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Amendment 2

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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 2

ITU-T Recommendation G.991.2 (2003) –
Amendment 2



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ITU-T Recommendation G.991.2

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

Amendment 2

Summary

The following text reflects the agreed modification for a second amendment to ITU-T Rec. G.991.2 (2003). The text modifications are shown with revision marks.

Source

Amendment 2 to ITU-T Recommendation G.991.2 (2003) was approved on 22 February 2005 by ITU-T Study Group 15 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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1) Modifications to clause 2, References, and to Bibliography in Appendix V

Add the following reference to the list in clause 2:

- [12] ITU-T Recommendation I.430 (1995), *Basic user-network interface – Layer 1 specification*.

Add the following references to the Bibliography in Appendix V:

- [B17] ETSI TBR 021 (1998-01), *Terminal Equipment (TE); Attachment requirements for pan-European approval for connection to the analogue Public Switched Telephone Networks (PSTNs) of TE (excluding TE supporting the voice telephony service) in which network addressing, if provided, is by means of Dual Tone Multi Frequency (DTMF) signalling*.
- [B18] ETSI EN 300 012-1 V1.2.2 (2000-05), *Integrated Services Digital Network (ISDN); Basic User-Network Interface (UNI); Part 1: Layer 1 specification*.
- [B19] ETSI EN 300 001 V1.5.1 (1998-10), *Attachments to the Public Switched Telephone Network (PSTN); General technical requirements for equipment connected to an analogue subscriber interface in the PSTN*.
- [B20] ETSI EG 201 185 V1.1.1 (1999-02), *Terminal support interface for harmonized analogue PSTN terminals*.

2) Addition to clause 3.2 – "Abbreviations"

Insert the following items to the Abbreviations list in clause 3.2:

BRA Basic Rate Access
e-SHDSL Enhanced SHDSL

3) Modification to clause 6.1.5 – "Power backoff"

Add the following text to the end of clause 6.1.5 after Table 6-2:

In the four-wire mode or M-pair mode, power backoff value PBO-1 shall be assigned to the pair on which the final G.994.1 transaction is conducted. Power backoff value PBO-2 shall be assigned to the remaining pair or pairs.

4) Modification to clause 6.3.1

Add the following Note at the end of clause 6.3.1:

NOTE – For 3 and 4 pairs, the current G.994.1 Annex B method of doing transactions on only one pair has some shortcomings when different parameter values, such as for PBO, might be required on each pair.

5) Modification to clause 6.3.2.1 – "Signal P_{ri} "

In the last paragraph of clause 6.3.2.1, add new text as follows:

In the optional M-pair mode, P_{ri} shall be sent in parallel on all wire pairs. The assignment of power backoff values in 4-wire/M-pair mode shall be as specified in 6.1.5.

6) Modification to clause 6.3.2.2 – "Signal P_{ci} "

In the last paragraph of clause 6.3.2.2, add new text as follows:

In the optional M-pair mode, P_{ci} shall be sent in parallel on all wire pairs. The assignment of power backoff values in 4-wire/M-pair mode shall be as specified in 6.1.5.

7) Modification to clause 6.4.3 – "G.994.1 transactions"

Insert the following new paragraph prior to the last paragraph in clause 6.4.3:

The assignment of power backoff values in 4-wire/M-pair mode shall be as specified in 6.1.5.

8) Modification to clause 11.5 – "Signal transfer delay"

Add the following new paragraph to the end of the text in clause 11.5:

The STU shall be capable of providing PMD-layer one-way, single-span latency of 500 μ s or less for user data rates of 1.5 Mbit/s and above, and 1.25 ms or less for user data rates below 1.5 Mbit/s as measured between the α and β interfaces.

M-pair (more than one pair) operation shall add no more than 0.25 ms to the single span latency.

9) Modification to clause A.5.2 – "Return loss"

Revise the text in clause A.5.2 to read as follows:

A.5.2 Return loss

For devices supporting Annex A functionality, return loss shall be specified based on the methodology of 11.3 and the limitations of Figure 11-6. The following definitions shall be applied to the quantities shown in Figure 11-6:

$$RL_{\text{MIN}} = 12 \text{ dB}$$

$$f_0 = 12.56 \text{ kHz}$$

$$f_1 = 50 \text{ kHz}$$

$$f_2 = f_{\text{sym}}/2$$

$$f_3 = 1.99f_{\text{sym}}$$

where f_{sym} is the symbol rate.

For all Annex F symbol rates greater than 770.67 ksymbol/s, the minimum return-loss requirement shall be identical to the one defined for 770.67 ksymbol/s. The leakage inductance of the line transformer is not a function of the symbol rate. The limitation of the return-loss requirement does not change the performance targets.

10) New clause B.2.4 – "Test loop measurement accuracy"

Add new clause B.2.4 as follows:

B.2.4 Test loop measurement accuracy

The different cable sections of the test loops are specified by two-port cable models that represent real twisted pair cables. Cable simulators as well as real cables can be used to construct these test loops. The associated models and line constants are specified in Appendix II.

The characteristics of each test loop, including those with cascaded sections, shall approximate the models within a specified accuracy. This accuracy specification does not apply to the individual sections.

- The magnitude of the test loop insertion loss shall approximate the insertion loss of the specified models within $\pm (0.4 \text{ dB} + 5\% \text{ of insertion loss})$ on a dB scale, up to a maximum of 2.1 dB, between F1 and F2, where F1 and F2 are given in Table B.2a.
- The Mean Error (ME) of the test loop insertion loss shall be less than 0.3 dB, and at the same time the Mean Absolute Error (MAE) shall be less than 1.5 dB, between F1 and F2 for transmission in one direction for SHDSL, where F1 and F2 are given in Table B.2a.
- The Mean Error (ME) of the test loop insertion loss shall be less than (*for further study*), and at the same time the Mean Absolute Error (MAE) shall be less than (*for further study*), between F1 and F2 for transmission in one direction for Enhanced SHDSL, where F1 and F2 are given in Table B.2a.

To verify compliance with these ME and MAE requirements, the simulated loop shall be measured over the frequency band from Frequency 1 to Frequency 2 (F1 to F2), where F1 shall be the lowest frequency in the transmission band and F2 shall be the frequency at which the nominal loop attenuation reaches a value at which no signal can be received, or the upper transmission frequency, (as defined in Table B.2a) whichever is lower. Measurements shall be made at N frequencies, separated by equal frequency increments of not more than 10 kHz.

Table B.2a/G.991.2 – Measurement frequency boundaries

	F1	F2
SHDSL	1 kHz	Fsym
e-SHDSL	1 kHz	TBD

The ME and MAE of the measured channel attenuation values in dB, relative to the theoretical loop attenuation values in dB, shall be calculated for the N points measured. Theoretical values of loop attenuation shall be calculated using the RLGC parameters in Appendix II assuming source and load impedances of R_V as defined in B.3.3.2.1.

ME is given by (Attenuation values in dB):

$$ME = \frac{\sum_{i=1}^N (ActualAttenuation_i - TheoreticalAttenuation_i)}{N}$$

MAE is given by (Attenuation values in dB):

$$ME = \frac{\left[\sum_{i=1}^N |ActualAttenuation_i - TheoreticalAttenuation_i| \right]}{N}$$

- The magnitude of the test-loop characteristic impedance shall approximate the characteristic impedance of the specified models within $\pm 7\%$ on a linear scale, between frequencies F1 and F2, as given in Table B.2a.
- The group delay of the test loop shall approximate the group delay of the specified cascaded models within $\pm 3\%$ on a linear scale, between frequencies F1 and F2, as given in Table B.2a.

The electrical lengths (insertion loss at specified test frequency) of the test loops, specified in B.2.3, are normative. If the physical length of a test loop implementation is such that *electrical* length is out of specification, its total *physical* length shall be adjusted accordingly to correct this error. This adjustment to the loop-insertion loss by scaling of the physical length should also be used to correct for extra attenuation caused by the noise-injection circuit.

11) Modifications to clause B.3.3.2.1 – "Differential-mode noise calibration"

Amend the text in clause B.3.3.2.1 to read as follows:

B.3.3.2.1 Differential-mode noise calibration

The differential-mode noise injection is calibrated using the configuration shown in Figure B.2b. During calibration the RX side of the noise injector is terminated by the design impedance R_V ($= 135 \Omega$) and the LX (Test Loop interface) side of the noise injector is terminated by an impedance Z_{LX} . The noise levels given in B.3.5 specify the PSD dissipated in R_V on the RX side when Z_{LX} on the LX side is equal to the calibration impedance Z_{cal} . The impedance Z_{cal} is defined in Figure B.2c.

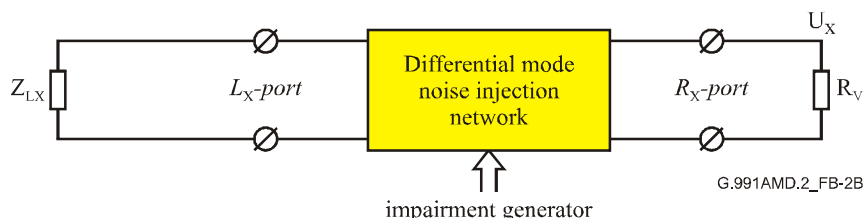


Figure B.2b/G.991.2 – Configuration for noise level calibration

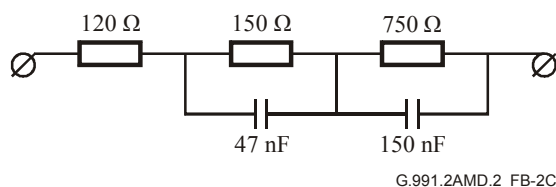


Figure B.2c/G.991.2 – Calibration impedance Z_{cal}

When calibrating the noise source, the impedance Z_{LX} on the LX side of the noise injection circuit is equal to the calibration impedance Z_{cal} as given in Figure B.2c. For this case, the PSD dissipated in the impedance R_V shall be equal to the differential noise PSD $P_{xn}(f)$ defined in B.3.5.1.

NOTE 1 – This calibration method is theoretically equivalent to the following: For an arbitrary value of the impedance Z_{LX} , the PSD dissipated in R_V from a calibrated source is equal to:

$$P_{cal}(f) = G(f, Z_{LX}) P_{xn}(f)$$

NOTE 2 – For a calibrated noise source this theoretically determined P_x should be identical to the measured PSD dissipated in R_V in the presence of Z_{LX} .

NOTE 3 – The impedance dependent correction factor is specified as:

~~where $G(f, Z_{LX})$ is the impedance dependent correction factor, which is specified as:~~

$$G(f, Z_{LX}) = \left| \frac{\frac{1}{Z_{cal}} + \frac{1}{Z_{inj}} + \frac{1}{R_V}}{\frac{1}{Z_{LX}} + \frac{1}{Z_{inj}} + \frac{1}{R_V}} \right|^2$$

where Z_{cal} is the calibration impedance given in Figure B.2c, Z_{inj} is the Norton equivalent impedance of the noise injection circuit (see Figure B.2a), and $R_V = 135 \Omega$ is the SHDSL design impedance.

The noise-generator gain settings determined during calibration shall be used during performance testing. During performance testing, the noise-injection circuit will be configured as shown in Figure B.2. Because the loop impedance and the impedance of the modem under test may differ from the impedances Z_{LX} and R_V used during calibration, the voltage over the RX port of the modem may differ from the voltage U_X observed during calibration.

12) Edit to clause B.3.4 – "Performance test procedure"

Add the following Note to the end of clause B.3.4 after Table B.3.

NOTE – Table B.3 constitutes a rationalized subset of tests that are considered to be representative of the full set of tests. For conformance, these tests (subset) are required. Other tests (possibly based on other test loops) are under study.

13) New text for clause B.3.5.3.7 – "Impulse noise generator [G7]"

Replace the text in B.3.5.3.7 with the following:

A test with this noise generator is required to prove the burst noise immunity of the SHDSL transceiver. The impulse noise waveform $V(t)$ (hereafter called the "test impulse") is defined as:

$$V(t) = \begin{cases} K|t|^{-3/4} & t > 0 \\ 0 & t = 0 \\ -K|t|^{-3/4} & t < 0 \end{cases}$$

where t is time given in units of seconds and K is a constant defined numerically in Table B.5a. If the pulse is realized using discrete samples of $V(t)$, the waveform should be sampled at $t = (2n-1)\frac{T}{2}$, where T is the sampling period and $(1/T)$ should be at least twice the symbol rate of the system under test. The sampled peak-to-peak amplitude will vary with sampling rate. It can be calculated using the following formula:

$$V_{p-p} = 2K \left| \frac{T}{2} \right|^{-\frac{3}{4}}$$

Table B.5a/G.991.2 – Impulse noise peak-to-peak voltage requirement

K	V_{p-p} of the test impulse sampled at 2 Msamples/s
1.775×10^{-6}	320 mV

For a sampling rate of 2 Msamples/s, a minimum of 8000 samples is required with an amplitude accuracy of at least 12 bits. Figure B.5a shows the test impulse sampled at 2 Msamples/s. The injection circuit shall be identical to that described in B.3.3.1.1.

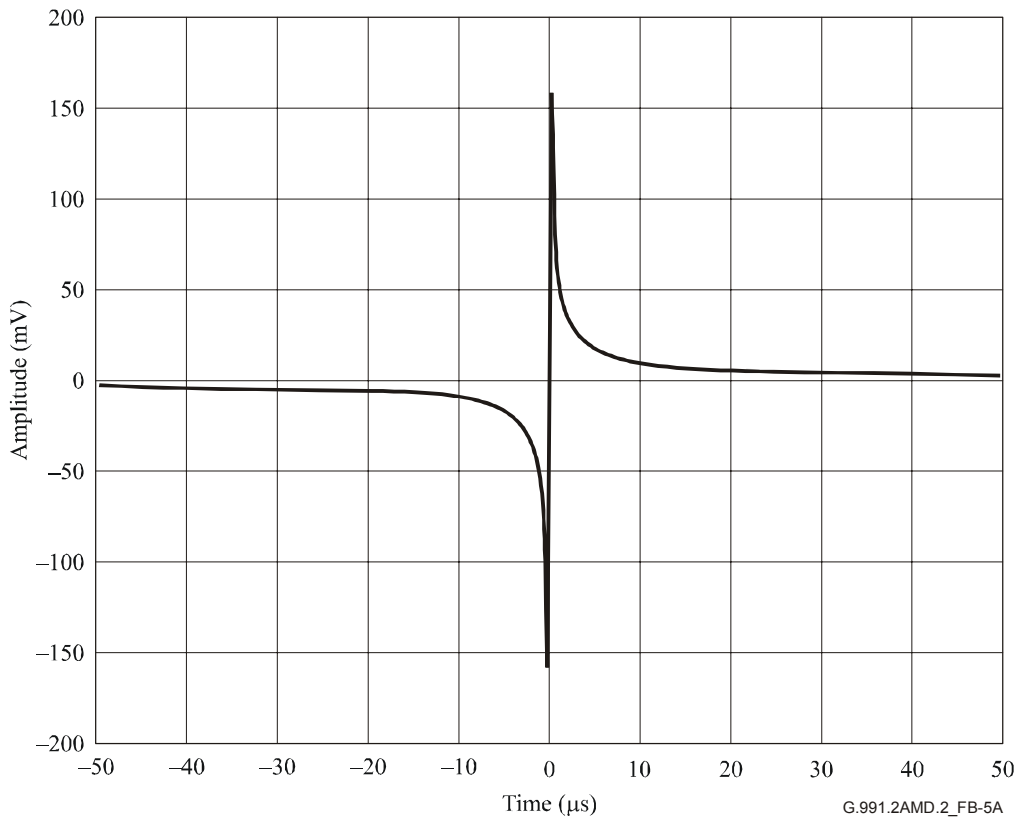


Figure B.5a/G.991.2 – Time domain representation of the test pulse sampled at 2 Msamples/s

A compliant unit shall pass the impulse noise test specified in Table B.5b. The minimum test period shall be 10 s. Each SHDSL termination shall be tested independently, i.e., the impulse noise waveform is not injected at both terminations simultaneously. No other impairment source shall be active during this test.