The ATM Forum
Technical Committee

E1 Physical Interface Specification

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Table of Contents

Table of Figures

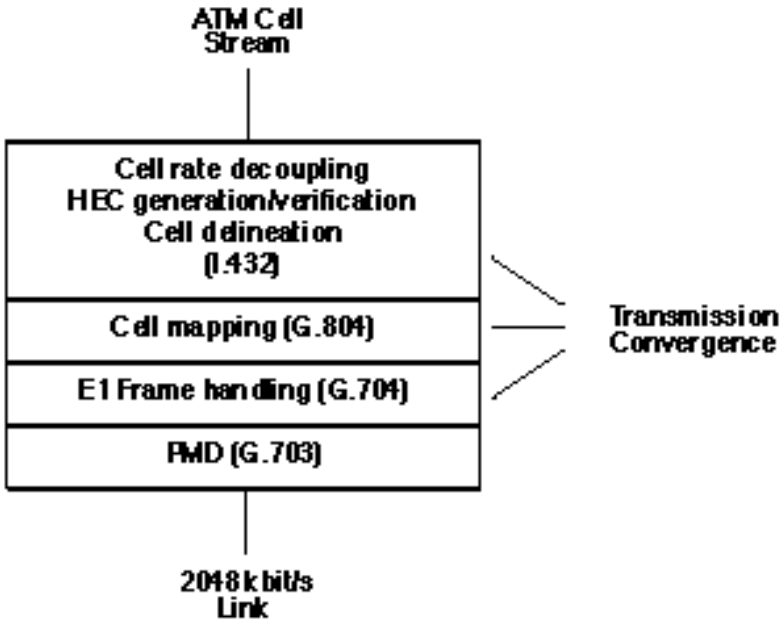
1. Introduction

This document specifies the requirements for the ATM Forum E1 Physical Layer interface operat-ing at 2048 kbit/s.

The specification shall apply to 2048 kbit/s interfaces at the public UNI, the private UNI and private NNI.

Figure 1 shows the ITU-T Recommendations on which this specification is primarily based.

Figure 1 Physical Layer Functions for E1 ATM UNI



2. Acronyms

CRC	Cyclic Redundancy Check
DIN	Deutsche Industrie Norm
ETSI	European Telecommunications Standards Institute
HDB3	High Density Bipolar of order 3
HEC	Header Error Check IEC International Electrotechnical Commission
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
ITU-T	International Telecommunication Union - Telecommunication
NNI	Network-Node Interface

OAM	Operation, Administration and Maintenance
PMD	Physical Medium Dependent
PRC	Primary Reference Clock
PRI	Primary Rate Interface
RDI	Remote Defect Indication
TC	Transmission Convergence
UNI	User Network Interface

3. Physical Medium Dependent (PMD) Sublayer

3.1 Physical Connection

A list of recommended connectors is given in Appendix A on page 13.

3.2 Electrical Characteristics

The rate, electrical characteristics, and other attributes of the E1 signal are defined in ITU-T Recommendation G.703[1], section 6.

3.2.1 Bit rate and Line Code

(R) For receiver design purposes, the bit-rate shall be 2048 kbit/s ± 50 ppm and the bit encoding shall be HDB3 as specified in section 6.1 of ITU-T Recommendation G.703[1].

3.2.2 Physical/Electrical Characteristics

(R) The output signal shall have the pulse characteristics, test load impedance, and jitter specifica-tions as specified in section 6.2 of ITU-T Recommendation G.703[1].

(R) The signal presented at the input port shall be as defined above but modified by the character-istics of the interconnecting pair such as specified in section 6.3 of ITU-T Recommendation G.703[1] and with the jitter tolerance specified in the next section.

3.2.3 Jitter

(R) The maximum level of jitter at the network side output shall be as specified in ITU-T Recom-mendation G.823[4].

Note: This requirement is equivalent to the requirements contained in specification ETS 300 247[19].

(R) The maximum level of jitter at the output and the jitter transfer characteristics in the loop tim-ing clock slave mode shall be as specified for the 2048 kbit/s rate in ITU-T Recommendation I.431[10], Section 5.4.3.

Note: This requirement fulfills also ITU-T Recommendation G.823[4].

3.2.4 Timing Requirements

This section specifies the timing requirements for public UNI, and private UNI/NNI. The require-ments are based on ITU-T Recommendations G.811[6] and G.812[7], and specification ISO/IEC 11573[16].

3.2.4.1 Timing for public UNI

When used as a public UNI, the E1 interface must be synchronized to a primary reference clock (PRC)[1] .

(R) In normal synchronous operation, the transmit timing at the public UNI from the network toward the customer shall be traceable to a PRC.

(R) In normal synchronous operation, the transmit timing at the public UNI from the customer toward the network shall be traceable to a PRC. This can be achieved by performing loop timing on the incoming signal (traceable to a PRC) or by synchronizing the interface to an alternate source traceable to a PRC (see ITU-T Recommendation I.431[10], section 5.3, for further details).

(R) In the absence of traceability to a PRC, the signal timing shall be maintained within ± 50 ppm of 2048 kbit/s.

3.2.4.2 Timing for private UNI/NNI

When used as a private UNI or NNI, the E1 interface may or may not require synchronization to a PRC. In the case of dial-up/ISDN lines, synchronization to a PRC is required. In the case of trans-parent lines, synchronization to a PRC is not required.

(R) When synchronization to a PRC is required, it shall be provided as described in Section 3.2.4.1 for public UNI.

(R) When synchronization to a PRC is not required, the transmit timing in both directions of trans-mission shall be within ± 50 ppm of 2048 kbit/s as specified in G.703[1], section 6.

(R) When synchronization to a PRC is not required in the private NNI environment, one side shall be defined as a clock master and the other side (slaved) shall be loop-timed to it.

Note: Refer to ISO/IEC 11573[16] for more details on synchronization methods and technical requirements for Private Integrated Services Networks.

[1] Note that Primary Reference Clock (PRC) is the expression used in ITU-T Recommenda-tions [6] while Primary Reference Source (PRS) is used in ANSI standard specifications.

4. Transmission Convergence (TC) Sublayer

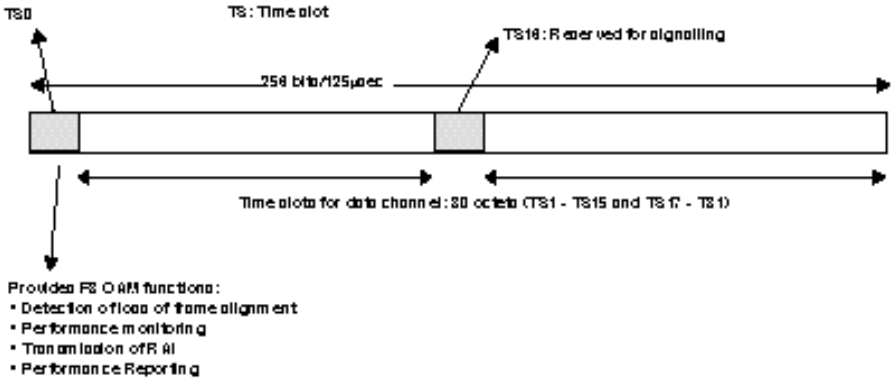
4.1 Transport Specific TC Functions

4.1.1 E1 Transmission Frame Format

The E1 transmission frame structure shall be as specified in ITU-T Recommendation G.704[2], Section 2.3 and Section 5.2.

(R) The E1 transmission frame shall consist of 32 time slots (octets), numbered 0 to 31. The E1 frame repetition rate is 8000 Hz. Slots 0 and 16 shall be reserved for framing, OAM and signalling functions. Slots 1 to 15, and slots 17 to 31 are available for carrying data traffic. This is shown in Figure 2.

Figure 2 E1 Frame Structure



The following sections give the requirements for usage of time slots 0 and 16.

4.1.1.1 Time slot 0

(R) Time slot 0 shall be used for framing and OAM functions. Processing of bits number 1 to 8 in slot 0 for frames containing the frame alignment signal and for frames not containing the frame alignment signal shall be as specified in ITU-T Recommendation G.704[2]. Figure 3 shows the structure of slot 0 over multiframes I and II.

Figure 3 Structure of Time Slot 0

	Slot 0								Slot 1
frame n	CRC-4	0	0	1	1	0	1	1	
frame n+1	0	1	A	Sa4	Sa5	Sa6	Sa7	Sa8	
frame n+2	CRC-4	0	0	1	1	0	1	1	
frame n+3	0	1	A	Sa4	Sa5	Sa6	Sa7	Sa8	
.....									
frame n+13	E	1	A	Sa4	Sa5	Sa6	Sa7	Sa8	
frame n+14	CRC-4	0	0	1	1	0	1	1	
frame n+15	E	1	A	Sa4	Sa5	Sa6	Sa7	Sa8	

Note: This figure has been taken from ITU-T Recommendation G.704, Table 4b.

(R) The A bit in time slot 0 shall be used for Remote Alarm Indication (RAI). The A bit shall be set to binary "0" for no remote alarm indication and shall be set to binary "1" for remote alarm indication.

(R) The CRC-4 multiframe structure and procedures as defined in ITU-T Recommendation G.704[2], Section 2.3.3 and in ITU-T Recommendation G.706[3] shall be used.

(R) The E-bits in time slot 0 shall be used as specified in ITU-T Recommendation G.704[2], Sec-tion 2.3.3.4.

Note: The E-bits are used to report loss of CRC-4 multiframe alignment.

Note: In the short term, there may exist equipments which do not use the E-bits; in this case the E-bits shall be set to "1" (see ITU-T Recommendation G.704[2], Section 2.3.3.4).

(R) The Sa bits shall be used as defined in ITU-T Recommendation G.704[2], section 2.3.2 Table 4a.

4.1.1.2 Time slot 16

(R) Slot 16 shall be reserved for the use of signalling as defined in ITU-T Recommendation G.804[5], section 3.1, and ITU-T Recommendation G.704[2], section 5.2.1.

4.1.2 Reframe Time

(R) The maximum average reframe time to achieve multiframe alignment shall be 8 milliseconds as specified in ITU-T Recommendation G.706[3], Section 4.2.

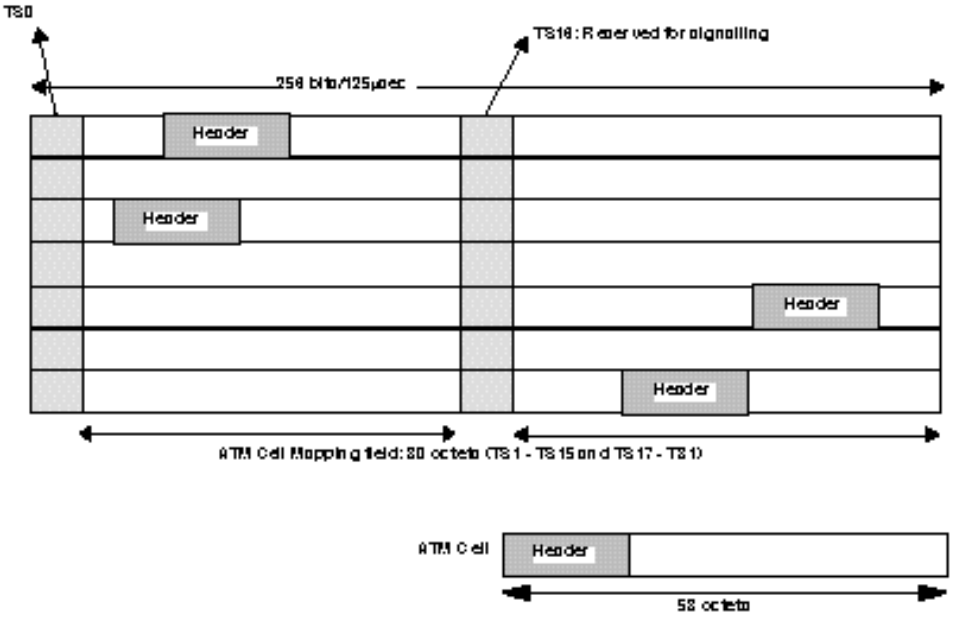
4.2 ATM-Specific TC Functions

4.2.1 ATM Cell Mapping

(R) The ATM cell is mapped into bits 9 to 128 and bits 137 to 256 (i.e. time slots 1 to 15 and time slots 17 to 31) of the 2048 kbit/s frame as specified in ITU-T Recommendation G.704[2] and as shown in Figure 4. The ATM cell octet structure shall be aligned with the octet structure of the frame.

(R) There shall be no relationship between the beginning of an ATM cell and the beginning of an 2048 kbit/s transmission frame.
Note: Since the frame payload capacity (30 octets) is not an integer multiple of cell length (53 octets), ATM cells will cross the E1 frame boundary.

Figure 4 E1 Frame Structure Used to Transport ATM Cells.



Note: This figure has been taken from ITU-TR recommendation G.804, Figure 8-1

4.2.2 Cell Rate Decoupling

(R) The cell rate adaptation to the payload capacity of the E1 transmission frame (1920 kbit/s) shall be performed by the insertion of idle cells as defined in ITU-T Recommendation I.432[11] Section 4.4. The idle cell header shall be as defined in [11], Table3/I.432.

4.2.3 Cell Header Error Check (HEC) Processing

(R) The Header Error Control (HEC) value shall be verified as specified by ITU-T Recommenda-tion I.432[11], Section 4.3.1.

(O) When single bit HEC errors are corrected, this shall be done as specified by ITU-T Recom-mendation I.432[11], Section 4.3.1.

(R) The Header Error Control (HEC) value shall be generated in compliance with ITU-T Recom-mendation I.432[11], Section 4.3.2.

4.2.4 Cell Delineation and Scrambling

(R) The cell delineation function shall be performed using the HEC mechanism as defined in ITU-T Recommendation I.432[11], Section 4.5.

(R) The ATM cell payload shall be scrambled using a self synchronizing scrambler as defined in ITU-T Recommendation I.432[11], Section 4.5.3.

5. References

[1] ITU-T Recommendation G.703, Physical/Electrical Characteristics of Hierarchical Digital Interfaces, 1991.

[2] ITU-T Recommendation G.704, Synchronous Frame Structures Used at Primary and Secondary Hierarch Levels, 1991.

[3] ITU-T Recommendation G.706, Frame Alignment and Cyclic Redundancy Check (CRC) Procedures Relating to Basic Frame Structures Defined in Recommendation G.704, 1991.

[4] ITU-T Recommendation G.823, The Control of Jitter and Wander Within Digital Networks Based on the 2048 kbit/s Hierarchy, 1992.

[5] ITU-T Recommendation G.804, ATM Cell Mapping into Plesiochronous Digital Hierarchy (PDH), July 1995.

[6] ITU-T Recommendation G.811, Timing Requirements at the Outputs of Primary Reference Clocks Suitable for Plesiochronous Operation of International Digital Links, 1988.

[7] ITU-T Recommendation G.812, Timing Requirements at the Outputs of Slave Clocks Suitable for Plesiochronous Operation of International Digital Links, 1988.

[8] DIN 47 295, HF-connection 1.6/5.6: characteristic impedance 75 ohms, 1976.

[9] DIN 47 297, HF-connection 1.0/1.2: characteristic impedance 50 ohms, 1976.

[10] Draft ITU-T Recommendation I.431, ISDN User-Network Interfaces, Primary Rate UNI Layer 1 Specification, March 1993.

[11] Draft ITU-T Recommendation I.432, B-ISDN User-Network Interface - Physical Layer Specification, December 1995.

[12] IEC 169-8, Radio-frequency connectors - Part 8: R.F. coaxial connectors with inner diameter of outer conductor 6.5 mm (0.256 in) with bayonet lock - Characteristic impedance 50 ohms (Type BNC), 1978.

[13] ISO 4903, Information technology -- Data communication -- 15-pole DTE/DCE interface connector and contact number assignments, 1989

[14] ISO/IEC 8877, Information technology -- Telecommunications and information exchange between systems -- Interface connector and contact assignments for ISDN Basic Access Interface located at reference points S and T, 1992.

[15] ISO/IEC 10173, Information Technology - Integrated Services Digital Network (ISDN) Primary Access Connector at Reference Points S and T, 1991.

[16] ISO/IEC 11573, Information Technology - Telecommunications and information exchange between systems - Synchronization methods and technical requirements for Private Integrated Services Networks, 1994.

[17] prETS 300 337, Transmission and Multiplexing (TM); Generic frame structures for the transport of various signals (including ATM cells) at the ITU-T Recommendation G.702 hierarchical rates of 2 048 kbit/s, 34 368 kbit/s and 139 264 kbit/s, February 1995.

[18] prETS 300 246, Business Telecommunication (BT); Open Network Provision (ONP) Technical Requirements; 2048 kbit/s Digital Unstructured Leased Line (D2048U) Interface Pre-sentation, February 1993.

[19] prETS 300 247, Business Telecommunication (BT), Open Network Provision (ONP) Tech-nical Requirements; 2048 kbit/s Digital Unstructured Leased Line (D2048U) Connection Characteristics, February 1993.

[20] prETS 300 248, Business Telecommunication (BT); Open Network Provision (ONP) Technical Requirements; 2048 kbit/s Digital Unstructured Leased Line (D2048U) Terminal Equipment Interface, February 1993.

Appendix A Recommended E1 Connectors

Although it is not a requirement, it is recommended to use one of the following connectors for E1 interfaces.

• Balanced 120 ohm (symmetrical twisted pair):
— 8 contact connector socket specified in ISO/IEC 10173[15]
— 8 contact connector socket specified in ISO/IEC 8877[14]
— 15 contact connector socket specified in ISO 4903 [13]

• Unbalanced 75 ohms (coaxial cable):
— 1.6/5.6 coaxial type socket as defined in DIN 47295[8], Type A
— 1.0/2.3 coaxial type socket as defined in DIN 47297[9], Type A
— IEC SC46D connector
— IEC 169-8 connector [12]