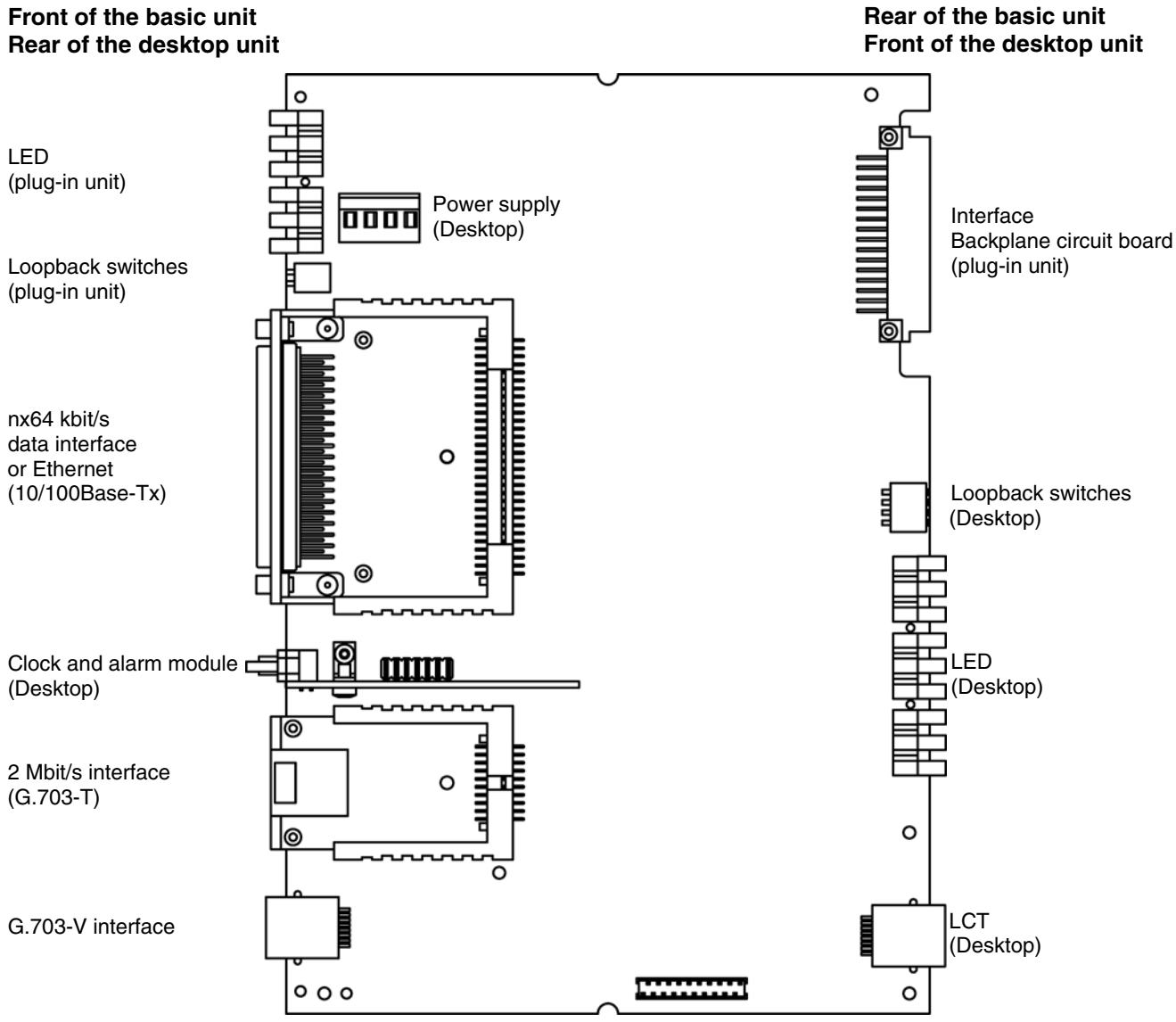


Fig. 2.62 G.703 termination unit GTU

The following operating modes are supported by the GTU:

- NT1 function according to ITU-T I.431 [12] or ETSI ETS 300 011 [13] / ETSI ETS 300 233 [14]
- Interface converter from nx64 kbit/s interfaces (V.36, V.35 and X.21) or Ethernet (10Base-T) to G.703 [7] / G.704 [8]
- Add/Drop (mixed mode nx64 kbit/s, Ethernet / 2 Mbit/s)

Chap. 2.8.4 describes the use of the GTU as a plug-in unit, Chap. 2.8.5 describes its use as a desktop unit.

2.8.2 Interfaces

The motherboard of the GTU is equipped with a G.703-V interface. In addition the board can accept the following interface modules:

- G.703 interface
- Data or Ethernet interface (10/100Base-Tx)
- Clock and alarm interface (for desktop units only)

You will find the interface modules in Chap. 2.9.

2.8.3 Service functions

For fault tracing various loopback circuits can be used. Loopback circuits are triggered by a software command (e.g. via the LCT) or using switches. The control command to activate the loopback circuit can be transferred from the ISDN exchange in NT1 mode using Sa6 bits in the service word of the 2 Mbit/s frame.

See Chapter 1.14.6 for further information about loopback circuits.

2.8.4 Using the GTU as a plug-in unit

2.8.4.1 Mechanical construction

The plug-in unit is produced to double eurocard format. The GTU is equipped with a front panel for insertion into the subrack.

The front of the plug-in unit incorporates

- the display and operating elements
- the subscriber interface and
- transmission interface.

2.8.4.2 Indicators and operating elements

When the GTU is inserted into subrack, the operating state and the alarm signalling are indicated by one green, two red and three yellow LEDs.

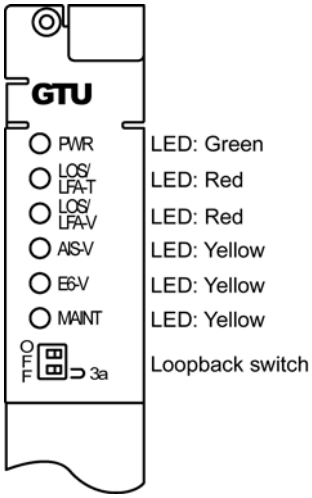


Fig. 2.63 Indicators and operating elements on the plug-in unit

LED	Color	Status	
		Off	On
PWR	Green	No power supply	Power supply OK
LOS/LFA-T	Red	No alarm	Signal level/frame synchronization loss at T
LOS/LFA-V	Red	No alarm	Signal level/frame synchronization loss at V
AIS-V	Yellow	No alarm	AIS at V
E6-V	Yellow	No alarm	Block error rate $>10^{-6}$ at V
MAINT	Yellow	No maintenance function	Local maintenance function activated

Tab. 2.20 Visual indications on the plug-in unit

2.8.4.3 Power supply

When the GTU is used as a plug-in unit, power is supplied via the backplane circuit board of the subrack. The plug-in unit is equipped with a DC/DC converter and the input voltage is 48 V_{DC}/60 V_{DC}.

2.8.5 Using the GTU in the desktop unit

When the GTU is used in the desktop unit, it is installed in a plastic casing. The casing can also be wall mounted. The overall dimensions are 175 mm x 47 mm x 272 mm.

The desktop unit features the same functionality as the plug-in unit and can be extended using the same submodules.

2.8.5.1 Mechanical construction

The indicators and operating elements and the V.24 connection for the local LCT are located on the front panel.

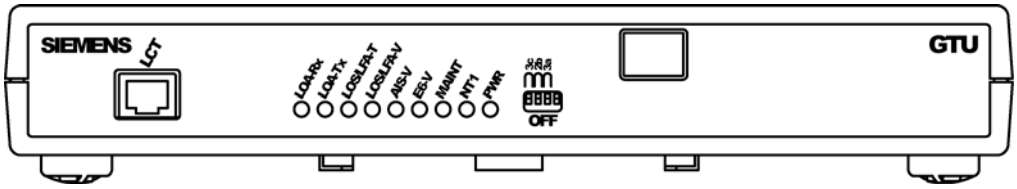


Fig. 2.64 Front panel of the desktop unit

The subscriber interface, the transmission interface, the clock and alarm interface and the power supply connection are located on the rear panel.

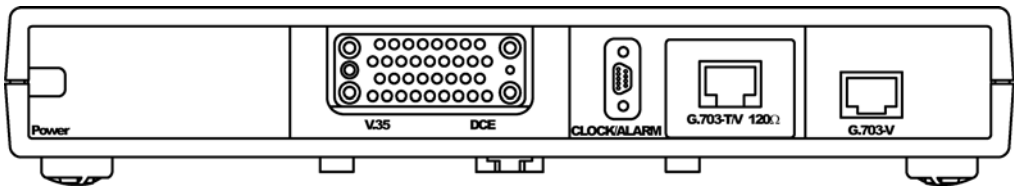


Fig. 2.65 Rear panel of the desktop unit

2.8.5.2 Indicators and operating elements

Nine LEDs are located on the front panel. The meaning of these LEDs is explained in Tab. 2.21.

LED	Color	Status	
		Off	On
LOA-Rx	Yellow	No fixed position at 0 or 1	Fixed position at 0 or 1 (no data present)
LOA-Tx	Yellow	No fixed position at 0 or 1	Fixed position at 0 or 1 (no data present)
LOS/LFA-T	Red	No alarm	Lights: Loss of Signal at the T interface Flashes: Loss of Frame Alignment at the T interface
LOS/LFA-V	Red	No alarm	Lights: Loss of Signal at the V interface Flashes: Loss of Frame Alignment at the V interface
AIS-V	Yellow	No alarm	Alarm Indication Signal at V
E6-V	Yellow	No alarm	Block error rate >10^{-6} at V
MAINT	Yellow	No maintenance function	Loopback 2 inserted
NT1	Green	Transparent mode	NT1 mode
PWR	Green	No power supply	Power supply OK

Tab. 2.21 Visual indications on the desktop unit

The electrical 2 Mbit/s signal to the V interfaces is routed via an RJ45 connector. The interface impedance can be adjusted by means of a jumper.

The operating modes of the GTU are set with the aid of DIP switches or LCT. The operating mode setting is indicated by a green LED.

For further information about the operating elements, refer to the ULAF+ Installation Manual [1].

The reason why any of the alarm signalling diodes (red and yellow LEDs) illuminates may not always be primarily due to a fault. Under certain circumstances it can also be a follow-on response.

Bit error evaluation and LFA are only indicated in NT1 mode. An AIS is only displayed if suppression has not been set.

2.8.5.3 Power supply

The following alternative types of power supply are available for the desktop unit:

- Local power supply with 230 V_{AC} via a permanently connected mains cable
- Local power supply with 48 V_{DC} / 60 V_{DC} via a permanently connected battery cable

A default voltage of 230 V_{AC} is supplied to the desktop unit via a mains cable which is permanently connected to the unit. As an alternative, a voltage of 48 V_{DC} / 60 V_{DC} can be supplied via a permanently connected battery cable. The battery cable is also permanently screwed to the module; for further information, refer to the ULAF+ Installation Manual [1].

2.9 Interface modules to the plug-in units and desktop models

	BSTU		BSTU4		QSTU		GTU4		BOTU		GTU	
	Plug-In unit	Desktop unit	Plug-In unit	Desktop unit	Plug-In unit	Desktop unit	Plug-In unit	Desktop unit	Plug-In unit	Desktop unit	Plug-In unit	Desktop unit
G.703; RJ45	–	–	–	–	–	–	–	–	–	–	Yes	Yes
G.703; BNC	–	–	–	–	–	–	–	–	–	–	Yes	Yes
G.703; 1.6/5.6	–	–	–	–	–	–	–	–	–	–	Yes	Yes
G.703; Sub-D	–	–	–	–	–	–	–	–	–	–	Yes	Yes
Advanced Bridge	Yes[1)]	Yes[1)]	–	–	–	–	–	–	–	Yes[1)]	Yes	Yes
Advanced Bridge & Router	Yes[1)]	Yes[1)]	–	–	–	–	–	–	–	Yes[1)]	Yes	Yes
X.21	Yes[1)]	Yes[1)]	–	–	–	–	–	–	–	Yes[1)]	Yes	Yes
V.35 (M34 connector)	–	Yes[1)]	–	–	–	–	–	–	–	Yes[1)]	–	Yes
V.35; Sub-D25	Yes[1)]	Yes[1)]	–	–	–	–	–	–	–	Yes[1)]	Yes	Yes
V.36	Yes[1)]	Yes[1)]	–	–	–	–	–	–	–	Yes[1)]	Yes	Yes
Alarm/Clock	Yes[1)]	Yes[1)]	–	Yes	–	Yes	–	Yes	–	–	–	Yes

1) For specified variants only

Tab. 2.22 Use interface and submodules

2.9.1 Modules for the 2 Mbit/s interface (G.703)

This slot can be equipped with the following interface submodules:

- RJ45 connector (interface impedance 120 Ω)
- Sub-D connector (interface impedance 120 Ω)
- BNC connector (interface impedance 75 Ω)
- 1.5/5.6 connector (interface impedance 75 Ω).

These modules consist of a circuit board with two connectors and the mechanical fittings for attachment to the transmission module. For details of the PIN assignment of the connectors, refer to the ULAF+ Installation Manual [1].

2.9.2 Modules for the ‘Data interface’ slot

Depending on requirements, the data interface can be equipped with different connectors.

The following modules are available:

- Advanced Bridge Module
  The module is equipped as Ethernet Bridge with a 10/100 Base-Tx Ethernet interface. 'Auto Negotiation', 'Transparent VLAN' and 'Spanning Tree' are supported. The configuration is performed via the console interface (RS232), either using Telnet or Web. You will find information on the configuration in the Advanced Bridge Module user manual [3].
- Advanced Bridge & Router Modul
  The Advanced Bridge & Router Module also has the IP routing functions (static, RIP1/2 and NAT), DHCP and DNS Client/Relay. With 'Frame Relay' and 'PPP' you can set up connections to external devices via V.36/V.35/X.21/E1. You will find information on the configuration in the Advanced Bridge Module user manual. [3].
- X.21 DCE (Sub-D 15-pin)
- V.35 DCE (M34 connector) for the desktop unit
- V.35 DCE (Sub-D 25-pin)
- V.36 DCE (Sub-D 37-pin)

In addition to the mechanical fittings and connectors, the necessary interface transceiver is also installed on these modules. For details of the PIN assignment of the connectors, refer to the ULAF+ Installation Manual [1].

2.9.3 Module for the clock and alarm interface

The urgent/non urgent alarms are emitted on two floating alarm contacts on the clock and alarm interface module. Access is via a 9-pin Mini-Sub-D connector. The clock input/clock output is operated at 75 Ω. The settings for the direction of the clock signal is adjusted by means of jumpers; see the ULAF+ Installation Manual [1].

Fig. 2.66 Clock and alarm interface

i The module for the clock and alarm interface can only be used in desktop units.

2.10 SHDSL regenerator BSRU

2.10.1 Overview

The 2 wire-pair regenerator BSRU can be used to bridge long distances that exceed the range of the SHDSL. The regenerator can be used in 1 wire-pair operation or in 2 wire-pair operation.

The following table shows the maximum usable regenerator stages when using the different modules.

Application possibilities	FW-ID of the QSTU	Max. Reg. steps
QSTU with BSTU/QSTU	633	4
QSTU with BSTU4/GTU4	649	4
BSTU with BSTU	– –	8

Tab. 2.23 Maximum usable BSRUs

2.10.2 Mechanical construction

The module is accommodated in a plastic housing. The outside of the housing has guide grooves for plugging it into the regenerator box. Application examples for the regenerator can be found in chapter 2.3.2.

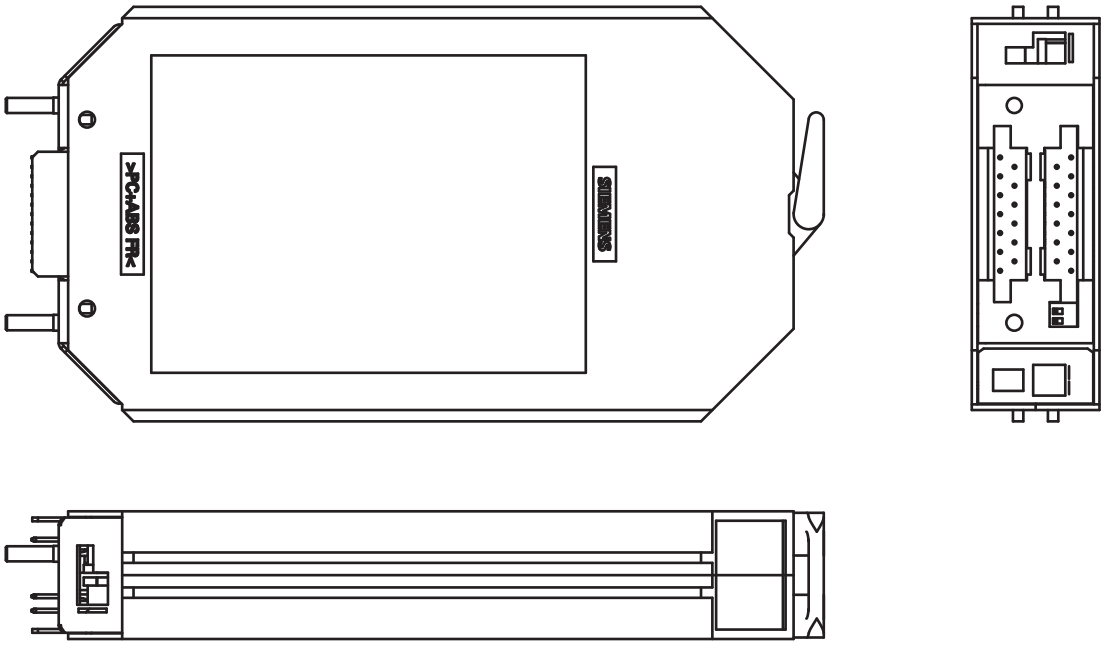


Fig. 2.67 SHDSL regenerator BSRU

The mechanical features and pin usage of the BSRU are compatible with an HDB3-ZWR (regenerator) conforming to the Deutsche Telekom norm.

2.10.3 Interfaces

The regenerator has four SHDSL interfaces and regenerates the attenuated and distorted incoming signals. The interfaces support the extended SHDSL standards (ETSI Annex E and ITU Annex G), so that in the case of a BSTU – BSTU application bitrates of up to 5696 kbit/s per wire-pair can be achieved

2.10.4 Powering of the BSRU

The following possibilities are available for supplying power to a BSRU:

- remote supply from the LT or NT side,
- through-transmission of a remote supply,
- local remote supply via a separate wire-pair (see ULAF+ Installation Manual [1])
- Locally via separate cable terminals.

The maximum remote supply voltage is 180 V_{DC}, the maximum for local supply is 120 V_{DC}. The range of a local power supply voltage is 40 V_{DC} – 120 V_{DC}.

The power supply is configured via an externally accessible DIP switch.

Three examples of applications of the BSRU are listed below:

- Remote power supply of the BSRUs from the LT:

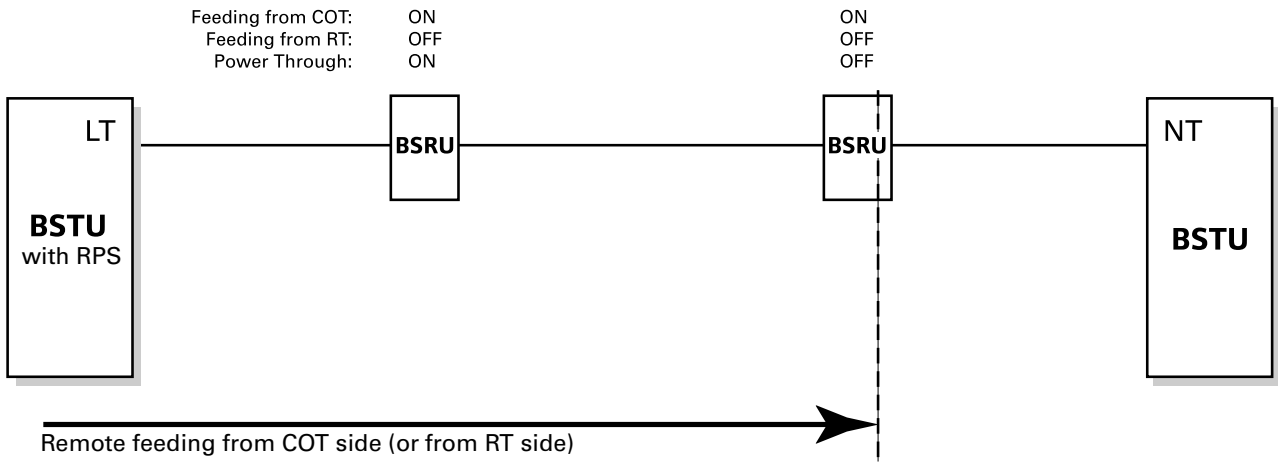


Fig. 2.68 Example of configuration: remote power supply of the BSRUs from the LT

- Remote power supply of the BSRU and the NT

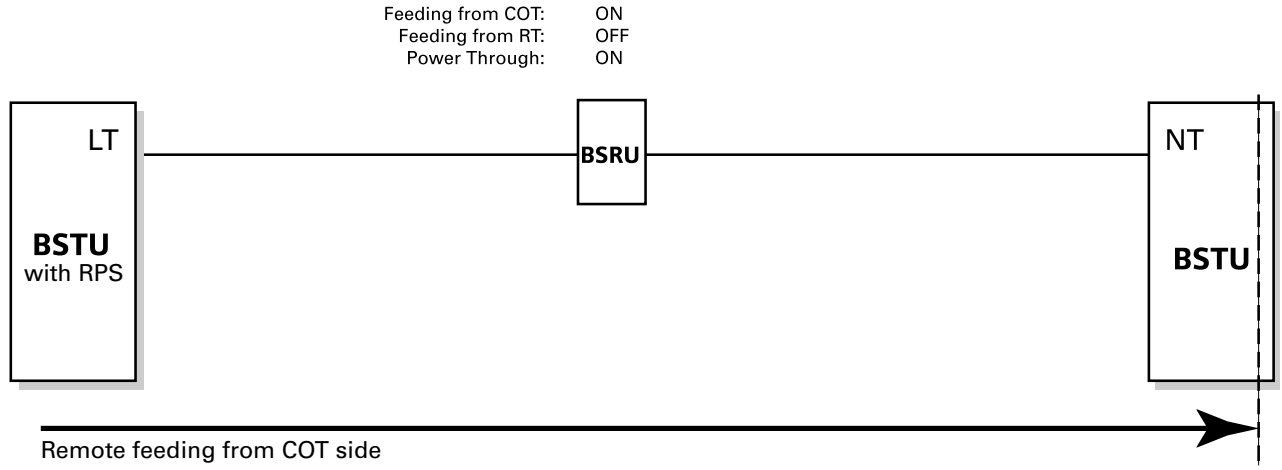


Fig. 2.69 Example of configuration: remote power supply of the BSRU ant the NT

- Combination of remote power supply and local power supply of the BSRUs

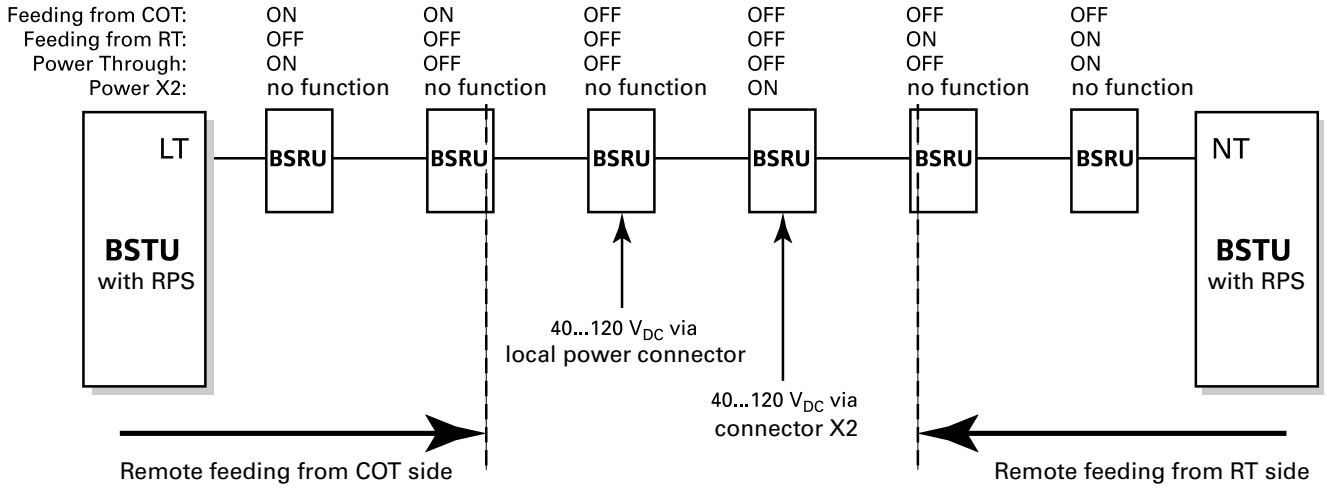


Fig. 2.70 Example of configuration: Combination of remote power supply and local power supply of the BSRUs

2.10.5 Monitoring and signalling

The functioning of the SHDSL regenerator is monitored from the exchange-side transmission module. Alarms are displayed on the LCT/AccessIntegrator.

Loopbacks and CRC6 check sums can be used for error location.

Loopbacks are activated on the regenerator by the LCT or AccessIntegrator.

3 Operation and monitoring

The ULAF+ is operated and monitored via the LCT or the NMS interface on the OMI SNMP Operating and Maintenance module.

The LineIntegrator network management system is used for centralized operation and maintenance of the ULAF+, with an LCT (Local Craft Terminal) being used for local operating and maintenance tasks.

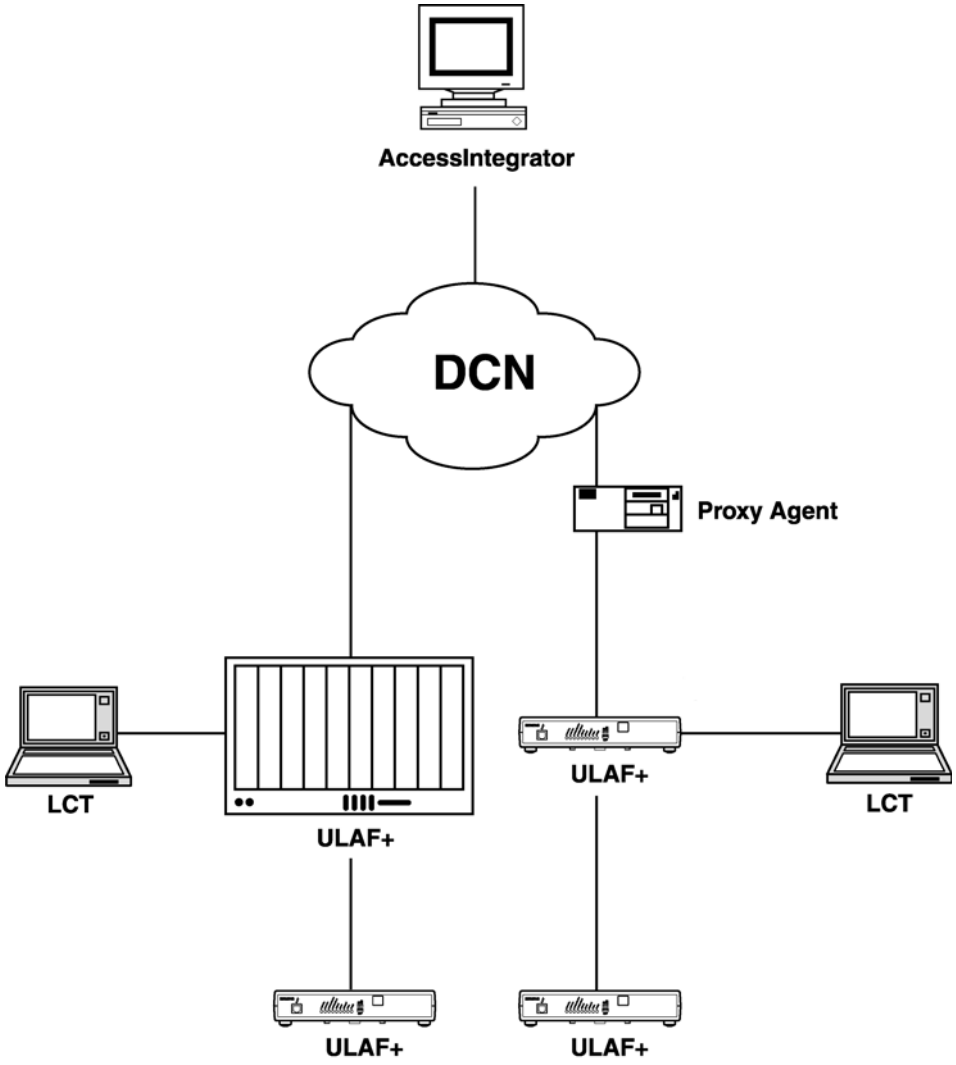


Fig. 3.1 NMS concept

3.1 AccessIntegrator

Network Management

AccessIntegrator (AcI) is the Siemens AG network management solution for controlling and monitoring access/network products. An own 'Element Manager' is available in the AccessIntegrator family for ULAF+. The ULAF+ Element Manager uses the universal management protocol SNMP for communication with the ULAF+ system.

The AccessIntegrator also supports the CORBA North Bound Interface, which enables connection of an AcI Cross Domain Manager (CDM) or an umbrella management system.

Platform

AccessIntegrator runs under Windows 2000 and Windows 2003 Server. The AcI-Client also runs under Windows XP.

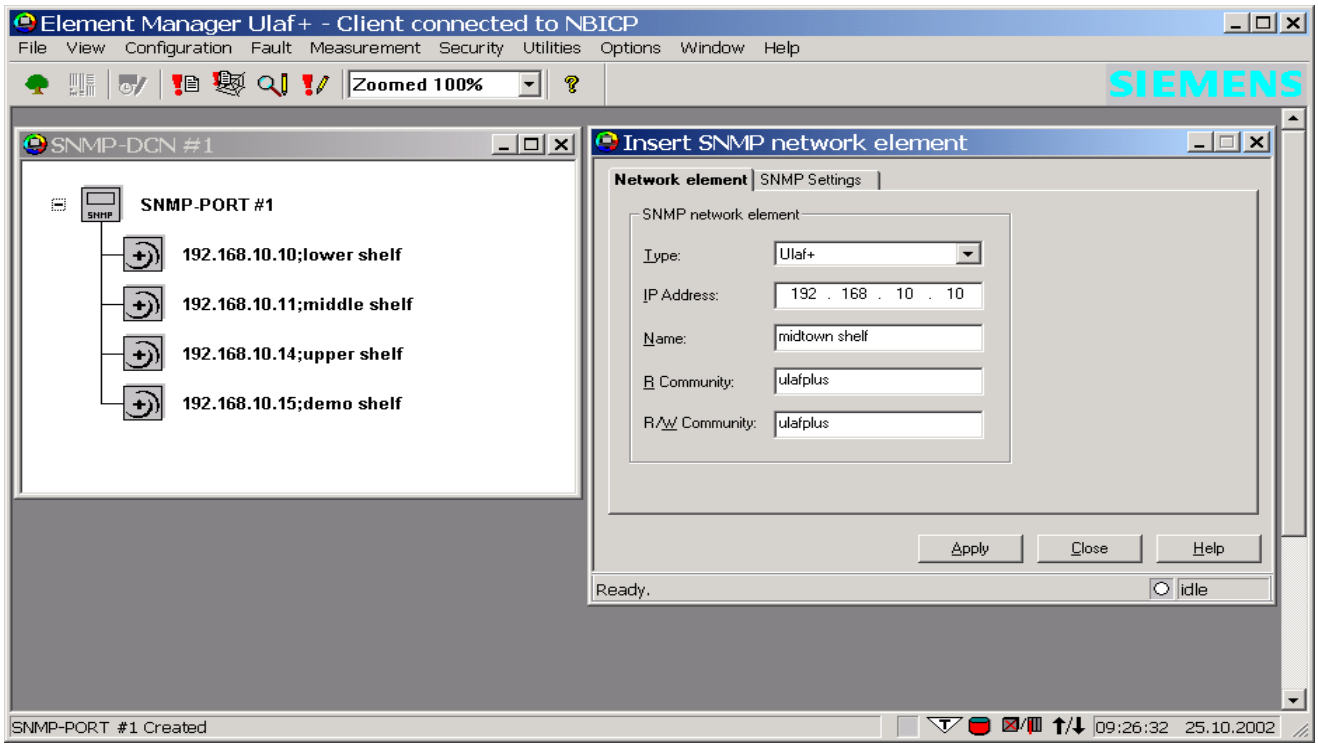


Fig. 3.2 'Element Manager ULAF+' main window

For further details of the AccessIntegrator, refer to the relevant manuals; see Chapter 5 References.

3.2 Operation via LCT

For local control, an LCT can be connected to the OMI SNMP either

- via a RS232 interface or
- via TCP/IP.

The LCT can also be connected to a desktop unit via the RS232 interface.

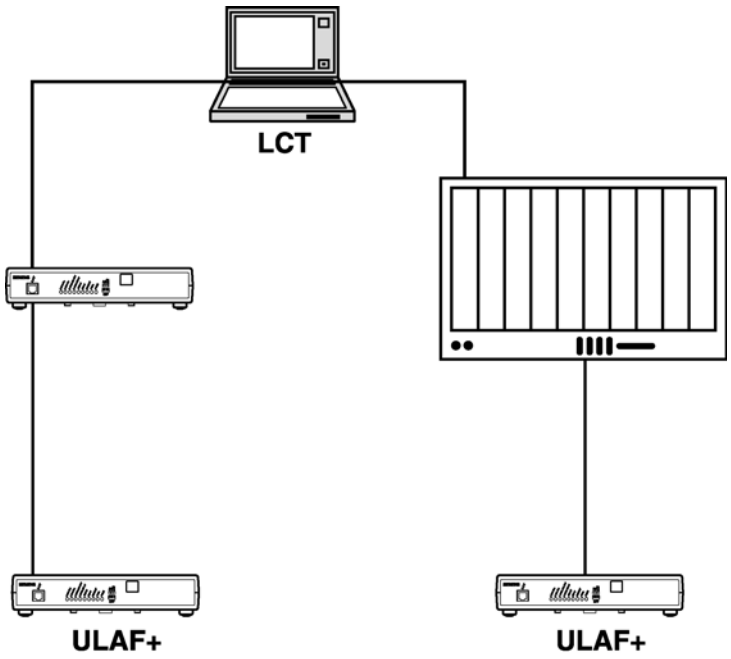


Fig. 3.3 Operation/maintenance via an LCT

LCT platform

The ULAF+ LCT runs on a PC (or laptop) on

- Windows 98
- Windows 2000
- Windows XP.

Graphical user interface

In the ‘Line view’, the graphical user interface shows the installed network elements (LT/NT and optional connected regenerators). If the LCT is connected to the NT, only the unit is displayed but not the path.

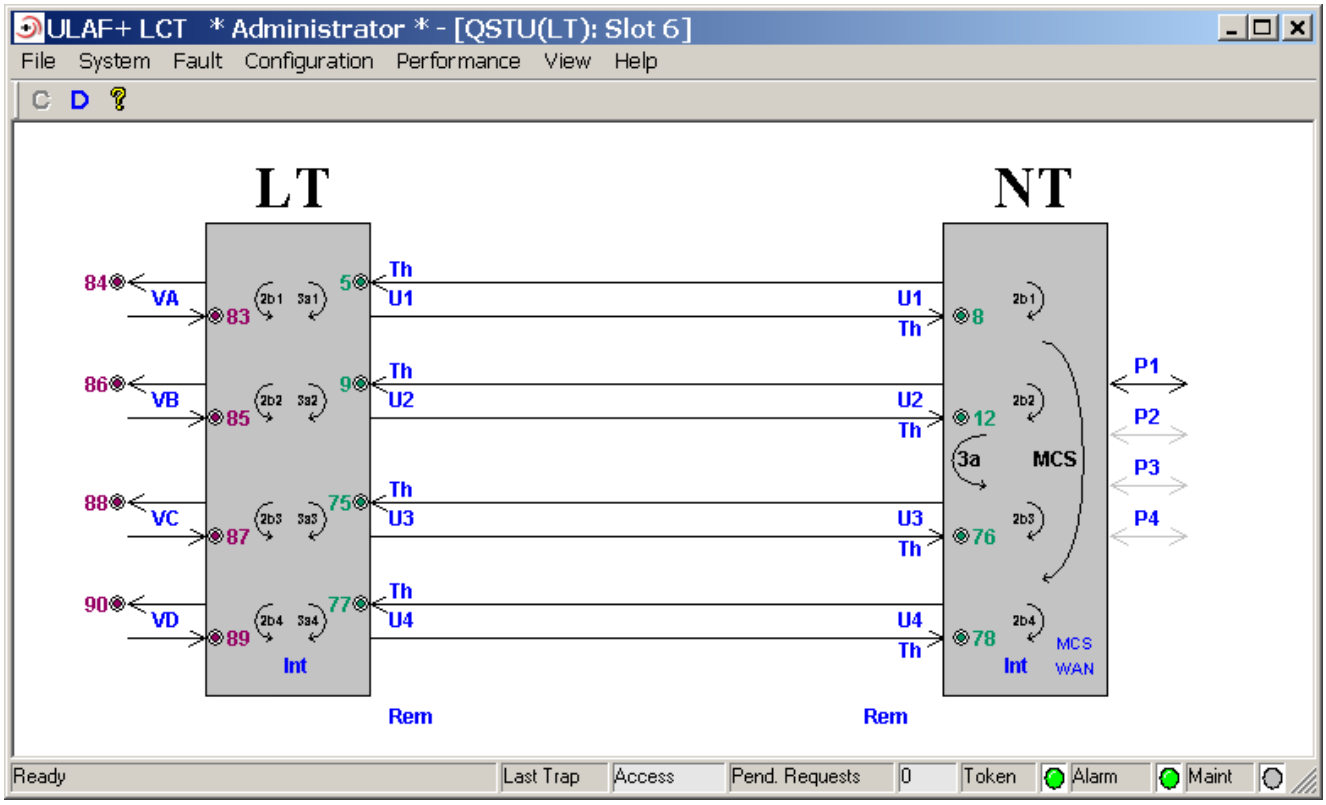


Fig. 3.4 'ULAF+ LCT' main window

The system provides the following functionality:

- Functional presentation of the path
- Path-oriented administration of the line
- Reading and writing of the configuration of individual network elements
- Event-driven recording of the alarms
- Optical and/or acoustic alarm signalling in the event of malfunctions
- Masking of alarm messages
- Monitoring of quality data
- Execution of long-term measurements of quality data

4 Technical Data

4.1 Subracks (S3105-B128-C211)

Operating voltage, nominal:	48 V_{DC} / 60 V_{DC}
Input voltage	36 V_{DC} to 72 V_{DC}
Clock input	2048 kHz / ITU-T G.703
Impedance	75 Ω / 120 Ω
Mechanical design	
Dimensions (W x H x D)	482 x 314 x 242 mm Suitable for installation in a 19” or ETSI rack
Environmental conditions	
Storage	ETS 300 019-1-1, Class 1.2
Transport	ETS 300 019-1-2; Class 2.3
In Operation	ETS 300 019-1-3; Class 3.1/3.2
Ambient temperature	-5...+55 degrees Celsius (5% to 95% relative air humidity)
DC voltage	ETS 300 132-2
EMC	ETS 300 386-1

4.2 OMI SNMP Operating and Maintenance Module

Input voltage	48 V_{DC} / 60 V_{DC}
Max. power consumption	3 W
Alarm outputs	3
Contact loading	60 V_{DC} or 42,4 V_{AC} 0.2 A (isolated from ground)
RS232 (LCT access)	RJ45 connector 9600 baud 8 data bits, 1 start bit, 1 stop bit
10Base-T (AccessIntegrator access)	RJ45 connector
OMI bus	V.11 level, bidirectional 38.4 kbit/s
Dimensions	
Plug-in unit	Double eurocard format
Operating temperature	-5...+55° C (5% to 95% relative air humidity)

4.3 BSTU termination unit

Input voltage	
Plug-in unit	48 V_{DC} / 60 V_{DC}
Desktop unit	48 V_{DC} / 60 V_{DC} 110 V_{AC} / 230 V_{AC}
(remote power)	max. 180 V_{DC}
Power consumption (max.)	< 5 W
with remote power supply 180V/60mA	< 25 W
With remote power supply	
Output voltage at 120 V_{DC}	113 V ± 2 V
Output voltage at 180 V_{DC}	173 V ± 2 V
SHDSL interface	
Transmission technology	SHDSL (ETSI TS 101 524 [24], ITU-T G.991.2 [13])
Line code	TC-PAM 16 / TC-PAM 32
Payload Bitrate	192 kbit/s to 5696 kbit/s (per wire pairs)
Ethernet interface	1x 10/100Base-Tx (Half/Full Duplex, Auto Negotiation, Auto Crossover)
Dimensions	
Plug-in unit	Double eurocard format
Desktop unit (B x H x T)	272 x 47,5 x 175 mm
Temperature (in operation)	-5 ... +55° C at 5 – 95 % rel. humidity

4.4 QSTU termination unit

Input voltage	
Plug-in unit	48 V_{DC} / 60 V_{DC}
Desktop unit	48 V_{DC} / 60 V_{DC} 110 V_{AC} / 230 V_{AC}
(remote power)	max. 120 V_{DC}
Power consumption (max.)	< 6 W
with remote power supply 120V/50mA	< 37 W
with remote power supply 120V/60mA	< 42 W
With remote power supply	
Output voltage at 120 V_{DC}	113 V $\pm$ 2 V
SHDSL interface	
Transmission technology	SHDSL (ETSI TS 101 524 [24], ITU-T G.991.2) [13]
Line code	TC-PAM16
Payload Bitrate	4x 192 kbit/s to 2048 kbit/s or 2x 384 kbit/s to 2048 kbit/s or 1x 786 kbit/s to 2048 kbit/s
Dimensions	
Plug-in unit	Double eurocard format
Desktop unit (B x H x T)	272 x 47,5 x 175 mm
Temperature (in operation)	-5 ... +55° C at 5 – 95 % rel. humidity

4.5 BSTU4 termination unit

Input voltage	
Plug-in unit	48 V_{DC} / 60 V_{DC}
Desktop unit	48 V_{DC} / 60 V_{DC} 110 V_{AC} / 230 V_{AC}
Power consumption (max.)	< 12.7 W
with remote power supply 4x 120V/50mA	< 38 W
with remote power supply 4x 120V/60mA	> 45 W
Ethernet switch	4x 10/100Base-Tx (Half / Full Duplex, Auto negotiation, Auto Crossover) Self learning (1024 MAC adresses)
Transmission technology	SHDSL (ETSI TS 101 524 [24], ITU-T G.991.2) [13]
Line code	TC-PAM16 / TC-PAM 32
Payload Bitrate	192 kbit/s to 5696 kbit/s (each wire-pairs) 1 to 4 wire pairs (max. 22,8 Mbit/s with 4 wire pairs)
Dimensions	
Plug-in unit	Double eurocard format
Desktop unit (B x H x T)	272 x 47,5 x 175 mm
Temperature (in operation)	-5 ... +55° C at 5 – 95 % rel. humidity

4.6 GTU4 termination unit

Input voltage	
Plug-in unit	48 V_{DC} / 60 V_{DC}
Desktop unit	48 V_{DC} / 60 V_{DC} 110 V_{AC} / 230 V_{AC}
(remote power)	max. 120 V_{DC}
Power consumption (max.)	< 6 W
Ethernet switch	4x 10/100Base-Tx (Half / Full Duplex, Auto negotiation, Auto Crossover) Self learning (1024 MAC adresses)
Transmission technology	G.703
Payload Bitrate	192 kbit/s to 2048 kbit/s (each wire-pairs)
Dimensions	
Plug-in unit	Double eurocard format
Desktop unit (B x H x T)	272 x 47,5 x 175 mm
Temperature (in operation)	-5 ... +55° C at 5 – 95 % rel. humidity

4.7 BOTU/QOTU termination unit

Input voltage	
Plug-in unit	48 V_{DC} / 60 V_{DC}
Desktop unit	48 V_{DC} / 60 V_{DC} 95 V_{DC} / 260 V_{AC}
Power consumption	< 6 W
Ethernet switch	4x 10/100Base-Tx (Half / Full Duplex, Auto negotiation, Auto Crossover)
Transmission technology	Optical transmission, Slot for SFP modules (155 Mbit/s)
Payload Bitrate	100 Mbit/s Ethernet + 4x 2 Mbit/s G.703 or 4698 kbit/s + 2 Mbit/s G.703
Dimensions	
Plug-in unit	Double eurocard format
Desktop unit (W x H x D)	272 x 47.5 x 175 mm
Temperature (in operation)	-5 ... +55° C at 5 – 95 % rel. humidity

4.8 GTU4 termination unit

Input voltage	
Plug-in unit	48 V_{DC} / 60 V_{DC}
Desktop unit	48 V_{DC} / 60 V_{DC} 110 V_{AC} / 230 V_{AC}
(remote power)	max. 120 V_{DC}
Power consumption (max.)	< 6 W
Ethernet switch	4x 10/100Base-Tx (Half / Full Duplex, Auto negotiation, Auto Crossover) Self learning (1024 MAC adresses)
Transmission technology	G.703
Payload Bitrate	192 kbit/s to 2048 kbit/s (each wire-pairs)
Dimensions	
Plug-in unit	Double eurocard format
Desktop unit (B x H x T)	272 x 47,5 x 175 mm
Temperature (in operation)	-5 ... +55° C at 5 – 95 % rel. humidity

4.9 2 wire pairs SHDSL Regenerator (BSRU)

Feed voltage (local)	40...120 V_{DC}
Max. feed current (local)	55 mA
Feed voltage (remote feeding)	max. 180 V_{DC}
Power consumption	< 3,4 W
Line code	TC-PAM16 / TC-PAM32
Dimensions (W x H x D)	110 x 35 x 225 mm
Ambient temperature (during operation)	-5 ... +55° C at 5 to 95 % relative humidity

5 References

[1] ULAF+ Installation Manual (IMN)
SIEMENS Switzerland Ltd
A3118-X300-M100-*-76D1

[2] ULAF+ User Manual LCT (UMN)
SIEMENS Switzerland Ltd
A3118-X300-M100-*-7619

[3] User Manual Advanced Bridge & Router Module
User Manual Advanced Bridge Module
SIEMENS Switzerland Ltd
A3118-X359-D091-*-7618

[4] AccessIntegrator Installation Manual (IMN)
SIEMENS Switzerland Ltd
A50010-T3-U100-*-76D1

[5] AccessIntegrator Administration Manual (ADMN)
SIEMENS Switzerland Ltd
A50010-T3-U100-*-7671

[6] AccessIntegrator Operation Manual (OMN)
SIEMENS Switzerland Ltd
A50010-T3-U100-*-7619

[7] ITU-T Recommendation G.703 - Physical/Electrical characteristics of hierarchical digital interfaces

[8] ITU-T Recommendation G.704 - Synchronous frame structures uses at 1544, 6312, 2048, 8488 and 44 736 kbitu/s hierarchical levels

[9] ITU-T Recommendation G.706 - Frame alignment and cyclic redundancy check (CRC) procedures relating to basic frame structures defined in recommendation G.704

[10] ITU-T Recommendation G.821 - Error performance of an international digital connection operating at a bit rate below the primary rate and forming part of an integrated services digital network

[11] ITU-T Recommendation G.823 - The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy

[12] ITU-T Recommendation G.826 - Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate

[13] ITU-T Recommendation G.991.2 - Single-Pair High-Speed Digital Subscriber Line (SHDSL) Transceivers

[14] ITU-T Recommendation I.431 - Primary Rate User-Network Interface - Layer 1 Specification

[15] ITU-T Recommendation K.17 - Protection against Interference; Tests on power-fed repeaters using solid-state devices in order to check the arragements for protection from external interference

[16] ITU-T Recommendation K.20 - Protection against Interference; Resistibility of telecommunication equipment installed in a telecommunications centre to overvoltages and overcurrents

[17] ITU-T Recommendation K.21 - Protection against Interference; Resistibility of subscribers' terminals to overvoltages and overcurrents

[18] ITU-T Recommendation K.50 - Safe limits of operating voltages and currents for telecommunication systems powered over the network

[19] ITU-T Recommendation K.51 - Safety criteria for telecommunication equipment

[20] ETSI ETS 300 011 - Integrated Services Digital Network (ISDN); Primary Rate User Network Interface (UNI); Part 1: Layer 1 specification

[21] ETSI ETS 300 233 - Integrated Services Digital Network (ISDN); Access digital section for ISDN primary rate

[22] ETSI ETS 300 386 - Equipment Engineering (EE); Public telecommunication network equipment Electro-Magnetic Compatibility (EMC) requirements; Part 1: Product family overview, compliance criteria and test levels

[23] ETSI ETS 135 - Transmission and Multiplexing (TM); High bit-rate digital Subscriber Line (HDSL) transmission system on metallic local lines; HDSL core specification and applications for combined ISDN-BA and 2048 kbit/s transmission

[24] ETSI TS 101 524 - Symmetric single pair high bit rate digital subscriber line (SDSL) transmission system on metallic local lines

6 Abbreviations

ABAR	Advanced Bridge and Router Module
AIS	Alarm Indication Signal
BER	Bit Error Rate
BERT	Bit Error Rate Tester
BOTU	Optical Termination Unit BOTU
BRAS	Broadband Remote Access Server
BSC	Base Station Center
BSRU	SHDSL Regenerator Unit BSRU
BSTU	Network Termination Unit BSTU
BSTU4	NetworkTermination Unit BSTU4
BTS	Base Transceiver Station
CM	Configuration Master
CoS	Class of Service
COT	Central Office Terminal
CRC	Cyclic Redundancy Check
CS	Configuration Slave
DCE	Data Carrier Equipment
DCN	Data Communication Network
DSLAM	Digital Subscriber Line Access Multiplexer
DTE	Data Terminal Equipment
ES	Errored Seconds
ETSI	European Telecommunications Standards Institute
FEXT	Far End Cross Talk
FW	Firmware
GSM	Global System for Mobile Communications
GTU	G.703 Termination Unit
GTU4	Ethernet over TDM Inverse Multiplexer GTU4
IP	Internet Protocol
ISDN	Integrated Service Digital Network
ITU	International Telecommunication Union
LAG	Link Aggregation
LAN	Local Area Network
LCT	Local Craft Terminal
LED	Light Emitting Diode
LFA	Loss of Frame Alignment
LFP	Link Failure Propagation
LOA	Loss of Activity
LOSW	Loss of Synchronisation Word

LT	Line Termination
MAC	Media Access Control
MCS	Multi Channel Synchronisation
MIR	Maximum Information Rate
MPLS	Multi-Protocol Label Switching
MSC	Mobile Switching Center
NEXT	Near End Cross Talk
NMS	Network Management System
NT	Network Termination Unit
OC	Over Current
OMI	Operating and Maintenance Interface unit
PBO	Power Back-Off
PBRS	Pseudo Random Bit Sequence
POTS	Plain Old Telephone System
PQ	Priority Queuing
PRA	Primary Rate Access
PSD	Power Spectrum Density
PWLAN	Public Wireless Local Area Network
QSTU	Network Termination Unit QSTU
RPS	Remote Power Supply
RT	Remote Terminal
SDH	Synchronous Digital Hierarchy
SHDSL	Single-pair High Speed Digital Subscriber
SNMP	Simple Network Management Protocol
STS	Signalling Time Slot
TC-PAM	Trellis Coded Pulse Amplitude Modulation
TDM	Time Division Multiplex
TMN	Telecommunications Management Network
TS	Time Slot
UC	Under Current
ULAF+	Universal Line Equipment Access Family
UNBAL	Unbalanced
VDSL	Very High Speed Digital Subscriber Line
VLAN	Virtual Local Area Network
WAN	Wide Area Network
WFQ	Weighted Fairness Queuing

7 Index

Numerics

A

B

C

D

E

G

I

L

M