INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.991.2

Amendment 1

(11/2001)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital sections and digital line system – Access networks

Single-pair high-speed digital subscriber line (SHDSL) transceivers

Amendment 1

ITU-T Recommendation G.991.2 (2001) – Amendment 1

ITU-T G-SERIES RECOMMENDATIONS

TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

INTERNATIONAL TELEPHONE CONNECTIONS AND CIRCUITS	G.100–G.199
GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS	G.200–G.299
INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES	G.300–G.399
GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES	G.400–G.449
COORDINATION OF RADIOTELEPHONY AND LINE TELEPHONY	G.450–G.499
TESTING EQUIPMENTS	G.500–G.599
TRANSMISSION MEDIA CHARACTERISTICS	G.600–G.699
DIGITAL TERMINAL EQUIPMENTS	G.700–G.799
DIGITAL NETWORKS	G.800–G.899
DIGITAL SECTIONS AND DIGITAL LINE SYSTEM	G.900–G.999
General	G.900–G.909
Parameters for optical fibre cable systems	G.910–G.919
Digital sections at hierarchical bit rates based on a bit rate of 2048 kbit/s	G.920–G.929
Digital line transmission systems on cable at non-hierarchical bit rates	G.930–G.939
Digital line systems provided by FDM transmission bearers	G.940–G.949
Digital line systems	G.950–G.959
Digital section and digital transmission systems for customer access to ISDN	G.960–G.969
Optical fibre submarine cable systems	G.970–G.979
Optical line systems for local and access networks	G.980–G.989
Access networks	**G.990–G.999**
QUALITY OF SERVICE AND PERFORMANCE	G.1000–G.1999
TRANSMISSION MEDIA CHARACTERISTICS	G.6000–G.6999
DIGITAL TERMINAL EQUIPMENTS	G.7000–G.7999
DIGITAL NETWORKS	G.8000–G.8999

For further details, please refer to the list of ITU-T Recommendations.

ITU-T Recommendation G.991.2

Single-pair high-speed digital subscriber line (SHDSL) transceivers

Amendment 1

Summary

This amendment provides a list of identified defects and associated corrections to the text of ITU-T Rec. G.991.2. These defects include typographical errors, technical errors, and ambiguities.

Source

Amendment 1 to ITU-T Recommendation G.991.2 (2001) was prepared by ITU-T Study Group 15 (2001-2004) and approved under the WTSA Resolution 1 procedure on 29 November 2001.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Page

ITU-T Recommendation G.991.2

Single-pair high-speed digital subscriber line (SHDSL) transceivers

Amendment 1

Introduction

ITU-T Rec. G.991.2 describes a transmission method for providing Single-pair High-speed Digital Subscriber Line (SHDSL) service as a means for data transport in telecommunications access networks. This amendment lists identified defects in that Recommendation and contains text corrections for each detect. These defects may include typographical errors, editorial errors, ambiguities, omissions or inconsistencies, and technical errors.

1) Table 6.3, Timing for activation signals

Change the parameter description for t_{Act_Global} as follows:

~~Maximum time~~Time from start of initial pre-activation session (6.3) to $Data_r$ ‡

Add the associated note:

‡ In the majority of the cases, t_{Act_Global} will be less than 30 seconds. However, since the definition of the handshake mechanism in ITU-T Rec. G.994.1 is outside the scope of this Recommendation, a maximum value t_{Act_Global} cannot be assured.

2) Clause 6.2.2.1, Signal C_r

After the paragraph, add the following Note:

NOTE – The end of preactivation can be defined in two ways according to ITU-T Rec. G.994.1. For the purpose of this Recommendation, the end of preactivation will be from the end of the ACK(1) message transmission plus the required timers. The minimum and maximum values of those timers are 0.04 and 1.0 second. Therefore, the total time between the end of the ACK(1) message and the beginning of C_r should be between 0.34 and 1.3 s.

3) Clause 6.2.2.8, Exception state

Make the following text change:

If activation is not achieved within t_{act} (Table 6-3) ~~or if preactivation and activation are not completed within t_{act_global} (Table 6.3)~~ or if any exception condition occurs, then the exception state shall be invoked.

4) Clause 6.3.2.1, Signal P_{ri}

Make the following text change:

… If multiple remote probe symbol rates are negotiated during the G.994.1 session, then multiple probe signals will be generated, starting with the lowest symbol rate negotiated and ending with the highest symbol rate negotiated. If "transmit silence" is negotiated, then a probe signal consisting of transmitted silence will precede the lowest symbol rate probe signal. P_{ri} is the ith probe signal (corresponding to the ith symbol rate negotiated or silence). …

5) Clause 6.3.2.2, Signal P_{ci}

Make the following text change:

… If multiple remote probe symbol rates are negotiated during the G.994.1 session, then multiple probe signals will be generated, starting with the lowest symbol rate negotiated and ending with the highest symbol rate negotiated. If "transmit silence" is negotiated, then a probe signal consisting of transmitted silence will precede the lowest symbol rate probe signal. ~~Waveform~~ P_{ci} is the ith probe signal (corresponding to the ith symbol rate negotiated or silence). …

6) Clause 6.4.1, G.994.1 code point definitions

Add the following text following the description of Base Data Rate/PSD:

NOTE – In CLR, upstream training parameters indicate what data mode rates the STU-R is capable of transmitting and downstream training parameters indicate what data mode rates the STU-R is capable of receiving. In CL, downstream training parameters indicates what data mode rates the STU-C is capable of transmitting and upstream training parameters indicate what data mode rates the STU-C is capable of receiving. If optional line probe is used, the receiver training parameters will be further limited by the probe results. If repeaters are used, the training parameters of the SRU-R will be further limited by the training parameters of all downstream SRUs and the STU-R.

7) Clause 7.1.2.5.3, *fbit3* = *ps* (power status)

Make the following text changes:

The power status bit *ps* is used to indicate the status of the local power supply in the STU-R. The power status bit is set to 1 if power is normal and to 0 if the power has failed. On loss of power at the STU-R, there shall be enough power left to send the *ps* bit in at least 1 and preferably 3 consecutive frames ~~communicate three "Power Loss" messages~~ towards the STU-C. Note that, in the event of a power failure, the *ps* bit should be set to 0 for as many frames as possible before deactivation. If the *ps* bit is set for less than three frames, it is up to the application at the STU-C to determine the validity of the message. Regenerators shall pass this bit transparently. In four-wire mode, *ps* on Pair 1 shall carry the primary power status indication. The Pair 2 *ps* bit shall be a duplicate of the Pair 1 *ps* bit.

8) Clause 9.2.7, Loss of sync word failure (LOSW failure)

Make the following text changes:

An LOSW failure shall be declared after 2.5 ± 0.5 s of contiguous LOSW defect. The LOSW failure shall be cleared when the LOSW defect is absent ~~for~~ between 2 and 20 s ~~or less (i.e. clear within 20 s)~~. The minimum hold time for indication of LOSW failure shall be 2 s.

9) Clause 9.5.5.4, Frame check sequence

Make the following text change:

The frame check sequence (FCS) shall be calculated as specified in IETF RFC 1662 [4]. (Note that the FCS is calculated before data transparency.) The FCS shall be transmitted as specified in IETF RFC 1662~~: Bit 1 of the first octet is the MSB and bit 8 of the second octet is the LSB, i.e. the FCS bits are transmitted reversed from the normal order~~.

10) Clause 9.5.5.7.2, Discovery response – Message ID 129

Insert the following text before the last sentence in the paragraph:

The Vendor ID field is used to identify the system integrator, as specified in 9.5.5.7.4.

11) Clause 9.5.5.7.4, Inventory response – Message ID 130

Insert the following text before the last sentence in the paragraph:

The Vendor ID field is used to specify the system integrator. In this context, the system integrator usually refers vendor of the smallest field-replaceable unit. This typically is also the entity pointed to by the Unit Identification Code (CLEI^{TM}) Field. As such, the Vendor ID field contents may not be the same as the Vendor ID indicated within ITU-T Rec. G.994.1. The serial number, model number, issue number, list number, and software revision number shall all be assigned with respect to the same system integrator.

12) Clause 11.4.2, Test circuit calibration

In the second sentence, make the following text change:

… frequency band of ~~1 kHz~~ 3 kHz to 3 MHz …

13) Clause 11.4.3, Total transmit power requirement

Replace the paragraph with the following text:

The average transmit power of the STU-C shall be measured while continuously sending either signal S_c (6.2.2.2) or signal $Data_c$ (6.2.2.7). If $Data_c$ is used, the total power measured into 135 Ω shall fall in the range (P_{SHDSL} ± 0.5 dB) as specified in A.4 and B.4. If S_c is used, the total power measured into 135 Ω shall fall in the range (P_{SHDSL} – 0.2 dB ± 0.5 dB). The average transmit power of the STU-R shall be measured while continuously sending either signal S_r (6.2.2.3) or signal $Data_r$ (6.2.2.7). If $Data_r$ is used, the total power measured into 135 Ω shall fall in the range (P_{SHDSL} ± 0.5 dB) as specified in A.4 and B.4. If S_r is used, the total power measured into 135 Ω shall fall in the range (P_{SHDSL} – 0.2 dB ± 0.5 dB). This power measurement in activation mode will be 0.2 dB lower than the associated data mode transmit power due to the 2-PAM constellation definition.

The transmit power spectral density of the STU-C shall be measured while continuously sending either signal S_c (6.2.2.2) or signal $Data_c$ (6.2.2.7). The transmit power spectral density of the STU-R shall be measured while continuously sending either signal S_r (6.2.2.3) or signal $Data_r$ (6.2.2.7). If $Data_c$ or $Data_r$ is used, the measured transmit PSD into 135 Ω shall remain below the corresponding *PSDMask(f)* from A.4 and B.4. If S_c or S_r is used, the measured transmit PSD into 135 Ω shall remain below the corresponding *PSDMask(f)* from A.4 and B.4 reduced by 0.2 dB in the passband (i.e. *PSDMask(f)* with PBO increased by 0.2 dB).

14) Clause A.3.1.3, Calibration measurement of crosstalk generator

After the paragraph, add the following Note:

NOTE – The injected noise is intended to match the theoretical noise PSD when the transceiver under test is connected to the loop. On Loop S for payload rates of 1024 kbit/s and below, and on all loops for payload rate of 192 kbit/s, it has been found that impedance mismatch could generate an increased noise PSD at low frequencies. One method of compensation is to modify the factor, Δ, defined in A.3.1.4, by replacing the theoretical noise, *N(f)*, in step 3 of A.3.1.4 with the noise PSD measured when connected to the loop under test. A second method is to place a passive circuit, consisting of a resistor R in parallel with a capacitor C, in series with each wire of the noise generator output pair. The RC values of R = 1.2 Kohms and C = 1 µF are suggested and should be adjusted for each noise generator such that the injected noise matches the theoretical noise PSD. A third method is to calibrate the noise generator waveform into the loop under test such that when connected to the loop under test, the theoretical noise waveform is present at the transceiver terminals.

15) Clause A.4, PSD masks

Add the following text after the first paragraph:

The inband PSD for $0 < f < 1.5$ MHz shall be measured with a 10 kHz resolution bandwidth.

NOTE – Large PSD variations over narrow frequency intervals (for example near the junction of the main lobe with the noise floor) might require a smaller resolution bandwidth (RBW) to be used. A good rule of thumb is to choose RBW such that there is no more than 1 dB change in the signal PSD across the RBW.

16) Clause A.5.3.3, Wetting current

Replace the second paragraph with the following text:

The STU-C (or SRU-C) may optionally supply power to support wetting current if span powering is disabled or is not supported. When enabled, this power source should produce a nominal –48 V potential measured at ring with respect to tip. The maximum voltage of the power source (if provided) should be limited to –56.5 V. The minimum voltage should be high enough to ensure a voltage of at least –39 V at the inputs of the STU-R (or SRU-R), measured at ring with respect to tip, to guarantee that the STU-R (or SRU-R) metallic termination will turn on and allow wetting current to flow. In no case shall the wetting current source apply a potential greater than –72 V between ring and tip. The potential at tip with respect to ground should be zero or negative.

17) Clause B.3.2, Test set-up definition

Add the following Note at the end of the clause:

NOTE – The injected noise is intended to match the theoretical noise PSD when the transceiver under test is connected to the loop. On loop #2 and #3 for payload rates of 1024 kbit/s and below, it has been found that impedance mismatch could generate an increased noise PSD at low frequencies. One method of compensation is to modify the factor, Δ, defined in A.3.1.4, by replacing the theoretical noise, *N(f)*, in step 3 of A.3.1.4 with the noise PSD measured when connected to the loop under test. A second method is to place a passive circuit, consisting of a resistor R in parallel with a capacitor C, in series with each wire of the noise generator output pair. The RC values of R = 1.2 Kohms and C = 1 μF are suggested and should be adjusted for each noise generator such that the injected noise matches the theoretical noise PSD. A third method is to calibrate the noise generator waveform into the loop under test such that when connected to the loop under test, the theoretical noise waveform is present at the transceiver terminals.

18) Clause B.3.5.2, Cable crosstalk models

Make the following text change to the third bullet item:

- Variable *L* identifies ~~an average~~the physical length of the actual test loop in meters. This physical length is calculated from the cable models in Appendix II from the specified electrical length. Values are summarized in Tables B.1 and B.2 for each combination of payload bit rate, noise model, and test loop.

19) Clause B.3.5.4.1.1, Self crosstalk profiles

Make the following text changes to the first paragraph:

The noise profiles XS.C.# and XS.R.#, representing the equivalent disturbance of self crosstalk, are ~~implementation~~ specific to the PSD parameters of the SHDSL system under test, defined by the specific payload, symmetry and power-back-off features. For compliance with the requirements of this Recommendation, the appropriate nominal PSD from B.4 shall be used. ~~Transceiver manufacturers are left to determine these levels. For compliance with the requirements of this recommendation, the transceiver manufacturer shall determine the signal spectrum of the SHDSL system under test, as it can be observed at the TX port of the test set-up as described in B.3.2. The measurement bandwidth for PSD shall be 1 kHz or less.~~

20) Clause B.3.5.6, Measurement of crosstalk noise margin

Make the following text changes:

For measuring the crosstalk margin, the crosstalk noise level of the impairment generator as defined in ~~Table B-7 or Table B-8~~B.3.5.4.1 shall be increased by adjusting the gain of amplifier A1 in Figure ~~B-2~~B.5, equally over the full frequency band of the SHDSL system under test, until the bit error ratio is higher than 10^{-7}. This BER will be achieved at an increase of noise of *x* dB, with a small uncertainty of ~~Δx~~Δ dB. This value *x* is defined as the crosstalk noise margin with respect to a standard noise model. The indicated noise margins shall have a tolerance of 1.25 dB due to the aggregate effect of crosstalk generator tolerance and calibrated loop simulator tolerance. The offset Δ is defined using the same procedure as in A.3.1.4.

The noise margins shall be measured ~~for upstream as well as downstream transmission.~~using the test loops specified in Figure B.1and scaled according to Tables B.1and B.2.

21) Clause B.4.1, Symmetric PSD masks

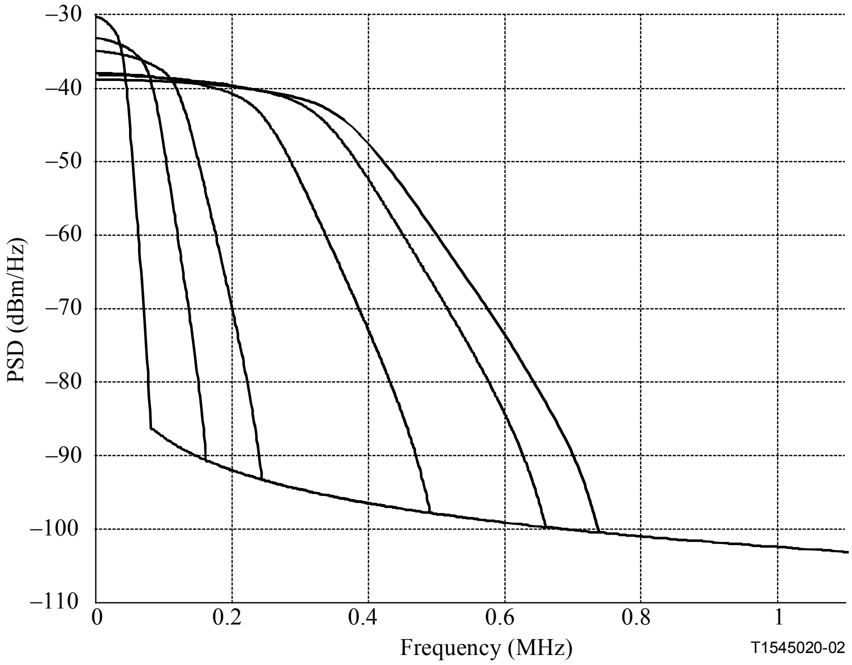
Make the following addition to the text:

The inband PSD for $0 < f < 1.5$ MHz shall be measured with a 10 kHz resolution bandwidth.

Note – Large PSD variations over narrow frequency intervals (for example near the junction of the main lobe with the noise floor) might require a smaller resolution bandwidth (RBW) to be used. A good rule of thumb is to choose RBW such that there is no more than 1 dB change in the signal PSD across the RBW.

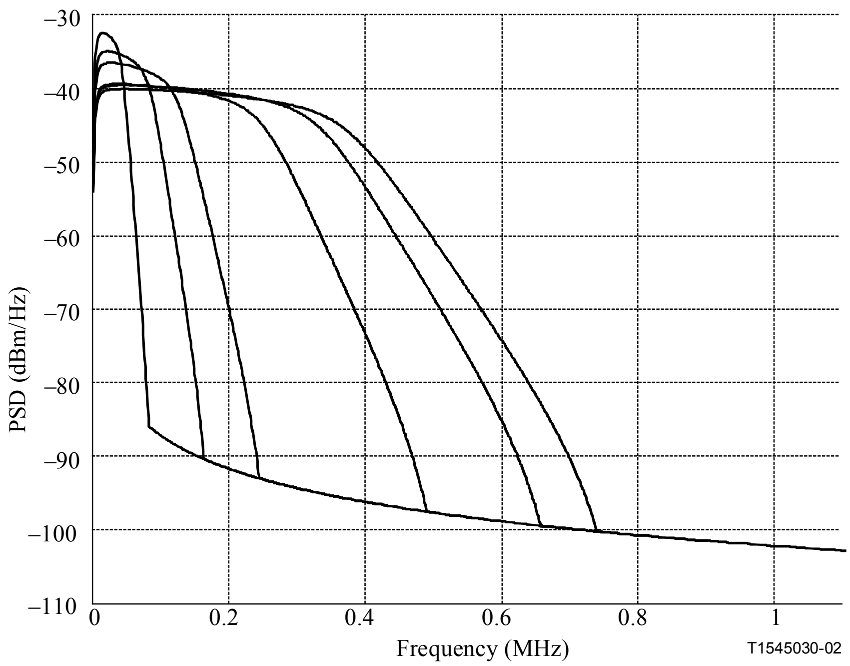
22) Figure B.7, PSD masks for 0 dB power backoff

Replace the figure with the following:



23) Figure B.8, Nominal symmetric PSDs for 0 dB power backoff

Replace the figure with the following:



24) Clause B.4.2, Asymmetric 2.048 Mbit/s and 2.304 Mbit/s PSD masks

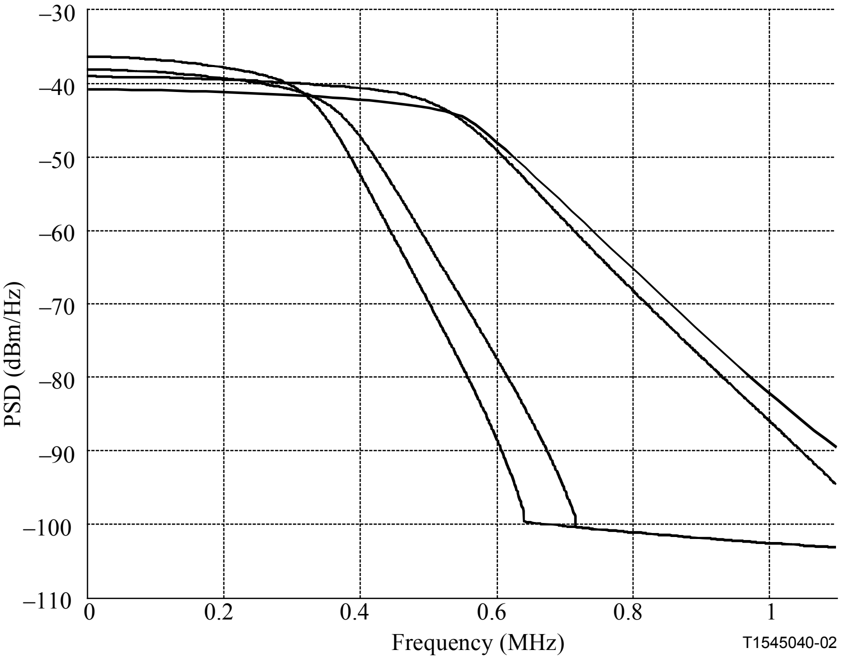
Make the following addition to the text:

The inband PSD for $0 < f < 1.5$ MHz shall be measured with a 10 kHz resolution bandwidth.

NOTE – Large PSD variations over narrow frequency intervals (for example near the junction of the main lobe with the noise floor) might require a smaller resolution bandwidth (RBW) to be used. A good rule of thumb is to choose RBW such that there is no more than 1 dB change in the signal PSD across the RBW.

25) Figure B.9, PSD masks for 0 dB power backoff

Replace the figure with the following:



26) Clause B.5.2, Return loss

Make the following value changes in the definitions:

RL_{MIN} = 12~~14~~ dB

f_0 = 12.56~~3.99~~ kHz

f_1 = 50~~20~~ kHz

$f_2 = f_{sym}/2$

f_3 = 1.99~~2.51~~f_{sym}

Add the following Note after the last paragraph:

NOTE – The intention of the return loss specification is to maintain some power constraint, even under severe mismatched conditions, when SHDSL modems are connected to real cables. A minimum return loss bounds the (complex) output impedance Z_s within a restricted range around the design impedance R_v = 135 Ω, and thus the maximum available power from that source. Therefore it is expected that the power dissipated into a complex load impedance Z_L should never exceed the appropriate PSD masks and maximum aggregate powers for all values Z_L in the range of $10\ \Omega < |Z_L| < 2000\ \Omega$, as specified for R_v = 135 Ω in B.4 and in Tables B.12 and B.13. The extension of the existing power constraints to the severely mismatched case is for further study.

27) Clause B.5.3.2, Power feeding of the STU-R

Make the following text change in the first sentence of the third paragraph:

The STU-R shall be able to draw ~~between 200 µA and~~ up to a maximum of ~~3~~10 mA as wetting current from the remote feeding circuit when the STU-R is being powered locally.

After the last paragraph, add the following text:

It is optional for the STU-C to provide wetting current.

28) Clause E.4, TPS-TC for aligned DS1/fractional DS1 transport

Add the following text at the end of the first paragraph:

Aligned DS1/fractional DS1 mode is also applicable to 1.544 Mbit/s PRI (Primary Rate ISDN), as described in 4.2/I.431 [B10].

29) Clause E.7, TPS-TC for aligned European 2048 kbit/s digital structured leased line (D2048S) and fractional

Add the following text at the end of the first paragraph:

Aligned D2048S mode is also applicable to 2.048 Mbit/s PRI (Primary Rate ISDN), as described in 5.2/I.431 [B10].

30) New Clause E.9.2.3, IMA using the ATM TPS-TC (Informative)

Add the following new clause:

E.9.2.3, IMA using the ATM TPS-TC (Informative)

The ATM TPS-TC, as defined in E.9, is intended to be compatible with Inverse Multiplexing for ATM (IMA) Specification, as defined in af-phy-0086.001 [B12]. IMA is a protocol that provides for inverse multiplexing of an ATM cell stream over multiple physical layer transmission links. It operates by multiplexing the ATM cell stream between the links on a cell-by-cell basis and then inserting special IMA Control Protocol (ICP) cells into each of the individual ATM cell streams. Since the IMA cell stream for each link is structurally identical to a stream of normal ATM cells, IMA cell streams may be carried without modification using the SHDSL ATM TPS-TC. Note that the IMA Specification assumes that the ATM TPS-TC will be compatible with the IMA exceptions to the Interface Specific Transmission Convergence Sublayer, as defined in section 5.2.1 of the IMA Specification (specifically, items R-3 and R-4).

The IMA Specification (section 9.1) indicates that the differential delay from the IMA transmitter to the loop interface (U-R or U-C) is to be no greater than 2.5 cells. Clause 7.1.6 recommends a maximum differential signal transfer delay between non-repeatered SHDSL wire pairs of no more than 50 µs at 150 kHz. With regard to repeaters, note that this Recommendation (see 9.5.5.5) allows up to 8 repeaters in an access link; however, it does not define the delay though the repeater. Also, note that the number of repeaters deployed in a loop is dependent on network-specific conditions. Implementers are encouraged to take into account the various sources of differential delay, including differential latencies introduced by repeaters (if present), in the design of IMA systems.

31) Clause E.10.2, Dual bearer mode types

Make the following text changes:

The following three types of dual bearer modes are supported within SHDSL:

Type 1 – ~~Synchronous ISDN BRA~~<u>STM</u> + Broadband

Type 2 – ~~Narrow-band~~ <u>STM</u> + ATM

Type 3 – ~~Narrow-band~~<u>STM</u> + Clear Channel

32) Table E.22, Supported TPS-TCs in dual bearer mode

Make the following text changes in the Description column of the table:

Type	Description	TPS-TCa	TPS-TCb
1	~~Synchronous ISDN BRA~~STM + Broadband	…	…
2	~~Narrow-band~~STM + ATM	…	…
3	~~Narrow-band~~STM + Clear Channel	…	…

33) Appendix II – Typical characteristics of cables

Add the following Note:

NOTE – Parameters in this appendix differ from those specified in ITU-T Rec. G.996.1 [B11] for PE 04 and PE 05 cable.

34) Tables II.1, II.2, II.3, II.4, II.5, II.6 and II.7 – Parameters of cables

Replace Tables II.1 through II.7 with the following tables:

Table II.1/G.9991.2 – PE cable constants

	PE 04			PE 05			PE 06			PE 08		
freq [Hz] $\times 10^{3}$	**Rs [Ω/m] $\times 10^{-3}$**	**Ls [H/m] $\times 10^{-9}$**	**Cp [F/m] $\times 10^{-12}$**	**Rs [Ω/m] $\times 10^{-3}$**	**Ls [H/m] $\times 10^{-9}$**	**Cp [F/m] $\times 10^{-12}$**	**Rs [Ω/m] $\times 10^{-3}$**	**Ls [H/m] $\times 10^{-9}$**	**Cp [F/m] $\times 10^{-12}$**	**Rs [Ω/m] $\times 10^{-3}$**	**Ls [H/m] $\times 10^{-9}$**	**Cp [F/m] $\times 10^{-12}$**
0	268	680	45.5	172	680	25	119	700	56	67	700	37.8
10	268	678	45.5	172	678	25	120	695	56	70.0	700	37.8
20	269	675	45.5	173	675	25	121	693	56	72.5	687	37.8
40	271	669	45.5	175	667	25	125	680	56	75.0	665	37.8
100	282	650	45.5	190	646	25	146	655	56	91.7	628	37.8
150	295	642	45.5	207	637	25	167	641	56	105	609	37.8
200	312	635	45.5	227	629	25	189	633	56	117	595	37.8
400	390	619	45.5	302	603	25	260	601	56	159	568	37.8
500	425	608	45.5	334	592	25	288	590	56	177.5	543 + 17	37.8
700	493	593	45.5	392	577	25	340	576	56	209	553	37.8
1000	582	582	45.5	466	572	25	405	570	56	250	547	37.8
2000	816	571	45.5	655	565	25	571	560	56	353	540	37.8

Table II.2/G.991.2 – PVC cable constants

	PVC 032			PVC 04			PVC 063		
freq [Hz] $\times 10^3$	**Rs [Ω/m] $\times 10^{-3}$**	**Ls [H/m] $\times 10^{-9}$**	**Cp [F/m] $\times 10^{-12}$**	**Rs [Ω/m] $\times 10^{-3}$**	**Ls [H/m] $\times 10^{-9}$**	**Cp [F/m] $\times 10^{-12}$**	**Rs [Ω/m] $\times 10^{-3}$**	**Ls [H/m] $\times 10^{-9}$**	**Cp [F/m] $\times 10^{-12}$**
0	419	650	120	268	650	120	108	635	120
10	419	650	120	268	650	120	108	635	120
20	419	650	120	268	650	120	108	635	120
40	419	650	120	268	650	120	111	630	120
100	427	647	120	281	635	120	141	604	120
150	453	635	120	295	627	120	173	584	120
200	493	621	120	311	619	120	207	560	120
400	679	577	120	391	592	120	319	492	120
500	750	560	120	426	579	120	361	469	120
700	877	546	120	494	566	120	427	450	120
1000	1041	545	120	584	559	120	510	442	120
2000	1463	540	120	817	550	120	720	434	120

35) Appendix IV, Bibliography

Add the following entries:

[B10] ITU-T Recommendation I.431 (1993), *Primary rate user-network Interface – Layer 1 specification*.

[B11] ITU-T Recommendation G.996.1 (2001) *Test procedures for digital subscriber line (DSL) transceivers*.

[B12] ATM Forum AF-PHY-0086.001 (1999), *Inverse Multiplexing for ATM (IMA) Specification, Version 1.1*.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series B	Means of expression: definitions, symbols, classification
Series C	General telecommunication statistics
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	**Transmission systems and media, digital systems and networks**
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks and open system communications
Series Y	Global information infrastructure and Internet protocol aspects
Series Z	Languages and general software aspects for telecommunication systems

Geneva, 2002