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

Digital transmission systems – Digital sections and digital  
line system – Access networks

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**Asymmetric digital subscriber line (ADSL)  
transceivers**

ITU-T Recommendation G.992.1

(Previously CCITT Recommendation)

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## ITU-T RECOMMENDATION G.992.1

### ASYMMETRIC DIGITAL SUBSCRIBER LINE (ADSL) TRANSCEIVERS

#### Summary

This Recommendation describes Asymmetric Digital Subscriber Line (ADSL) Transceivers on a metallic twisted pair that allows high-speed data transmission between the network operator end (ATU-C) and the customer end (ATU-R). This Recommendation provides a variety of bearer channels in conjunction with one of three other services dependent on the environment:

- 1) ADSL transmission simultaneously on the same pair with voice (band) service;
- 2) ADSL transmission simultaneously on the same pair with G.961 (Appendix I or II) ISDN services; or
- 3) ADSL transmission on the same pair with voiceband transmission and with TCM-ISDN (G.961 Appendix III) in an adjacent pair.

Systems allow approximately 6 Mbit/s downstream and approximately 640 kbit/s upstream data rates depending on the deployment and noise environment.

This Recommendation specifies the physical layer characteristics of the Asymmetric Digital Subscriber Line (ADSL) interface to metallic loops.

This Recommendation has been written to help ensure the proper interfacing and interworking of ADSL transmission units at the customer end (ATU-R) and at the network operator end (ATU-C) and also to define the transport capability of the units. Proper operation shall be ensured when these two units are manufactured and provided independently. A single twisted pair of telephone wires is used to connect the ATU-C to the ATU-R. The ADSL transmission units must deal with a variety of wire pair characteristics and typical impairments (e.g. crosstalk and noise).

An ADSL transmission unit can simultaneously convey all of the following: downstream simplex bearers, duplex bearers, a baseband analogue duplex channel, and ADSL line overhead for framing, error control, operations and maintenance. Systems support a minimum of 6.144 Mbit/s downstream and 640 kbit/s upstream.

This Recommendation includes mandatory requirements, recommendations and options; these are designated by the words "shall", "should" and "may" respectively. The word "will" is used only to designate events that take place under some defined set of circumstances.

Two categories of performance are specified. Category I performance is required for compliance with this Recommendation; performance enhancement options are not required for category I equipment. Category II is a higher level of performance (i.e. longer lines and greater impairments). Category II performance and characteristics are not required for compliance with this Recommendation.

This Recommendation defines several optional capabilities and features:

- echo cancellation;
- trellis coded modulation;
- dual latency;
- transport of a network timing reference;
- transport of STM and/or ATM;
- reduced overhead framing modes.

It is the intention of this Recommendation to provide, by negotiation during initialization, for U-interface compatibility and interoperability between transceivers complying to this Recommendation and between transceivers that include different combinations of options.

#### Source

ITU-T Recommendation G.992.1 was prepared by ITU-T Study Group 15 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on 22 June 1999.

- 3.19 FEC output data frame:** The grouping of bytes from fast or interleaved path over a single symbol time period after addition of FEC bytes and before interleaving (at reference point B, Figures 7-8, and 7-9).
- 3.20 indicator bits:** Bits used for OAM purposes; embedded in the synchronization bytes.
- 3.21 loading coils:** Inductors placed in series with the cable at regular intervals in order to improve the voiceband response; removed for DSL use.
- 3.22 Mux data frame:** The grouping of bytes from fast or interleaved path over a single symbol time period before addition of FEC bytes and before interleaving (at reference point A, Figures 7-8 and 7-9).
- 3.23 near-end:** Near-end means performance of the loop-side received signal at the input of the ATU (see Figure 9-4).
- 3.24 net data rate:** Data rate that is available for user data in any one direction; for the downstream direction this is the sum of the net simplex and duplex data rates.
- 3.25 network timing reference:** An 8 kHz timing marker used to support the distribution of a timing reference over the network.
- 3.26 primitives:** Primitives are basic measures of performance, usually obtained from digital signal line codes and frame formats, or as reported in overhead indicators from the far-end. Performance primitives are categorized as events, anomalies and defects. Primitives may also be basic measures of other quantities (e.g. ac or battery power), usually obtained from equipment indicators (see Figure 9-4).
- 3.27 subcarrier:** A particular complex valued input,  $Z_i$ , to the IDFT (see 7.11.2).
- 3.28 showtime:** The state of either ATU-C or ATU-R – reached after all initialization and training is completed – in which user data is transmitted.
- 3.29 single latency:** Simultaneous transport of one or more bearer channels in any one direction, in which all user data is allocated to either the fast or the interleaved path; that is, either  $\text{sum}(B_F) > 0$  or  $\text{sum}(B_I) > 0$ .
- 3.30 splitter:** Filter that separates the high frequency signals (ADSL) from the voiceband signals; (frequently called POTS splitter even though the voiceband signals may comprise more than POTS).
- 3.31 superframe:** A grouping of 68 data symbols and one synchronization symbol, over a total time duration of 17 ms (see Figure 7-5).
- 3.32 symbol rate:** The rate at which all symbols, including the synchronization symbol, are transmitted  $[(69/68)*4.0 = 4.0588 \text{ kbaud}]$ ; contrasted with the data symbol rate.
- 3.33 sync byte:** An overhead byte present at the beginning of each mux data frame (called "fast" byte in the fast path and "sync" byte in the interleaved path).
- 3.34 sync frame:** A frame with deterministic content sent in the 69th symbol of a superframe (called "synchronization symbol" in Figure 7-5).
- 3.35 thresholds:** See clause 8/G.997.1.
- 3.36 Threshold Crossing Alert:** See Recommendation G.997.1.
- 3.37 total data rate:** Aggregate data rate plus FEC overhead.
- 3.38 upstream:** The transport of data in the ATU-R to ATU-C direction.
- 3.39 voiceband:** 0 to 4 kHz; expanded from the traditional 0.3 to 3.4 kHz to deal with voiceband data services wider than POTS.
- 3.40 voiceband services:** POTS and all data services that use the voiceband or some part of it.