



WATSON

Watson TDM

Operating Manual

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Declaration of Conformity



Tabletop

Watson TDM tabletop 1p E1 120 Ohm	SZ.847.V310
Watson TDM tabletop 1p nx64, E1 120 Ohm	SZ.847.V318
Watson TDM tabletop 1p E1 75 Ohm	SZ.847.V330
Watson TDM tabletop 1p nx64, E1 75 Ohm	SZ.847.V338
Watson TDM tabletop 2p E1 120 Ohm	SZ.847.V410
Watson TDM tabletop 2p nx64, E1 120 Ohm	SZ.847.V418
Watson TDM tabletop 2p E1 75 Ohm	SZ.847.V430
Watson TDM tabletop 2p nx64, E1 75 Ohm	SZ.847.V438

Plug-in

Watson TDM plug-in 4xDSL 2xE1 120 Ohm	SZ.867.V612
Watson TDM plug-in 4xDSL 4xE1 120 Ohm	SZ.867.V614
Watson TDM plug-in 4xDSL 2xE1 75 Ohm	SZ.867.V632
Watson TDM plug-in 4xDSL 4xE1 75 Ohm	SZ.867.V634
Watson TDM plug-in 4xDSL 2nx64	SZ.867.V682
Watson TDM plug-in 2xDSL nx64 E1 120 Ohm	SZ.867.V218
Watson TDM plug-in 2xDSL nx64 E1 75 Ohm	SZ.867.V238
Watson TDM plug-in 2xDSL nx64 E1 120 Ohm	SZ.867.V218

Regenerator

Regenerator Watson TDM and Watson 5	SZ.856.V310
Regenerator Watson TDM and Watson 5	SZ.856.V311
Regenerator Watson TDM and Watson 5	SZ.856.V410

Manufacturer:

Schmid Telecom AG, Binzstrasse 35, CH-8045 Zurich

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<p>2004/108/EC Directive containing requirements regarding electromagnetic compatibility.</p>	<p>The compliance of the above mentioned product with the requirements of the directive 2004/108/EC is ensured by complete application of the following harmonized European Standards: EN 300386:2000</p>
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The compliance of the above mentioned products with the specified requirements of the applicable directives and harmonized and non-harmonized standards is shown in the following internal and external test reports:

- Watson_TDM_EMG_Report_0.1.pdf
- wTdm_ntu_safetyPreTestReport_847418
- Watson_TDM_EMG_External_Report_1.pdf

CE Label attached to the product(s): on minirack, on tabletop, on 19" subrack (for plug-in only)
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Signatures:

Signature 1



Ronny Colotto

Signature 2



Rolf Frey

Important Safety Precautions

To reduce the risk of fire, bodily injury, and damage to the equipment the following precautions must be observed:

- Read and follow all warning notices and instructions marked on the product or included in the manual.
- Installation of this equipment has to be done by qualified personnel only.
- To achieve safety and satisfactory EMC performance, the plug-in boards have to be inserted into appropriate subracks. Subrack slots that are not used must be covered with a blanking plate.
- The subracks must be connected to earth. This is achieved by installing the subracks into properly grounded rack or by connecting the protective ground terminal provided on some subracks to the earthing network.
- If the subracks are installed in racks then these racks must be connected to the earthing network according to ETS 300 253.
- Where protective ground terminals are available on subracks these terminals are marked with the symbol . The following rules must be observed:
 - The earthing network must be connected to the protective ground terminal continuously and securely.
 - Where the subracks are fitted with an AC power connector the earthing network must be connected securely to the protective ground terminal even if the AC power cord is disconnected from the subracks.
 - The protective grounding may only be disconnected from the subracks after the DSL line has been disconnected from the plug-in.
- This product is to be used with telecommunications circuits. Take the following precautions:
 - Never install telephone wiring during a lightning storm.
 - Never install telephone jacks in wet locations unless the jack is specifically designed for wet locations.
 - Never touch uninsulated telephone wires or terminals unless the telephone line has been disconnected at the network interface.
 - Use caution when installing or modifying telephone lines.
 - Avoid using a telephone (other than a cordless type) during an electrical storm. There may be a remote risk of electric shock from lightning.
 - Do not use the telephone to report a gas leak in the vicinity of the leak.
- Condensation may occur externally or internally if this product is moved from a colder room to a warmer room. When moving this product under such conditions, allow ample time for this product to reach room temperature and to dry before operating.
- This product is intended for use in environments as stated in the technical specifications. Do not use this product in areas classified as hazardous locations. Such areas include patient care areas of medical and dental facilities,

oxygen-laden environments, or industrial facilities. Contact your local electrical authority governing building construction, maintenance, or safety for more information regarding the installation of this product.

- Slots and openings in this product are provided for ventilation and should never be blocked or covered, since these ensure reliable operation of this product and protect it from overheating. This product should not be placed in a built-in apparatus such as a rack unless the apparatus has been specifically designed to accommodate the product, proper ventilation is provided for the product, and the product instructions have been followed.
- This product should be placed away from radiators, heat registers, stoves, or other pieces of equipment that produce heat. Allow sufficient air circulation around the product and the AC adapter during use to ensure adequate cooling of the device.
- Do not use this product in a wet location.
- Normal operation of this product is only possible when the external housing is left in place.
- This product should be operated only from the type of power source indicated on the product's electrical ratings label. If you have questions about the type of power source to use, contact your local Schmid Distributor or local power company.
- Be sure that the power outlet you plug the power cord into is easily accessible and located as close to the equipment operator as possible. When you need to disconnect power to this product, be sure to unplug the power cord from the electrical outlet.
- Ensure that the voltage select switch, if provided on this product, is in the correct position for the type of voltage in your country (115 VAC or 230 VAC).
- Do not allow anything to rest on any of the attached cables and do not position this product where persons will walk or trip on the cables.
- Unplug this product from the wall outlet before cleaning. Do not use liquid cleaners or aerosol cleaners. Use a damp cloth for cleaning.
- Never push a foreign object through an opening in this product.
- Unplug the product from the electrical outlet and contact your local Schmid Distributor under the following conditions:
 - The power cord, extension cord, or plug is damaged.
 - Liquid has been spilled or an object has fallen into this product.
 - This product has been exposed to water.
 - This product has been dropped or damaged in any way.
 - There are noticeable signs of overheating.
 - This product does not operate normally when you follow the operating instructions.

- Do not attempt to service this product yourself, as opening or removing covers may expose you to dangerous high voltage points or other risks. Refer all servicing to your local Schmid Distributor.
- Upon completion of any service or repairs to this product, have your local Schmid Distributor perform any safety checks required by the repair procedure or by local codes to determine that the product is in proper operating condition.

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2 **Watson TDM Overview**

2.1 **Introduction**

The Watson TDM family is an SHDSL transmission system compliant to ITU-T G.991.2 [11] and to ETSI TS 101 524 [10].

SHDSL uses pulse amplitude modulation (PAM) with 16 or 32 constellations and Trellis coding. Multiple line rates as well as 1-pair, 2-pair, and 4-pair DSL transmission are supported.

The Watson TDM modems are available as plug-in cards and as tabletop units. The plug-in cards normally work as Line Termination Units (LTU, STU-C in [11]). They can be configured for remote powering of tabletop modems.

The tabletop units normally operate as Network Termination Units (NTU, STU-R in [11]). Tabletop modems can either be powered remotely from a plug-in modem or locally with an AC/DC adaptor.

Both plug-in and tabletop modems can be configured either as DSL master (STU-C in [11]) or as DSL slave (STU-R in [11]).

The Watson TDM Regenerator is used to extend the reach of a DSL link. The regenerator works in 1-pair and 2-pair modes, is cascadeable for very long links and is available with a number of housing options. Powering of the regenerator is either from a plug-in modem or locally.

2.2 **Modem Features**

The Watson TDM modems are designed to transport E1 or nx64 kbps data signals.

Multiservice operation: on modems equipped with both E1 and data interfaces both interfaces can be active simultaneously. In multiservice operation the available DSL line rate is split between E1/fractional E1 and data services. The timeslot assignment between the two services is freely configurable.

Multimode operation: it is possible to establish DSL links between modems with E1 interfaces and modems with data interfaces. The modems will map the nx64 signals on fractional E1 or transparent 2.048 Mbps G.703 signals. No additional converter is required.

Multipoint operation: the Watson TDM plug-in modems have a built-in cross connect function. In multipoint operation timeslots from several DSL links are aggregated on a single channelized E1 (G.704) interface. Cascading of several multipoint plug-ins is also possible.

2.3 Accessories

A range of accessories and system cables are available for the Watson TDM modem family:

Plug-in modems can be mounted in a 19" subrack with 12 slots (SZ.379.V3) [6] which has up to 12 free slots for Watson modems. This subrack is normally equipped with an Alarm Control Unit (ACU SZ.369, [2]) which has a serial interface for a configuration terminal (Monitor interface) and two alarm relay outputs.

Remote management with the Simple Network Management Protocol SNMP is possible if a Communications Management Unit (CMU SZ.366, [3]) is inserted in the subrack.

Single plug-in modems can also be mounted in the minirack mechanics (SZ.876, [7]) or in the tabletop housing for plug-ins (SZ.875, [8]).

For tabletops a 19" rack mount SZ.896 is available that accommodates one or two tabletop modems.

For the regenerator a number of weatherproof cases is available accommodating one or several regenerators. See [9] for a description of the regenerator cases.

2.4 Compatibility with other Watson modems

Watson TDM is compatible with other Watson modems using the G.SHDSL linecode (Watson 5). It is possible to freely mix Watson TDM modems, Watson 5 modems and Watson 5/Watson TDM regenerators on a single DSL link.

Having a different linecode Watson TDM is not directly compatible with the HDSL-based Watson modems (Watson 2, Watson 3, Watson 4).

Mechanically all Watson modems are compatible, i. e. it is possible to mix Watson 2/3/4/5 and Watson TDM modems in a subrack or use the same minirack mechanics for Watson TDM and Watson 5.

3

Watson TDM Features

3.1 DSL Interface

The following configuration options refer to the DSL side and do not affect the user interface operating mode.

3.1.1 Master / Slave

To start up a DSL link, one system unit must be configured as DSL master (STU-C) and the other one as DSL slave (STU-R). The master controls the link start-up procedure. If both system units are configured as master or as slave, no start-up will occur.

Usually, plug-in modems are configured as master and tabletop modems as slave (default setting). However, it is possible to set up a DSL link with two plug-in or two tabletop modems, as long as one is configured as master and the other one as slave. In these cases, remote powering is not possible.

Generally, the master-slave permissions are:

- On a slave unit it is possible to change the local configuration. A slave can neither access nor modify the master unit's configuration or data. Access to the slave unit's configuration or data is possible via local monitor or via the master unit.
- On a master unit both local and the slave configuration can be modified. For safety reasons the master / slave configuration and the Autorestart option cannot be altered by the master unit over the DSL link.

When the "Remote" LED on the front panel of a tabletop modem is lit, the system unit is configured as master.

3.1.2 Linerates and payload rates

Watson TDM supports payload bitrates on multiples of 64 kbit/s with the optional use of one Z-bit according to ETSI TS 101 524.

The Z-bit can be configured to add bandwidth for the embedded operating channel (EOC) within the SHDSL overhead. The effective bandwidth of the EOC without the Z-bit is 3.2 kbit/s. The EOC bandwidth is increased to 11.2 kbit/s with the Z-bit.

Some Watson TDM modems also support m-wire operation on 2, 3 and 4 wire pairs.

The payload rate, i.e. the data rate available to the application is calculated as follows:

$$\begin{aligned}
 \text{PayloadRate} &= m \times n \times 64 \quad [\text{kbit/s}] \\
 m &= \text{number of wire pairs (1 \Lambda 4)} \\
 n &= \text{number of timeslots per pair (3 \Lambda 89)}
 \end{aligned}$$

The linerate per pair is

$$\begin{aligned}
 \text{Linerate} &= n \times 64 + \text{OH} + Z \quad [\text{kbit/s}] \\
 n &= \text{number of timeslots (3 \Lambda 89)} \\
 \text{OH} &= \text{SHDSL Overhead (8 kbit/s including 3.2 kbit/s EOC)} \\
 Z &= 8 \text{ kbit/s if Z-bit enabled, 0 otherwise}
 \end{aligned}$$

The linerate determines the DSL reach. Decreasing the linerate increases DSL reach and vice versa. The payload rate has no influence on the DSL reach.

3.1.3 Multipair operation

Watson TDM modems equipped with more than one DSL system can be configured for multipair operation:

Modem Type	LTUMODE	Mode	System			
			1	2	3	4
2 x DSL single link	1	1	A			
	2	1	A			
	2	2	A/B			
4 x DSL quad link	1	1	A	B	C	D
	2	1	A	C		
	2	2	A/B	C/D		
	4	1	A			
	4	2	A/B			
	4	3	A/B/C			
	4	4	A/B/C/D			

LTUMODE is set by the **LTUMODE** command in the monitor, see 8.2.2

Mode is set by the **MODE** command in the monitor, see 0

A/B/C/D: DSL Pairs

1/2/3/4: subsystems addressable through the monitor

Not available

Table 3-1: Multipair configurations

When a Watson TDM modem is operating in configured for 3- or 4-pair mode against a Watson 5 modem then the following restrictions apply:

3-pair operation	Max data rate of E1 user interface	32 x 64kbit/s
	Max data rate of nx64 user interface	96 x 64kbit/s
	Max user data rate per pair	32 x 64kbit/s
4-pair operation	Max data rate of E1 user interface	32 x 64kbit/s
	Max data rate of nx64 user interface	72 x 64kbit/s
	Max user data rate per pair	18 x 64 kbit/s

Table 3-2: 3p and 4p restrictions with Watson 5 modems

Note: *These restrictions are only applicable in mixed links with Watson 5 and Watson TDM. Links terminated with Watson TDM modems at both ends have no restrictions they support the full payload rate of $3 \times 89 = 267 \times 64$ kbit/s in 3-pair mode and $4 \times 89 = 356 \times 64$ kbit/s in 4-pair mode.*

3.1.4 DSL Clocking options

Watson TDM has a crystal controlled DSL clock that does not depend on the clocking of the user interface signals. Data rate adaptation between the user interface signal clock and the DSL clock is achieved by stuffing/deleting bits in the DSL frames (plesiochronous operation).

Watson TDM supports clock modes 1 and 2, see [10]:

Clock-mode	Mode	STU-C Symbol Clock Reference	STU-R Symbol Clock Reference	Example Application
1	Plesiochronous	Local oscillator	Received symbol clock	"Classic" SHDSL.
2	Plesiochronous with timing reference	Network reference clock	Received symbol clock	SHDSL with embedded timing reference.

Table 3-3: DSL Clock Modes

If the E1 signals use the same Network reference clock as the DSL then no additional Wander is generated in Clock mode 2 by the DSL transmission. This is especially useful for low linerates.

An external 2 Mbps Clock input is available on the Watson subrack and minirack mechanics.

3.1.5 Power Backoff

In order to reduce interference on other transmission systems operating on adjacent pairs bundled in the same cable, the DSL transmit power can be decreased by activating the power back-off mode.

With enabled power back-off the transmit power will be reduced adaptively in function of the estimated power loss i. e. the estimated cable attenuation:

Estimated Power Loss(*)	Power Backoff
< 1 dB	6 dB
< 2 dB	5 dB
< 3 dB	4 dB
< 4 dB	3 dB
< 5 dB	2 dB
< 6 dB	1 dB
≥ 6 dB	no backoff

(*) Calculated as Tx Power – Estimated Rx Power

Table 3-4: Power Backoff

Activating the power backoff setting on one end of a DSL link causes the *other* end of the link to reduce its transmit power.

Power backoff can be enabled individually for both ends of the link. Since the STU-R always follows the configuration of the STU-C enabling power backoff on the STU-C causes a symmetrical situation with STU-C and STU-R both using power backoff:

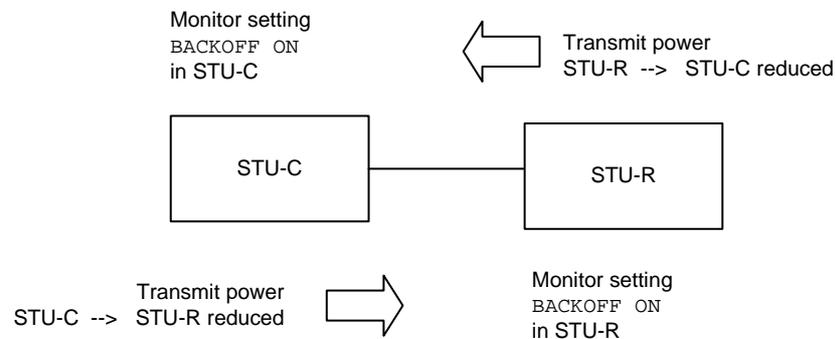


Figure 3-1: Power backoff

There is no power backoff setting in regenerators. A regenerator is however capable of reducing its transmit power if the other end of the link has power backoff enabled:

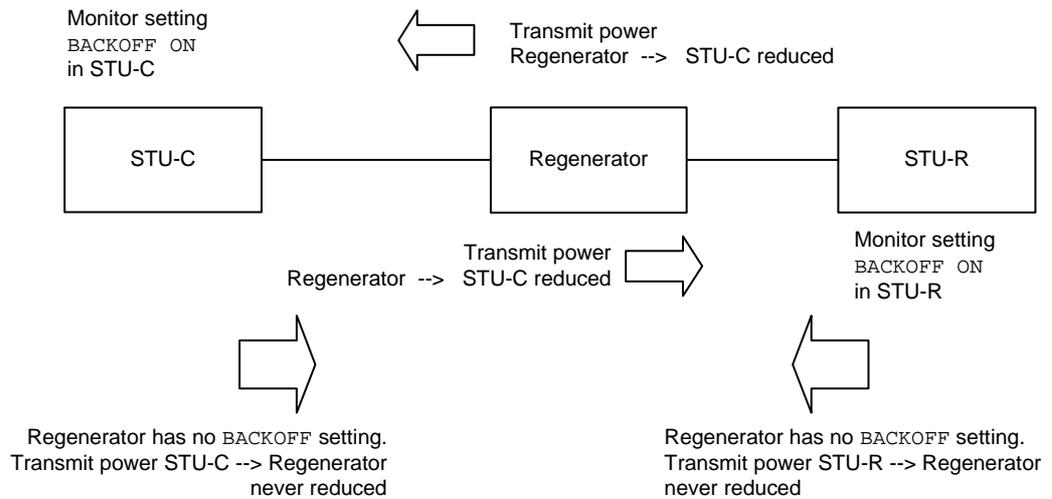


Figure 3-2: Power backoff with regenerator

3.1.6 Wetting Current

The remote powering circuit of a plug-in modem can be used to inject a wetting current on the DSL link:

- To use wetting current enable remote powering on the plug-in modems (Monitor command `POWER ON`) and use local powering for the tabletop modems.
- On the tabletop modems sinking of wetting current must be enabled with the `WETTING` monitor command, see 0

3.2 E1 Interface

3.2.1 Framing

Transparent Mode

In transparent mode, the E1 signal is transmitted without any changes.

The "CRC4 " and "E-bit Insertion" options are not relevant in transparent mode.

Framed Mode ITU-T G.704

In framed mode (framing according to ITU-T G.704), the E1 stream passes through an E1 framer before entering the DSL section, and the E1 stream received from the DSL section first passes through the E1 framer before being transmitted to the E1 network.

The E1 framer operates in Common Channel Signaling (CCS) mode. Timeslot 16 and all national bits are fully transparent.

CRC-4 and E-bit insertion are supported in framed mode:

CRC4

- If enabled, the E1 framer synchronizes on CRC4 multiframes and CRC4 errors are reported. In the outgoing E1 signal the framer generates the CRC4 multiframe alignment and checksum words. The A-Bit and the Sa-Bits pass transparently.
- If disabled, the international bits are set to '1' in the outgoing E1 signal. All national bits are fully transparent. On the receive side, the E1 framer synchronizes on basic frames only and no CRC4 errors are reported.

E-bit Insertion

- If automatic E-Bit generation is enabled, detected CRC4 errors will cause the assertion of the E-bits.
- If disabled, all E-Bits are set to '1'.

3.2.2 AIS Detection

If AIS detection is enabled, receiving AIS from the E1 side causes the following actions:

- The Non-Urgent alarm is activated (AIS-S).
- AIS is transmitted to the remote station by sending AIS-R over the DSL

With AIS detection disabled AIS from the E1 interface is ignored.

3.2.3 AIS Generation

If this option is enabled, AIS is sent over the local E1 interface if

- the DSL link to the remote station is not established (loss of signal or loss of frame alignment on DSL side) or
- the remote station is sending AIS-R.

If AIS generation is disabled, no signal is transmitted on the E1 side. The E1 interface will be switched off if either of these two conditions arises.

AIS Generation can also be set to transparent: in this mode AIS is sent on the local E1 interface if AIS is signaled from the remote interface (reception of AIS-R). The local E1 interface is switched off if the DSL link loses synchronization.

3.2.4 E1 Clock Modes

Clock architecture

The following block diagram shows the clock architecture of the modems. The external clock option is only available on plug-in modems.

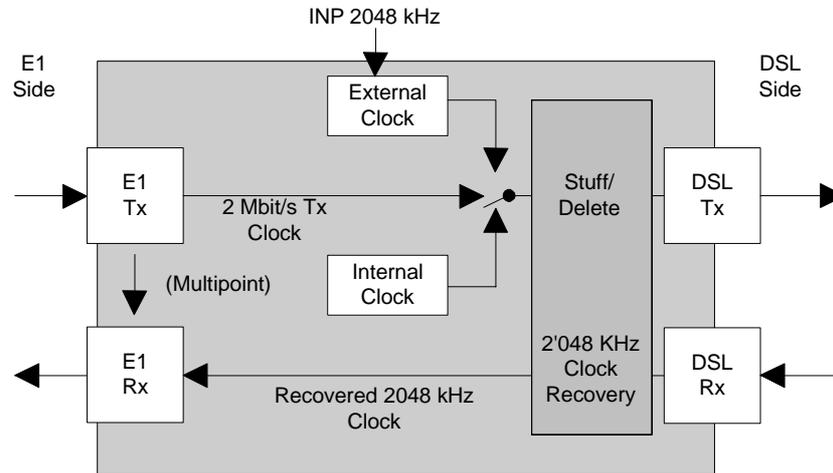


Figure 3-3: Clock architecture

Note:

Signals sent towards the DSL link are denoted as Tx and signals coming from the DSL link are denoted as Rx.

As long as the DSL link is not established, the internal clock signal is used as clock source.

The clock sources are automatically switched by the microcontroller, depending on the current signal and clock status, which is updated every 100 ms.

The transmit clocks of the two E1 data directions are independent of each other. Both plesiochronous and synchronous operation modes are possible. Synchronous operation occurs when the E1 equipment at one end of the DSL link uses the receive clock as transmit clock, as shown below.

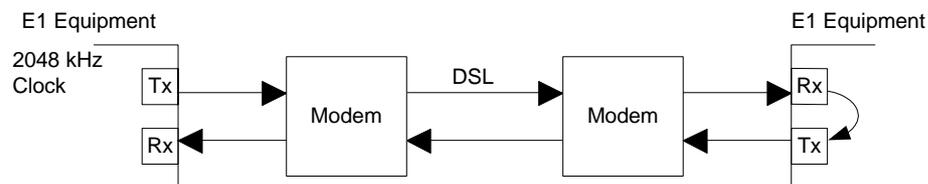


Figure 3-4: Synchronous Operation (=Loop Timing)

Warning:

Do not configure the E1 interfaces at both ends to use the receive clock as transmit clock except if one DSL modem is a plug-in card using the "External Clock" or "Internal clock" option. Otherwise there will be no defined clock.

External Clock Mode

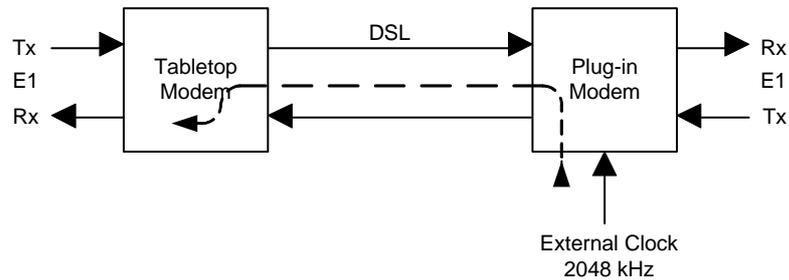


Figure 3-5: External Clock Mode

In external clock mode, the 2048kHz input clock is fed directly in the plug-in from the clock input of the minirack mechanics or via the ACU clock input. The external clock is used as the E1 reference clock.

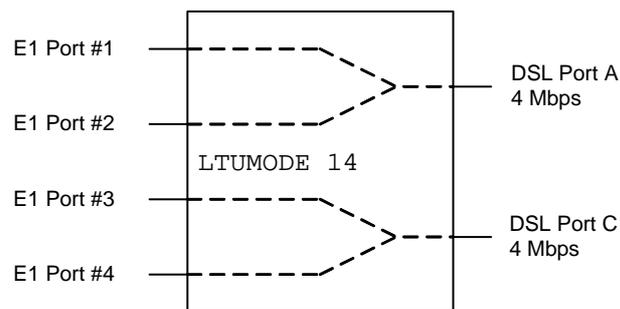
If no external clock is present at the 2048kHz clock input, the E1 transmit clock is used as the clock source. If no signal is received at the E1 Port, then the internal clock is used as the clock source.

If the external clock option is disabled, the primary E1 clock source is the 2Mbit/s transmit clock. If no signal is received at the E1 Port, then the internal clock is used as the clock source.

The external clock is never used to drive the E1 Rx direction.

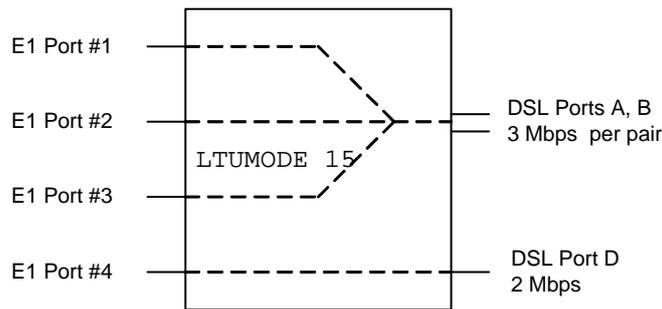
3.2.5 High Capacity E1

Watson TDM plug-in modems with E1 interfaces can be configured to G.SHDSL.bis line rates and transport more than one E1 over a DSL span. High Capacity E1 is activated with LTUMODES 14, 15 and 16:



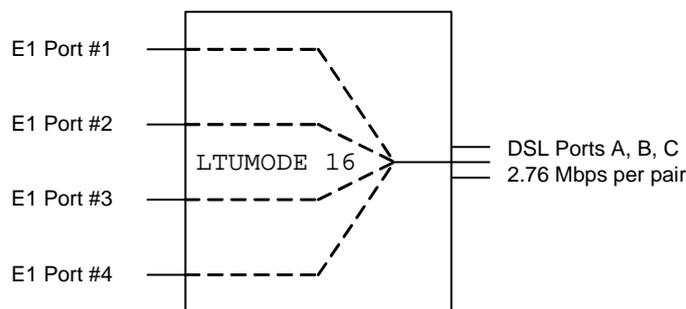
Note: DSL Ports B, D are unused

Figure 3-6: LTUMODE 14



Note: DSL Port C is unused

Figure 3-7: LTUMODE 15



Note: DSL Port D is unused

Figure 3-8: LTUMODE 16

The following restrictions apply in all High Capacity E1 configurations:

- Only unframed G.703 operation is supported in High Capacity E1 configuration
- The E1 signals must be synchronized one to another. If they are not synchronous then slips will occur which result in bit errors. The errors are visible in the G.826 statistics for the E1 interfaces (Monitor command G826 E1). The G826 values are based on slip events rather than on CRC4 errors or FAS errors.
- The following Monitor commands are only available on sub-systems having active DSL port(s), i.e. 1st sub-system in each case, and 3rd sub-system in case of LTUMODE 14:

```
BACKOFF          LOOP2          LOOPREG
MASTER           POWER          RESET
RESETG826 ALL   RESTART       STARTAL
STOPAL
```

- For the following Monitor commands the subsystems without active DSL ports will report the values from the associated subsystems with active DSL ports:

```
ALARM            CONFIG
DIAGNOSTIC      G826
STATUS
```

- PRA and APS are not available in High Capacity E1 configuration

3.3 ISDN PRA Interface

In PRA mode, the DSL modem offers the functions of an ISDN PRA NT1, an LT or a combination of the functions of NT1 and LT. This allows for the following configurations:

- The modem at the customer premises is configured as NT1, the modem at the central office is configured as LT.
- The modem at the customer premises is configured as NT1 & LT. Direct access to the exchange is established by a bit-transparent DSL-Link. All data, including timeslot 0, from the exchange must be transmitted transparently to the customer modem, therefore the DSL equipment providing the line termination in the exchange is working in transparent mode (see Figure 3-9).

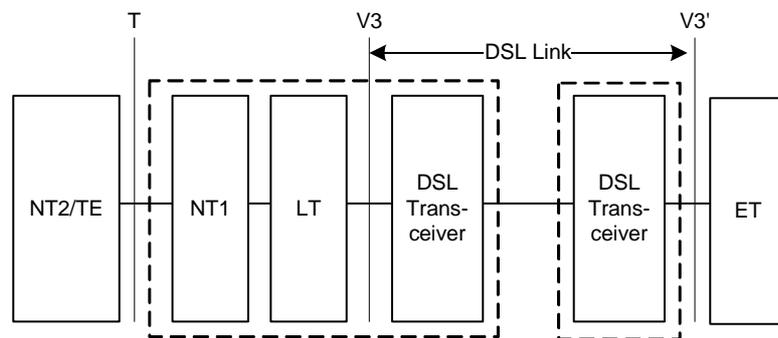


Figure 3-9: Reference Points of the PRA

The E1 interface of the DSL modem is the user/network-interface for primary rate access (T reference point in ISDN terminology). The equipment at the user side of the T reference point, which may be TE1, TA or NT2, is termed NT2/TE. The interface towards the exchange (ET function) is the V3 reference point.

3.3.1 CRC4 Processing Options

In addition to the usual PRA operation with CRC4 processing in both directions, the PRA interface also offers other modes of operation. Following ITU-T Rec. I.604 Annex A, three subscriber access options for a digital link are supported. The PRA interface can be configured to work either as a digital link without CRC processing (option 1), a digital link with CRC processing in the NT1 (option 2) or a digital link with CRC monitoring only in the NT1 (option 4). A digital link with CRC processing in the LT and NT1 is possible by using a DSL link consisting of an NT1 and an LT, both configured with CRC processing on.

Digital Link without CRC Processing (Option 1)

In this mode, transparent transmission between the ET and the NT2/TE is possible. There is no CRC4 processing in the DSL modems; the CRC processing is only done in the ET and the NT2/TE.

When loss of incoming signal is detected on either side, AIS is transmitted to the opposite side.

The detection of events and the state information are still valid as in normal PRA operation mode (option 2).

Depending on the distribution of NT1 and LT functionality, two configurations are possible for option 1:

- The master is E1 configured transparent, AIS-generation on and AIS-detection off; the slave is PRA NT1 & LT, CRC4 processing off.
- The master is PRA LT with CRC4 processing off; the slave is PRA NT1 with CRC4 processing off.

Note: For proper operation in Option 1, the equipment at the customer side (NT2) and at the central office side (ET) must be in CRC4 framed mode.

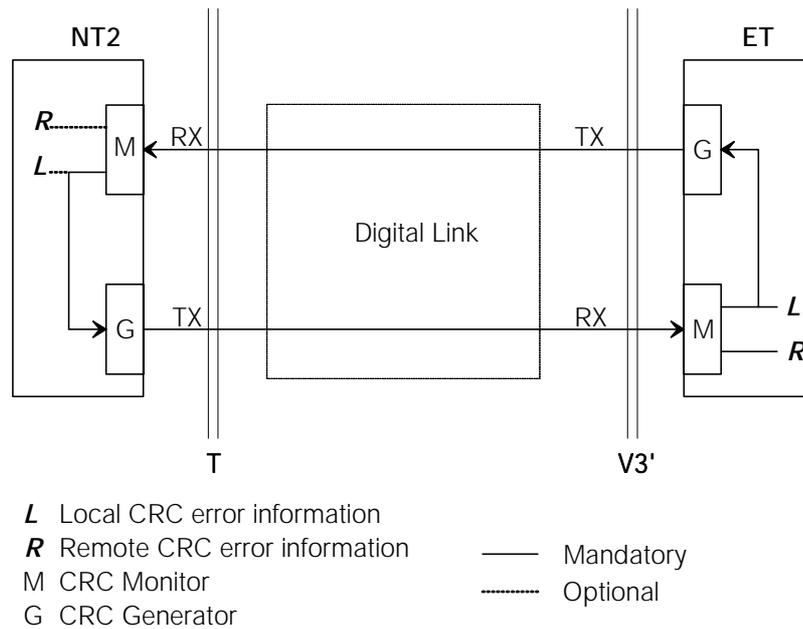


Figure 3-10: Digital Link without CRC Processing

Digital Link with CRC Processing in the NT1 (Option 2)

This is the usual PRA operating mode as described in ETS 300 233 and ITU-T Rec. G.962 Annex B. The PRA interface is intended to be used in this mode.

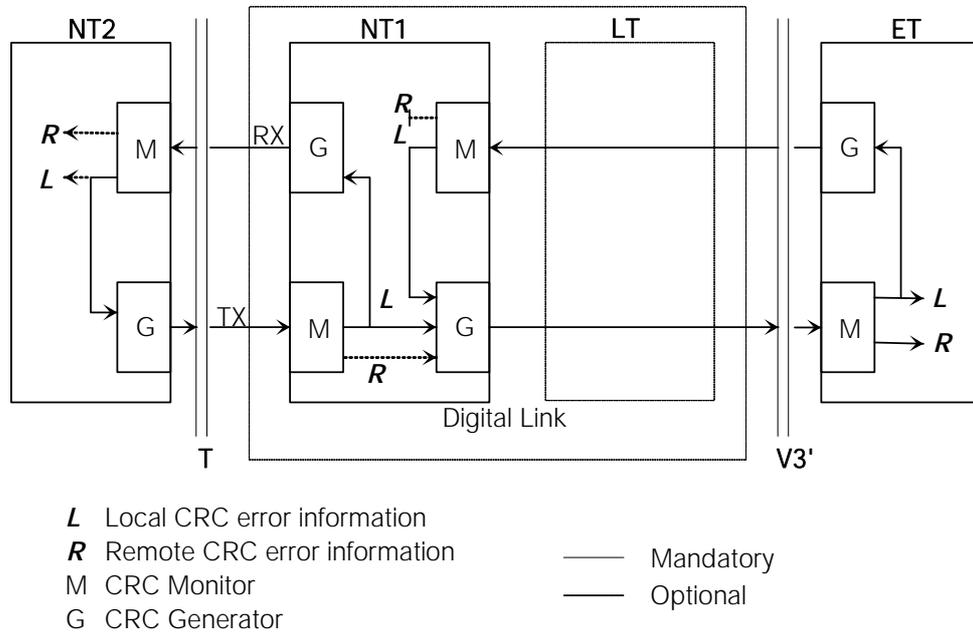


Figure 3-11: Digital Link with CRC Processing in the NT1

CRC4 is generated towards the NT2/TE and towards the ET and monitored at both sides of the NT1. When a block with a CRC4 error is received from the NT2/TE, CRC4 error information is transmitted towards the NT2/TE (via E-bits) and optionally towards the ET (via Sa6-bits). When a block with a CRC4 error is received from the ET, error information is transmitted towards the ET (via E-bits). CRC4 errors detected at the T reference point of the NT2/TE are reported to the NT1 (via E-bits) and optionally towards the ET (via Sa6-bits). CRC4 errors detected at the V3 reference point of the ET are reported to the NT1 (via E-bits). Loopback 1 and 2 control facilities and monitoring of defect conditions are implemented according to ETS 300 233.

Depending on the distribution of NT1 and LT functionality, two set-ups are possible for option 2:

- The master is E1 configured transparent, AIS-generation on and AIS-detection off; the slave is PRA NT1 & LT, CRC4 processing on.
- The master is PRA LT with CRC4 monitoring on; the slave is PRA NT1 with CRC4 processing on.

Digital Link with CRC Processing in the LT and NT1 (Option 3)

In this mode, the NT1 behaves like in option 2. The LT is not transparent, but has CRC4 generation and monitoring in both directions. This option is not possible when using combined NT1 & LT mode, the set-up for option 3 is:

- The master is PRA LT with CRC4 processing on; the slave is PRA NT1 with CRC4 processing on.

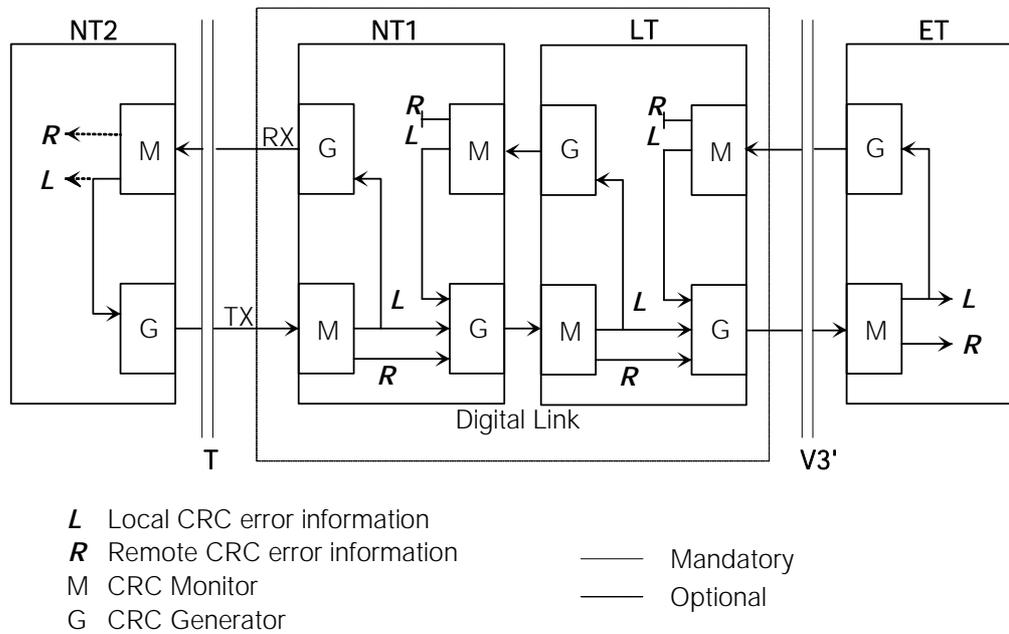


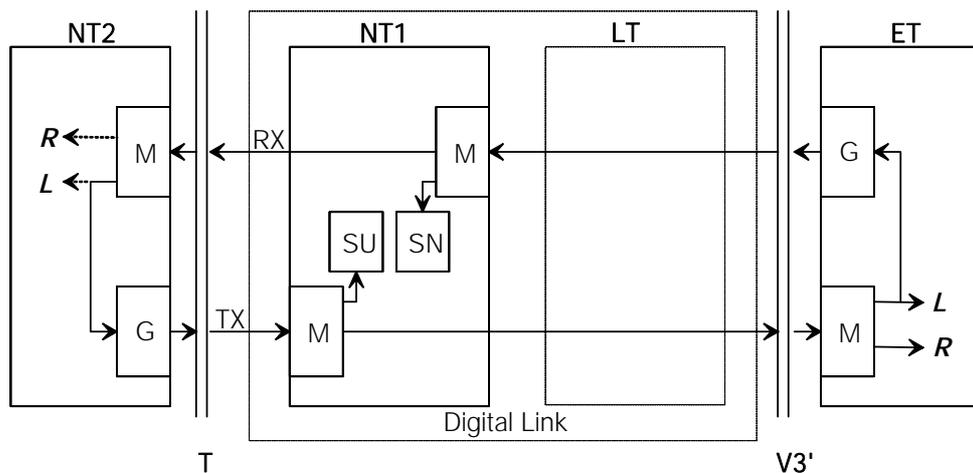
Figure 3-12: Digital Link with CRC Processing in the LT and NT1

Digital Link with CRC Monitoring in the NT1 (Option 4)

CRC4 multiframe alignment and checksum words are not regenerated in both directions, i.e. data will be transmitted without changes in both directions. However, blocks with CRC4 errors received from the NT2/TE and the ET will be detected and monitored by the G.826 performance management functions of the modems.

When loss of signal or loss of frame alignment is detected at either side, AIS is transmitted at the opposite side.

The detection of events and the state information are still valid as in normal PRA operation mode (option 4).



- | | | | |
|----------|----------------------------------|---|-----------|
| <i>L</i> | Local CRC error information | — | Mandatory |
| <i>R</i> | Remote CRC error information | ⋯ | Optional |
| M | CRC Monitor | | |
| G | CRC Generator | | |
| SN | Storage for network side monitor | | |
| SU | Storage for user side monitor | | |

Figure 3-13: Digital Link with CRC Monitoring in the NT1

Depending on the distribution of NT1 and LT functionality, two configurations are possible for option 1:

- The master is E1 configured transparent, AIS-generation on and AIS-detection off; the slave is PRA NT1 & LT, CRC4 monitoring on.
- The master is PRA LT with CRC4 processing off; the slave is PRA NT1 with CRC4 monitoring on.

3.3.2 Generation of CRC4 error notifications to the ET

For enhanced maintenance capabilities, CRC4 errors detected at the interface at the T reference point may optionally be reported to the ET. CRC block errors detected at the T reference point of the NT1 and CRC error indications received from the NT2/TE in the E-bits are reported to the ET using the Sa6-bits. An ET applying asynchronous detection of the Sa6-bits (no synchronization of the Sa6-bits to the sub-multiframe) will mistake such CRC4 error reports from the NT1 for

other errors, e.g. loss of power at NT1 or FC4. To avoid this it is possible to disable Sa6-bit indication.

If the CRC4 error notification in Sa6 is enabled, Sa6=0001 indicates an E-bit received from the NT2/TE, Sa6=0010 indicates a CRC4 error detected at the T reference point of the NT1, and Sa6=0011 indicates the simultaneous occurrence of both errors.

If disabled, Sa6 is always 0000 in normal operation state.

As sending of Sa-bits requires regeneration of the CRC4 frames in the NT1, this option is only activated when option 2 (Digital link with CRC processing in the NT1) is selected.

3.4 nx64 kbit/s Interface

3.4.1 Features

- The nx64 kbit/s interface is software-configurable between V.35, V.36 and X.21.
- The bitrate can be selected in steps of 64kbit/s from 64kbit/s (n=1) up to 9'984 Kbps (n = 156)
- Independent receive and transmit clocks for V.35 and V.36.
- Transmit clock is configurable either co-directional (clock defined by user equipment connected to nx64 Port) or contra-directional (clock generated from internal reference or from receiving clock).
- Detection for loss of clock and clock rate mismatch in co-directional clock mode.
- Standard SubD25 connector (ISO 2110 for V.35, RS-530 for V.36, proprietary for X.21) for DCE operation, other connectors (ISO 2593 for V.35, ISO 4902 for V.36, ISO 4903 for X.21) both for operation as DCE or DTE are available by means of system cables.
- Loop 1 and Loop 2 supported, for V.35 and V.36. Loop control is also possible by circuits 140 (RL) and 141 (LL), according to V.54.
- Support for byte timing (circuit B) in X.21 mode.
- Activity indication of nx64 kbit/s interface on front LED of tabletop if operated as DSL slave
- Multiservice operation: it is possible to use nx64 kbit/s and an E1 user interfaces simultaneously, sharing share the DSL bitrate between them.

3.4.2 Handshake Operation

When no loopback is established, the control circuits perform the following handshake protocol:

- 105 (RTS Request to send, X.21: C): Input from DTE. For X.21, C = OFF will cause a DTR alarm.
- 106 (CTS Ready for sending, X.21: I):
 - if Handshake option enabled: is set ON when a DSL connection is established and 105 = ON is detected.
 - if Handshake option disabled: is set ON when a DSL connection is established
- 107 (DSR Data set ready): is set ON when a DSL connection is established
- 108 (DTR Data terminal ready): input from DTE. For V.35 and V.36, 108 = OFF will cause a DTR alarm.
- 109 (RLSD Data channel received line signal detector): is set ON when a DSL connection is established.
- 140 (RL Loopback / Maintenance test): Input from DTE; will be set OFF in normal mode.
- 141 (LL Local loopback): input from DTE; will be set OFF in normal mode.
- 142 (TM Test indicator): is set OFF in normal mode.

3.4.3 Supported V.54 Loops

ITU-T recommendation V.54 defines four test loops. Loops 2 and 3 correspond to DSL loopbacks 2 and 1. The interchange circuits are set in the following way:

- V.54 Loop 2
Loop in remote DCE, i.e. DSL loopback 2 in the remote modem.
The output interchange circuits are set as follows:
 - Master: 107 = ON and 142 = ON
 - Slave: 104 (received data) = 1, 106 = OFF, 107 = OFF, 109 = OFF and 142 = ON.
- V.54 Loop 3
Local loop established in the DCE, i.e. DSL loopback 1 in the local modem.
The output interchange circuits are set as follows: 107 = ON and 142 = ON

3.4.4 Automatic Loop Control through the DTE/DCE Interface

Automatic control through the interface is achieved by using circuits 140 and 141:

- 140 = ON and 141 = OFF \Rightarrow V.54 loop 2 (DSL loopback 2)
- 140 = OFF and 141 = ON \Rightarrow V.54 loop 3 (DSL loopback 1)

This automatic loop control can be switched on/off using the `V54LOOPS` monitor command.

3.4.5 Clock Direction

For V.35 and V.36 interface types, the clock direction can be configured by the user. If codirectional, Transmit Data 103 is sampled with Transmit Clock 113. If contradirectional, Transmit Data 103 is sampled with Transmit Clock 114. It is recommended to use codirectional transmit timing whenever possible, in particular for bitrates > 32 x 64 kbit/s.

3.4.6 Clock Polarity

In X.21 mode the sampling instant for the incoming data stream on circuit T of the user interface (UIF) can be switched to the rising or falling slope of the contradirectional clock circuit S.

Data transitions of the received data on UIF circuit R are not influenced by this setting.

By default circuit T is sampled on rising edge of clock S. The data transitions on T and R occur at the OFF to ON transition of S (according X.24 standard). The ON to OFF transition of circuit S nominally indicates the center of each signal element, in this case on circuit R.

When Clock Polarity is set to "inverted", circuit T is sampled with the falling slope of S. The incoming data at X.21 circuit T will be sampled at the OFF to ON transition of S.

3.4.7 Byte Timing

In the X.21 mode, the byte timing circuit B according to X.24 can be activated (Monitor command `BYTETIMING`) As the circuits B (byte timing) and X (co-directional transmit clock) share the same pins on the 15-pin ISO 4903 connector, special cables have to be used in this case.

3.4.8 Multiservice / nx64 Clock Modes

For V.35 and V.36, the receive and transmit clocks are independent. The receive clock is always the recovered remote clock. The clock mode configuration only applies to the transmit clock.

Note: *The modem is a data communications equipment (DCE). Therefore the transmit clock is directed towards the modem, the receive clock is directed towards the data terminal equipment (DTE).*

For X.21, there is only one clock (circuit S) to receive and transmit. The clock mode determines the source of that single clock; however, in the co-directional nx64 Port clock mode, X is used as a co-directional transmit clock and S is used only as receive clock.

The following clock modes are supported:

- nx64 Port: The transmit clock is the co-directional clock coming from the equipment connected to the nx64 port (circuit 113, X).
- E1 Port: The transmit clock is generated based on the transmit clock used at the E1 port. It is available at the contra-directional transmit clock output (cir-

cuit 114). This clock mode should be used for multiservice operation (simultaneous use of E1 and nx64 kbit/s).

- Internal: The transmit clock is generated from the internal reference clock (contra-directional, circuit 114).
- Remote: The transmit clock is the recovered remote clock, i.e. the same clock as the receive clock (115) at the V.35 and V.36 interface (contra-directional, circuit 114).

The clock mode to be used depends on the network configuration. First thing to check is whether the equipment connected to the nx64 port uses a transmit clock output or input. In the first case, the co-directional nx64 port mode can be used. In the latter case, one of the contra-directional clock modes should be used. The internal clock mode should be suitable in most cases, the remote clock can be used if the receive and transmit clocks have to be equal.

The contra-directional X.21 clock modes use only one clock signal. Therefore the following configurations are possible: nx64 port - nx64 port, nx64 port - remote, internal - remote.

It is recommended to have at least one clock reference. Configurations with remote clocks on both ends must be avoided.

Remote clocking will also lead to problems if the remote modem has an E1 interface and the E1 equipment connected to the remote E1 port uses loop timing (i.e. it uses the received clock as transmit clock).

3.5 Timeslot Mapping

Generally, the user interface timeslots are mapped onto the DSL frame according to ETSI TS 101 524. The timeslots of the user interfaces are linearly mapped to the B-channels of the DSL and vice versa. Unused B-channels are filled with all ones. After startup, the complete mapping information is exchanged between STU-C and STU-R.

3.5.1 E1 mappings

E1 mapping is determined by the configuration of the E1 interfaces on STU-C and STU-R.

Application	Mapping rule	TS0/TS16 options	
User interfaces	TS 101 524	(See Table 3-6)	
2 Mbps transparent G.703 – G.703	Unaligned D2048S	(none)	
ISDN PRA G.704 – G.704 PRA	Aligned D2048S	(none)	
2 Mbps framed G.704 – G.704	Aligned D2048S	MP 4 MP 5	
Fractional E1 G.704 – G.704	Aligned fractional D2048S	MP 0 MP 1 MP 2	MP 3 MP 4 MP 5

Table 3-5: E1 mappings

In framed and fractional E1 mapping modes the treatment of TS0 (synchronization timeslot) and TS16 (signaling timeslot) is configurable with the `MP monitor` command:

Mapping Mode (<code>MP x</code>)	TS0 treatment	TS16 treatment
MP 0	TS0 towards user interface generated by modem and not transported over the DSL	TS16 towards user interface generated by modem and not transported over DSL if less than 16 timeslots are configured. TS16 transported over DSL if 16 or more timeslots are configured
MP 1	TS0 transported over DSL	TS16 towards user interface generated by modem and not transported over DSL if less than 16 timeslots are configured. TS16 transported over DSL if 16 or more timeslots are configured
MP 2	TS0 towards user interface generated by modem and not transported over the DSL	TS16 transported over DSL
MP 3	TS0 transported over DSL	TS16 transported over DSL
MP 4	TS0 towards user interface generated by modem and not transported over the DSL	TS16 generated by modem and not transported over DSL
MP 5	TS0 transported over DSL	TS16 generated by modem and not transported over DSL

Table 3-6:TS0/TS16 options

If TS0 or TS16 are generated by the modem and not transported over the DSL they do not take up DSL bandwidth. This allows to reduce the DSL linerate and increase the reach correspondingly.

If TS0 is generated by the modem then the SA-Bits are set to 1 and the A-Bit is set to 0. The Si – Bit is set to 1 if CRC4 checking is off.

If TS16 is generated by the modem then an all-1 pattern (11111111) is transmitted.

3.5.2 nx64 mappings

Application	Mapping rule
User interfaces	TS 101 524
nx64, $178 \geq n \geq 32$ nx64 – nx64	Unaligned D2048S
nx64, $n < 32$ nx64 – nx64	Aligned D2048S

Table 3-7: nx64 mappings

3.5.3 Multiservice and Mixed Mode mappings

When both E1 and nx64 kbit/s interface are equipped, they can be used concurrently (multiservice application). The available DSL bandwidth is shared between the timeslots of the E1 interface and the timeslots of the nx64 interface. In multiservice applications the nx64 data occupies always the first bearer channels of the DSL frame, the E1 timeslots are transmitted after the nx64 timeslots.

E1 and nx64 user interfaces can be mixed on a DSL link, allowing to transport nx64 data in E1 timeslots without further converters. This is called Mixed Mode mapping:

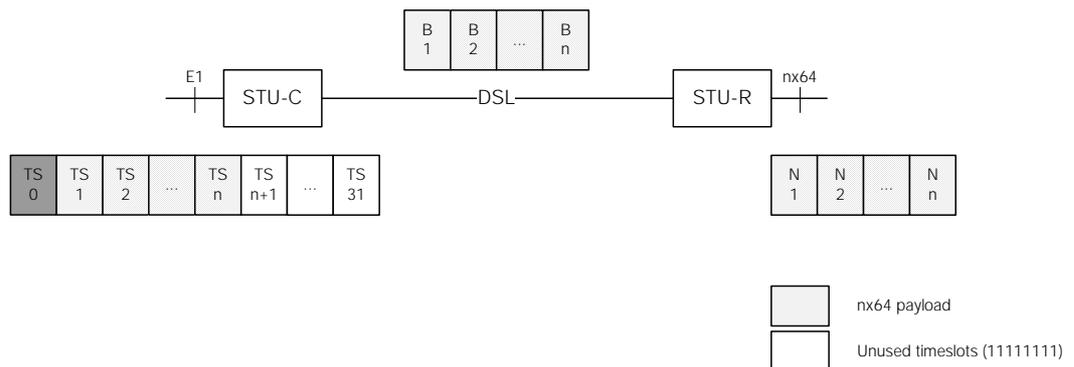


Figure 3-14: Mixed mode mapping

Mixed mode and multiservice can be combined on a DSL link, allowing a fractional E1 signal and nx64 data to be transported over a single E1:

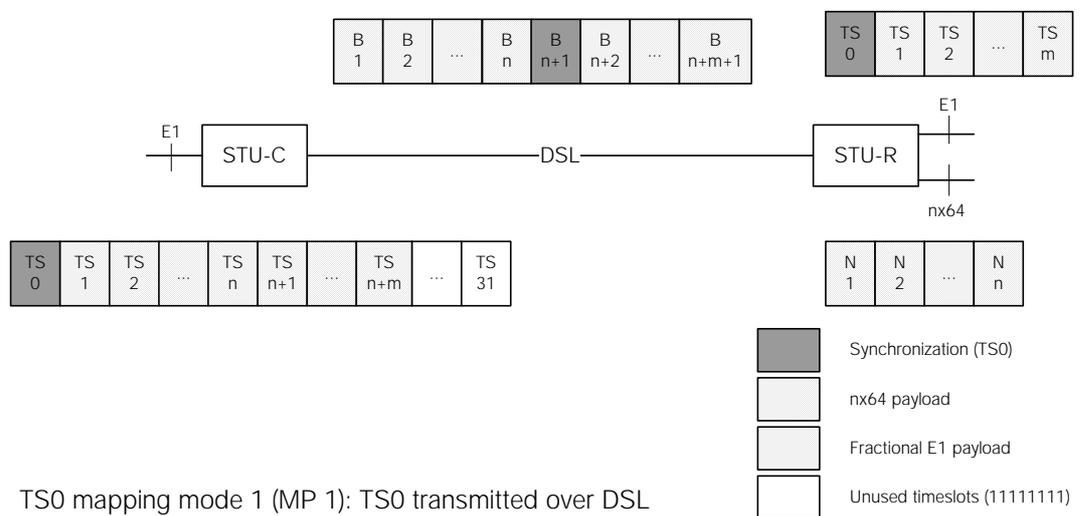


Figure 3-15: Mixed Mode multiservice mapping

Handling of TS0 and TS16 in Mixed Mode mapping is configurable:

Application User interfaces	Mapping rule TS 101 524	TS0/TS16 options (See Table 3-6)	
Mixed Mode 2 Mbps G.703 – nx64	Unaligned D2048S n = 32	(none)	
Mixed Mode framed G.704 – nx64	Aligned D2048S	MP 0 MP 4 MP 5	
Mixed Mode Multiservice G.704 – G.704 & nx64	Aligned D2048S	MP 0 MP 1 MP 2	MP 3 MP 4 MP 5

Table 3-8: Mixed Mode mappings

3.6 Point-to-Multipoint Operation

3.6.1 Introduction

With point-to-multipoint operation it is possible to aggregate several low-bitrate DSL links into few E1 systems. This allows concentration of DSL links carrying small traffic loads on fewer E1 interfaces, saving resources in the E1 transport network. Multipoint operation on a single plug-in allows to concentrate up to 4 DSL links to a single E1 interface. Multipoint plug-ins can also be cascaded for even higher concentration factors.

Multipoint operation is compatible with multiservice and mixed mode operation.

Figure 3-16 shows some examples of multipoint configurations. The cascading of plug-ins to increase the number of links is shown in configuration c).

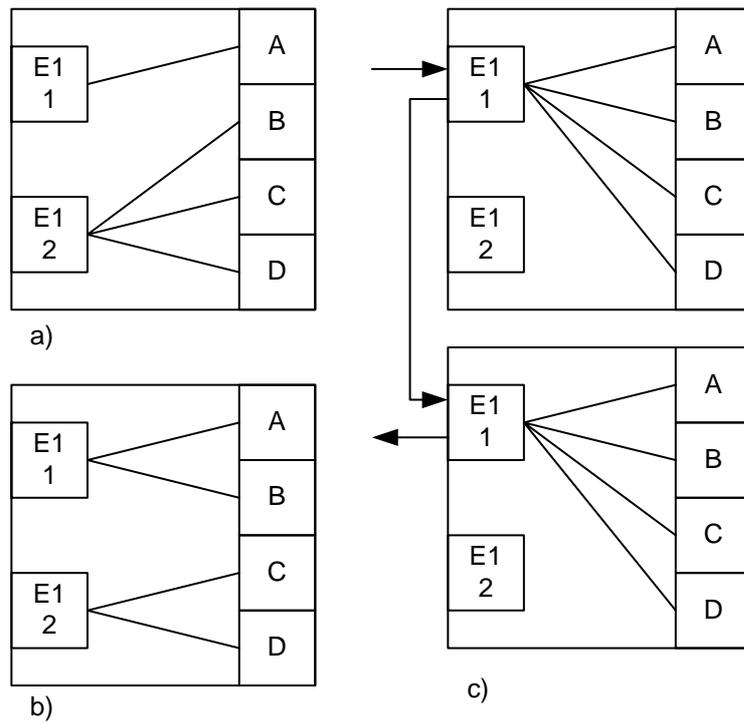


Figure 3-16: Examples of Multipoint Configuration

3.6.2 Configuration

The configuration of a point-to-multipoint system includes the following steps:

- Configure the plug-in for multipoint operation: Monitor command `LTUMODE 5`. This command configures four single-pair systems on the plug-in and sets the DSL Master mode (STU-C) on all DSL interfaces.
- E1 interface configuration: the E1 interfaces have to work in framed mode (Monitor command `G704 ON`). When CRC4 multiframes are used, CRC4 and E-Bit insertion have to be switched on.
- E1 timeslot mapping: associates timeslots from the E1 interfaces with DSL links. Each timeslot of an E1 interface can be associated with one DSL link.
- DSL timeslot mapping: for each DSL link its associated E1 timeslots must be mapped to physical bearer channels (B-channels).

The Monitor command **MP** controls timeslot mapping. It takes two parameters:

MP Interface Map

Interface	Map	Description
1, 2	0ABCDL	E1 timeslot mapping: set associations of E1 timeslots from E1 interface <i>Interface</i> to DSL links. The <i>Map</i> is a string of up to 32 characters. The first character determines the association for the first E1 timeslot (TS0), the subsequent characters map the following timeslots. Possible values are 0: TS unused (filled with 11111111) A: TS associated with DSL link A B: TS associated with DSL link B C: TS associated with DSL link C D: TS associated with DSL link D L: TS looped back If the <i>Map</i> contains less than 32 characters, the remaining timeslots are set to 0 (unused, filled with 11111111)
A, B, C, D	012	DSL timeslot mapping: configures which DSL bearer channels of DSL link <i>Interface</i> carry the associated timeslots of the E1 interfaces. The <i>Map</i> is a string of up to 32 characters. The first character controls the bearer channel on the DSL loop, the subsequent characters are assigned to following channels. Possible values are 0: Channel unused (filled with 11111111) 1: Channel filled with to associated timeslot of E1 interface 1 2: Channel filled with to associated timeslot of E1 interface 2

Table 3-9: Multipoint configuration command **MP**

MP 1 OFF and **MP 2 OFF** will switch off E1 interfaces 1 and 2 respectively.

MP without parameters displays the current configuration:

```

LTU_01> MP

Multipoint Configuration
~~~~~
TS 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3
Nr 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1

1  - A A A A A A A A A A B B B B B B B B B C C C C C D D D D A
2  - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

A  - 1 1 1 - 1 1 1 1 1 1 1 1 - - - - - - - - - - - - - - - -
->0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
B  - 1 1 1 1 1 1 1 1 1 1 - - - - - - - - - - - - - - - - -
->0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
C  - - - - - - - 1 1 1 1 1 - - - - - - - - - - - - - - - -
->0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
D  - 1 - 1 - 1 - 1 - - - - - - - - - - - - - - - - - - - - -
->0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
~~~~~
    
```

Figure 3-17: Multipoint configuration screen

The columns show the timeslots (0 ... 31), the rows the E1 interfaces (1 and 2) and the DSL links (A, B, C and D).

In the configuration shown in Figure 3-18 the following mapping rules are active:

E1 interface 1 TS0	unused, i. e. TS0 towards the E1 interface is generated by the modem and not transported over the DSL
E1 interface 1 TS 1 - 3	transported over DSL link A, channels 1 – 3
E1 interface 1, TS 4 - 10	transported over DSL link A, channels 1 – 11
E1 interface 1 TS 11 - 20	transported over DSL link B, channels 1 – 10
E1 interface 1 TS 21 - 26	transported over DSL link C, channels 8 – 13
E1 interface 1 TS 27	transported over DSL link D, channel 1
E1 interface 1 TS 28	transported over DSL link D, channel 3
E1 interface 1 TS 29	transported over DSL link D, channel 5
E1 interface 1 TS 30	transported over DSL link D, channel 7
E1 interface 1 TS 27	transported over DSL link A, channel 12

The E1 interface 2 and all other DSL channels are unused. This is indicated by the hyphen character –

The MP configuration screen also displays how the remote modem maps DSL channels to its local E1 or nx64 interface. This is indicated on the lines marked with -> (below A, B, C and D) with the following symbols:

- 1 DSL channel mapped to the corresponding E1 timeslot
- N DSL channel mapped to the nx64 user interface
- 0 channel not mapped to the E1 user interface

Note that the multipoint configuration will *not* change any timeslot mapping on the remote modem. Proper configuration of both multipoint and remote mapping must be done to avoid any mapping conflicts or ambiguities. The symbol ! at the beginning of a -> line indicates a conflict on the time slot mapping between local and remote modem.

Notes:

- *The E1 timeslot mapping characters are shown in lowercase (a .. d) if a timeslot has been associated with a DSL link, but its channel on that link has not yet been defined. Timeslots which are associated with a channel on the DSL link are displayed in uppercase (A .. D) in the E1 timeslot mapping.*
- *If you select more timeslots in the DSL timeslot mapping than are currently mapped to the link by the E1 timeslot mapping, superfluous timeslots will not be enabled. Also timeslots which are outside of the range used by the line rate configured will not be enabled.*
- *TS0 is used for E1 framing (FAS/NFAS) and is normally generated at the remote modem. TS0 on the DSL links can only be used for transmission of TS0 from one E1 interface at the multipoint modem.*

3.6.3 Multipoint Configuration Example

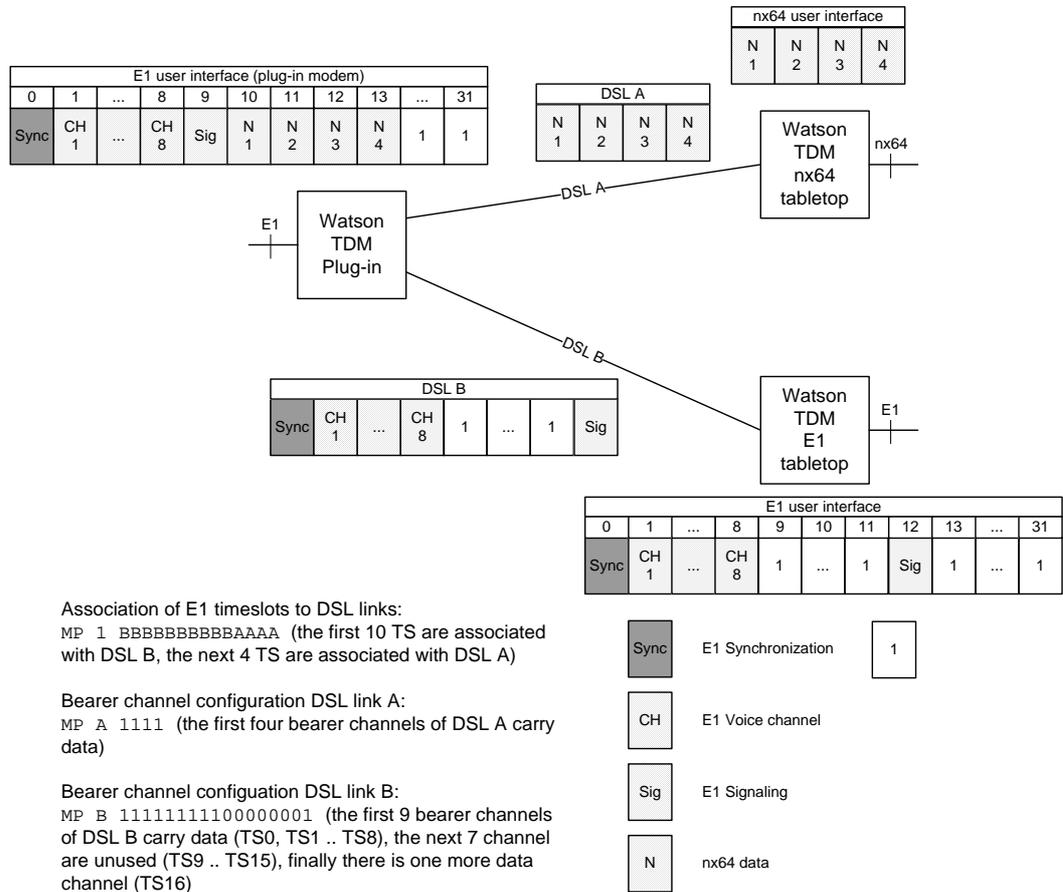


Figure 3-18: Multipoint example

3.6.4 Multipoint Cascading

If only a small number of timeslots has to be sent to every remote station, four DSL links per E1 interface are not enough to fill all 32 timeslots. In such cases, several multipoint plug-ins can be cascaded. For cascading it is possible to associate some timeslots from an E1 interface not with a DSL link but to loop them back to the E1 interface.

The E1 transmit signal is connected to the E1 input of the 1st plug-in. The E1 output of the 1st plug-in will contain the timeslots associated with the DSL links of the 1st plug-in plus the looped timeslots which are unchanged. This E1 output is connected to the E1 input of the 2nd plug-in. The 2nd plug-in will send some of the timeslots that have been looped in the 1st plug-in to its four remote stations while looping the timeslots which have been used by the 1st plug-in and also all other timeslots which are used by subsequent plug-ins in the cascade.

The E1 output of the last plug-in is the common E1 receiving signal.

Example: we want to provision eight 256 kbps (4 timeslots) services. Four modems (STU-R #1 – STU-R #4) are connected to plug-in #1 which distributes timeslots 0 – 15 among them. The next four modems are connected to plug-in #2 and use timeslots 16 – 31 of the E1:

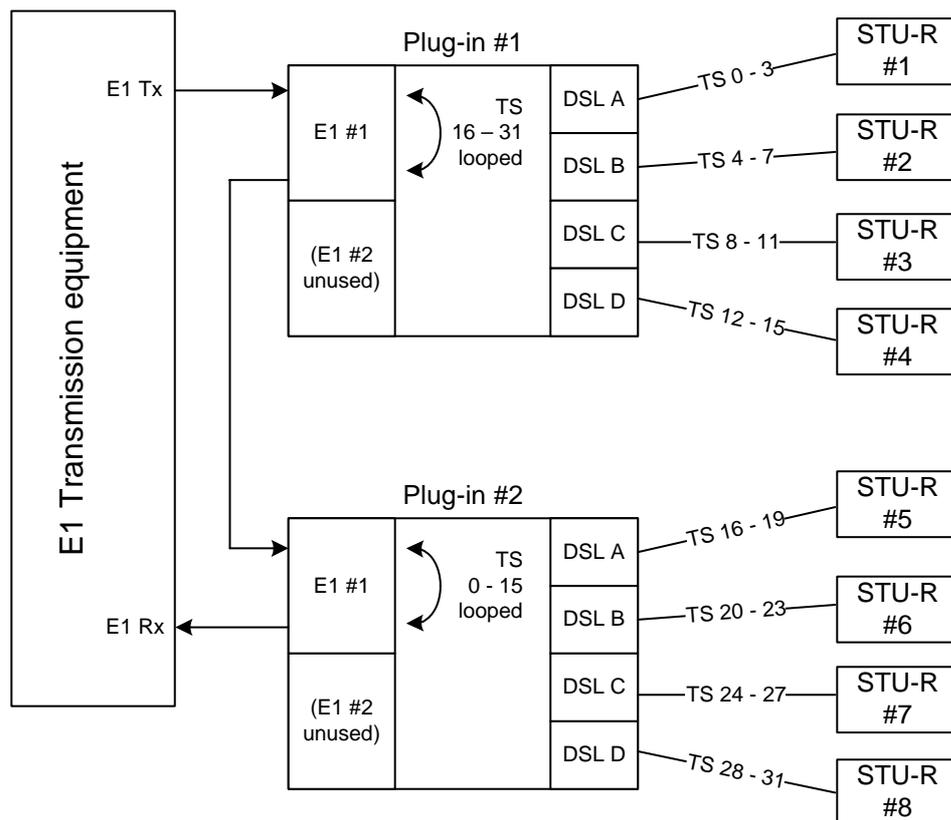


Figure 3-19: Multipoint cascading example

Plug-in #1 is configured using the following commands

```
MP 1 AAAABBBBCCCCDDDDLLLLLLLLLLLLLLLLLLLL
MP A 1111
MP B 01111
MP C 01111
MP D 01111
```

which results in the following configuration:

Multipoint Configuration	
TS	0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3
Nr	0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
1	A A A A B B B B C C C C D D D D L L L L L L L L L L L L L L L L L L
2	- -
A	1 1 1 1 -
->1	1 1
B	- 1 1 1 1 -
->1	1 1
C	- 1 1 1 1 -
->1	1 1
D	- 1 1 1 1 -
->1	1 1

For plug-in 2 we use the commands

```
MP 1 LLLLLLLLLLLLLLLLLAAAABBBBCCCCDDDD
MP A 01111
MP B 01111
MP C 01111
MP D 01111
```

Multipoint Configuration	
TS	0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3
Nr	0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
1	L L L L L L L L L L L L L L L L A A A A B B B B C C C C D D D D
2	- -
A	- 1 1 1 1 -
->1	1 1
B	- 1 1 1 1 -
->1	1 1
C	- 1 1 1 1 -
->1	1 1
D	- 1 1 1 1 -
->1	1 1

The E1 equipment of the transmission network is connected to the E1 input of plug-in #1 and the E1 output of plug-in #2. The E1 output of plug-in #1 is connected to the E1 input of plug-in #2.

Note that timeslot 0 of the E1 is sent over the DSL of plug-in 1 to STU-R #1 which generates FAS/NFAS information towards the transmission equipment. The effective service rate of STU-R #1 is 192 kbps (3 timeslots).

3.7 Performance Monitoring

3.7.1 DSL Parameters

The Watson TDM modems provide information about the current Signal Quality and Attenuation of a DSL link:

The Signal Quality is the noise margin calculated by the modem:

$$SQ = SNRI - SNR0$$

Where

SQ is the calculated noise margin

SNRI is the signal to noise ratio calculated by the transceiver by analyzing the error correction bits (Trellis bits) in the line code.

SNR0 is the signal to noise ratio that gives a bit error rate of 10^{-7} in presence of average white Gaussian noise. For TC-PAM16 the theoretical value for *SNR0* is 27.7 dB.

The Attenuation is the link attenuation calculated by the modem, assuming 0.4mm PE cable without bridged taps and measured at 150 kHz (for linerates of 200 kbit/s up to 1'992 kbit/s) or 200 kHz (for linerates of 2'056 kbit/s and above). Note that the calculated attenuation may differ from the attenuation measured by other equipment for other cable configurations (other cable diameter, splices, bridged taps).

Both Signal Quality and Attenuation are effective maintenance tools for determining inadequate or bad cable pairs.

3.7.2 G.826 Performance Monitoring

The G.826 error performance parameters provide quantitative performance information of a specific link. They are intended to be used for long-term evaluation of operating DSL links.

The evaluation of the G.826 error performance parameters is based on CRC (Cyclic Redundancy Check) error detection.

DSL Interface

On the DSL side, six CRC6 check bits are generated per DSL frame for each channel and direction. The software counts block errors and evaluates the error performance according to ITU-T G.826 using these CRC6 bits.

E1 Interface

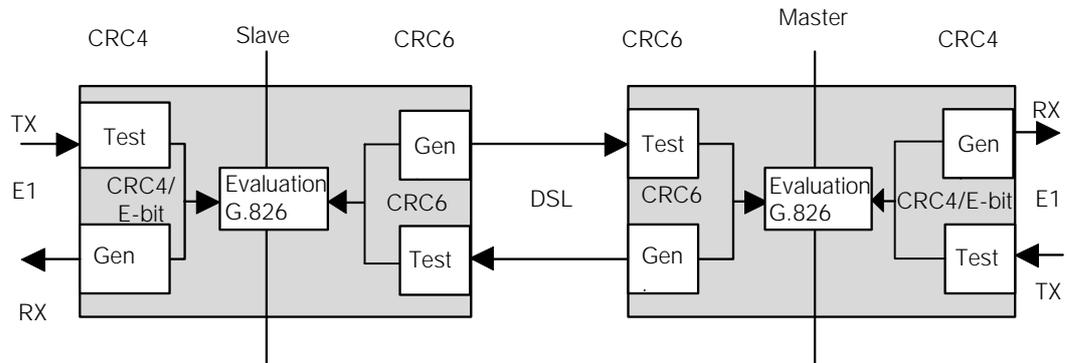


Figure 3-20: E1 G.826 Performance Evaluation

On the E1 side, four CRC4 check bits are generated per sub-multiframe (SMF) and compared with the corresponding CRC4 bits in the following SMF. If they do not match, the CRC4 error counter is incremented. The opposite station is informed of detected CRC4 errors by setting E-bits in the transmitted frames. At the same time, the E-bits from the opposite station are counted and can be used for performance monitoring.

For the E1 interface, calculations according to G.826 are only possible in framed mode with CRC4 option enabled. In framed mode with CRC4 option disabled only FAS-errors are detected.

ISDN PRA Interface

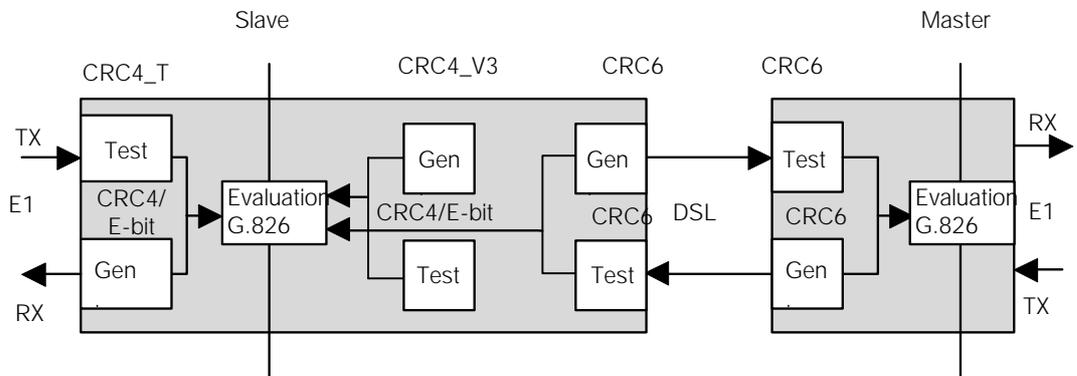


Figure 3-21: PRA G.826 Performance Evaluation

When the PRA interface works with CRC4 processing or monitoring (options 2 and 4) four CRC4 check bits are generated per sub-multiframe (SMF) received from the ET and the NT2/TE and are compared with the corresponding CRC4 bits in the following SMF. If they do not match, the corresponding CRC4 error counter is incremented. At the same time, the E-bits from the ET and the NT2/TE are counted and can be used for performance monitoring.

3.8 Test loops

Test loops can be activated via the monitor from both master and slave sides. Loop 1 will initiate a loopback in the local modem, Loop 2 will initiate a loopback in the remote modem. Regenerators can be individually looped. Only one test loop can be active at any time.

Loops are controlled with the LOOP1, LOOP2, LOOPREGn monitor commands, see 8.3.

Activation of a test loop will deactivate any previous loop. A system reset will deactivate any test loop. A non-urgent alarm is raised while any loop is active.

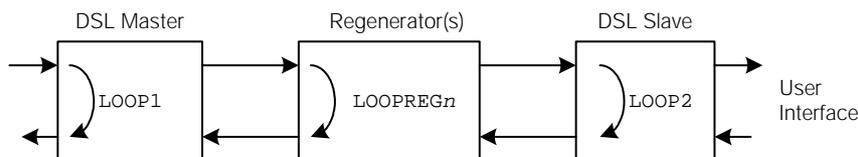


Figure 3-22: Test Loops controlled by the DSL Master

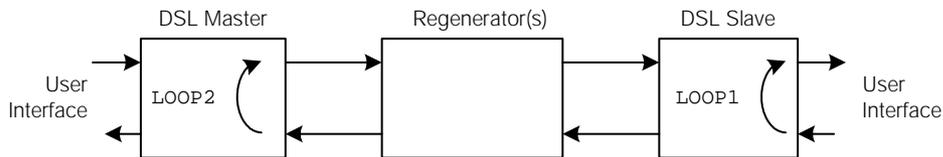


Figure 3-23: Test Loops controlled by the DSL Slave

Notes:

- Both the “Local” LED on the slave and the “Remote” LED on the master is lit amber when a loopback is active.
- On the master side Loop 1 can only be activated locally. Activating Loop 2 turns on Loop 2 at the slave station. The “Status Local” LED will be lit amber when Loop 1 is active.
- A non-urgent alarm is raised while Loop 1 or Loop 2 is active

3.9 Automatic Protection Switching (APS)

Watson TDM plug-in modems support automatic protection switching. Two DSL links are configured to form a protection group. One link within the group is designated as working link and carries user traffic. The other link is designated the protection link. On the protection link the DSL is synchronized but this link carries no traffic.

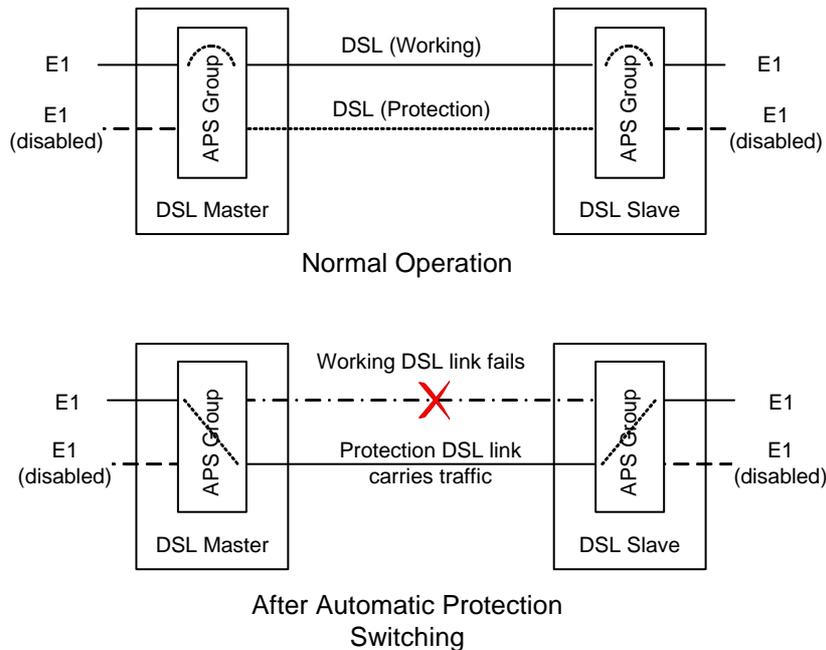


Figure 3-24: Automatic Protection Switching

If the working link fails then traffic is automatically switched to the protection link. Protection is bi-directional i. e. transmit and receive directions are switched simultaneously. Protection is non-revertive: once a working link has failed and traffic has been switched to the protection link there will be no automatic switch back to the working link should this link become active again.

Protection groups are always configured on the DSL master (STU-C). The DSL slave (STU-R) will follow the configuration of the STU-C modem. On a protection group the line rate of the protection link is automatically set to equal to the line rate of the working link.

APS is available on single-pair and on two-pair links.

- Notes**
- APS works only between plug-in modems. It is not supported on tabletop modems
 - Automatic protection switching and ISDN PRA functions are not available at the same time

3.10 Password Protection

On tabletop modems the access to the Monitor can be protected by a password to avoid unauthorized reconfiguration of modems installed at the customer site.

While in protected mode it is required to enter a password before any Monitor command can be executed from a terminal connected to the local RS-232 port of the modem.

Password protection is only active on the local RS-232 port. There is no password protection when accessing the modem through the DSL EOC. This allows to reset the password of a protected modem configured as STU-R (DSL slave) from the STU-C (DSL master).

One command is allowed without entering a password while password protection is active: the `DSLSLAVE` command. `DSLSLAVE` configures a modem from DSL master to DSL slave. If the password of a modem configured as DSL master has been lost then this modem can be reconfigured as DSL slave with `DSLSLAVE`, allowing to reset the password through the DSL EOC.

Notes:

- *Password commands through the DSL EOC are not possible if the ACU48 is present in the subrack.*
- *Password commands are only available on tabletop modems*
- *Password protection is disabled by default.*

4

Watson TDM Regenerator

4.1 Operating modes

The Watson TDM regenerator has four DSL interfaces. It can be used either as one regenerator for a two-pair system or as a dual regenerator for two independent 1-pair systems. No configuration is needed to select the operating mode. In fact the only configuration command possible on the regenerator is activation and deactivation of the DSL Autorestart, see 8. All other DSL parameters are defined by the DSL master settings.

4.2 Interface Designation

The regenerator interfaces are named according to the standard [10]: the link towards the LTU is called R-Side (REG-R) because it has the role of a DSL STU-R. The link towards the NTU is called C-Side as it has the role of a DSL STU-C:

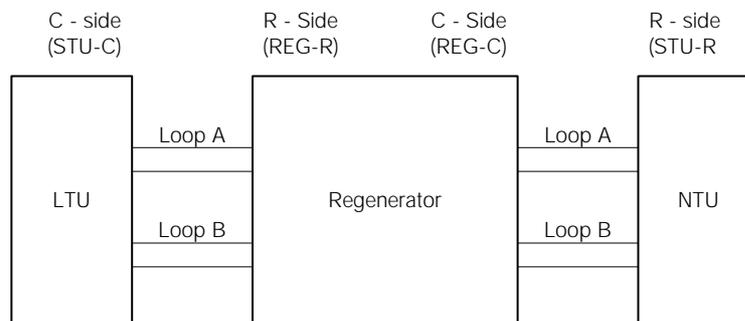


Figure 4-1: Regenerator Interface Designation

4.3 Cascading

The Watson TDM Regenerator can be cascaded to form long links. The maximum allowed length of a link is 9 spans, i.e. 8 regenerators in series:

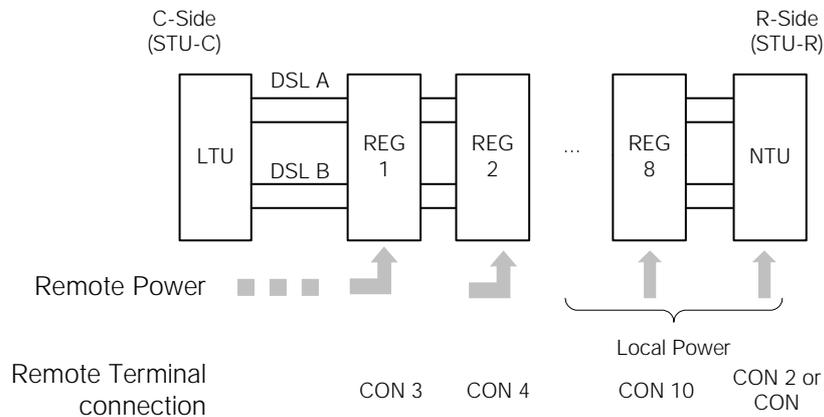


Figure 4-2: Cascading and addressing regenerators

4.4 Powering

The Watson TDM Regenerator can be powered locally or remotely.

A local DC power source can be connected to the regenerator directly, see 9.7. The alternative is to use remote powering from the LTU. Both local and remote powering can be present simultaneously. No powering configurations have to be done in the regenerator.

Warning *The local powering inputs are galvanically connected to the DSL wire pairs. Power supplies used for local powering must be certified according to EN 60950-1.*

If a battery is used for local powering then all other devices connected to this battery must be protected against overvoltage from the DSL wire pairs.

Installation of the local powering circuitry from the power supply or the battery must ensure that it is not possible to touch any conductive parts of the installation that are connected directly or indirectly with the local powering inputs.

The distance achievable with remote powering depends on both the cable characteristics (ohmic resistance) and the number of remotely powered nodes (regenerators and the NTU). As a general rule one node can be remotely powered per wire pair, i.e. one regenerator or the NTU on a single-pair system and two regenerators (or one regenerator and the NTU) on a two-pair system. For longer links both the NTU and the regenerators must be powered locally.

Two factors limit the powering distance:

- The regenerator requires a minimal voltage (57 VDC) at its input for proper operation
- The feeding current per pair is limited by the LTU to comply with relevant safety requirements (the DSL link is classified as a TNV-3 circuit according to EN 30069).

Figure 4-3 shows powering reach for single 1-pair and 2-pair regenerators under the assumption that the NTU is locally powered:

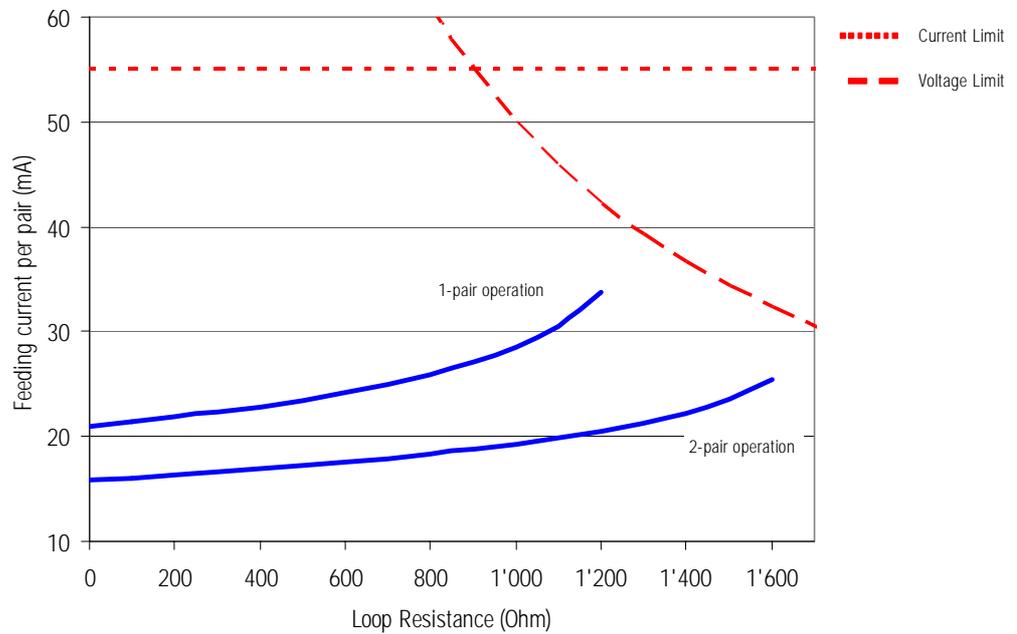


Figure 4-3: Regenerator powering reach vs. Loop resistance

5.1 Plug-in

Each plug-in is fed via subrack backplane with (dual) -48VDC (referenced to 0VDC of the exchange battery). The minirack mechanics has two -48VDC inputs and on model SZ.876.V100 also an AC powering input. The plug-in generates the used voltages onboard.

The ground reference of all voltages on the secondary side of the plug-in DC/DC-converter is tied to FPE (Functional Protective Earth).

Additionally, the plug-in is fed over the backplane with an auxiliary +5VDC supply (referenced to ground) generated on the ACU. The only purpose of this voltage is to drive the alarm circuitry on each plug-in, even in the case of a failure of the plug-in onboard DC/DC-converter.

5.2 Tabletop

5.2.1 Power and Grounding

The ground of a tabletop modem is normally floating when referenced to earth. If a tabletop modem is equipped with an E1 or nx64 kbit/s user interface, the shields / signal ground of the cables are coupled to the ground of the modem. On tabletop modems a ground connector is available on the rear panel of the modem.

A slide switch located on the rear of the housing selects the power source of the tabletop unit (remote powering over the DSL line or local powering by an external 48VDC source).

The position of the switch can be changed with a small screwdriver. Before operating the switch, the DSL line connector and the mains adapter connector must be removed.

Caution: *Switching from local to remote powering leads to an interruption of the DSL link. Before changing the position of the powering switch the tabletop must be switched off and disconnected from the DSL line.*

- Caution:** Only power sources below maximum hazardous energy levels according IEC 60950-1 chapter 1.2.8.10 may be used as local power source. The insulation voltage of the power source must support elevated insulation voltage according to EN 60950-1 (at least 4 KV insulation). The power adapters available from Schmid Telecom fulfill these requirements.
- Caution:** Do not connect a 48VDC supply directly to the "AC/DC adapter" connector! High voltage transients from the DSL line may damage other equipment connected to the battery. A DC/DC converter with 4kV transient isolation voltage should be used in this case and the ground connector on the tabletop modem should be connected to ground.
- Caution:** The local supply voltage input is protected against reversal of polarity but not fused. Appropriate fusing has to be done externally.

5.3 Remote Powering

Watson TDM supports the line powering concept of SHDSL. Plug-ins can supply remote power over the DSL copper pairs. Tabletop modems and Regenerators can be remotely powered over these copper pairs. Remote powering is available on all pairs of a multipair system.

5.3.1 Remote power feeding on plug-ins

Plug-ins are equipped with a remote powering circuits with the following characteristics:

- Per pair remote power feed
- Cross-wiring tolerant
- Power feeding voltage within limits of EN 60950 TNV-3
- Independent current limiters on a per pair basis (microcontroller - controlled)
- Tolerant against micro-interruptions
- Automatic system restart after power failure

Remote powering is controlled through the `POWER` command of the monitor.

The remote powering circuit is protected against overvoltage and overcurrent, see 11.1.1.

In case of overvoltage or overcurrent the powering is disconnected within less than 700ms.

- Note:** During the power-up phase of the plug-in the disconnect delay can be up to 900 ms.

When remote powering was disconnected by overcurrent protection then it is switched on automatically after 10 seconds.

When remote powering was disconnected by overvoltage protection then it will be disconnected until a hardware reset is done on the plug-in (removal of the plug-in from the subrack). In this state the plug-in LEDs 1 and 3 will be red blinking and no monitor access is possible. The overvoltage protection is only activated by serious hardware faults in the feeding circuit which require analysis and repair by the manufacturer.

Note: *If a remotely powered tabletop modem consumes more power than can be fed over the DSL link then it will not start up properly. This can lead to the loss of a remote modem through misconfiguration, e.g. by enabling the nx64 interface on a multiservice modem which is operating at the power limit with the nx64 interface switched off. With such reconfigurations the power consumption of the modem increases and it will not work properly anymore, making it impossible to get back to a working configuration under remote control. In such cases manual intervention at the site of the remote modem is required to reconfigure the unit with a local terminal.*

The reach attainable with remote powering depends on the power consumption of the modem and on the loop resistance (wire diameter and cable length and resistance of the feeding/protection circuitry in the plug-in).

5.3.2 Remote powering of Tabletops

The tabletops have a backplane switch to select local or remote powering. In the default switch position "REM" the tabletop modem is powered via the DSL line and will start operation immediately after connection of the DSL line. In position "LOC", the tabletop modem is powered locally and needs to be connected to a power supply to operate.

5.3.3 Powering Status Display

The current powering status of a tabletop modem is available in the STATUS display of the monitor (Unit Power Source UPS):

UPS = 01 for local powering

UPS = 02 for remote powering

5.3.4 Power Failure Alarm

The power supply bit `fbit3` of the DSL frame is used to indicate the status of the local power supply in the tabletop modem. The power status bit is set to ONE if power is normal and to ZERO if the power has failed. In case of power loss at the remote modem there is enough power left to communicate three "Power Loss" messages towards the LTU. In case of a failure of the tabletop modem power supply, both LEDs will be extinguished.

5.3.5 Remote powering reach

The remote power feeding current per pair can be approximated using the following formula:

$$I_{loop} = \frac{2P}{U_{feed} + \sqrt{U_{feed}^2 - 4R_{Loop}P}}$$

I_{loop} feeding current per pair. I_{loop} is limited to 55 mA by the LTU.

U_{feed} feeding voltage from LTU (112V)

P Power consumption per pair, i.e. $\frac{1}{2}$ of the total NTU power consumption on a two-pair system (and $\frac{1}{4}$ of total power consumption for 4-pair NTUs)

R_{loop} Ohmic resistance of loop. This includes the resistance of the copper loop and the resistance of the feeding and protection circuits on LTU and Regenerator.

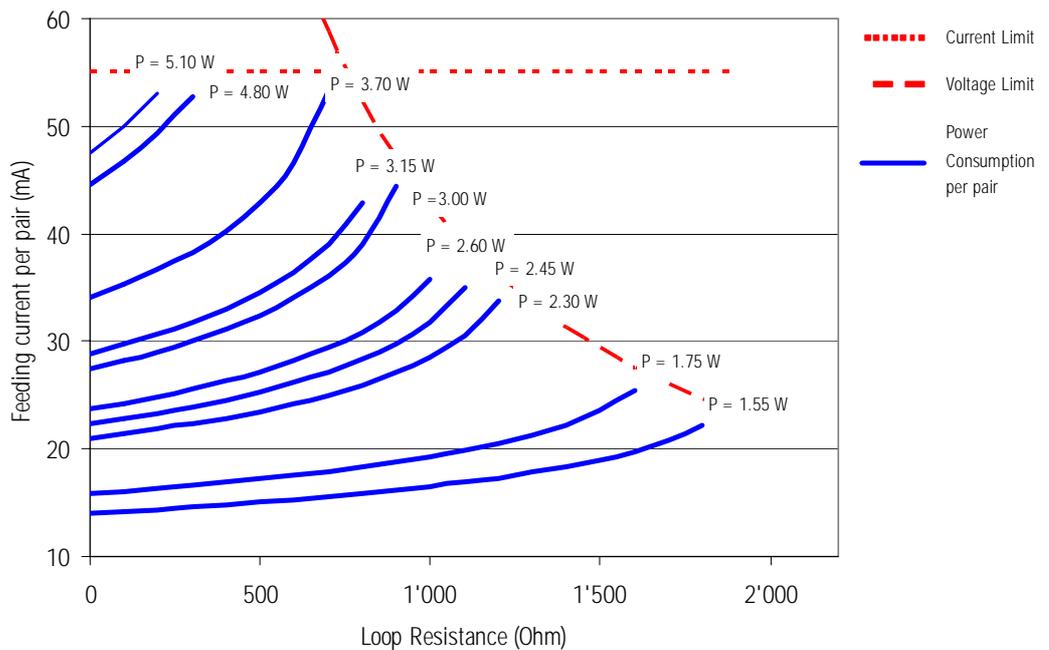


Figure 5-1: Line feed current vs. loop resistance for different values of power

6

LEDs, Alarms

6.1 Plug-in LEDs

6.1.1 Plug-in LED mapping

The plug-in cards are equipped with 4 LEDs that indicate local and remote alarm status depending on the number on DSL systems fitted on the plug-in card.

LED Number	LTUMODE 1 Quad link (1p)		LTUMODE 2 LTUMODE 3 LTUMODE 4 Dual link (1p/2p)	
	System	Function	System	Function
A	1	Local Status	1	Local Status
B	2	Local Status	1	Remote Status
C	3	Local Status	2	Local Status
D	4	Local Status	2	Remote Status

Table 6-1: LED mapping for plug-in

6.1.2 Plug-in LED Indications

Status	Local Status	Remote Status
Power failure	Off	Off
Hardware / Software failure	blinking red	Off
Remote Powering Overvoltage	blinking red (*)	Off
Normal operation (Master)	Green	Green
Normal operation (Slave)	Green	Off
Non-urgent alarms (local / remote) or loop active	Amber	Amber (off for Slave)
Urgent alarms (local / remote)	Red	Red (off for Slave)

(*) LEDs 1 and 3 blinking simultaneously

Table 6-2: Plug-in LED indications

During Firmware Download, the LEDs are used as follows:

Download Status	Local Status	Remote Status
Flash erase	blinking red	Off
Download in progress	blinking green	Off
Download completed	blinking amber	Off
Remote download in progress	blinking amber	blinking amber

Table 6-3: Plug-in LED indications during firmware download

6.2 Tabletop LEDs

6.2.1 Tabletop LED mapping

The tablespots are fitted with two LEDs labeled "1" and "2". The LEDs display the local status and (if the tabletop is configured as a DSL master) the remote status.

6.2.2 Tabletop LED Indications

Status	LED "1"	LED "2"
Power failure	Off	Off
Hardware / Software failure	Blinking red	Off
Normal operation (Master)	Green	Green
Normal operation (Slave)	Green	Off
User Interface Activity on Tx (Slave)	Green	Blinking Green
User Interface Activity on Rx (Slave)	Green	Blinking Amber
Non-urgent alarms (local / remote) or loop active	Amber	Amber (off for Slave)
Urgent alarms (local / remote)	Red	Red (off for Slave)

Table 6-4: Tabletop LED indications

During Firmware download the LEDs are used as follows:

Download Status	LED "1"	LED "2"
Flash erase	blinking red	Off
Download in progress	blinking green	Off
Download completed	blinking amber	Off
Activating remotely downloaded firm-ware	Off	blinking amber

Table 6-5: Tabletop LED indications during firmware download

6.3 Alarm Conditions

An alarm condition is displayed on the LEDs if one of the following conditions occurs:

Urgent alarm (red):

- Hardware or software failure (blinking)
- Loss of signal / frame alignment on the DSL side (LOSW)
- DSL block-error-rate according G.826 $\geq 30\%$ (BER-H)
- LTU only: overcurrent detected in remote power feeding circuit (CLD)

Non-urgent alarm (amber):

- DSL block-error-rate according G.826 $> 15\%$ (BER-L)
- Either Loop 1, Loop 2, Analog Loopback, or the Regenerator Loopback is active (LOOP1, LOOP2, ALB, LOOPREG, BERT)
- Alarm cut off is activated (ACO)

E1 Interface:

- LOS-S: loss of signal
- LFA-S: loss of frame alignment
- EXT-LOC: Loss of external clock (in external clock mode only)
- AIS-S: Receiving AIS on E1 side
- BER-S: Excessive block error rate on E1 side

PRA Interface:

- Loss of signal at the T reference point (LOS-S)
- Loss of frame at the T reference point (LFA-S)
- Receiving AIS at the T reference point (AIS-S)
- Loss of frame at the V3 reference point (LFA-V3)
- Receiving AIS at the V3 reference point (AIS-V3)

nx64 kbit/s Interface:

- LOC: Loss of codirectional clock or clock rate mismatch (clock mode: nx64 Port) on the nx64 kbit/s side
- DTR-S: Data Terminal Ready (DTR, circuit 108/2) on the nx64 Port is detected as 'OFF'. For X.21, the control-signal (C) is represented by DTR.
- The loops 1 and 2 can be controlled by the circuits 140 (RL) and 141 (LL), thus the alarms LOOP1 and LOOP2 can also be caused by the nx64 kbit/s interface

If no alarm condition is present then the LED will be green. Displaying an urgent alarm has a higher priority than displaying a non-urgent one.

6.4 Alarm Relays

The ACU2R [2], the minirack mechanics [7] and the plug-in tabletop housing [8] have two alarm relays to signal urgent and non-urgent alarms:

Urgent Alarm:

- At least one of the plug-in LEDs displays an urgent alarm
- Power failure of both $-48V_{DC}$ supplies

Non-urgent Alarm:

- At least one of the plug-in LEDs displays a non-urgent alarm and none of the LEDs displays an urgent alarm
- Power failure of one of the $-48 V_{DC}$ supplies

6.5 Initialization Errors

At system startup, various hardware selftests are performed. If any initialization errors occur, the startup procedure will be aborted and the monitor will display an initialization error code in hexadecimal representation. The table below lists the possible initialization errors and their corresponding error codes:.

Error Code	Initialization Error
0x01	Microcontroller RAM test failure
0x04	Framer initialization failure
0x08	DSL transceiver failure (Loop A)
0x10	DSL transceiver failure (Loop B)
0x1000	DSL transceiver failure (Loop C)
0x2000	DSL transceiver failure (Loop D)
0x40	Nx64 interface initialization failure
0x100	E1 interface initialization failure
0x8000	Software Copyright Protection Error

Table 6-6: Software Initialization Errors

Several initialization errors might occur simultaneously. In this case the error code displayed is the logical OR of the individual error codes. For example if both the microcontroller RAM test fails (error code 0x01) and the framer initialization fails (error code 0x04) then code 0x05 will be displayed.

7.1 Introduction

For configuration and diagnostics the modems have a serial interface to connect a terminal or a PC with terminal emulation. The terminal gives access to a commandline interface (the Monitor) to supervise and configure the modems.

All tabletop modems, the minirack mechanics and the tabletop housing for plug-ins are equipped with a RS-232 serial Monitor interface.

If the plug-ins are installed in a subrack then the serial interface is available on the ACU.

The monitor is also accessible from the master side through the DSL EOC on a DSL slave.

The terminal emulation must be VT100 compatible and must be configured as follows:

- 9600 baud, asynchronous
- 8 bits, no parity, one stop bit
- No new line on carriage return (i.e. no line feed on carriage return)
- XON/XOFF enabled

Notes:

- *The XON/XOFF protocol is used between terminal and the plug-ins for flow control. In order to re-enable communication with a plug-in occasionally left in XOFF state, it is recommended to start each session with Ctrl-Q (=XON) followed by an ECHO command.*
- *If you use the HyperTerm terminal emulator delivered with Windows® then you must configure HyperTerm for VT100 emulation in the "Settings" tab of the connection properties (File – Properties).*

7.2 Addressing

7.2.1 Plug-in in subrack

The monitor terminal connects through the ACU to a serial bus on the subrack backplane which is accessible by all plug-ins.

At any time, only one of the plug-ins in the subrack can be logically connected to the monitor interface. The appropriate plug-in subsystem is addressed (i.e. selected) according to its physical position in the subrack, starting with the leftmost slot number 01 and ascending rightwards to number 12. If an plug-in supports a second subsystem, it may be addressed by adding 12 to the address of the first interface. The third subsystem is addressed by adding 24 to the first address, and the fourth subsystem by adding 36.

To select a subsystem on a plug-in in slot number type the character % followed by the address of the subsystem, e.g. to select the first DSL link in slot 01, type %01.

In the main menu of a plug-in you can also use the N (Next) command to move from one subsystem to the next.

Note that the number of subsystems on a plug-in can change if the LTUMODE of the plug-in is changed, see 8.2.2.

Unit	Plug-in	ACU	PSB												
First Subsystem	%01	%02	%03	%04	%05	%06	%07	%08	%09	%10	%11	%12			

Figure 7-1: Addressing for plug-ins with one subsystem

Unit	Plug-in	ACU	PSB												
First Subsystem	%01	%02	%03	%04	%05	%06	%07	%08	%09	%10	%11	%12			
Second Subsystem	%13	%14	%15	%16	%17	%18	%19	%20	%21	%22	%23	%24			

Figure 7-2: : Addressing for plug-ins with two subsystems

Unit	Plug-in	ACU	PSB												
First Subsystem	%01	%02	%03	%04	%05	%06	%07	%08	%09	%10	%11	%12			
Second Subsystem	%13	%14	%15	%16	%17	%18	%19	%20	%21	%22	%23	%24			
Third Subsystem	%25	%26	%27	%28	%29	%30	%31	%32	%33	%34	%35	%36			
Fourth Subsystem	%37	%38	%39	%40	%41	%42	%43	%44	%45	%46	%47	%48			

Figure 7-3: : Addressing for plug-ins with four subsystems

To see which subsystems in a rack are available, you can use the `ECHO` command. Each subsystem will respond with its associated slot number (`%nn`).

The response could be: `%01 %03 %08 %10 %11 %12 %15`

7.2.2 Plug-in in minirack mechanics or tabletop housing

If the plug-in is operated in the Minirack mechanics the addresses of the subsystem(s) are 1, 2, 3 and 4.

After power-up of a plug-in installed in the minirack mechanics or in the tabletop housing for plug-ins the monitor main menu appears with the first subsystem activated. The command `ECHO` and the selection of a subsystem with `%nn` is not possible in this case. Use the `N` command from the monitor main menu to switch between subsystems.

7.2.3 Tabletop

Tabletop modems have only one DSL subsystem, no addressing is required. After power-up of a tabletop modem the main menu of the monitor appears directly.

7.3 The Monitor

7.3.1 Main Menu

After connecting the Terminal/PC a welcome screen is shown with information about the modem type, firmware version and administrative name, e.g.:

```
                Watson TDM SHDSL
                E1 Monitor V4.1 Quad (4x1p)
                ZRHBI351
Copyright (C) 2001-2007 by Schmid Telecom AG Zuerich, Switzerland

                +-----+
                | Main Menu |
                +-----+

                1. Performance management (PM)
                2. Fault and maintenance management (FMM)
                3. Configuration management (CM)
                4. Security and remote management (SM)
                5. Exit
                N. Next sub-system

LTU_01> Select [1..5,N]:
```

To select the desired sub-menu, type the appropriate number.

- Notes:**
- *The Exit command is only available on a plug-in inserted in a subrack. To address another plug-in, type %SN*

7.3.2 Menus

The monitor commands are grouped into four submenus:

- Performance Management: gives access to performance data collected in the modem
- Fault and Maintenance Management: gives access to fault, alarm and diagnostic data
- Configuration management: modem configuration commands
- Security and remote management: miscellaneous commands

7.3.3 Help

In each menu you can use the command `HELP` or `H` to display a list of available commands

7.3.4 Shortcuts

The available commands depend on the sub-menu currently active. The most popular commands are available in all submenus as shortcuts:

Command	Shortcut
CONNECT	CON
DIAGNOSTIC	DIA
DISCONNECT	DIS or <ESC> key

Table 7-1: Command Shortcuts

7.3.5 Continuous Displays

Some commands (`DIAGNOSTIC`, `BERT`) continuously update the screen with the latest information. These commands will stop updating the screen but continue to collect information in the background if a new command is entered that generates displays with more than one line. (e.g. `CONFIG`, `STATUS`, `ALARM`, `READBER`).

8

Monitor Command Reference

8.1 Introduction

This chapter defines the Monitor command language. The language is made up of the following elements:

COMMAND	Commands are written in CAPITALS
KEYWORD	Keywords are written in CAPITALS
<i>Parameter</i>	Parameters are written in Italics. Replace the parameter with the actual value. Example: LINERATE n
<i>Parameter</i> <i>Parameter</i> KEYWORD KEYWORD	Choices are denoted with vertical bars . In a choice group one of the parameters must be specified.
[<i>Parameter</i>] [KEYWORD]	Optional parameters are enclosed in [brackets]. Optional parameters can be specified but are not required.

Table 8-1: Command language elements

8.2 Configuration Management CM

The commands available in the configuration management menu vary depending on modem hardware, firmware and current configuration. Example:

```
LTU_01_CM> H
~~~~~
CONFIG          Display local configuration
G704 [ON,OFF]   Set framed mode / transparent mode
CRC4 [ON,OFF]   Set CRC4 mode on/off
EBIT [ON,OFF]   Set automatic E-Bit insertion on/off
AISGEN [ON,OFF,T] Set AIS generation on/off/transparent
AISDET [ON,OFF] Set AIS detection on/off
CLK2M [EXT,INT,E1] Select 2Mbit reference clock:
                  external/internal/2Mbit Port
MP              Display E1 time slot map
MP [0..5]       Set E1 time slot mapping mode
MASTER [ON,OFF] Set SHDSL master mode / slave mode
POWER [ON,OFF] Set remote powering on/off
RESTART [ON,OFF] Set autorestart on/off
BACKOFF [ON,OFF] Set power backoff on/off
LINERATE n i    Select line rate (n=[3..89] i=[0,1])
MODE [1,2]      Set SHDSL operating mode (number of pairs)
LTUMODE [mode]  Select basic LTU operating mode:
                  1: 4x1p          L: Local Oscillator
                  2: 2x2p (UIF 1&2) N: Network Reference
                  3: 1x2p + 2x1p
                  4: 1x4p
                  5: Multipoint
                  6: 2x2p (UIF 1&3)
                  8: 2x2p (UIF 3&4)
                  12: 1x3p + 1x1p
                  14: 2xE1 on 1p
                  15: 3xE1 on 2p
                  16: 4xE1 on 3p
GROUP           Display available 1+1 protection groups
GROUPn [ON,OFF] Enable / disable 1+1 protection group
ADDRESS slot rack Set TMN address (slot=[1..12] rack=[0..1])
V11WIRES [2,4]  Set number of V.11 wires
ADMIN-NAME [name] Set / display this system's administrative name
DEFAULT [0..2]  Set default configuration
MAIN (M)        Return to main menu
```

8.2.1 General Commands

ADMIN-NAME [*String*]

Sets an administrative name for the subsystem. The administrative name of the subsystem is displayed in the Monitor welcome screen and in the CONFIG screen. Use quotes (" ") to enter an upper/lowercase administrative name.

ADMIN-NAME without parameter will display the administrative name.

CONFIG

The CONFIG command displays the current configuration of the modem:

```
LTU_01_CM>CONFIG
~~~~~
Local Configuration                               Id : 2 MBit/s G.703
~~~~~
2 MBit/s
Framing      : ITU-T G.704
CRC4         : On
E-Bit Insertion : On
AIS Generation : On
AIS Detection  : On
Clock Mode   : Local 2Mbit Port
Data Rate    : 01 x 64 = 00064 kbit/s
TS Mapping Mode : 2
SHDSL
Master/Slave : Master
Autorestart  : Enabled
Power Backoff : Disabled
Payload Rate : 00192 kbit/s
Operating Mode : 1 Pair
Line Rate    : 00208 kbit/s
Remote Powering : On
Regenerators : --
TMN
Address      : 01
V.11 wires   : 02
Management
Admin Name   : ZRHBINZ35
```

Notes:

- After each configuration change, the new configuration is automatically displayed.
- If the DSL clock mode is set to "Network reference" (*LTUMODE N*) then this is shown in the Operating Mode line
- For tabletop modems the wetting current status (wetting current sink on/off) is shown instead of the Remote Powering status

When both an nx64 kbit/s and an E1 interface are equipped, the configuration display shows first the E1/PRA configuration and then the nx64 kbit/s configuration, e.g.:

```
LTU_01_CM>CONFIG
~~~~~
Local Configuration                               Id : Multiservice
~~~~~
2 MBit/s
Framing      : ITU-T G.704
CRC4         : Off
E-Bit Insertion : --
AIS Generation : On
AIS Detection  : Off
Data Rate    : 11 x 64 = 00704 kbit/s
X.21
Bitrate      : 20 x 64 = 01280 kbit/s
Clock Mode   : Remote
Clock Polarity : Normal
Byte Timing   : Off
Handshake     : Disabled
SHDSL
Master/Slave : Slave
Autorestart  : Enabled
Power Backoff : Disabled
Payload Rate : 02048 kbit/s
Operating Mode : 1 Pair
Line Rate    : 02056 kbit/s
```

DEFAULT configuration

The DEFAULT command sets a default configuration.

On plug-in modems DEFAULT sets the following parameters:

Parameter	DEFAULT 0	DEFAULT 1	DEFAULT 2
SHDSL			
Master/Slave	Master	Master	Master
Autorestart	Enabled	Enabled	Enabled
Power Backoff	Disabled	Disabled	Disabled
Payload Rate	2048 kbit/s	2048 kbit/s	2048 kbit/s
Operating Mode ^(*)	1/2/4 Pair	1/2/4 Pair	1/2/4 Pairs
Linerate per pair ^(*)	2056/1032/520 kbit/s	2056/1032/520 kbit/s	2056/1032/520 kbit/s
2 MBit/s			
Framing	Transparent	ITU-T G.704	Transparent
CRC4	--	On	--
E-Bit Insertion	--	On	--
AIS Generation	On	On	On
AIS Detection	On	On	Off
Clock Mode	Local 2 Mbps port	Local 2 Mbps port	Local 2 Mbps port
Data Rate	32 x 64 = 2048 kbit/s	31 x 64 = 1984 kbit/s	32 x 64 = 2048 kbit/s
Linerate per pair ^(*)	2056/1032/520 kbit/s	2056/1032/520 kbit/s	2056/1032/520 kbit/s
TS Mapping Mode	--	1	--

^(*) operating mode and linerate depend on the current LTUMODE. Each system on the card will be configured to carry 2048 kbit/s Payload rate, e.g. a single-pair system for 2056 kbit/s and a two-pair system for 2 x 1032 kbit/s.

Table 8-2: DEFAULT values for Watson TDM plug-ins with 4 x E1 user interfaces

For tabletop modems the following parameters are modified with the `DEFAULT` command:

Parameter	DEFAULT 0	DEFAULT 1	DEFAULT 2
SHDSL			
Master/Slave	Slave	Slave	Slave
Autorestart	Enabled	Enabled	Enabled
Power Backoff	Disabled	Disabled	Disabled
Payload Rate	Determined by master	Determined by master	Determined by master
Operating Mode	1 Pair	Determined by master	Determined by master
Line Rate	Determined by master	Determined by master	Determined by master
Wetting Current	Off	Off	Off
2 MBit/s			
Framing	Transparent	ITU-T G.704	Transparent
CRC4	--	On	--
E-Bit Insertion	--	On	--
AIS Generation	On	On	On
AIS Detection	On	On	Off
Clock Mode	Local 2 Mbps port	Local 2 Mbps port	Local 2 Mbps port
Data Rate	32 x 64 = 2048 kbit/s	31 x 64 = 1984 kbit/s	32 x 64 = 2048 kbit/s
TS Mapping Mode	--	1	--
n x 64			
Bitrate	Off	Off	Off
Clock Mode	Remote	Remote	Remote
Clock Direction	Codirectional	Codirectional	Codirectional
V.54 Loops	Disabled	Disabled	Disabled
Handshake	Disabled	Disabled	Disabled
LEDs			
User Interface Activity indication	Off	Off	Off

Table 8-3: `DEFAULT` values for Watson TDM tabletop modems

Note *The factory setting can be loaded using the `DEFAULT 2` command. All modems are delivered with this configuration.*

8.2.2 Plug-in Configuration

LTUMODE [Mode]

The Watson TDM plug-ins can be configured flexibly to support 1/2/4 pair operation and different DSL clocking modes.

This is done with the LTUMODE command. Entering LTUMODE without any parameter will display the current LTU basic mode and mapping of user interfaces to xDSL interfaces:

```

LTU_01_CM> LTUMODE
~~~~~
LTUMODE 2: 2x2p, UIF 1 + 2
~~~~~
System      Clk      E1 Port      SHDSL Port  Line Rate  Power
~~~~~
LTU_01:     E1 Rx     1 <-----+-----> 1          1032      On
              |
              +-----> 2          1032      On
LTU_13:     E1 Rx     2 <-----+-----> 3          1032      On
              |
              +-----> 4          1032      On
~~~~~
LTU_01_CM>
    
```

In the example above the plug-in is configured as two 2-pair systems.

The first system uses DSL ports 1/2 and E1 port 1. If the plug-in is inserted in slot 1 of the subrack then the address of this system is %01.

The second system uses DSL ports 3/4 and E1 port 2. It operates in two-pair mode (MODE 2). Its address is %13 assuming the plug-in is inserted in slot 1 of d subrack.

Available LTU modes:

LTUMODE	Configuration
1	4x1p, four independent 1-pair systems
2	2x2p, two independent 2-pair systems connected to E1 user interfaces 1 + 2
3	1x2p + 2x1p, one 2-pair and two 1-pair systems (E1 user interfaces 1, 2 and 4)
4	1x4p, one 4-pair system connected to E1 user interface 1
5	Multipoint
6	2x2p, two independent 2-pair systems connected to E1 user interfaces 1 + 3
8	2x2p, two independent 2-pair systems connected to E1 user interfaces 3 + 4
12	1x3p + 1x1p
14	2xE1 on 1 pair
15	3xE1 on 2 pairs
16	4xE1 on 3 pairs
L	Selects DSL Clock Mode 1 (Local Clock). See 3.1.4
N	Selects DSL Clock Mode 2 (Network Reference). See 3.1.4

Table 8-4 : LTU modes

When changing the LTU operating mode, all DSL links will be reset and the current configuration will be overwritten with the default configuration of the new

mode as per Table 8-2. Note that only the DSL defaults as per Table 8-2 are set, the E1 interface configuration is not changed by `LTUMODE`. For security reasons, the command must be confirmed.

The `LTUMODE` can only be changed within the configuration menu of the first subsystem of a plug-in.

`LTUMODE` without parameters will display the current LTU mode

Note *Depending on the hardware configuration of a plug-in not all possible `LTUMODES` are supported.*

8.2.3 DSL Configuration

`BACKOFF ON | OFF`

Set SHDSL Power Back-Off function ON / OFF.

`LINERATE n [z] [p] [a]`

Set line rate:

`n` the number of DSL timeslots to be transmitted ($3 \leq n \leq 89$)

`z` use of one Z-bit: Setting `z` to 0 or omitting `z` means that the DSL EOC runs at 3.2 kbit/s. Setting `z` to 1 increases the EOC bandwidth to 11.2 kbit/s.

`p` the number of constellations: use 16 for `p` to configure 16 constellations (TC-PAM 16) and 32 for 32 constellations (TC-PAM 32). If possible (i.e. consistent with `n`) the DSL link will be configured with this desired constellation. If `p` is omitted, TC-PAM 16 will be configured when possible and TC-PAM 32 otherwise.

`a` 1 denotes asymmetric PSD operation

Notes

- *Asymmetric PSD is only possible without Z-bits, i.e. $a = 1$ implies $z = 0$*
- *The additional Z-bit is not supported by the Watson TDM Regenerator. Links with regenerators should be configured without specifying `z`. Other values for `z` are ignored on regenerated links.*
- *Watson 5 does not support TC-PAM 32. A DSL link between Watson TDM (as DSL master) and Watson 5 (as DSL slave) will not start if the DSL master is configured for TC-PAM 32.*

`MASTER ON | OFF`

Set DSL master mode ON / OFF (`MASTER OFF` configures the modem as DSL slave).

On a plug-in with several subsystems each DSL link can individually be configured as DSL master or DSL slave

MODE number-of-pairs

MODE 1: 1 pair operation

MODE 2: 2 pair operation

MODE 3: 3 pair operation

MODE 4: 4 pair operation

See 3.1.3.

Note *MODE causes a restart of the DSL link*

POWER ON | OFF

Set DSL remote powering ON / OFF.

RESTART ON | OFF

Set DSL autorestart ON / OFF.

WETTING ON | OFF

Enables (ON) or disables (OFF) sinking of wetting current. Only available on tabletop modems.

8.2.4 User Interface Configuration

ACTLED ON | OFF

Turns user interface activity on (ACTLED ON) or off (ACTLED OFF). If turned on then activity on the user interface will be shown on the LED "2" (LED "Remote") on the tabletop modem. The Activity LED blinks if at least one signal transition has been detected within one second on Tx or Rx.

If activity is detected on Tx (user data towards DSL) then the LED is blinking green. If activity is detected on Rx (user data from DSL) the LED will blink amber. If activity is detected on both Tx Data and Rx Data, the LED will blink alternating green/amber.

User interface activity indication is available on modems with a nx64 user interface and on modems with an E1 user interface and if the interface is operated in G.703 transparent/unframed mode. In case of multiservice operation, only activity of the nx64 user interface is indicated, while activity on the E1 interface is not monitored.

Invoking a DEFAULT command will disable user interface activity indication.

Note: *User interface activity indication is only available if the unit is configured as Slave.*

MP mode

The MP command sets the E1 mapping mode (see 3.5)

- MP 0 : TS0 generated locally in the modem, TS16 only if frE1 > 16
- MP 1 : TS0 always transmitted, TS16 only if frE1 > 16
- MP 2 : TS0 generated locally in the modem, TS16 always transmitted
- MP 3 : TS0 and TS16 always transmitted
- MP 4: TS0 and TS16 generated locally in the modem
- MP 5: TS0 always transmitted, TS16 generated locally in the modem

Multiservice only:

- MP ON: switch E1 Port on
- MP OFF: switch E1 Port off

The MP command without parameters displays the E1 timeslot mapping mode.

```

LTU_01_CM> MP
~~~~~
E1 Timeslot Map                                     (Mode: 1)
~~~~~
TS 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 3 3
Nr 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Tx 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Rx 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
    
```

- TS Nr Timeslot number (0 .. 31)
- Tx Timeslot mapping in transceive (towards DSL) and receive (towards E1) directions:
- Rx Timeslot mapping in transceive (towards DSL) and receive (towards E1) directions:
- 0 timeslot is not mapped to DSL
- 1 timeslot is mapped to DSL
- N timeslot is mapped to DSL and contains nx64 data
- timeslot unused (Multiservice only)

- Notes:**
- Tx mapping is given by the local configuration, Rx mapping by the mapping mode configured on the remote site. Theoretically it is possible to use different mapping modes in each direction. However this is not recommended. If Tx and Rx mapping are not equal, a warning message is displayed.
 - In Multipoint operation the MP command has other parameters, see chapter 3.6.

UIF Interface-type

Set the user interface type

- E1 E1 user interface
- PRA E1 user interface with PRA functions
- V35 nx64 interface with V.35
- V36 nx64 interface with V.36
- X21 nx64 interface with X.21

8.2.5 E1 Configuration

AISDET ON | OFF

Set AIS detection (see 3.2.2):

- ON Reception of AIS on the E1 user interface generates an AIS alarm
- OFF AIS on the E1 user interface is ignored

AISGEN ON | OFF | T

Set AIS generation (see 3.2.3):

- ON AIS is generated on the E1 user interface if AIS is detected on the remote user interface or if the DSL link loses synchronization
- OFF AIS is never generated on the E1 user interface. The E1 user interface is switched off if AIS is detected on the remote user interface or if the DSL link loses synchronization
- T Transparent: if AIS is signaled from the remote E1 interface (reception of AIS-R) then AIS is sent on the local interface. The E1 interface is switched off if the DSL link loses synchronization.

CLK2M Clockmode

Select source of 2 MBit/s clock:

- EXT external clock source
- INT internal clock source
- E1 clock from E1 port

Note: *The CLK2M command can only be applied to the first DSL system and the command must be confirmed by entering it twice. It will then affect all other systems configured with LTUMODE on the plug-in, see 8.2.2.*

CRC4 ON | OFF

Set CRC4 mode on / off.

EBIT ON | OFF

Set automatic E-Bit insertion on / off.

G704 ON | OFF

Set framed mode / transparent mode.

8.2.6 PRA Configuration

CRC4 option

Set CRC4 processing option (Subscriber access option):

- CRC4 1 digital link without CRC4 processing
- CRC4 2 digital link with CRC4 processing
- CRC4 4 digital link with CRC4 monitoring

This configuration only selects the subscriber access option of the whole digital section (NT1 and LT) if PRA Mode NT1 & LT is selected. If NT1 and LT functions run on different modems, the CRC4 settings of both modems determine the access option (see 3.2).

CRC4SA6 ON | OFF

Set generation of CRC4 error notifications to the ET on / off (applies only to NT1).

PRA option

Select the ISDN PRA functional entities of the modem:

PRA OFF	no PRA function (transparent transmission)
PRA NT1LT	both NT1 and LT
PRA LT	only LT
PRA NT1	only NT1

8.2.7 n x 64 kbit/s configuration

BITRATE rate

Set bitrate of the nx64 Port : n = 1 .. 156 (64 Kbps .. 9'984 Kbps)

To switch off the nx64 Port, set bitrate to 0.

Warning: *If a multiservice tabletop modem is remotely powered be sure not to enable the nx64 kbit/s interface (by setting BITRATE to a value > 0) if the modem is operating at the remote power limit with just the E1 interface enabled. Due to the higher power consumption of the nx64 kbit/s interface the current limiter at the plug-in might operate, thus switching off remote power feeding. Subsequent startups will not be successful. The system will not operate until the tabletop modem is reconfigured locally.*

BYTETIMING ON | OFF

Select whether or not circuit B for byte timing is used in X.21 mode. Note that to use byte timing you need the appropriate cable and cannot use the co-directional transmit clock.

This command is only available in X.21 mode.

CLOCKDIR direction

Select clock direction: 0 = codirectional, 1 = contradirectional.

This command is only available in V.35 and V.36 modes.

CLOCKMODE source

Select clock source: 0 = nx64 Port, 1 = E1 Port 2, 2 = Internal, 3 = Remote.

CLOCKPOL polarity

The CLOCKPOL command selects the sampling instant for the incoming data stream on circuit T of the X.21 user interface. In normal configuration (CLOCKPOL 0) circuit T is sampled on the rising edge of clock S. The data transitions on T and R occur at the OFF to ON transition of S (according X.24). The ON to OFF transition of circuit S nominally indicates the center of each signal element, in this case on circuit R.

When Clock Polarity is set to inverted (CLOCKPOL 1), circuit T is sampled with the falling slope of S and the incoming data at X.21 circuit T is sampled at the OFF to ON transition of S.

This command is only available in X.21 mode.

HANDSHAKE ON | OFF

Set RTS/CTS (C/I) handshake mode.

User interface type V.35/V.36

HANDSHAKE ON: Circuit 107 (DSR) and 109 (RLSD) are set to status ON when an DSL link is established. Circuit 106 (CTS) is set to status ON only when link is established and circuit 105 (RTS) is in ON state.

HANDSHAKE OFF: Circuit 106 (CTS), 107 (DSR) and 109 (RLSD) are set into status ON when an DSL link is established. Status of circuit 108 (DTR) is detected and displayed by DTR-S alarm in both cases.

User interface type X.21

HANDSHAKE ON: Circuit I is set to status ON when circuit C is in ON state and the DSL link is established, OFF otherwise.

HANDSHAKE OFF: Circuit I is set to status ON when the DSL link is established and OFF otherwise independent of circuit C.

V54LOOPS ON | OFF

Select whether it is possible to switch loop 1 and 2 using the control circuits 140 (RL) and 141 (LL).

This command is only available in V.35 and V.36 modes.

8.2.8 Automatic Protection Switching (APS) Configuration

GROUP

Displays the available APS groups:

```
LTU_08_CM> GROUP
~~~~~
APS Groups (1+1 protection, bidirectional, non-revertive)
~~~~~
Group Number      : 1          2
Group Name        : Group_08   Group_32
Configuration Status : Enabled  Disabled
Working Line      : LTU_08     LTU_32
Protection Line   : LTU_20     LTU_44
```

The number of groups is set by the card configuration (LTUMODE). The group names are defined by the card position within the subrack (the name is Group_xx where xx is the interface address of the first system of the group).

Note: The GROUP command is only available on the first system of a plug-in.

GROUPn ON | OFF

Enables (GROUPn ON) or disables (GROUPn OFF) the APS function of a protection group.

Protection groups can only be enabled/disabled on the Master. After power-up or reset, the protection groups on the Slave are disabled by default, but will be automatically enabled by the Master after link startup. If a 1+1 protection group is enabled then the line rate of the protection line will be automatically set equal to the line rate of the working line. The LINERATE command is not available on the protection line.

If a 1+1 protection group is enabled the user interface of the protection line is switched off, and the user interface configuration commands are disabled on the protection line system.

If 1+1 protection is enabled, the LTUMODE display shows the protection group(s):

LTU Mode 1: 4x1p, Local Oscillator, 1+1 Protection						
System	Clk	E1 Port		SHDSL Port	Line Rate	Power
LTU_08:	E1 Rx	1	<----->	1 (W)	2056	On
			: Group_08			
LTU_20:			:.....>	2 (P)	2056	On
LTU_32:	E1 Rx	3	<----->	3	2056	On
LTU_44:	E1 Rx	4	<----->	4	2056	On

1+1 protection configuration is shown in the CONFIG display:

Working link:

Local Configuration		Id : 2 MBit/s G.703
~~~~~		
2 MBit/s		
Framing	:	Transparent
CRC4	:	--
E-Bit Insertion	:	--
AIS Generation	:	On
AIS Detection	:	On
Clock Mode	:	Local 2Mbit Port
Data Rate	:	32 x 64 = 02048 kbit/s
TS Mapping Mode	:	--
1+1 Protection	:	Enabled, Working Line, Group_08
SHDSL		
Master/Slave	:	Master
Autorestart	:	Enabled
Power Backoff	:	Disabled
Payload Rate	:	04096 kbit/s
Operating Mode	:	2 Pair, Local Oscillator
Line Rate	:	02056 kbit/s
Remote Powering	:	On
Regenerators	:	1
TMN		
Address	:	08
V.11 wires	:	02

Protection link:

Local Configuration		Id : 2 MBit/s G.703
~~~~~		
2 MBit/s		
1+1 Protection	:	Enabled, Protection Line, Group_08
SHDSL		
Master/Slave	:	Master
Autorestart	:	Enabled
Power Backoff	:	Disabled
Payload Rate	:	04096 kbit/s
Operating Mode	:	2 Pair, Local Oscillator
Line Rate	:	02056 kbit/s
Remote Powering	:	On
Regenerators	:	1
TMN		
Address	:	08
V.11 wires	:	02

Note: The GROUP1 and GROUP2 commands are only available on the first system of a plug-in

8.3 Fault and Maintenance Management FMM

The commands available in the fault and maintenance management menu vary depending on modem hardware, firmware and current configuration. Typing H (for Help) gives a list of available commands, e.g.

```

LTU_01_FMM> H
-----
DIAGNOSTIC (DIA)  Activate / deactivate diagnostic display
STATUS           Display local system status
ALARM            Display local alarm status
ALARM T          Turn alarm trace on/off
ALARM H hh:mm    Display alarm history (hh:mm = [0:00..23:59])
CLEAR           Clear alarm history
ACO [ON,OFF]     Activate / deactivate alarm cutoff
PSB [ON,OFF]     Enable / disable power supply alarms
LOOP1 [ON,OFF] m Activate / deactivate Loop 1
                  for m=[0..480] minutes (0:unlimited)
LOOP2 [ON,OFF] m Activate / deactivate Loop 2 at remote unit
                  for m=[0..480] minutes (0:unlimited)
LOOPREGn [ON,OFF] m Activate / deactivate regenerator loopback
                  for m=[0..480] minutes (0:unlimited)
STARTAL         Start analog loopback
STOPAL          Stop analog loopback
RESET           Reset SHDSL link
RESETCARD       Perform general HW and SW reset
MAIN (M)       Return to main menu
    
```

8.3.1 Diagnostic and Status

DIAGNOSTIC

The DIAGNOSTIC command shows signal quality, G.826 parameter, attenuation, status and alarms of one LTU/NTU:

```

LTU_01_FMM> DIAGNOSTIC
-----+-----
Diagnostic:  SQ  G.826(ES)  Attn  Status  | Alarms
-----+-----
LTU-A:      +13.5  00000001  +00.79  Sync    | PID
LTU-B:      +14.0  00000000  +00.86  Sync    |
LTU-C:      +16.5  00000001  +00.00  Sync    |
LTU-D:      +15.0  00000000  +00.08  Sync    |
-----+-----
NTU-A:      +14.5  00000001  +00.00  Sync    |
NTU-B:      +14.0  00000000  +00.00  Sync    |
NTU-C:      +11.5  00000000  +00.02  Sync    |
NTU-D:      +11.5  00000000  +00.00  Sync    |
    
```

If regenerators are present in the DSL link then the DIAGNOSTIC information is extended:

LTU_01_CM> DIAGNOSTIC					
Diagnostic:	SQ	G.826(ES)	Attn	Status	Alarms
LTU-A:	+16.0	00000007	+00.26	Sync	
LTU-B:	+16.5	00000009	+00.49	Sync	
REG-RA:	+24.0	00000001	+00.00	Sync	
REG-RB:	+24.0	00000001	+00.00	Sync	
REG-CA:	+18.5	00000020	+00.00	Sync	
REG-CB:	+17.5	00000009	+00.00	Sync	
NTU-A:	+16.0	00000000	+00.31	Sync	
NTU-B:	+16.0	00000000	+00.39	Sync	

Notes:

- Upper part (LTU - lines) contains local, lower window (NTU - lines) contains remote diagnostic information
- The command will only show the status of the equipped pairs (A, A and B, A/B/C/D depending on modem type)
- A DSL Slave displays only local information
- In case of an NTU-NTU or LTU-LTU connection, the unit designators are changed accordingly
- The *DIAGNOSTIC* command is available from all menus by typing *DIA*. Help information is only displayed from the Fault and Maintenance Management menu.
- If the output of the *DIAGNOSTIC* command is longer than 22 lines (more than 4 Regenerators in a 1 pair link), the monitor display can be scrolled by pressing <Space>

STATUS

The STATUS command displays the current system status:

LTU_01_FMM> STATUS					
Local System Status					V4.0
SYNC-A: 02	OPS-A: 01	PID-A: 01	PWR-A: +13.50	UPS: 01	
SYNC-B: 02	OPS-B: 01	PID-B: 02	PWR-B: +13.50		

SYNC	Status of SHDSL synchronization according to ETSI TS 101 524.
00	Out of Sync State
01	State 0
02	In Sync State
03	State 1
04	State 2
05	State 3
06	State 4
07	State 5

OPS	Operational mode of the transceiver
00	Idle Mode
01	Data Mode
10	Startup handshake in progress
18	Startup training in progress
80	Local analog loopback

PID	Pair Identification when 4p operation is enabled
-----	--

PWR	Transmit power of each channel [dBm]
-----	--------------------------------------

UPS	Unit Power Source
01	locally powered
02	remotely powered

PRA	Current state of the digital section (DS) according to ETS 300 233 section 9.4. Only the states possible in NT1 & LT mode are displayed. The PRA status is shown in PRA mode only
00	NTU dying
01	NTU dying & FV3/FC5
02	NTU dying & FC4
03	NTU dying & FC4 & FV3/FC5
04	NTU dying & AIS
05	NTU dying & AIS & FC4
06	Normal function
07	FC4
08	FV3/FC5
09	FV3/FC5 & FC4
10	Loopback 1
11	Loopback 1 & FC4
12	Loopback 2
13	Loopback 2 & FC4
14	Loopback 1 & NTU dying
15	Loopback 1 & NTU dying & FC4
16	Loopback 2 & NTU dying
16	Loopback 2 & NTU dying & FC4
18	AIS
19	AIS & FC4

Note: *In multipair modems the status values will be displayed per pair with suffix -A, -B, -C and -D*

If used with the Regenerator then the STATUS display is

```

REG_01_FMM_REMOTE> STATUS
~~~~~
Local System Status                                     V2.0
~~~~~
SYNC-RA: 02  OPS-RA: 01  PID-RA: 01  PWR-RA: +13.50
SYNC-RB: 02  OPS-RB: 01  PID-RB: 02  PWR-RB: +13.50
SYNC-CA: 02  OPS-CA: 01  PID-CA: 01  PWR-CA: +13.50
SYNC-CB: 02  OPS-CB: 01  PID-CB: 02  PWR-CB: +13.50

```

SYNC Status of SHDSL synchronization according to ETSI TS 101 524.

- 00 Out of Sync State
- 01 State 0
- 02 In Sync State
- 03 State 1
- 04 State 2
- 05 State 3
- 06 State 4
- 07 State 5

OPS Operational mode of the transceiver

- 00 Idle Mode
- 01 Data Mode
- 10 Startup handshake in progress
- 18 Startup training in progress
- 80 Local analog loopback

PID Pair Identification when 4p operation is enabled

PWR Transmit power of each channel [dBm]

RPV-A Remote Power Voltage of loop A and B (in Volts)

RPV-B

Note: *To display regenerator status you have to log on to the remote monitor terminal of a Regenerator with the CONNECT command.*

8.3.2 Automatic Protection Switching

APS [*command*]

APS without parameters displays the current status of the APS groups:

```

~~~~~
APS Status (1+1 protection, bidirectional, non-revertive)
~~~~~
Group
Number          : 1
Name            : Group_08
Config Status   : 01 (active)
Command Status  : 01 (noCmd)
Current Status  : 00
Switched Line   : Protection Line
Working Line
Line            : LTU_08
Switchovers     : 00000000
Last Switchover : 00000000
Switchover Seconds : 00000000
Protection Line
Line            : LTU_20
Switchovers     : 00000000
Last Switchover : 00000000
~~~~~

```

Group

Number	Group number (1 or 2)
Name	Group name (defined by system address)
Config Status	Current configuration: 1 (active, enabled) or 2 (not in service, disabled)
Command Status	Current APS command
Current Status	Current status: 00: normal operation 01: mode mismatch: the remote unit does not support APS 02: channel mismatch: working line and protection line are not connected to the same protection group on the remote unit or pairs of the working line have been connected to pairs of the protection line
Switched Line	The line currently carrying traffic (working line or protection line)

Working Line, Protection Line

Line	System address
Switchovers	Number of switchovers
Last Switchover	Time of last switchover
Switchover Seconds	Cumulative protection switching duration time in seconds, i. e. the cumulative number of seconds that service was carried on the protection line.

Note: *The counters start counting as soon as the APS group is activated (GROUPn ON). They are reset with the RESETAPS command or by deactivating the group (GROUPn OFF).*

APS *command* issues a command to the APS group:

Command	Result
2	clear: clears any active command
3	Lockout of protection: Prevents the working line from switching to the protection line
4	Forced switch work to protect: switches from the working line to the protection line regardless of the current state of the protection line
5	Forced switch protect to work: switches from the protection line to the working line regardless of the current state of the working line
6	Manual switch work to protect: switches from the working line to the protection line unless there is a failure on the protection line
7	Manual switch protect to work: switches from the protection line to the working line unless there is a failure on the working line
8	Exercise: accepts and acknowledges a switchover command without actually executing the switchover

RESETAPS

Resets the APS counters.

8.3.3 Alarm and Alarm History

ACO ON | OFF

The ACO (Alarm Cut Off) command enables or disables the alarm relays. When ACO is 'on', all alarms are disabled and the alarm-relays are inactive. The local alarm LED signals a non-urgent alarm.

ALARM

The ALARM command displays the current alarm status:

```

LTU_01_FMM> ALARM
~~~~~
Local Alarm Status
~~~~~
LOS-S:off  AIS-S:off  LOOP1:off  ACO:off  EXT-LOC:off
LFA-S:off  BER-S:off  LOOP2:off  ALB:off  LOOPREG:off
LOSW-A:off BER-A:off  SEG-A:off  CLD-A:off BERT:off
    
```

Alarms:

ACO	Alarm cutoff
AIS-S	AIS (Alarm Indication Signal) detected at subscriber (E1) side
AIS-V3	Alarm indication signal at V3-reference point (PRA mode)
ALB	Analog loopback
BER-x	SHDSL block-error-rate according G.826 $\geq 30\%$ on channel x (A, B, C or D)
BER-S	Excessive Block Error Rate on subscriber side If CRC4 enabled : BER-S = on if more than 805 CRC4 Errors per second. If CRC4 disabled : BER-S = on if more than 28 FAS Errors per second.
BERT	BER test activated
CLD-x	Current limit detection on channel x (A, B, C or D)
DTR-S	Status of DTR (Data Terminal Ready) Handshake Signal in V.35/V.36 mode: DTR Signal is detected as 'ON': DTR-S Alarm is off DTR Signal is detected as 'OFF': DTR-S Alarm is on In X.21 mode the DTR-S alarm depends on the state of Control-signal C. DTR-S alarm will always be off in X.21 mode if handshake is set to OFF.
EXT-LOC	Loss of external clock
LFA-S	Loss of frame alignment at subscriber (E1) side
LFA-V3	Loss of frame alignment at V3-reference point (PRA mode)

LOC-S	Loss Of Clock (When Local Clock mode is selected). Only displayed if an nx64 interface is available on the modem. LOC is also active when the incoming clock bitrate is not equal to the programmed bitrate (n). Clock master present with correct bitrate (Status: off) Clock master not present and/or bitrate mismatch (Status: on)
LOOP1	SHDSL test loop 1 active (see section 0)
LOOP2	SHDSL test loop 2 active
LOOPREG	Regenerator loopback active
LOSW-x	Loss of Sync Defect (LOSW defect) on channel x (A, B, C or D)
LOS-S	Loss of signal at subscriber (E1) side
PID	Display a pair mismatch when operating in 4p mode (master only)
SEG-A	Segment defect alarm indication if regenerators present on channel x (A or B)

ALARM T

Turns alarm trace on / off. When ALARM T is active then the screen is continuously updated with any changes in active alarms. Alarms are displayed with a time stamp counted in *min:sec:millisec* from the last system reset.

The alarm changes will be displayed until ALARM T is deactivated by entering ALARM T a second time or until the FMM menu is left:

```

LTU_01_FMM> ALARM T
14:37:80 alarm trace on
14:37:80 LOS-S alarm on
14:37:80 remote alarm on
14:50:30 LOSW-A alarm on
14:50:30 remote alarm off
15:16:80 CLD-A alarm on
15:26:80 CLD-A alarm off
17:36:20 LOSW-A alarm off
17:36:20 remote alarm on
    
```

Note: *When both an nx64 kbit/s and an E1 interface are equipped, the ALARM command displays first the E1/PRA alarms and then the nx64 kbit/s alarms.*

ALARM H [time]

The ALARM H command displays alarm events of the past with a time stamp based on the internal system time of the modem and an offset. The time stamp has the format *day:hour:minute*.

The internal system and the time offset are set to zero by each RESET command or on power-on.

Use ALARM H *hh:mm* to define a time offset used when calculating timestamps. The time offset is interpreted as current time.

```
LTU_10_FMM> ALARM H
~~~~~
Alarm History (day:hour:min)
~~~~~
+0:00:00  LOS-S alarm on
+0:00:00  remote alarm on
+0:00:02  LOS-S alarm off
+0:00:02  remote alarm off
~~~~~End of Alarm History~~~~~

(the current time is 14:23)

LTU_10_FMM> ALARM H 14:23
~~~~~
Alarm History (day:hour:min)
~~~~~
+0:14:18  LOS-S alarm on
+0:14:18  remote alarm on
+0:14:20  LOS-S alarm off
+0:14:20  remote alarm off
~~~~~End of Alarm History~~~~~

(three days later...)

LTU_10_FMM> ALARM H
~~~~~
Alarm History (day:hour:min)
~~~~~
-3:14:18  LOS-S alarm on
-3:14:18  remote alarm on
-3:14:20  LOS-S alarm off
-3:14:20  remote alarm off
~~~~~End of Alarm History~~~~~
```

Note:

- *The alarm history is limited to 500 alarm messages per system / DSL link and a maximum collection time of about 240h*
- *Once a time offset has been defined with the ALARM H time command, the offset is stored in the modem. Subsequent ALARM H commands will display time stamps calculated on basis of the offset previously entered.*
- *Power-on or RESET resets the internal system time and clears stored events*
- *The current system time is displayed if the alarm history is empty*

CLEAR

The CLEAR command erases all entries of the event log memory as well as the time adjustment of a previously entered ALARM H command. The internal system time is not reset by this command.

Events which occur after the CLEAR command will again be displayed with the internal system time.

PSB ON | OFF

Enables/disables generation of alarms if one of the two power supplies of the plug-in fails. Use **PSB OFF** if the subrack is fed from a single power source to avoid a continuous alarm.

8.3.4 Loops

LOOP1 ON [*timeout*] | OFF

The **LOOP1** command controls the local loopback, see chapter 3.8:

```
LTU_01_FMM> LOOP1 ON 5
01:10:50 Loop 1 activated for 00005 minutes

LTU_01_FMM> LOOP1 OFF
01:11:30 Loop 1 deactivated
```

The loop is automatically cleared after the timeout specified in the command (5 minutes in the example above). If no timeout value is specified then the loop will stay active until it is deactivated by a monitor command.

If an nx64 user interface is equipped, Loop 1 can also be controlled via V.54. If V.54 loopback control is enabled, Loop 1 requests from the nx64 user interface will have higher priority than the local monitor **LOOP1** commands.

LOOP2 ON [*timeout*] | OFF

The **LOOP2** controls starts the remote loopback, see 3.8:

```
LTU_01_FMM> LOOP2 ON 5
01:10:50 Loop 2 activated at remote station for 00005 minutes

LTU_01_FMM> LOOP2 OFF
01:11:30 Loop 2 deactivated
```

The loop is automatically cleared after the timeout specified in the command (5 minutes in the example above). If no timeout value is specified then the loop will stay active until it is deactivated by a monitor command.

A Loop 2 request from the master has higher priority than a Loop 2 request from the slave, i.e. if the **LOOP2** command is entered on both master and slave, only Loop 2 on the slave will be activated.

If an nx64 user interface is equipped, Loop 2 can also be controlled via V.54. If V.54 loopback control is enabled, **LOOP2** requests from the nx64 user interface will have higher priority than the local monitor **LOOP2** commands. In case of remote Loop 2 requests, the master has higher priority than the slave.

Note *LOOP2 is not supported if the card is configured in Multipoint mode*

LOOPREG n ON [*timeout*] | OFF

The LOOPREG n command controls the loopback in the n^{th} regenerator, see chapter 3.8:

```
LTU_01_FMM> LOOPREG1 ON 5
29:25:70 regenerator (1) loopback activated for 00005 minutes

LTU_01_FMM> LOOPREG1 OFF
29:26:40 regenerator (1) loopback activated
```

STARTAL

Starts analog loopback. The DSL connector on the modem must be disconnected for an analog loopback to work.

STOPAL

Stops analog loopback.

8.3.5 Reset Commands

RESET

Typing RESET restarts the DSL link.

RESETCARD

The RESETCARD command initiates a complete hardware and software reset of the plug-in. This means that all systems on the plug-in are affected (not just the one the Monitor is currently connected to). The RESETCARD must be confirmed before it is processed:

8.4 Performance Management PM

```

LTU_01_PM> H
~~~~~
G826          Display local SHDSL G.826 parameter
G826 C        Display local SHDSL G.826 parameter continuously
G826 E1       Display local E1 G.826 parameter
G826 E1 C     Display local E1 G.826 parameter continuously
RESETG826     Reset G.826 error performance parameter
STARTBER m dir p Start BER test for m minutes dir=[0..3] p=[0,1)
STOPBER       Stop BER test
READBER       Display results of BER test
READBER C     Display results of BER test continuously
RESETBER      Reset BER counters
MAIN (M)      Return to main menu
    
```

8.4.1 G.826 Statistics

G826 [C]

The G826 command displays the ITU-T G.826 error statistics on the DSL line side of the local and remote DSL unit. G826 C will continuously update the display. The G.826 statistics are calculated from CRC6 errors.

```

LTU_01_PM> G826
~~~~~
G.826 Error Performance : CRC6 A
~~~~~
Errored blocks          : 00000000
Errored seconds         : 00000000
Severely errored seconds : 00000000
ESR [%]                 : 0.00
SESR [%]                : 0.00
BBER [%]                : 0.00
Available time          : 00624483
Unavailable time        : 00000024
    
```

Errored blocks	A block in which one or more bits are in error
Errored seconds	One second periods with one or more errored blocks
Severely errored seconds	One second periods with more than 30% errored blocks
ESR	Errored seconds ratio. The ratio of errored seconds to seconds in available time
SESR	Severely errored seconds ratio. The ratio of severely errored seconds to seconds in available time
BBER	Background block error ratio. The ratio of errored blocks to total blocks, excluding all blocks during severely errored seconds and unavailable time
Available time	Time without errors, with errored seconds and with less than 10 consecutive severely errored seconds.
Unavailable time	A period of unavailable time starts with 10 consecutive severely errored seconds. These 10 seconds are considered to be part of unavailable time. A new period of available time begins with 10 consecutive non-severely errored seconds. These 10 seconds are considered to be part of available time.

G826 E1 [C]

The G826 E1 command displays the G.826 error statistics for the E1 interface. Depending on the current configuration of the interface the G.826 values are calculated differently. Use G826 E1 C for continuous display

If CRC4 mode is on the G.826 statistics are calculated by evaluating the CRC4 and the E-Bit:

```

LTU_01_PM> G826 E1
~~~~~
G.826 Error Performance :      CRC4      E-Bit
~~~~~
Errored Blocks          : 00000000 00000000
Errored seconds         : 00000000 00000000
Severely errored seconds : 00000000 00000000
ESR [%]                 :      0.00      0.00
SESR [%]                :      0.00      0.00
BBER [%]                :      0.00      0.00
Available time          : 00524129 00524129
Unavailable time        : 00000024 00000024
    
```

If CRC4 mode is off, the G826 statistics are calculated by evaluating the Frame Alignment Signal (FAS) on the E1 side. The criteria for severely errored seconds (SES) is 28 FAS-Errors per second (in accordance to G.821).

```

LTU_01_PM> G826 E1
~~~~~
G.826 Error Performance :      FAS
~~~~~
Errored blocks          : 00000000
Errored seconds         : 00000000
Severely errored seconds : 00000000
ESR [%]                 :      0.00
SESR [%]                :      0.00
BBER [%]                :      0.00
Available time          : 00009841
Unavailable time        : 00000024
    
```

In PRA mode, the G826 E1 command displays the ITU-T G.826 error statistics based on CRC4 and E-Bit evaluation on the T and the V3 reference points, see 3.2.5:

```

LTU_01_PM> G826 E1
~~~~~
G.826 Error Performance :      CRC4_T      E-Bit_T      CRC4_V3      E-Bit_V3
~~~~~
Errored Blocks          : 00000000 00000000 00000000 00000000
Errored seconds         : 00000000 00000000 00000000 00000000
Severely errored seconds : 00000000 00000000 00000000 00000000
ESR [%]                 :      0.00      0.00      0.00      0.00
SESR [%]                :      0.00      0.00      0.00      0.00
BBER [%]                :      0.00      0.00      0.00      0.00
Available time          : 00524129 00524129 00524107 00524107
Unavailable time        : 00000024 00000024 00000046 00000046
    
```

Note: *The G826 E1 command is only available if option 2 (CRC4 processing) or option 4 (CRC4 monitoring) is selected in the configuration.*

RESETG826 [ALL]

The `RESETG826` command resets the G.826 error performance parameters back to zero. Both DSL and E1 G.826 counters are reset with the `RESETG826` command.

`RESETG826 ALL` will reset all G.826 statistics of an entire link, i. e. the statistics of STU-C, STU-R and any regenerators that might be present on the link.

8.4.2 Bit Error Rate Tests

STARTBER *m dir p*

The `STARTBER m dir p` command starts the pseudo random binary sequence (PRBS) generator and bit error rate (BER) meter for a duration of *m* minutes.

The test signal generator sends a PRBS of length $2^{15}-1$ according to ITU-T O.151 (*p* = 0) or a PRBS of length $2^{11}-1$ according to ITU-T O.152 (*p* = 1).

The PRBS is sent towards the remote modem (*dir* = 0), towards the first user interface (*dir* = 1) or towards the second user interface (*dir* = 2, Multiservice only).

When no parameter is specified, the default values are *m* = 24 hours, *dir* = 0 and *p* = 0.

When running a BER test with *dir* = 0, an external hardware loop must be established at the user interface of the remote modem (loopback connector).

Selecting *dir* = 3 will start an internal DSL bit error rate test which is independent of the user interfaces. A loopback with `LOOP2` on a regenerator or the remote modem must be established in this case. Make sure that the DSL link is running before starting the internal BER test. If the DSL link fails during the internal BER test, the test must be restarted after the link is re-established.

The test will be stopped automatically after *m* minutes; a manual stop is possible with the `STOPBER` command. The results of the BER test can be displayed by the `READBER` command.

```
LTU_01_PM>STARTBER 3
~~~~~
BER Test Results                                     Test running
~~~~~
Test direction      :      SHDSL
Test interval       :         180
Test pattern        :      2^15-1
Test bitrate        :     1984000
Bit errors          :             0
Bit error rate      :     0.00E+00
Sync loss seconds  :             0
Elapsed seconds     :             6
```

Notes:

- *The STARTBER command is not available when the NTU E1 interface is in PRA modes*
- *In Multipoint configurations the test with dir = 1 is only available on systems with dedicated E1 interfaces, i. e. on system 1 and 3*

STOPBER

A BER test can be terminated manually by this command.

READBER

The results of a BER test can be displayed using this command. When a test is running, the current results are displayed, when no test is running, the results of the last BER test are displayed.

```
LTU_01_PM> READBER
~~~~~
BER Test Results                                     Test completed
~~~~~
Test direction      :      SHDSL
Test interval       :         180
Test pattern        :      2^15-1
Test bitrate        :    1984000
Bit errors          :           0
Bit error rate      :    0.00E+00
Sync loss seconds  :           0
Elapsed seconds     :         180
```

RESETBER

The RESETBER command resets the error and time counters of a BER test.

8.5 Security and Remote Management SM

```

LTU_01_SM> H
~~~~~
CONNECT adr (CON)   Connect remote terminal (adr=[2..10])
                    2=NTU remote, 3=REG 1, 4=REG 2, etc.
DISCONNECT (DIS)   Disconnect remote terminal(s)
                    alternatively press <Esc>
RHM                Read HM-Code
RCHM               Read CHM-Code
RFW                Read FW-Code
MAIN (M)           Return to main menu
    
```

8.5.1 Connection control

CONNECT

The `CONNECT n` command sets a connection to a remote unit for configuration purposes. A remote unit is either a regenerator or the NTU. Remote units are addressed as per TS 101 524, see Table 8-5. If no address is entered the `CONNECT` command will connect to the NTU.

Device	Unit Address
LTU, DSL Master	1
NTU, DSL Slave	2
Regenerator	3-10

Table 8-5: SHDSL EOC addressing

DISCONNECT

The `DISCONNECT` command breaks the connection to the remote unit. If no remote terminal is currently connected, the `DISCONNECT` command lists all remote units currently available. Instead of typing `DISCONNECT`, the ESC key can be used to return to the local terminal in a more convenient way.

Note: *The `CONNECT` and `DISCONNECT` commands are available from all sub-menus, but are not displayed in the respective help screens.*

8.5.2 Inventory

RCHM

The `RCHM` command reads out the hardware and firmware identification code of the modem (CHM Code).

RFW

The `RFW` command displays the version of the currently installed firmware.

RHM

The `RHM` command reads out the serial number (HM code) from the modem.

8.5.3 Password Commands

Password commands are only available on tabletop modems.

CHANGE PASSWORD

The CHANGE PASSWORD command is used to change a password. The old password has to be known to change it. The new password must be entered twice to confirm it.

```
NTU_SM> CHANGE PASSWORD
Old_password: *****
New_password: *****
Confirm new password: *****
52:11:40 new password set
```

CLEAR PASSWORD

The CLEAR PASSWORD command clears the currently set password and disables password protection. This is the factory default setting.

```
NTU_SM> CLEAR PASSWORD
Old_password: *****
52:12:40 password cleared and monitor protection disabled
```

DSLSLAVE

The DSLSLAVE commands configures a tabletop modem as DSL slave. This is the only command available without entering a password while password protection is active.

```
Monitor Password Protection
Enter password: ***** (typed DSLSLAVE)
47:55:90 device is now DSL slave
```

LOGOFF

LOGOFF activates the password protected mode. The password before any new monitor commands can be issued via the local terminal.

SET PASSWORD

The SET PASSWORD command allows definition of a password on a tabletop modem. Once a password is set the NTU will go into a protected mode either after the command LOGOFF is issued, after a timeout of 5 minutes or after a restart.

```
NTU_SM> SET PASSWORD
New_password: *****
Confirm new password: *****
47:52:50 new password set and monitor protection enabled
```

8.6 Monitor Commands for minirack operation

If a plug-in is operated in the Minirack mechanics additional commands are available in the configuration menu to configure the TMN address of the plug-in.

ADDRESS *slot rack*

The ADDRESS command allows the user to assign a TMN address to the first DSL interface of a LTU inserted in the Minirack mechanics.

slot identifies the slot number, *rack* identifies the rack number. The plug-in will behave as if it had been inserted in the 19" subrack *rack* at slot position *slot*.

```
LTU_01_CM> ADDRESS 04 01
~~~~~
Local Configuration                               Id : 2 MBit/s G.703
~~~~~
2 MBit/s
Framing      : ITU-T G.704
CRC4         : On
E-Bit Insertion : On
AIS Generation : On
AIS Detection  : On
External Clock : Disabled
Data Rate    : 31 x 64 = 01984 kbit/s
SHDSL
Master/Slave : Master
Autorestart  : Enabled
Power Backoff : Disabled
Payload Rate : 02048 kbit/s
Operating Mode : 1 Pair
Line Rate    : 02056 kbit/s
Remote Powering : On
Regenerators : --
TMN
Address      : 04
V.11 wires   : 04
~~~~~
```

- Notes**
- *The CONFIG command always shows the TMN address, not the rack/slot numbers*
 - *RESET command, DEFAULT command and power down have no influence on settings made for the TMN interface.*
 - *Carefully note already used interface address numbers. There is no automatic protection against multiple LTUs assigned to the same interface address in a set-up with several Minirack LTUs. Two interfaces with the same address on the TMN bus will cause addressing conflicts and the units will not be accessible by remote management*

V11WIRES *n*

The V11WIRES command allows to switch between 2- or 4-wire communication on the TMN interface.

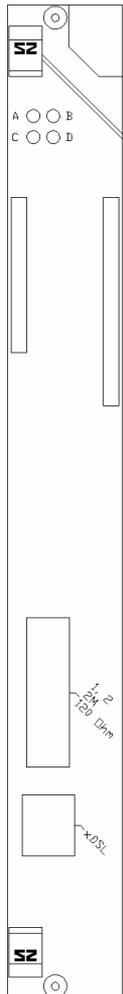
9

Connectors

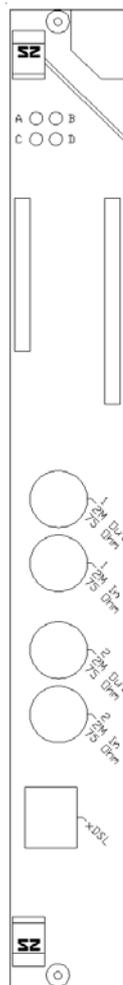
9.1 Location of connectors

9.1.1 Plug-in Modems

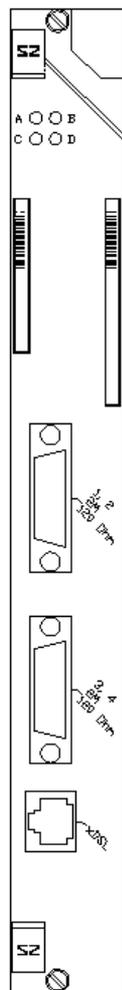
SZ.867.V612



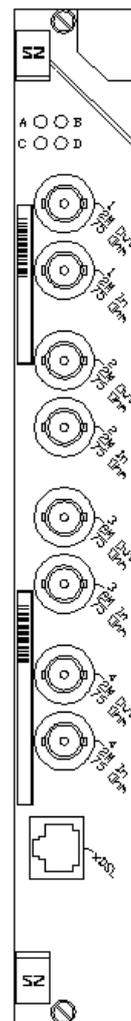
SZ.867.V632



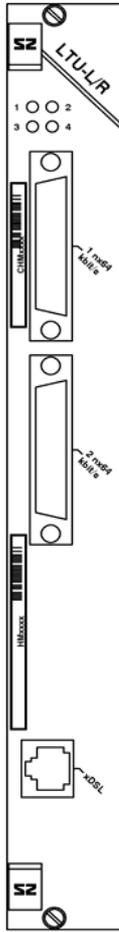
SZ.867.V614



SZ.867.V634



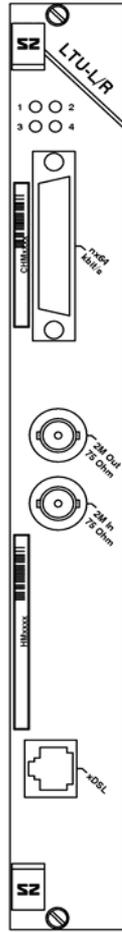
SZ.867.V682



SZ.867.V218

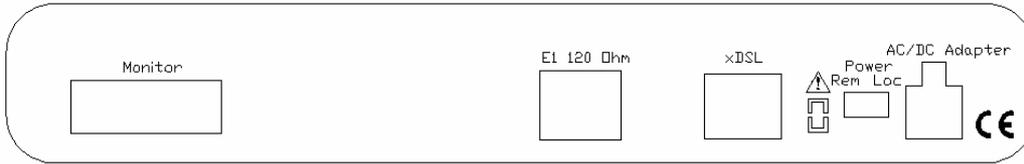


SZ.867.V238

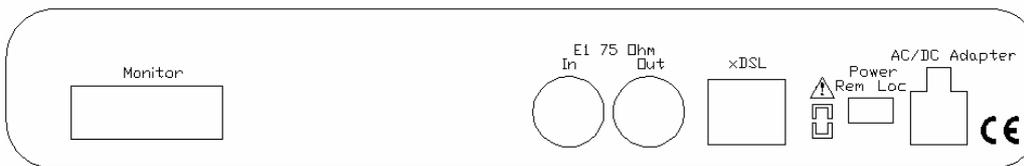


9.1.2 Tabletop Modems

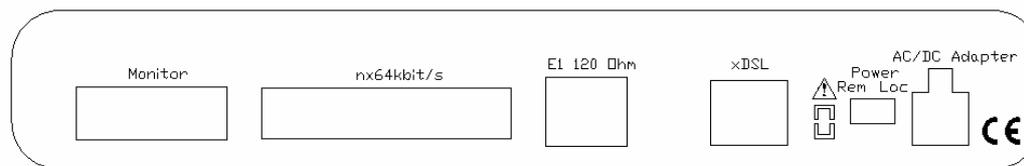
SZ.847.V310, SZ.847.V410



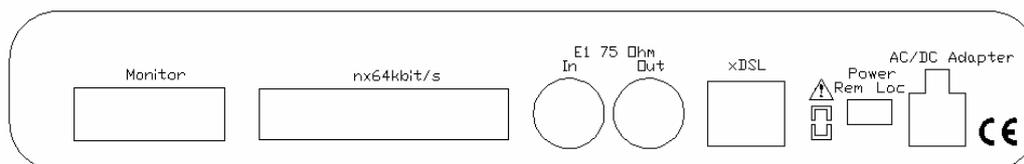
SZ.847.V330, SZ.847.V430



SZ.847.V318, SZ.847.V418

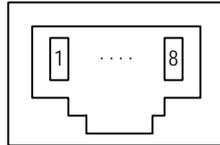


SZ.847.V338, SZ.847.V438



9.2 DSL Connector

Connector Type RJ45-8



Front View

The connector pin assignment for plug-ins is as follows:

Pin	Signal	Description
1	LD.a	Loop D, tip
2	LD.b	Loop D, ring
3	LB.a	Loop B, tip
4	LA.a	Loop A, tip
5	LA.b	Loop A, ring
6	LB.b	Loop B, ring
7	LC.a	Loop C, tip
8	LC.b	Loop C, ring

The connector pin assignment for the tabletop modems is as follows:

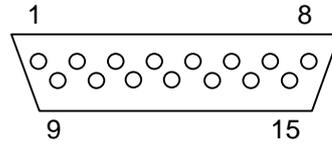
Pin	Signal	Description
1	NC	-
2	Shield	DSL cable shield (optional)
3	LB.a	Loop B, tip
4	LA.a	Loop A, tip
5	LA.b	Loop A, ring
6	LB.b	Loop B, ring
7	Shield	DSL cable shield (optional)
8	NC	-

Pins 2 and 7 of the tabletop are connected to ground. They can be used to connect the shield of the DSL cable or can be left open.

9.3 E1 Connectors

9.3.1 120 Ohm Connectors on Plug-in

2 x E1, 120 Ohm
Type: SubD15 male (Front View)



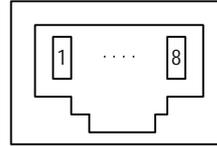
Pin	Signal	Description
1	RX1a	E1 120Ω Output 1 (wire A)
2	GND-RX1	Ground (cable shield RX1)
3	TX1a	E1 120Ω Input 1 (wire A)
4	GND-TX1	Ground (cable shield TX1)
5	GND-RX2	Ground (cable shield RX2)
6	RX2a	E1 120Ω Output 2 (wire A)
7	GND-TX2	Ground (cable shield TX2)
8	TX2a	E1 120Ω Input 2 (wire A)
9	RX1b	E1 120Ω Output 1 (wire B)
10	-	Not Connected
11	TX1b	E1 120Ω Input 1 (wire B)
12	-	Not Connected
13	RX2b	E1 120Ω Output 2 (wire B)
14	-	Not Connected
15	TX2b	E1 120Ω Input 2 (wire B)

Notes

- On multiservice plug-ins with only E1 port 1 is available
- Plug-ins with 4 x E1 have two connectors carrying E1 ports 1/2 and 3/4 respectively

9.3.2 120 Ohm Connectors on Tabletop

1 x E1, 120 Ohm
Type: RJ45-8 (Front View)



Pin	Signal	Description
1	TXa	E1 120Ω Input (wire A)
2	TXb	E1 120Ω Input (wire B)
3	-	Not Connected
4	RXa	E1 120Ω Output (wire A)
5	RXb	E1 120Ω Output (wire B)
6	-	Not Connected
7	GND-TX	TX Ground (cable shield TX)
8	GND-RX	RX Ground (cable shield RX)

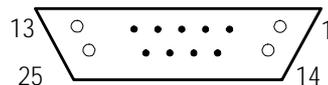
9.3.3 75 Ohm Connectors

Type: BNC 75 Ohm

9.4 nx64 kbit/s Connector

9.4.1 Connector

A female SubD25 connector is used for all nx64 interfaces. The table below shows the pin-out of the connector for the different modes (according to RS-530, ISO 2110) and the signal levels used for the signals.



Front View
SubD25, female

Pin Nr.	ITU-T Designation			Signal Level		
	V.35	V.36	X.21	V.35	V.36	X.21
1	FGND	FGND	FGND			
2	103A	103A	TA	V.35	V.11	V.11
3	104A	104A	RA	V.35	V.11	V.11
4	105	105A	CA	V.28	V.11	V.11
5	106	106A	IA	V.28	V.11	V.11
6	107	107A		V.28	V.11	
7	102	102	G			
8	109	109A		V.28	V.11	
9	115B	115B	BB	V.35	V.11	V.11
10		109B			V.11	
11	113B	113B	XB	V.35	V.11	V.11
12	114B	114B	SB	V.35	V.11	V.11
13		106B	IB		V.11	V.11
14	103B	103B	TB	V.35	V.11	V.11
15	114A	114A	SA	V.35	V.11	V.11
16	104B	104B	RB	V.35	V.11	V.11
17	115A	115A	BA	V.35	V.11	V.11
18	141	141		V.28	V.10	
19		105B	CB		V.11	V.11
20	108/2	108/2A	BIA	V.28	V.11	V.11
21	140	140		V.28	V.10	
22		107B			V.11	
23		108/2B	BIB		V.11	V.11
24	113A	113A	XA	V.35	V.11	V.11
25	142	142		V.28	V.10	

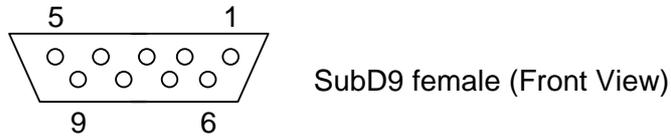
The ITU-T Numbers are according to ITU-T V.24 (V.35, V.36) and ITU-T X.24 (X.21):

ITU-T Designation	Description	From DCE	To DCE
102, G, SGND	Signal Ground		
103, T	Transmitted data		x
104, R	Received data	x	
105, C	Request to send		x
106, I	Clear to send	x	
107	Data set ready	x	
108/2	Data terminal ready		x
109	Data channel received line signal detector	x	
113, X	Co-directional transmitting clock, the transmitted data will be sampled with the rising edge.		x
114	Contra-directional transmitting clock, the transmitted data will be sampled with the rising edge.	x	
115, S	Receive clock, the received data will be sampled with the rising edge.	x	
140	Remote loopback		x
141	Local loopback		x
142	Test Mode	x	
B	Byte timing, OFF during the first half of the last bit of a byte.	x	
BI	Byte timing input (proprietary designation)		x

The interface is of type DCE, use the appropriate adapter cable for a DTE connector or the standard connectors ISO 2593 for V.35, ISO 4902 for V.36, ISO 4903 for X.21.

9.5 Monitor Connector

This connector is available on the tabletop modems only. The monitor connector for plug-ins is residing on the ACU, see [2].

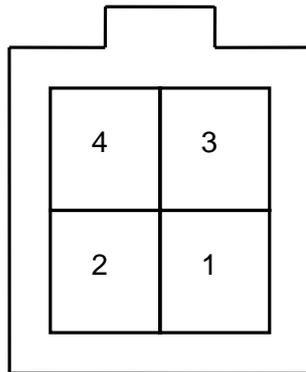


Pin	Signal	Description
1	SGND	RS-232 Signal Ground
2	TXD	RS-232 Transmit Data
3	RXD	RS-232 Receive Data
4	NC	Not connected
5	SGND	RS-232 Signal Ground
6	NC	Not connected
7	NC	Not connected
8	NC	Not connected
9	NC	Not connected

9.6 Power and Grounding Connectors

9.6.1 Tabletop Power Connector

Type: Molex Minifit Junior, safety approved connector to the mains adapter with snap-in characteristic. It is suitable for connection to the power supplies SZ.378.0A0.V1 and SZ.378.0A0.V2EA.



Molex-Type Power Connector
Front View

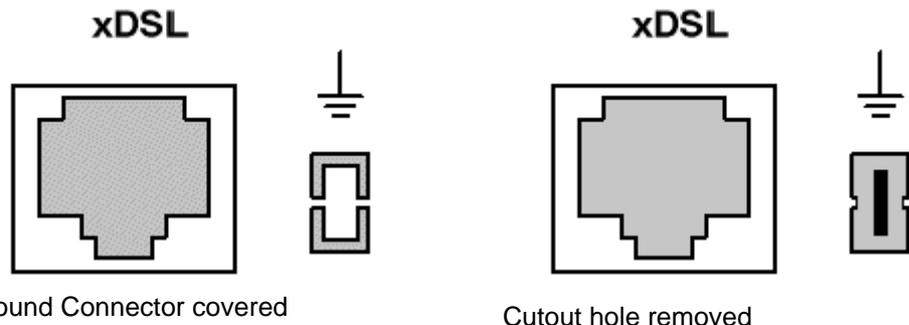
Pin	Signal	Description
1	-PWR	Negative power supply terminal for mains adapter
2	PROT	Connected to the center taps of the gas absorbers at the DSL line input
3	NC	Not connected
4	+PWR	Positive power supply terminal for mains adapter

9.6.2 Ground connector



The tabletop modems are fitted with a ground connector. To reach overvoltage protection according to ITU-T K.21 enhanced level this connector must be grounded. Without ground connection protection level according to ITU-T K.21 basic level is achieved.

The connector is normally covered by the rear panel of the housing. To get access to the connector a hole has to be cut in the rear panel around the indicated marks e.g. using a paper cutter:



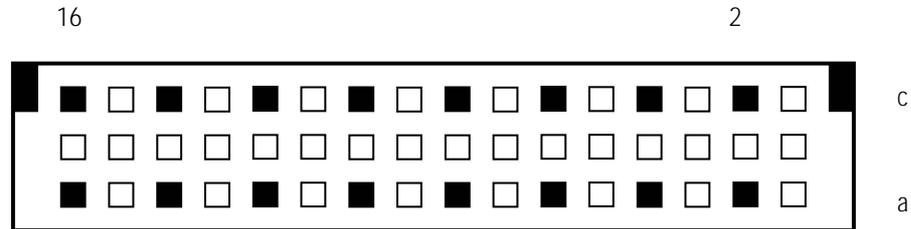
Ground Connector covered

Cutout hole removed

The connector type is Faston 4.8 x 0.5 mm connector (DIN 46244) The hole in the rear panel is dimensioned for non-insulated Faston ferrules (DIN 46245).

9.7 Regenerator Connector

The regenerator has one DIN-C/2 type male connector:



Pin No.	Signal Name	Pin No	Signal Name
2a	Tip REG C, Loop B	2c	Ring REG C, Loop B
4a	Tip REG C, Loop A	4c	Ring REG C, Loop A
6a	n.c.	6c	n.c.
8a	Local Power positive	8c	Local Power positive
10a	Local Power negative	10c	Local Power negative
12a	n.c.	12c	n.c.
14a	Tip REG R, Loop B	14c	Ring REG R, Loop B
16a	Tip REG R, Loop A	16c	Ring REG R, Loop A

n.c. = not connected

10 Cables and Mechanics

10.1 Overview

10.1.1 Plug-in

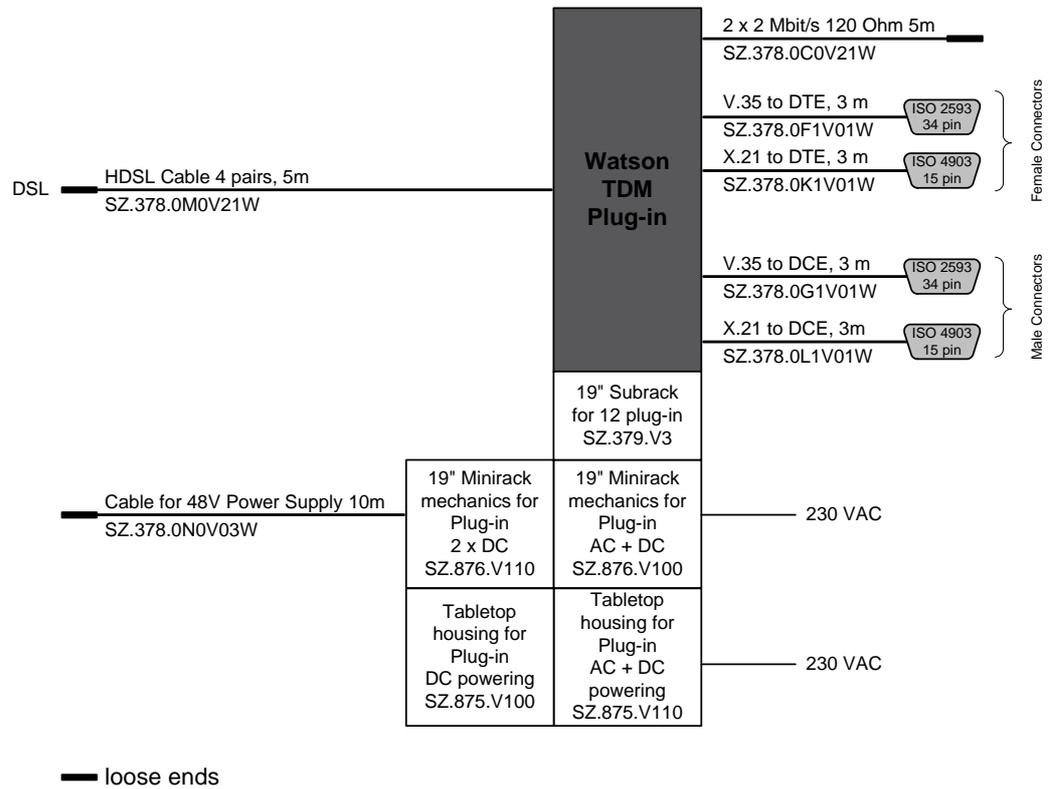


Figure 10-1: Plug-in cables and mechanics

10.1.2 Tabletop

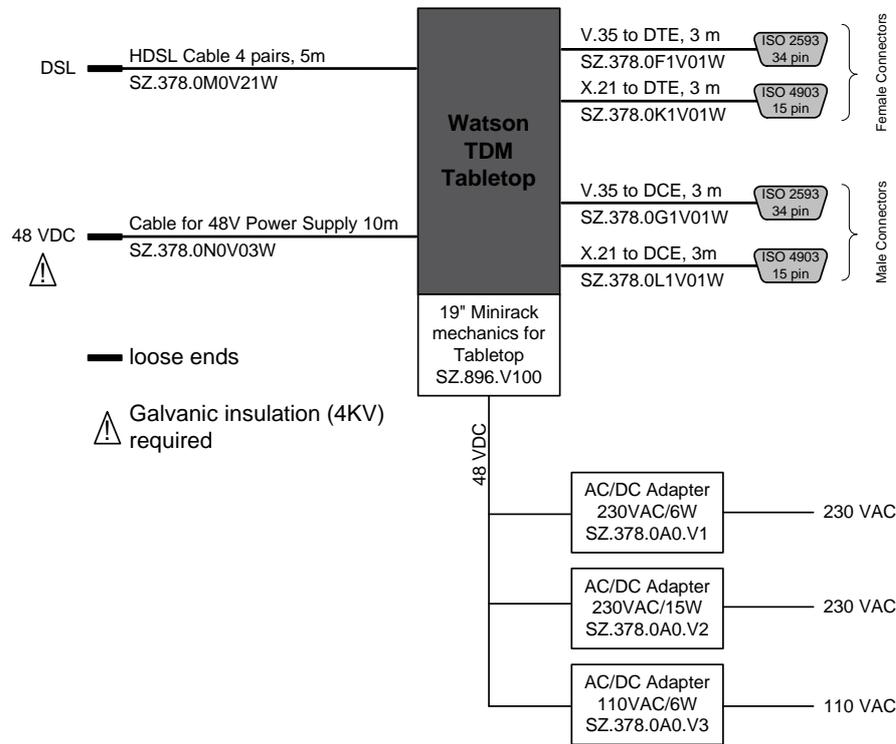


Figure 10-2: Tabletop cables and mechanics

10.2 Cable Reference

10.2.1 DSL Cable

SZ.378.0M0V21Wx: HDSL Cable, 4 pairs, 5m, open end

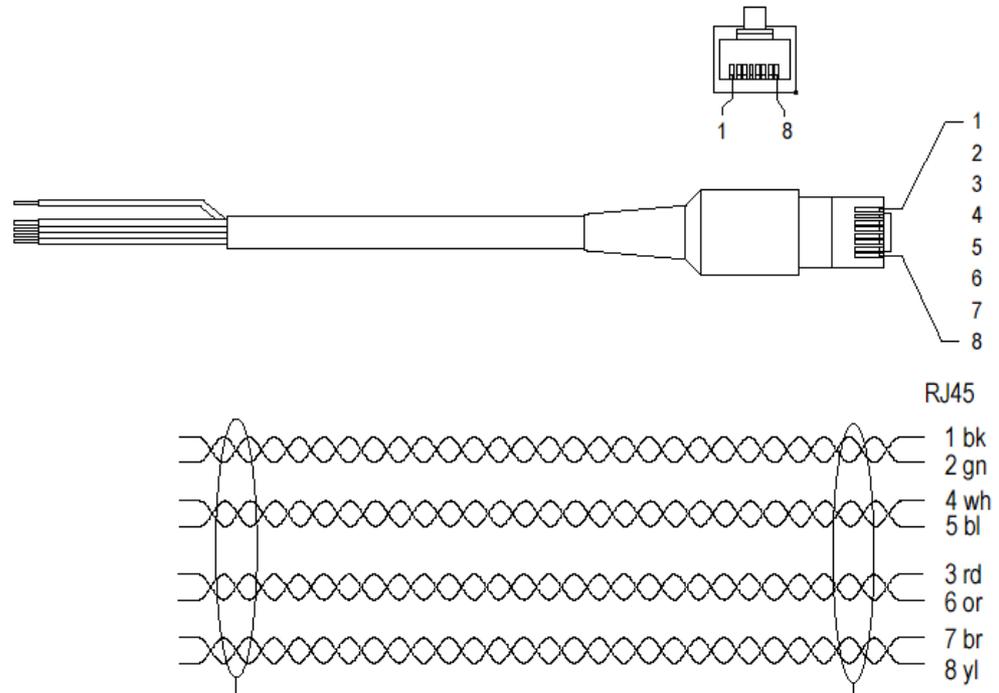


Figure 10-3: DSL Cable, 4 pairs, 5m, open end

10.2.2 120 Ohm Cable for Plug-in

SZ.378.0C0V21Wx: Cable 2 x E1, 5 m

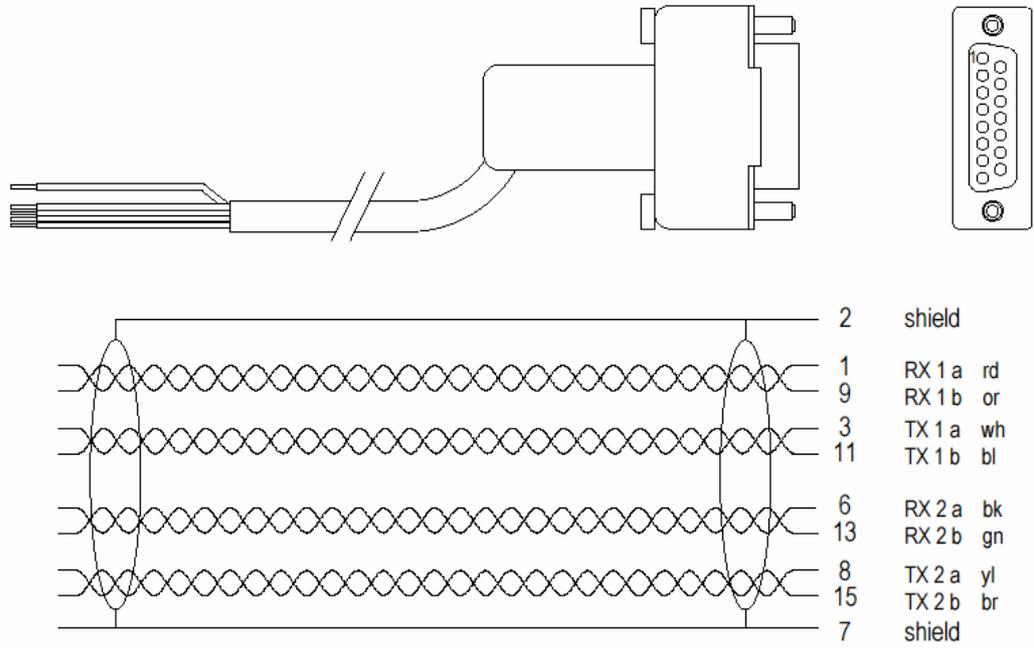
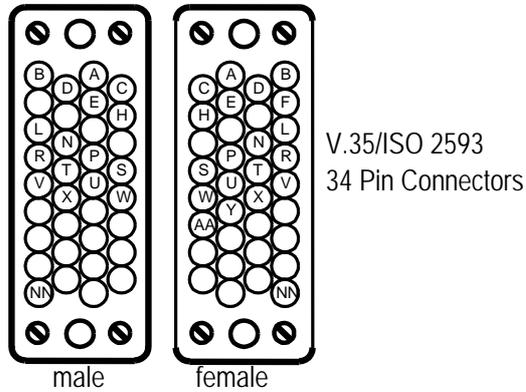


Figure 10-4: Cable 2 x E1, 5 m

10.2.3 V.35 DTE Cable

SZ.378.0F1V01Wx: V.35 DTE Cable, 3m



Connector Type: 34 pin (ISO 2593), female

ITU-T Signal	Connector ISO 2593 female	Connector on Modem (D-Sub 25 pin)
FGND	A	1
SGND	B	7
103	P/S	2/14
104	R/T	3/16
105	C	4
106	D	5
107	E	6
108	H	20
109	F	8
113	U/W	24/11
114	Y/AA	15/12
115	V/X	17/9
140	N	21
141	L	18
142	NN	25

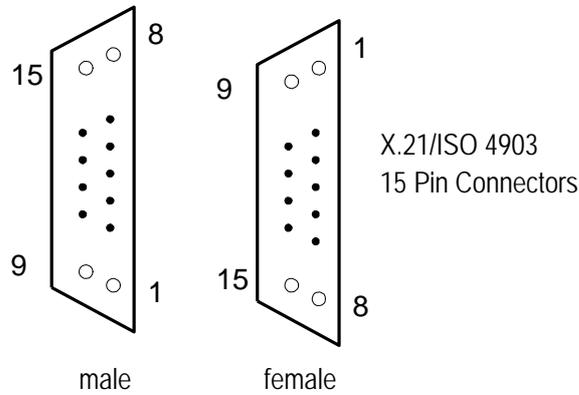
10.2.4 V.35 DCE Cable

SZ.378.0G1V01Wx: V.35 DCE Cable, 3m
Connector Type: 34 pin (ISO 2593), male

ITU-T Signal	Connector ISO 2593 male	Connector on Modem (D-Sub 25 pin)
FGND	A	1
SGND	B	7
103	P/S	3/16
104	R/T	2/14
105	C	5
106	D	4
107	E	20
108	H	6
109	-	-
113	U/W	17/9
114	-	-
115	V/X	24/11
140	N	25
141	L	25
142	NN	18

10.2.5 X.21 DTE Cable

SZ.378.0K1V01Wx: X.21 DTE Cable, 3m



Connector Type: 15 pin (ISO 4903), female

ITU-T Signal	Connector ISO 4903 female	Connector on Modem (D-Sub 25 pin)
FGND	1	1
G	8	7
S	6/13	15/12
R	4/11	3/16
T	2/9	2/14
C	3/10	4/19
I	5/12	5/13
X	7/14	24/11

10.2.6 X.21 DCE Cable

SZ.378.0L1V01Wx: X.21 DCE Cable, 3m

Connector Type: 15 pin (ISO 4903), male

ITU-T Signal	Connector ISO 4903 male	Connector on Modem (D-Sub 25 pin)
FGND	1	1
G	8	7
S	6/13	24/11
R	4/11	2/14
T	2/9	3/16
C	3/10	5/13
I	5/12	4/19
X	7/14	15/12

11

Technical Specifications

11.1 Interfaces

11.1.1 DSL Line Interface

Standard referred:	ETSI TS 101 524, ITU-T G.991.2 Annex B
Number of Pairs:	1, 2, 3, 4
Line Rate per Pair:	200-5'696 kbit/s
Line Code:	Trellis-coded PAM16, PAM-32
Nominal Line Impedance:	135 Ω
Transmit Power @ 135 Ω :	According to TS 101 524
Remote Powering	Symmetric 117 VDC max Current limit 59 mA max Fault current to earth 2 mA max
Wetting Current	2.5 mA per pair (tabletop modems only)
Overvoltage Protection:	Plug-in: ITU-T K.20 basic level (enhanced level with external protection) Tabletop: ITU-T K.21 basic level (enhanced level with additional ground connection) Regenerator: ITU-T K.45 basic level
Connector Type:	RJ-45, 8 pin

11.1.2 User Interfaces

E1:

Standard referred:	ITU-T G.703 / G.704
Bitrate:	2048kbit/s ± 50ppm
Line Code:	HDB3
Framing:	ITU-T G.704 / transparent
Input Impedance:	120Ω 75Ω
Signal Amplitude:	± 3.00V @ 120Ω ± 2.37V @ 75Ω
Jitter Performance:	According to ITU-T G.823
ESD - Protection:	8kV (Air discharge)
Connector Type:	Plug-in: SubD15 male 120Ω or BNC 75Ω Tabletop: RJ45-8 120Ω or BNC 75Ω

PRA:

Standard referred:	ETS 300 233, ETS 300 011, ETS 300 046
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nx64 kbit/s:

	V.35	V.36	X.21
Bitrate:	64 Kbps .. 9'984 Kbps (n x 64 Kbps with n = 1 .. 156)		
Signal Levels:			
Data Lines:	ITU-T V.35	ITU-T V.11	ITU-T V.11
Clock Lines:	ITU-T V.35	ITU-T V.11	ITU-T V.11
Control Lines:	ITU-T V.28	ITU-T V.11/V.10	ITU-T V.11
ESD-Protection:	8kV (Air discharge)		
Connector Type on modem:	SubD25 female (ISO 2110)	SubD25 female (RS 530)	SubD25 female
Connector Type Cable:	34 pin (ISO 2593)	n/a	15 pin (ISO 4903)

11.1.3 Monitor Interface

Signal Level:	RS-232
Data Rate:	9600 Baud, Asynchronous
Protocol:	8 Bit, No Parity, 1 Stop Bit No Linefeed with Carriage Return XON/XOFF enabled
Connector Type:	SubD9 female

11.2 Internal clock

Frequency	2'048 kHz ± 32 ppm
Jitter	< 8 ns

11.3 Automatic Protection Switching

Switchover time	max. 100 ms (not including detection time)
Detection criteria	Continuous BER alarm for 1 second Continuous LOSW alarm for 2 seconds SEGD alarm from regenerator

11.4 Power Consumption

11.4.1 Plug-in

Supply Voltage:	-40.5V _{DC} .. -72V _{DC}
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Interfaces	Order Codes	Power Consumption [W]
1 x E1, 1 x nx64, 2 x DSL	SZ.867.V218	3.0
	SZ.867.V238	
2 x E1, 4 x DSL	SZ.867.V612	5.5
	SZ.867.V632	
2 x nx64, 4 x DSL	SZ.867.V682	6.1
4 x E1, 4 x DSL	SZ.867.V614	6.5
	SZ.867.V634	

Notes: *The power consumption values above are measured without remote powering. If remote powering is used then the power consumption increases by 6.1 W per powered pair.*

11.4.2 Tabletop

	Local Power Supply	Remote Power Supply
Supply Voltage	-40.5V _{DC} .. -72V _{DC}	-112V _{DC} .. -65V _{DC} at DSL-Connector

Interfaces	Order Codes	Power Consumption [W]
1 x E1, 1 x DSL	SZ:847.V310 SZ.847.V330	3.0
1 x E1, 1 x nx64, 1 x DSL	SZ.847.V318 SZ.847.V338	3.3
1 x E1, 2 x DSL	SZ.847.V410 SZ.847.V430	3.2
1 x E1, 1 x nx64, 2 x DSL	SZ.847.V418 SZ.847.V438	3.5

11.4.3 Regenerator

Local power supply	60 V _{DC} .. 115 V _{DC} , 5W
Power consumption	3.0 W

11.5 MTBF Values

11.5.1 Plug-in

Plug-in 2 x E1, 4 x DSL	49 years
Plug-in 4 x E1, 4 x DSL	48 years
Plug-in 2 x nx64, 4 x DSL	45 years
Plug-in multiservice, 2 x DSL	64 years

11.5.2 Tabletop

Tabletop E1, 1 x DSL	67 years
Tabletop E1, 2 x DSL	56 years
Tabletop multiservice, 1 x DSL	61 years
Tabletop multiservice, 2 x DSL	52 years

11.5.3 Regenerator

Regenerator Watson TDM and Watson 5	52 years
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11.6 Environment

11.6.1 Climatic Conditions (Plug-in and Tabletop)

Storage:	ETS 300 019-1-1 Class 1.2
Transportation:	ETS 300 019-1-2 Class 2.3
Operation:	ETS 300 019-1-3 Class 3.2e

11.6.2 Climatic Conditions (Regenerator)

Storage:	ETS 300 019-1-1 Class 1.2
Transportation:	ETS 300 019-1-2 Class 2.3
Operation:	ETS 300 019-1-3 Class 4.1e

11.6.3 Safety

According to EN 60950:2006 (IEC60950:2005)

11.6.4 EMC

According to EN 300386:2000

11.7 Physical dimensions and weight

11.7.1 Plug-in

19" Plug-in unit: height: 259mm (6 HE), width: 30mm
PCB dimensions: height: 233.35mm, length: 220mm
Weight 500g

11.7.2 Tabletop

Tabletop unit: width 220mm, depth 195mm, height 43mm
Weight 750g

11.7.3 Regenerator

Width 105 mm, depth 154 mm, height 27 mm
Weight 350g

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Product Order Codes

12.1 Plug-in

Description	Order Code
Watson TDM plug-in 2xDSL nx64 E1 120 Ohm	SZ.867.V218
Watson TDM plug-in 2xDSL nx64 E1 75 Ohm	SZ.867.V238
Watson TDM plug-in 4xDSL 2xE1 120 Ohm	SZ.867.V612
Watson TDM plug-in 4xDSL 4xE1 120 Ohm	SZ.867.V614
Watson TDM plug-in 4xDSL 2xE1 75 Ohm	SZ.867.V632
Watson TDM plug-in 4xDSL 4xE1 75 Ohm	SZ.867.V634
Watson TDM plug-in 4xDSL 2xn64	SZ.867.V682

Table 12-1: Watson TDM plug-in modem order codes

12.2 Tabletop

Description	Order Code
Watson TDM tabletop 1p E1 120 Ohm	SZ.847.V310
Watson TDM tabletop 1p nx64, E1 120 Ohm	SZ.847.V318
Watson TDM tabletop 1p E1 75 Ohm	SZ.847.V330
Watson TDM tabletop 1p nx64, E1 75 Ohm	SZ.847.V338
Watson TDM tabletop 2p E1 120 Ohm	SZ.847.V410
Watson TDM tabletop 2p nx64, E1 120 Ohm	SZ.847.V418
Watson TDM tabletop 2p E1 75 Ohm	SZ.847.V430
Watson TDM tabletop 2p nx64, E1 75 Ohm	SZ.847.V438

Table 12-2: Watson TDM tabletop modem order codes

12.3 Regenerator

Description	Order Code
Regenerator Watson TDM and Watson 5	SZ.856.V310

Table 12-3: Watson TDM Regenerator order codes

12.4 Accessories

Description	Order Code
19" Subrack for WATSON HDSL (for 12 plug-in + 1 ACU/CMU)	SZ.379.V3
ETSI Adaptation Kit for 19" Rack	SZ.727.030V01
Cover Module 6U x 30mm for subrack SZ.379.V3 and V3F	SZ.738.060V01
Management Agent (CMU) for WATSON HDSL Hardware Rev.B	SZ.366.V301
Alarm Control Unit (2 Relays) with ext. Clock, for 19" Subrack	SZ.369.V5
19" Minirack Mechanics for Plug In 2xDC Power	SZ.876.V110
19" Minirack Mechanics for Plug In AC & 2xDC Power	SZ.876.V100
Installation kit for Watson 19"minirack for ETSI rack	SZ.727.010V01
Tabletop Housing for Watson Plug-in DC Powering	SZ.875.V100
Tabletop housing for Watson Plug In AC + DC Power	SZ.875.V110
DIN Rail mounting kit for housing SZ.875.V100Wx, SZ.875.V110W	SZ.875.090V1

Table 12-4: Accessories for plug-in modems

Description	Order Code
Poweradapter 230 VAC / 48 VDC Euro for Watson Tabletop.	SZ.378.0A0.V1
AC/DC Adapter 100-240 VAC, 48 VDC, 15W AC Euro Plug	SZ.378.0A0.V2
Poweradapter 115 VAC / 48 VDC US for Watson Table Top	SZ.378.0A0.V3
Wall mounting kit (set of 10) Watson Tabletop, SZ.875.V100	SZ.378.011V01
19" Minirack Mechanics for Table Top NTU	SZ.896.V100

Table 12-5: Accessories for tabletop modems

Description	Order Code
Regeneratorcase IP65 for 6 Regenerators	SZ.857.V2
Regeneratorcase IP68 for 6 Regenerators	SZ.858.V2
Pole mounting kit for Regeneratorcase SZ.857.V2 and SZ.858.V2	SZ.857.090.V1
Regeneratorcase IP68 for 1 regenerator	SZ.859.V2

Table 12-6: Accessories for regenerators

12.5 Cables

Description	Order Code
Cable 2 x 2Mbit/s 120 Ohm, 5 m	SZ.378.0C0V21W
Cable V.35 to DTE, 3m Connector ISO 2593 female	SZ.378.0F1V01W
Cable V.35 to DCE, 3m Connector ISO 2593 male	SZ.378.0G1V01W
Cable X.21 to DTE, 3m Connector ISO 4903 female	SZ.378.0K1V01W
Cable X.21 to DCE, 3m Connector ISO 4903 male	SZ.378.0L1V01W
HDSL Cable 4 pairs, 5 m loose ends	SZ.378.0M0V21W
Cable for 48V Power Supply with Molex, 10m, open	SZ.378.0N0V03W
SZ.378.0U0V01Wx Connector Molex 48VDC (female), 10pcs.	SZ.378.0U0V01W

Table 12-7: Cables