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INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

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OF ITU

I.432.2

(08/96)

SERIES I: INTEGRATED SERVICES DIGITAL NETWORK

ISDN user-network interfaces – Layer 1 Recommendations

B-ISDN user-network interface – Physical layer specification: 155 520 kbit/s and 622 080 kbit/s operation

ITU-T Recommendation I.432.2

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Superseded by a more recent version

ITU-T RECOMMENDATION I.432.2

B-ISDN USER-NETWORK INTERFACE – PHYSICAL LAYER SPECIFICATION: 155 520 kbit/s AND 622 080 kbit/s OPERATION

Summary

This Recommendation covers Physical Layer characteristics for transporting ATM cells at nominal bit rates of 155 520 and 622 080 kbit/s over coaxial cable and optical fiber interfaces at the T_B and S_B reference points of the B-ISDN User-Network (UNI). The maximum distance is approximately 2 km for optical fiber and approximately 200 m for coaxial cable.

This Recommendation is part of the I.432-Series Recommendations, and includes references to Recommendation I.432.1 on general characteristics.

Source

ITU-T Recommendation I.432.2 was prepared by ITU-T Study Group 13 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 27th of August 1996.

FOREWORD

ITU (International Telecommunication Union) is the United Nations Specialized Agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the ITU. The 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 Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 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.

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As of the date of approval of this Recommendation, the ITU had/had not 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.

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B-ISDN USER-NETWORK INTERFACE PHYSICAL LAYER SPECIFICATION: 155 520 kbit/s AND 622 080 kbit/s OPERATION

(Geneva, 1996)

1 Introduction

1.1 Scope

This Recommendation covers Physical Layer characteristics for transporting ATM cells at nominal bit rates of 155 520 and 622 080 kbit/s over coaxial cable and optical fiber interfaces at the T_B and S_B reference points of the B-ISDN User-Network Interface (UNI). The maximum distance is approximately 2 km for optical fiber and approximately 200 m for coaxial cable. The selection of the physical medium for the interfaces at the S_B and T_B reference points should take into account that optical fiber is agreed as the preferred medium to be used to cable customer equipment.

Functionality is presented in terms of physical media dependent and transmission convergence sublayers, and both SDH-based and cell-based formats are included.

The goal is to have maximum commonality between Physical Layer functions at the UNI described in the I.432-Series Recommendations and any functions which may be defined in future at the Network Node Interface (NNI). Implementations should allow terminal interchangeability.

1.2 Background

This Recommendation was previously contained in Recommendation I.432 (as published in March 1993), along with material now published as Recommendation I.432.1. Recommendation I.432.1 contains those general characteristics which are relevant to all B-ISDN transmission systems at the UNI.

This Recommendation contains only those characteristics that are specific to transmission systems operating at 155 520 kbit/s and 622 080 kbit/s. Information on other bit rates can be found in other Recommendations of the I.432-Series.

2 Reference configuration

Refer to Recommendation I.432.1.

3 Characteristics of the physical media dependent sublayer

These characteristics apply to interfaces at the T_B and S_B reference points.

3.1 Physical medium characteristics of the UNI at 155 520 kbit/s

3.1.1 Bit rate and interface symmetry

The bit rate of the interface is 155 520 kbit/s. The interface is symmetric, i.e. it has the same bit rate in both transmission directions. The nominal bit rate in free running clock mode is 155 520 kbit/s with a tolerance of ± 20 ppm.

Both optical and electrical interfaces are recommended. The implementation selected depends on the distance to be covered and user requirements arising from the details of the installation.

3.1.2 Timing

3.1.2.1 SDH-based

In normal operation, timing for the transmitter is locked to the timing received from the network clock. The tolerance under fault conditions is 155 520 kbit/s ± 20 p.p.m.

3.1.2.2 Cell-based

At the customer side of the interface at the T_B and S_B reference points, the cell-based Physical Layer may derive its timing from the signal received across the interface or provide it locally by the clock of the customer equipment.

3.1.3 Jitter and wander

For both electrical and optical B-UNIs, the interface output jitter is in accordance with the appropriate limits given in Recommendation G.825 [1] for the electrical and optical interfaces.

Equipments having an electrical or optical B-UNI (e.g., B-NT1, B-NT2, B-TE), and which meet the input jitter tolerance and the jitter transfer specifications given in Recommendations G.825 [1] and G.958 [2] respectively, are assured of proper operation when the interface output jitter conforms to the limits in Recommendation G.825 [1].

3.1.4 Electrical interface

3.1.4.1 Interface range

The maximum range of the interface depends on the specific attenuation of the transmission medium used. For example a maximum range of about 100 metres for microcoax (4 mm dia.) and 200 metres for CATV type (7 mm dia.) will be achieved.

3.1.4.2 Transmission medium

Two coaxial cables, one for each direction, are recommended. The wiring configuration is point-to-point.

The impedance is 75 ohms with a tolerance of ± 5% in the frequency range 50 MHz to 200 MHz.

The attenuation of the electrical path between the interface points I_a and I_b is assumed to follow an approximate square root (f) law and to have a maximum insertion loss of 20 dB at a frequency of 155 520 kHz.

3.1.4.3 Electrical parameters at interface points I_a and I_b

The digital signal presented at the output port and the port impedance should conform to Table 11 and Figures 24 and 25 of Recommendation G.703 [3] for the interface at 155 520 kbit/s.

The digital signal presented at the input port and the port impedance should also conform to Table 11 and Figures 24 and 25 of Recommendation G.703 [3] for the interface at 155 520 kbit/s, but modified by the characteristics of the interconnecting coaxial pair.

3.1.4.4 Electrical connectors

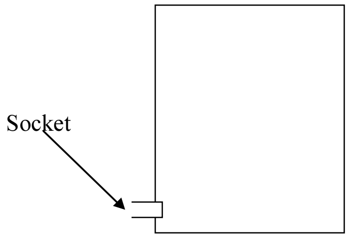
The presentation of interface point I_b at B-NT1 or B-NT2 is via a socket.

The presentation of interface point I_a at B-TE or B-NT2 is using either:

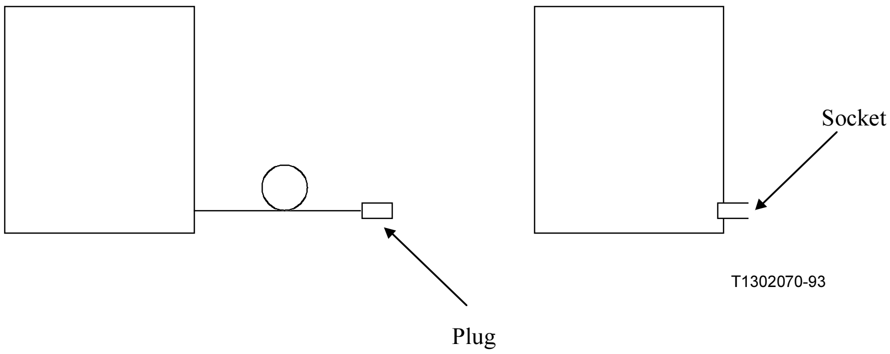
a) a socket, i.e. the connection is to be made to the equipment toward the network with a cable with plugs on both ends; or

b) an integral connecting cord with plug on the free end.

Refer to Figure 1.



Presentation of interface point I_b at B-NT1 and B-NT2



Presentation of interface point I_a at B-TE and B-NT2

Figure 1/I.432.2 – Connector types

3.1.4.5 Line coding

The line coding is CMI (Coded Mark Inversion) (refer to Recommendation G.703 [3]).

3.1.4.6 EMC/EMI requirements

Shielding properties of connectors and cables are defined by the specification of the respective values for the Surface Transfer Impedance (STI). The template indicating the maximum STI values for CATV cables is given in Figure 2 and Table 1. The applicability of these values for microcoax cables is for further study. For connectors, these template values are multiplied by 10 (20 dB).

The immunity of the interface against induced noise on the transmission medium should be specified by means of a Terminal Failure Voltage (TFV) which is overlaid to the digital signal at the output port. Figure 3 shows a possible measurement configuration.

The receiver should tolerate a sinusoidal TFV with the values defined in Figure 4 and Table 2 without degradation of the Bit Error Ratio (BER) performance.

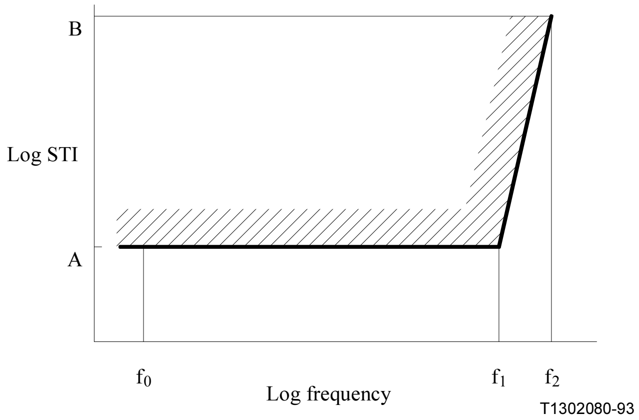


Figure 2/I.432.2 – Maximum STI values as function of frequency

Table 1/I.432.2 – TI values

Frequency [MHz]	STI value [ohm/m]
f0 = 0.1	A = 0.01
f1 = 100	
f2 = 1000	B = 1

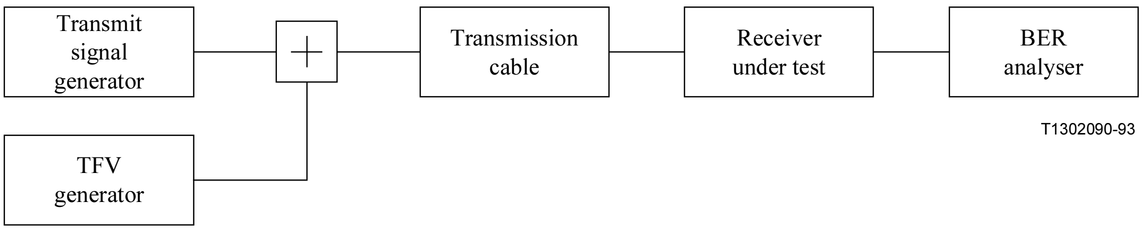


Figure 3/I.432.2 – Measurement configuration

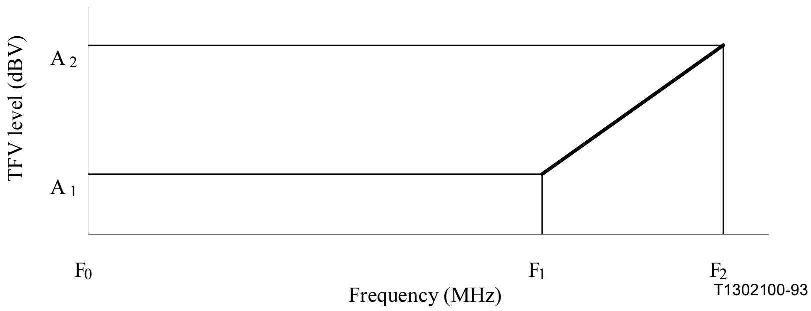


Figure 4/I.432.2 – Terminal failure voltage frequency response

Table 2/I.432.2 – Terminal failure voltage values

Frequency [MHz]	TFV amplitude [dBV] 0 dBV = $1V_{op}$
F0 = 1	
F1 = 200	A1 ≥ –17
F2 = 400	A2 ≥ –11

3.1.5 Optical interface

3.1.5.1 Attenuation range

The attenuation of the optical path between the specification points S and R, as defined in Recommendation G.957 [4], are in the range of 0 dB to 7 dB. Refer to 3.1.5.5.

3.1.5.2 Transmission medium

The transmission medium consists of two single-mode fibres according to Recommendation G.652 [5], one for each direction. Some national applications may use multi-mode fibres.

3.1.5.3 Line coding

The line coding is NRZ (Non Return to Zero).

The convention used for optical logic level is:

– emission of light for a binary ONE;

– no emission of light for a binary ZERO.

The extinction ratio must be in accordance with Recommendation G.957 [4] (classification I-1).

3.1.5.4 Operating wavelength

The operating wavelength is around 1310 nm (second window).

3.1.5.5 Input and output port characteristics

The optical parameters will be in accordance with Recommendation G.957 [4] (classification I-1). Some national application may use optical parameters for multi-mode fibres.

The specification points associated with interface points I_a and I_b correspond to measurement 'reference points' S and R as defined in Recommendation G.957 [4]. The optical parameters are specified for the transmitter and receiver at these specification points and for the optical path between these specification points, i.e. the connector at the interface is considered to be part of the equipment and not part of the fiber installation.

3.1.5.6 Optical connectors

The presentation of interface point I_b at B-NT1 or B-NT2 is via a socket.

The presentation of interface point I_a at B-TE or B-NT2 is using either:

a) a socket, i.e. the connection is to be made to the equipment toward the network with a cable with plugs on both ends; or

b) an integral connecting cord with plug on the free end.

Refer to Figure 1.

3.1.5.7 Safety requirements

For safety reasons, the parameters for IEC 825 [6] Class 1 devices should not be exceeded even under failure conditions.

3.2 Physical medium characteristics of the UNI at 622 080 kbit/s

These characteristics apply to interfaces at the T_B and S_B reference points.

3.2.1 Bit rate and interface symmetry

The bit rate of the interface in at least one direction is 622 080 kbit/s. The symmetry of the interface is for further study. The following possible interfaces have been identified:

a) an asymmetrical interface with 622 080 kbit/s in one direction and 155 520 kbit/s in the other direction;

b) a symmetrical interface with 622 080 kbit/s in both directions.

NOTE – Other solutions are for further study.

If option a) is chosen, then the 155 520 kbit/s component should comply with the characteristics of 3.1.

The nominal bit rate in free running clock mode is 622 080 kbit/s with a tolerance of ± 20 ppm.

3.2.2 Timing

3.2.2.1 SDH-based

In normal operation, timing for the transmitter is locked to the timing received from the network clock. The nominal bit rate under fault conditions is 622 080 kbit/s ± 20 ppm.

3.2.2.2 Cell-based

At the customer side of the interface at the T_B and S_B reference points, the cell-based Physical Layer may derive its timing from the signal received across the interface or provide it locally by the clock of the customer equipment.

3.2.3 Jitter and wander

For both electrical and optical B-UNI, the interface output jitter is in accordance with the appropriate limits given in Recommendation G.825 [1] for the electrical and optical interface.

Equipments having an electrical or optical B-UNI (e.g. B-NT1, B-NT2, B-TE), and which meet the input jitter tolerance and the jitter transfer specifications given in Recommendations G.825 [1] and G.958 [2] respectively, are assured of proper operation when the interface output jitter conforms to the limits in Recommendation G.825 [1].

3.2.4 Electrical interface

The feasibility of an electrical interface is for further study.

3.2.5 Optical interface

3.2.5.1 Attenuation range

The attenuation of the optical path between the specification points S and R are in the range of 0 dB to 7 dB (refer to 3.1.5.5).

3.2.5.2 Transmission medium

The transmission medium consists of two single-mode fibres according to Recommendation G.652 [5], one for each direction.

3.2.5.3 Line coding

The line coding is NRZ (Non Return to Zero).

The convention used for optical logic level is:

– emission of light for a binary ONE;

– no emission of light for a binary ZERO.

The extinction ratio must be in accordance with Recommendation G.957 [4] (classification I-4).

3.2.5.4 Operating wavelength

The operating wavelength is around 1310 nm (second window).

3.2.5.5 Input and output port characteristics

The optical parameters will be in accordance with Recommendation G.957 [4] (classification I-4). Some national application may use optical parameters for multi-mode fibres.

The specification points associated with interface points I_a and I_b correspond to measurement 'reference points' S and R as defined in Recommendation G.957 [4]. The optical parameters are specified for the transmitter and receiver at these specification points and for the optical path between these specification points, i.e. the connector at the interface is considered to be part of the equipment and not part of the fiber installation.

3.2.5.6 Optical connectors

The presentation of interface point I_b at B-NT1 or B-NT2 is via a socket.

The presentation of interface point I_a at B-TE or B-NT2 is using either:

a) a socket, i.e. the connection is to be made to the equipment toward the network with a cable with plugs on both ends; or

b) an integral connecting cord with plug on the free end.

Refer to Figure 1.

3.2.5.7 Safety requirements

For safety reasons, the parameters for IEC 825 [6] Class 1 devices should not be exceeded even under failure conditions.

4 Functions provided by the Transmission Convergence (TC) sublayer

4.1 Transfer capability

4.1.1 SDH-based

4.1.1.1 Interface at 155 520 kbit/s

The bit rate available for the ATM cells (user information cells, signalling cells, OAM cells, unassigned cells and cells used for cell rate decoupling) excluding Physical Layer overhead cells is 149 760 kbit/s.

4.1.1.2 Interface at 622 080 kbit/s

The bit rate available for the ATM cells (user information cells, signalling cells, OAM cells, unassigned cells and cells used for cell rate decoupling) excluding Physical Layer overhead layer cells is 599 040 kbit/s.

4.1.2 Cell-based

4.1.2.1 Interface at 155 520 kbit/s

For cell-based systems, Physical Layer overhead cells include Physical Layer OAM cells and idle cells. The transfer capacity is 149 760 kbit/s.

4.1.2.2 Interface at 622 080 kbit/s

For cell-based systems, Physical Layer overhead cells include Physical Layer OAM cells and idle cells. The transfer capacity is 599 040 kbit/s.

4.2 Transport-specific TC functions

4.2.1 SDH-based

4.2.1.1 Interface structure at 155 520 kbit/s

The bitstream of the interface has an external frame based on the Synchronous Digital Hierarchy (SDH) as described in Recommendation G.707 [7] and illustrated in Figure 5. The application of the SDH frame synchronous scrambler is described in Recommendation G.707 [7].

The ATM cell stream is first mapped into the C-4 and then mapped in the VC-4 container along with the VC-4 path overhead (refer to Figure 5). The ATM cell boundaries are aligned with the STM-1 octet boundaries. Since the C-4 capacity (2340 octets) is not an integer multiple of the cell length (53 octets), a cell may cross a C-4 boundary.

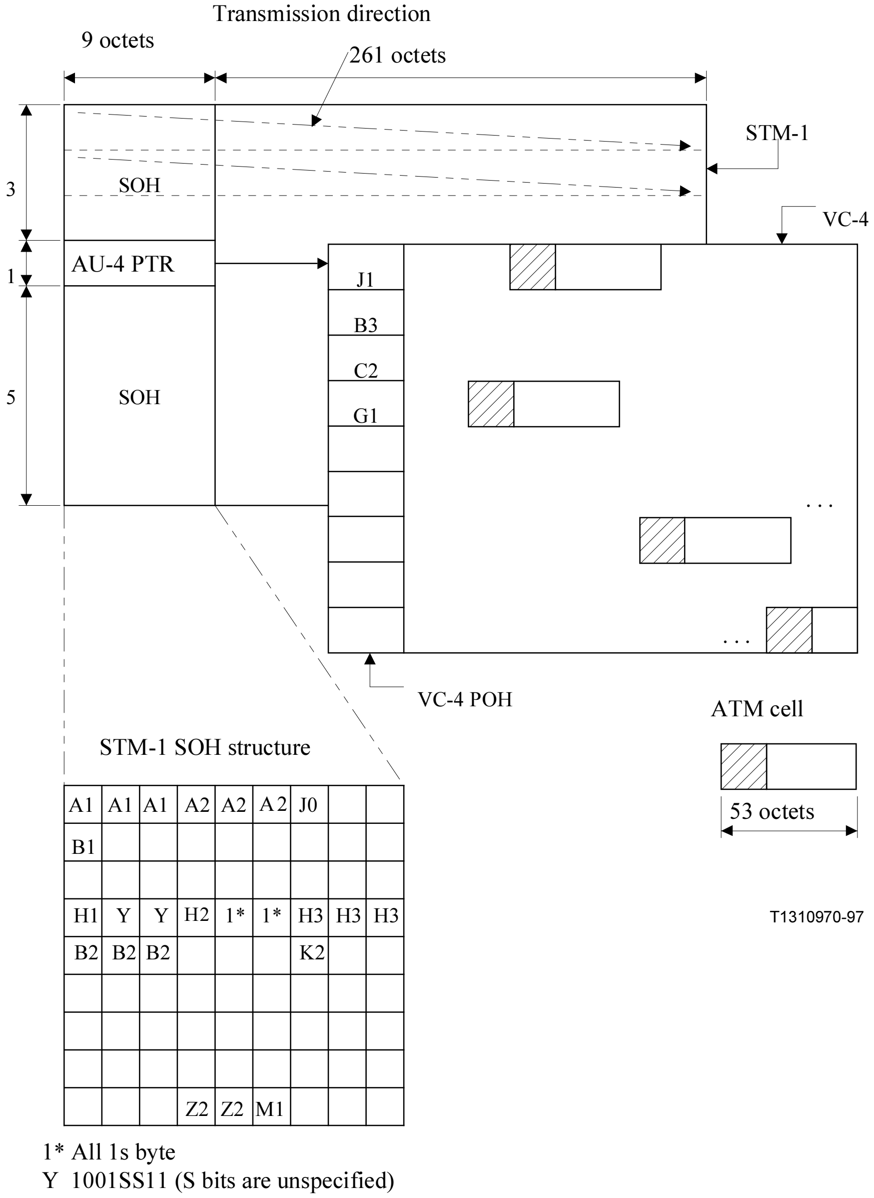


Figure 5/I.432.2 – 155 520 kbit/s frame structure for SDH-based UNI

The AU-4 pointer (octets H1 and H2 in the SOH) is used for finding the first octet of the VC-4. Path Overhead (POH) octets J1, B3, C2, and G1 are utilised. Use of the remaining POH octets is for further study.

For all representations shown in this Recommendation in binary format, bits are numbered within the octet as shown in Table 3 with the order of transmission being from left to right.

Table 3/I.432.2 – Order of transmission of bits within a byte

MSB 1	2	3	4	5	6	7	LSB 8
First bit transmitted	---→						Last bit transmitted
NOTE – The bit numbering used in this figure is different from the convention used in Recommendation I.361 [8] but in accordance with Recommendation G.707 [7].							

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4.2.1.2 Interface structure at 622 080 kbit/s

The bit stream of the interface has an external frame based on the Synchronous Digital Hierarchy (SDH) as described in Recommendation G.707 [7]. Specifically, the AU-4-4c structure as given in Recommendation G.707 is specified, and is illustrated in Figure 6. The application of the SDH frame synchronization scrambler is described in Recommendation G.707 [7].

The ATM cell stream is first mapped into the C-4-4c and then packed in the VC-4-4c container along with the VC-4-4c path overhead (see Figure 6). The ATM cell boundaries are aligned with the STM-4 octet boundaries. Since the C-4-4c capacity (9360 octets) is not an integer multiple of the cell length (53 octets), a cell may cross a C-4-c boundary.

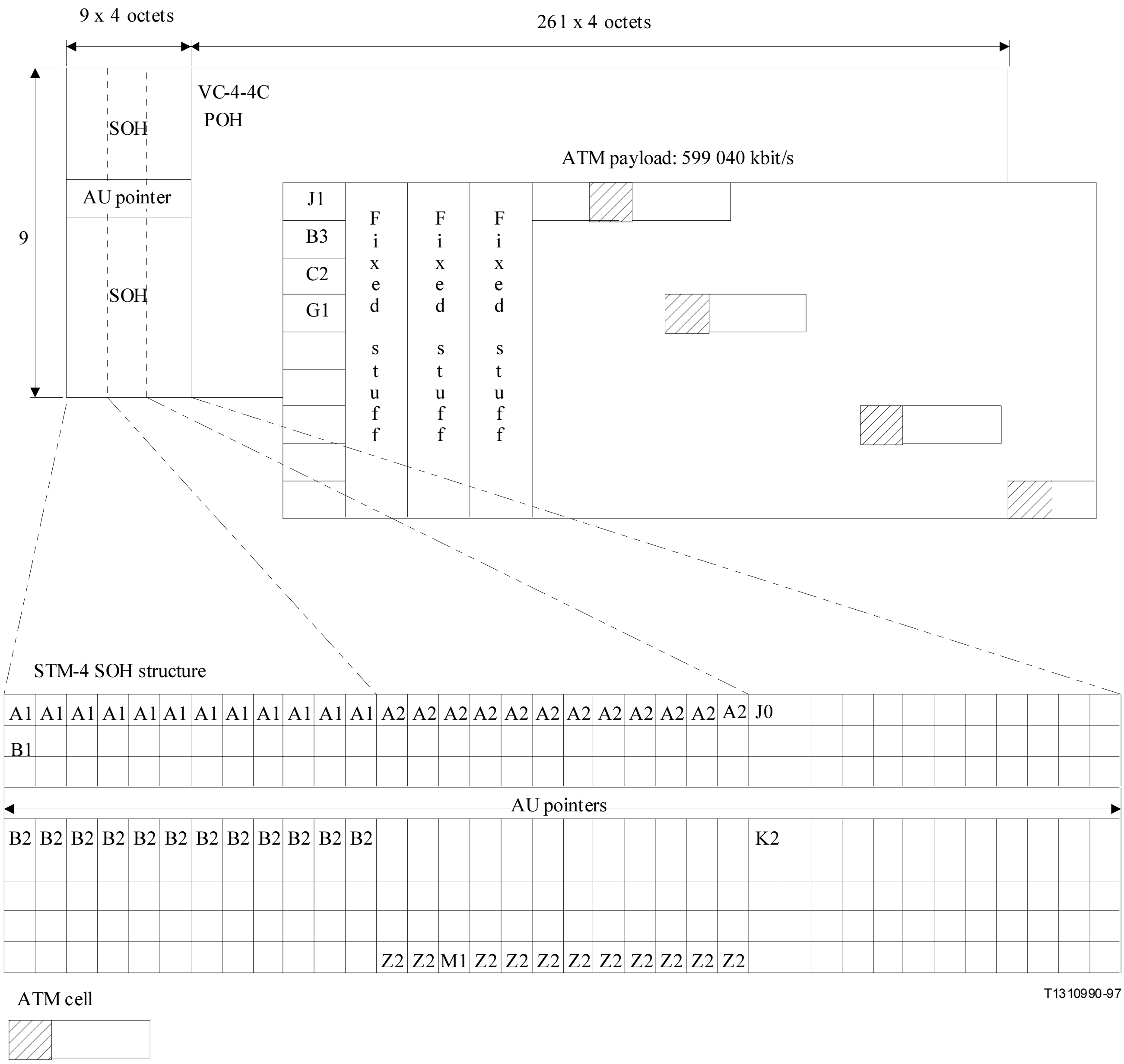


Figure 6/I.432.2 – 622 080 kbit/s frame structure for SDH-based UNI

The AU-pointers are used for finding the first octet of the VC-4-4c. Path overheads octets J1, B3, C2, and G1 are utilised. Use of the remaining POH octets is for further study.

4.2.1.3 OAM functionality

Transmission overhead allocation for the SDH Physical Layer functions (listed in Table 1/I.610 [9]) is given in Table 4. Use of these overheads (e.g. for frame alignment, AU pointer generation/interpretation, Bit Interleaved Parity (BIP) code calculation, etc.) should be in accordance with specifications in Recommendation G.707 [7].

Remote defect indications should be as defined in Recommendation G.707 [7].

Table 4/I.432.2 – SDH Overhead Octets Allocation at B-UNI

Octet	Function	Coding (Note 1)
STM section overhead:		
A1, A2	Frame alignment	
J0 (Note 7)	Regenerator Section trace	
B1	Regenerator Section error monitoring (Note 2)	BIP-8
B2	Multiplex Section error monitoring	BIP-24 (155 520 kbit/s)
		BIP-96 (622 080 kbit/s)
H1, H2	AU AIS, AU-4 pointer	All 1s
H3	Pointer action	
K2 (bits 6-8)	Section AIS/section RDI (Note 6)	111/110
M1 (Note 5)	Section error reporting (REI)	B2 error count
VC path overhead:		
J1	Access point ID/verification	
B3	Path error monitoring	BIP-8
C2	Path signal label	ATM cells (Note 3)
G1 (bits 1-4)	Path error reporting (REI)	B3 error count
G1 (bit 5)	Path RDI	"1"
G1 (bits 5, 6 and 7)	LCD	"010" (Note 8)

NOTE 1 – Only octet coding relevant to OAM function implementation is listed.

NOTE 2 – The use of B1 for regenerator section error monitoring across the UNI is application-dependent and is therefore optional.

NOTE 3 – Signal label code for ATM cell payload is 0001 0011 for VC.

NOTE 4 – The bit numbering of this table is different from the conventions used in Recommendation I.361 [8] but in accordance with Recommendation G.707 [7].

NOTE 5 – Using the notation of Recommendation G.707 [7], the bits to be used are bits (2-8) of octet S (9,6,1) in the case of the interface at 155 520 kbit/s, and bits (2-8) of octet S (9,4,3) in the case of the interface at 622 080 kbit/s.

NOTE 6 – The applicability of Multiplexer Section AIS (MS-AIS) at the B-UNI is for further study.

NOTE 7 – The need of this octet is for further study.

NOTE 8 – The use of G1 bits 6 and 7 is currently defined in Recommendation G.707 [7] as: "Bits 6 and 7 are reserved for an optional use described in VII.1. If this option is not used, bits 6 and 7 shall be set to 00 or 11. A receiver is required to be able to ignore the contents of these bits.".

4.2.1.3.1 Maintenance signals

Two types of maintenance signals are defined for the Physical Layer to indicate the detection and location of a transmission failure. These signals are:

– Alarm Indication Signal (AIS);

– Remote Defect Indication (RDI),

which are applicable at both the SDH section and path layers of the Physical Layer.

AIS is used to alert associated termination point in the direction of transmission that a failure has been detected and alarmed.

RDI is used to alert associated termination point in the opposite direction of transmission that a failure has been detected. Path RDI alerts the path termination point in the opposite direction of transmission that a failure has occurred along the path. Path RDI should be also used to indicate loss of cell delineation.

Operation of these signals is described further in clause 5 on OAM operational functionality.

Generation and detection of AIS and RDI are in accordance with Recommendation G.707 [7].

NOTE – For backward compatibility with equipment complying with the 1993 version of Recommendation I.432, new equipment may use "100" or "111" codes in bits 5 to 7 of G1 to indicate a remote Loss of Cell Delineation (LCD). New equipment may do this only when interworking with old equipment.

4.2.1.3.2 Transmission performance monitoring

Transmission performance monitoring across the UNI is performed to detect and report transmission errors. Performance monitoring is provided for the SDH Section and for the Path corresponding respectively to maintenance flows F2 and F3 in Figure 5 of Recommendation I.610 [9].

At the SDH Section (F2 flow), monitoring of the incoming signal is performed using the BIP-24 or BIP-96 inserted into the B2 field (for the 155 520 kbit/s bit rates and 622 080 kbit/s respectively). Monitoring of the outgoing signal is performed using the Remote Error Indication (REI). This error count, obtained from comparing the calculated BIP and the B2 value of the incoming signal at the far end, is inserted in a Z2 field and sent back: it reports to the near end section termination point about the error performance of its outgoing signal as REI.

Similar to the SDH section, at the SDH path (F3 flow), monitoring of the incoming signal is performed using the BIP-8 of the B3 octet. Monitoring of the outgoing signal is performed using the Path REI of bits 1-4 of the G1 octet.

Regenerator section monitoring (F1 flow) across the UNI is optional. If required, the incoming signal is monitored using the BIP-8 of the B1 octet. Capabilities in the SDH section overhead for monitoring the outgoing signal are not provided.

Further definitions are stated in Recommendation G.707 [7].

4.2.1.3.3 Control communication

Section layer communication channels and order-wires across the UNI are not required and are not provided.

Additional functions such as loopbacks (or their functional equivalent) or path layer communication channels are for further study.

The use of octets K1 and K2 (bits 1-5) for automatic protection switching across the UNI is for further study.

4.2.2 Cell-based

4.2.2.1 Format structure

The interface structure for both 155 520 kbit/s and 622 080 kbit/s consists of a continuous stream of cells. Each cell contains 53 octets.

The maximum spacing between successive Physical Layer cells is 26 ATM layer cells, i.e. after 26 contiguous ATM layer cells have been transmitted, a Physical Layer cell is inserted in order to adapt the transfer capability to the interface rate. Physical Layer cells are also inserted when no ATM layer cells are available.

The Physical Layer cells which are inserted can be either "idle cells" (see 4.3.5) or Physical layer OAM cells, depending on the OAM requirements.

4.2.2.2 OAM functionality

Physical Layer OAM cells are used for the conveyance of the Physical Layer OAM information. How often OAM cells are inserted should be determined by OAM requirements. However, there can be no more than one PL-OAM cell every 27 cells and not be less than one PL-OAM cell every 512 cells per flow in operational status. It is recognized that during some phases, for example start-up, it would be desirable to increase the insertion rate of the PL-OAM cell for improving the system response. The functional requirements for increasing the PL-OAM insertion rate requires further study. These spacings would apply only when the flow is actually implemented; it is recognized that not all applications will require implementations of all flows.

4.2.2.3 OAM cell identification

Recommendation I.610 [9] identifies three types of PL-OAM flows carried by maintenance cells using a specific pattern in the header:

– F1: Regenerator level;

– F2: Digital section level;

– F3: Transmission path level.

The F1 cell carries the OAM functions for the Regenerator level. This flow is inserted in the cell flow on a recurrent basis. If these PL-OAM cells have to take priority over an ATM cell, this has to be done without restricting ATM layer transfer capability.

The OAM flow F2 is not used and the corresponding functions are supported by the F3 OAM flow because there is no transmission frame passed across the cell-based UNI.

The F3 cell carries the OAM functions for the Transmission Path level.

These flows are inserted in the cell flow on a recurrent basis. If these PL-OAM cells have to take priority over an ATM cell, this has to be done without restricting ATM layer transfer capability.

The Physical Layer OAM cells must have a unique header so that they can be properly identified by the Physical Layer at the receiver. The patterns to be used are shown in Table 5 (see Note). The header patterns shown are given prior to scrambling.

Table 5/I.432.2 – Header pattern for OAM cell identification

Flow	Octet 1	Octet 2	Octet 3	Octet 4	Octet 5
F1	00000000	00000000	00000000	00000011	HEC=Valid code 01011100
F3	00000000	00000000	00000000	00001001	HEC=Valid code 01101010
NOTE – There is no significance to any of these individual fields from the point of view of the ATM Layer, as Physical Layer OAM cells are not passed to the ATM Layer.					

The possible need to identify other header values among those reserved for the use of the Physical Layer (refer to Recommendation I.361 [8]) to accommodate future identified OAM flows is for further study.

4.2.2.4 Allocation of OAM functions in information field

A provisional octet allocation for the F1 PL-OAM and F3 PL-OAM cells is shown in Table 6.

Table 6/I.432.2 – Allocation of OAM functions in information field

1	R	25	R
2	AIS	26	R
3	PSN	27	R
4	0 0 0 0 0 0 NIC (2)	28	R
5	NIC (8) (Note 1)	29	R
6	MBS	30	RDI (1) (Note 2)
7	NMB-EDC	31	NMB-EB
8	EDC-B1	32	EB2 EB1
9	EDC-B2	33	EB4 EB3
10	EDC-B3	34	EB6 EB5
11	EDC-B4	35	EB8 EB7
12	EDC-B5	36	R
13	EDC-B6	37	R
14	EDC-B7	38	R
15	EDC-B8	39	R
16	R	40	R
17	R	41	R
18	R	42	R
19	R	43	R
20	R	44	R
21	R	45	R
22	R	46	TEB (Note 3)
23	R	47	CEC (2)
24	R	48	CEC (8) (Note 4)

NOTE 1 – MSB is bit 2 of byte 4 and LSB is bit 1 of byte 5.

NOTE 2 – RDI is bit 1 of byte 30. Bits 2 to 8 are encoded as follows:

- 00000011 : RDI is triggered by AIS
- 00000101 : RDI is triggered by LOS
- 00000111 : RDI is triggered by LOM
- 00001001 : RDI is triggered by LCD
- Bits 4 to 8 are for future use.

NOTE 3 – When not used, this byte is coded 6A hexadecimal.

NOTE 4 – MSB is bit 2 of byte 47 and LSB is bit 1 of byte 48.

The following fields are identified for the F3 flow:

- **PL-OAM Sequence Number (PSN)**: It is designed so as to have a sufficiently large cycle compared with the duration of cell loss and insertion. 8 bits are allocated to PSN. The counting is then done modulo 256.
- **Number of Included Cells (NIC)**: Gives the number of cells included between the previous and the present F3 PL-OAM cell. The length of this field is proposed to monitor 512 cells (provisionally). The maximum value will be 375 cells for the 155 520 kbit/s bit rate and 511 cells for the 622 080 kbit/s bit rate. It includes the number of ATM cells and idle cells but not the PL-OAM cells.
- Transmission Path error monitoring and reporting includes the fields defined below:
  - **Monitoring Block Size (MBS)**: It is selected by balancing efficiency and monitoring accuracy. MBS should be fixed within the range (15-47) cells for the 155 520 kbit/s interface and within the range (36-64) cells for the 622 080 kbit/s interface.
  - **Number of Monitored Blocks (NMB-EDC)**: Gives the number of blocks included between this cell and the previous F3 OAM cell. This means the number of blocks for which error detection codes are contained in the following octets. NMB-EDC = 8 is proposed as an upper limit. The entire octet is allocated.
  - **Error Detection Code (EDC)**: This code is a BIP-8 calculated on a block of MBS cells repeated for each monitored block. A octet is allocated for each block.
  - **Number of Monitored Blocks at the far end (NMB-EB)**: Gives the number of transmission Path Far End Block Errors carried in the following octets. NMB-EB = 8 is proposed. The entire octet is allocated.
  - **Transmission Path Far End Block Error (TP-FEBE), (EB1, EB2,...,EB8)**: This reports the number of parity violations in each block. Four bits are necessary to indicate the number of parity violations in a BIP-8. With NMB-EB = 8, a total of 4 octets are necessary.
  - **Transmission Path Far End Total Errored Blocks (TEB)**: Gives the total number of errored blocks between two consecutive F3 OAM cells in accordance with anomalies a1 to a4 defined in Annex D/G.826 [10]. When this field is not used, the coding is 6A hexadecimal.
- **Transmission Path Alarm Indication Signal (TP-AIS)**: One octet is allocated (the coding to indicate the presence of the TP-AIS condition is all "1").
- **Transmission Path Remote Defect Indication (TP-RDI)**: A bit is allocated. It is set when one of the defects LCD, LOM, LOS or AIS (refer to 4.2.2.5) is detected.
- **Cell Error Control (CEC)**: Is used to detect errors in the cell payload. A CRC 10 is proposed[1].
- **Reserved Field (R)**: Contains the pattern of the octet of the idle cells.

The following fields are identified for the F1 flow:

- **PL-OAM Sequence Number (PSN)**: It is designed so as to have a sufficiently large cycle compared with the duration of cell loss and insertion. 8 bits are allocated to PSN. The counting is then done modulo 256.

[1] It should be the same as in F4/F5 flows.

- **Number of Included Cells (NIC)**: Gives the number of cells included between the previous and the present F1 PL-OAM cell. The length of this field is proposed to monitor 512 cells (provisionally). The maximum value will be 375 cells for the 155 520 kbit/s bit rate and 511 cells for the 622 080 kbit/s bit rate. It includes the number of ATM cells and idle cells and F3 PL OAM cells.
- Section error monitoring and reporting includes the fields defined below:
  - **Monitoring Block Size (MBS)**: It is selected by balancing efficiency and monitoring accuracy. MBS should be fixed within the range (15-47) cells for the 155 520 kbit/s interface and within the range (36-64) cells for the 622 080 kbit/s interface.
  - **Number of Monitored Blocks (NMB-EDC)**: Gives the number of blocks included between this cell and the previous F1 OAM cell. This means the number of blocks for which error detection codes are contained in the following octets. NMB-EDC = 8 is proposed as an upper limit. The entire octet is allocated.
  - **Error Detection Code (EDC)**: This code is a BIP-8 calculated on a block of MBS cells repeated for each monitored block. An octet is allocated for each block.
  - **Number of Monitored Blocks at the far end (NMB-EB)**: Gives the number of transmission Section Far End Block Errors carried in the following octets. NMB-EB = 8 is proposed. The entire octet is allocated.
  - **Section Far End Block Error (S-FEBE), (EB1, EB2,...,EB8)**: This reports the number of parity violations in each block. Four bits are necessary to indicate the number of parity violations in a BIP-8. With NMB-EB = 8, a total of 4 octets are necessary.
  - **Section Far End Total Errored Blocks (TEB)**: Gives the total number of errored blocks between two consecutive F1 OAM cells in accordance with anomalies a1 to a4 defined in Annex D/G.826 [10]. When this field is not used, the coding is 6A hexadecimal.
- **Section Alarm Indication Signal (S-AIS)**: One octet is allocated (the coding to indicate the presence of the P-AIS condition is all "1").
- **Section Remote Defect Indication (S-RDI)**: A bit is allocated. It is set when one of the defects LCD, LOM, LOS or Unacceptable error performance is detected.
- **Cell Error Control (CEC)**: Is used to detect errors in the cell payload. A CRC 10 is proposed. (It should be the same as in the F4/F5 flows.)
- **Reserved Field (R)**: Contains the octet pattern of "01101010", which is the same as that of the idle cells.

Other fields such as activation/deactivation or switch-on/switch-off status of the B-NT2 are for further study.

4.2.2.5 Maintenance signals

The following maintenance signals are defined:

- **Transmission Path Alarm Indication Signal (TP-AIS)**: It is used to alert associated termination point in the direction of transmission that an failure has been detected and alarmed.
- **Transmission Path Remote Defect Indication (TP-RDI)**: It is provided to alert the upstream equipment in the opposite direction of transmission that a defect has been detected along the downstream path. It is set when a Loss Of Cell Delineation (LCD), Loss of Maintenance Flow (LOM), LOS or AIS signal has been detected at the path level. The time to set this signal must be as short as possible but long enough to filter intermittent defect

informations. This time has to be defined. LCD is provided by the cell delineation algorithm. The time to indicate this state has to be defined. Loss of one OAM cell is detected when no F3 OAM cell is received when the maximum space between two F3 OAM cells is exceeded. A LOM defect is declared when two successive anomalies (loss of one F3 OAM cell) are detected. The method of detection of the AIS condition is for further study.

- **Section Alarm Indication Signal (S-AIS)**: It is used to alert the equipment in the direction of transmission that a failure has been detected and alarmed.
- **Section Remote Defect Indication (S-RDI)**: It is provided to alert the equipment in the opposite direction of transmission that a defect has been detected along the path. It is set when a Loss of Cell Delineation (LCD), LOM, LOS or unacceptable error performance has been detected at the regenerator section level. The time to set this signal must be as short as possible but long enough to filter intermittent defect informations; it has to be defined. LCD is provided by the cell delineation algorithm. The time to indicate this state has to be defined. Loss of one OAM cell is detected when no F1 OAM cell is received and the maximum space between two F1 OAM cells is exceeded. A LOM defect is declared when two successive anomalies (loss of one F1 OAM cell) are detected. The method of detection of unacceptable error performance is for further study.

4.2.2.6 Transmission performance monitoring

Transmission performance monitoring across the UNI is performed to detect and report transmission errors. At the transmission path (F3) level, this function is performed on the ATM layer and idle cells. At the regenerator section (F1) level this function is performed on ATM layer, idle and higher level PL-OAM cells. The PL-OAM cell carries the result for the monitoring of a certain number of blocks.

4.2.2.7 Error performance reporting

This function reports to the equipment in the opposite direction of transmission, the results of the path error monitoring carried out as contained in REI; for a BIP, it gives the number of parity violations in each block, calculated at the receiving end by comparison with the result carried by the cell.

4.2.2.8 Control communication

The provision of a data communication channel is for further study.

4.3 ATM-specific TC functions

For information on ATM cell formatting, header error control, cell delineation, scrambling and idle cells, refer to Recommendation I.432.1.

5 OAM operational functionality

5.1 SDH-based

5.1.1 Description of signals defined in Recommendation I.610 [9]

The following signals related to maintenance are defined below.

Indication of LOS, LOF, LOP and LCD are generated within the functional equipment.

Multiplex Section-AIS, Path-AIS, Multiplex Section-RDI, Path-RDI are signals transmitted/received across the B-UNI (see Note 7 to Table 4).

Loss of Signal (LOS) – LOS is considered to have occurred when the amplitude of the relevant signal has dropped below prescribed limits for a prescribed period.

Loss of Frame (LOF) – The interface detects a LOF when [to be determined (TBD)] or more consecutive errored framing patterns have been received.

Loss of Pointer (LOP) – The interface detects a LOP when a valid pointer can not be obtained using the pointer interpretation rules described in Recommendation G.783 [11].

5.1.2 Maintenance signals as defined in Recommendation I.610 [9]

Multiple section Alarm Indication Signal (MS-AIS) – MS-AIS is an STM signal containing valid Section Overhead and a scrambled all-ones pattern for the remainder of the signal. On detecting LOS or LOF on the incoming signal, MS-AIS is generated within (TBD) µs. MS-AIS is detected as an all "1"s in bits 6, 7 and 8 of the K2 byte after descrambling.

Path Alarm Indication Signal (P-AIS) – AU-AIS is sent to alert equipment in the direction of transmission that a failure has been detected. AU-AIS is an all-ones signal in H1, H2, and H3 octets, as well as in the entire payload. On detecting a failure or MS-AIS, AU-AIS is generated within (TBD) µs.

Multiple Section Far End Receive Failure (MS-RDI) – MS-RDI alerts equipment in the opposite direction of transmission that a failure has been detected. On detecting LOS, LOF, or a MS-AIS on the incoming signal, MS-RDI is sent within (TBD) µs by inserting the code '110' in bit positions 6, 7, and 8 of the K2 byte.

Path Far End Receive Failure (P-RDI) – P-RDI alerts the associated path terminating equipment that a failure in the direction of transmission has been declared along the STM Path. If LOS, LOF, LOP, LCD, MS-AIS, or AU-AIS are detected, P-RDI is generated within (TBD) µs by setting bit 5 in the path status byte, G1, to one.

5.1.3 Cell delineation signals

Out of Cell Delineation (OCD) – An OCD anomaly occurs when the cell delineation process changes from SYNC state to HUNT state while in a working state (refer to Figure 5/I.432.1). An OCD anomaly terminates when the PRESYNC to SYNC state transition occurs (refer to Figure 5/I.432.1) or when the OCD anomaly persists and the LCD maintenance state is entered (see below).

Loss of Cell Delineation (LCD) – An LCD defect occurs when an OCD anomaly (see above) has persisted for x ms. An LCD defect terminates when the cell delineation process (refer to Figure 5/I.432.1) enters and remains in the SYNC state for x continuous milliseconds. The value of x is in the range 0 to 4 for SDH-based UNIs. The value of x for other interface types is for further study.

NOTE – For implementations where the value of x is zero, the conditions for entering OCD and LCD signal states are identical, and are equivalent to the signal LCD (Loss of Cell Delineation) used in the 1993 version of Recommendation I.432.

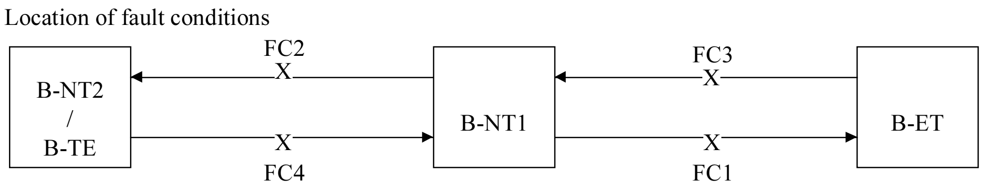
5.1.4 Maintenance state tables

This subclause applies for broadband access configurations that provide transmission path continuity between B-NT2/B-TE and B-ET. The more general case including ATM cross-connect functionality is for further study.

The user side and network side of the interface have to inform each other of the layer 1 states in relation to the different defects that could be detected.

For the purpose, two state tables are defined, one at the user side and one at the network side. States at the user side (F states) are defined in 5.1.4.1 and states at the network side (G states) are defined in 5.1.4.2. The state tables are defined in 5.1.4.4.

Fault conditions FC1 to FC4 that could occur at the network side or between the network side and user side are defined in Figure 7. These fault conditions directly affect the F and G states. Information on these fault conditions is exchanged between the user and network sides in the form of signals defined above.



Fault condition	Definition
FC4	Fault in the upstream direction of the interface
FC2	Fault in the downstream direction of the interface
FC3	Fault in the downstream direction in access digital section
FC1	Fault in the upstream direction in access digital section

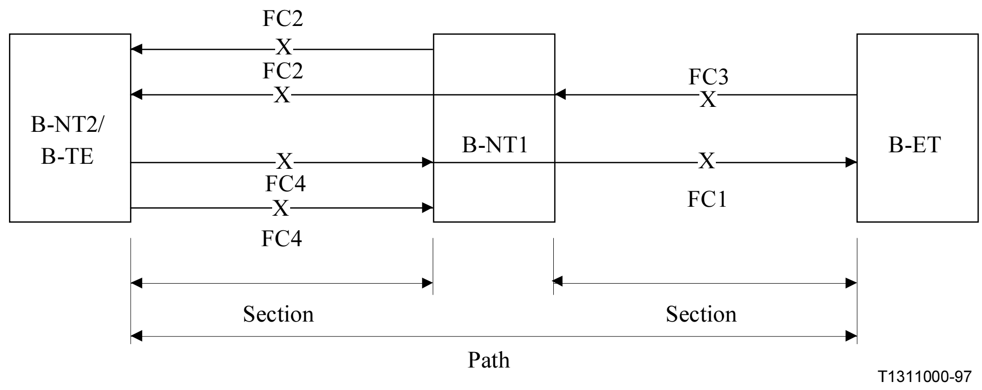


Figure 7/I.432.2 – Fault conditions and operational span of section path maintenance signals

NOTE 1 – Only stable states needed for operation and maintenance of the user and the network side of the interface (system reactions, user and network relevant information) are defined. The transient states relative to the detections of the error information are not taken into account except for power on/off transient states F6 and G13.

NOTE 2 – The user does not need to know where a failure is located in the network. The user must be informed on the availability and the continuity of the layer 1 service.

NOTE 3 – The user has all information relative to the performance associated with each direction of its adjacent section. The supervision of the quality of this section is the user's responsibility.

5.1.4.1 Layer 1 states on the user side of the interface

F0 state: Loss of power on the user side

– In general, the TE can neither transmit nor receive signals.

F1 state: Operational state

– Network timing and layer 1 service is available.

– The user side transmits and receives operational frames.

F2 state: Fault condition No. 1

– This fault state corresponds to the fault condition FC1.

– Network timing is available at the user side.

– The user side transmits operational frames.

– The user side receives frame containing Path-RDI indication.

F3 state: Fault condition No. 2

– This fault state corresponds to any combination of FC2 with FC1, FC3 and FC4.

– Network timing may not be available at the user side.

– The user side detects LOS, LOF, LOP, LCD.

– The user side transmits frames with associated Multiplex Section RDI and Path RDI.

F4 state:

– This fault state corresponds to fault condition FC3, or FC1 and FC3 or FC3 and FC4.

– Network timing may not be available at the user side.

– The user side detects Path AIS, LOP, or LCD.

– The user side transmits frames containing Path RDI indication.

F5 state: Fault condition No. 4

– This fault state corresponds to the fault condition FC4 or FC1 and FC4.

– Network timing is available at the user side.

– The user side transmits operational frames.

– The user side receives frames containing Multiplex Section RDI and Path-RDI indications.

F6 state:

– This fault corresponds to fault conditions FC3 + FC4 or FC3 + FC4 + FC1.

– Network timing may not be available at the user side.

– The user side receives frames containing MS-RDI and Path-AIS.

– The user side transmits frames containing Path-RDI.

F7 state: Power on state

– This is a transient state and the user side may change the state after detection of the signal received.

5.1.4.2 Layer 1 states at the network side of the interface

G0 state: Loss of power on the Network side

– In general, the B-NT1 can neither transmit nor receive any signal.

G1 state: Operational state

– The network timing and layer 1 service is available.

– The network side transmits and receives operational frames.

G2 state: Fault condition No. 1

– This fault state corresponds to the fault condition FC1.

– Network timing is provided to the user side.

– The path terminating equipment within the access network detects LOS, LOF, LOP, LCD, or Path AIS or Multiplex Section-AIS.

– The network side transmits frames containing Path RDI indication.

G3 state: Fault condition No. 2

– This fault state corresponds to the fault condition FC2.

– Network timing is not available to the user side.

– The network side transmits operational frames.

– The network side receives frames containing Multiplex Section RDI and Path RDI indications.

G4 state: Fault condition No. 3

– This fault state corresponds to the fault condition FC3.

– Network timing is not provided to the user side.

– The B-NT1 detects LOS/LOF or Multiplex Section AIS from the access network.

– The network side transmits Path AIS.

– The network side receives frames containing Path RDI indication.

G5 state:

– This fault states corresponds to the fault condition FC1 or FC2 and FC4.

– The network side transmits frame containing Multiplex Section RDI and Path RDI indication to the user side.

G6 state:

– This fault state corresponds to fault conditions FC1 and FC2.

– Network timing is not available at the user side.

– The network side transmits frames containing Path RDI indication.

– The B-NT1 receives Multiplex Section RDI and Path RDI indications from the user side and the Path terminating equipment detects LOS, LOF, LOP, LCD, Path-AIS or MS-AIS.

G7 state:

– This fault state corresponds to fault conditions FC1 and FC3.

– Network timing is not available at the user side.

– The network side transmits frames containing Path AIS indication.
– The network side receives frames containing Path.

G8 state:

– This fault state corresponds to fault conditions FC1 and FC4 or FC1 and FC2 and FC4.
– The network side transmits frames containing Multiplex Section RDI and Path RDI indications to the user side.

G9 state:

– This fault state corresponds to fault conditions FC2 and FC3.
– Network timing is not available to the user side.
– The network side transmits frames containing Path AIS.
– The network side receives frames containing Multiplex Section RDI and Path RDI indications.

G10 state:

– This fault state corresponds to fault conditions FC3 and FC4 or FC2 and FC3 and FC4.
– Network timing is not provided to the user side.
– The network side transmits frames containing Path AIS and Multiplex Section RDI indication to the user side.

G11 state:

– This fault state corresponds to fault conditions FC1 and FC2 and FC3.
– Network timing is not available at the user side.
– The network side transmits AU-AIS and MS RDI to the user side.
– The network side receives frames containing MS-RDI.

G12 state:

– This fault state corresponds to fault conditions FC1 and FC3 and FC4 or FC1 and FC2 and FC3 and FC4.
– Network timing is not available at the user side.
– The network side transmits frames containing Path AIS and MS RDI to the user side

G13 state: Power on state

– This is a transient state and the network side may change the state after detection of the signal received.

5.1.4.3 Definition of primitives

The following primitives should be used between the physical media dependent layer and the management entity [Management Physical Header (MPH) primitives].

MPH-AI MPH ACTIVATE INDICATION (is used as error recovery and initialization information)

MPH-DI MPH Deactivate Indication

MPH-EIn MPH ERROR INDICATION with parameter n (n defines the failure condition relevant to the reported error)

MPH-CIn MPH Correction Indication with parameter n (n defines the failure condition relevant to the reported recovery)

5.1.4.4 State tables

Operational functions are defined in Table 7 for the layer 1 states at the user side of the interface and in Table 8 for the network side.

Table 7/I.432.2 – F-state Table – Physical Layer 1 state matrix at the user side (Note 1)

	Initial state →	**F0**	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**
Definition of the states	Operational condition or fault condition	Power off at user side	Operational	FC1	FC2 fault conditions (Note 4)	FC3 or FC3&FC1	FC4 or FC4&FC1 or FC3&FC4	FC3&FC4 or FC3&FC4 &FC1	Power on at user side
	Signal transmitted by user towards the interface	No signal	Normal operational frames	Normal operational frames	Frames with M-section-RDI and Path-RDI	Frames with Path-RDI	Normal operational frames	Frames with Path-RDI	No signal
New event detected at the receiving side	Loss of power or power down mode at user side	/	PH-DI MPH-EI0 F0	MPH-EI0 F0	MPH-EI0 F0	MPH-EI0 F0	MPH-EI0 F0	MPH-EI0 F0	MPH-EI0 F0
	Return of power to user side	F7	/	/	/	/	/	/	/
	Normal operational frames from network side	/	–	PH-AI MPH-AI F1	PH-AI MPH-AI F1	PH-AI MPH-AI F1	PH-AI MPH-AI F1	PH-AI MPH-AI F1	PH-AI MPH-AI F1
	Reception of Path-RDI (FC1)	/	MPH-DI MPH-EI1 F2	–	ndp	–	–	–	MPH-EI1 F2
	LOS or LOF or (FC2) (Note 2)	/	MPH-DI MPH-EI2 F3	MPH-EI2 F3	–	MPH-EI2 F3	MPH-EI2 F3	MPH-EI2 F3	MPH-EI2 F3
	LCD or LOP or Path-AIS (FC3) or (FC1&FC3) (Note 3)	/	MPH-DI MPH-EI3 F4	MPH-EI3 F4	ndp	–	MPH-EI3 F4	–	MPH-EI3 F4
	Reception of Path-RDI and MS-RDI (FC4)	/	MPH-DI MPH-EI4 F5	MPH-EI4 F5	ndp	MPH-EI4 F5	–	–	MPH-EI4 F5
	Path AIS and MS-RDI or LCD, MS-RDI and Path-RDI or LOP MS-RDI (FC3 and FC4)	/	PH-DI MPH-EI3 MPH-EI4 F6	MPH-EI3 MPH-EI4 F6	ndp	MPH-EI4 F6	MPH-EI3 F6	–	MPH-EI3 MPH-EI4 F6

NOTE 1 – If the path trace is used, the path trace mismatch will be a path-related failure as LOP or LCD. In this table "LCD" will be substituted by "LCD or path trace mismatch".

NOTE 2 – When FC2 occurs, other fault conditions (FC1 or FC3 or FC4) can not be detected but they may occur simultaneously.

NOTE 3 – When FC3 occurs, FC1 (P-RDI) can not be detected but it may occur simultaneously.

NOTE 4 – The user side cannot distinguish among FC2, FC2&FC1, FC2&FC3, FC2&FC4, FC2&FC1&FC3, FC2&FC1&FC4, FC2&FC3&FC4, or FC2&FC1&FC3&FC4

Table 8/I.432.2 – G-state Table – Physical Layer 1 state matrix at the network side

	Initial state →	G0	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13
Definition of the state	Operational condition or failure condition	Power off at NT1	Operational	FC1	FC2	FC3	FC4 or FC2& FC4	FC1& FC2	FC1& FC3	FC1& FC4 or FC1& FC2 &FC4	FC2& FC3	FC3& FC4 or FC2& FC3& FC4	FC1& FC2 &FC3	FC1&FC3 &FC4 or FC3&FC4 &FC1& FC2	Power on at NT
	Signal transmitted toward the interface	No signal	Normal operational signal	Signal with P-RDI	Normal operational signal	Signal with AU-AIS	Signal with MS and P-RDI	Signal with P-RDI	Signal with AU-AIS	Signal with MS and P-RDI	Signal with AU-AIS	Signal with AU-AIS and MS-RDI	Signal with AU-AIS	Signal with AU-AIS and MS-RDI	No signal
New detected event	Loss of power or power down mode at NT1	–	PH-DI MPH-EI0 G0	MPH-EI0 G0	MPH-EI0 G0	MPH-EI0 G0	MPH-EI0 G0	MPH-EI0 G0	MPH-EI0 G0	MPH-EI0 G0	MPH-EI0 G0	MPH-EI0 G0	MPH-EI0 G0	MPH-EI0 G0	MPH-EI0 G0
	return of power at NT1	MPH-CI0 G13	/	/	/	/	/	/	/	/	/	/	/	/	/
	Normal operational frames	/	–	PH-AI MPH-AI G1	PH-AI MPH-AI G1	PH-AI MPH-AI G1	PH-AI MPH-AI G1	PH-AI MPH-AI G1	PH-AI MPH-AI G1	PH-AI MPH-AI G1	PH-AI MPH-AI G1	PH-AI MPH-AI G1	PH-AI MPH-AI G1	PH-AI MPH-AI G1	PH-AI MPH-AI G1
New appearing event	Internal network failure FC1	/	PH-DI MPH-EI1 G2	–	MPH-EI1 G6	MPH-EI1 G7	MPH-EI1 G8	–	–	–	MPH-EI1 G11	MPH-EI1 G12	–	–	MPH-EI1 G2
	Reception of MS&P-RDI (FC2)	/	PH-DI MPH-EI2 G3	MPH-EI2 G6	–	MPH-EI2 G9	ndp	–	MPH-EI2 G11	ndp	–	ndp	–	ndp	MPH-EI2 G3
	Internal network failure (FC3) (Note)	/	PH-DI MPH-EI3 G4	MPH-EI3 G7	MPH-EI3 G9	–	MPH-EI3 G10	MPH-EI3 G11	–	MPH-EI3 G12	–	–	–	–	MPH-EI3 G4
	LOS or LOF (FC4)	/	PH-DI MPH-EI4 G5	MPH-EI4 G8	MPH-EI4 G5	MPH-EI4 G10	–	MPH-EI4 G8	MPH-EI4 G12	–	MPH-E-I4 G10	–	MPH-EI4 G12	–	MPH-EI4 G5
Dis-appearing FC	FC1	/	/	MPH-CI1 G1	/	/	/	MPH-CI1 G3	MPH-CI1 G4	MPH-CI1 G5	/	/	MPH-CI1 G9	MPH-CI1 G10	/
	FC2	/	/	/	MPH-CI2 G1	/	–	MPH-CI2 G2	/	–	MPH-CI2 G4	–	MPH-CI2 G7	–	/
	FC3	/	/	/	/	MPH-CI3 G1	/	/	MPH-CI3 G2	/	MPH-CI3 G3	MPH-CI3 G5	MPH-CI3 G6	MPH-CI3 G8	/
	FC4	/	/	/	/		MPH-CI4 G3	/	/	MPH-CI4 G6	/	MPH-CI4 G9	/	MPH-CI4 G11	/

NOTE – If FC3 represents a path-related fault condition (e.g. LCD), the consequent reaction is not applicable for the G-state table, because this failure can not be recognized at the network side. Therefore, no state change will occur.

Explanations of the symbol used in Tables 7 and 8:

5.2 Cell-based

The applicability of the previous subclause 5.1 to the cell-based interface is for further study.

6 Power feeding

6.1 Provision of power

The provision of power to the B-NT1 via the user network interface is optional. When the power is provided, the following conditions should be considered.

A separate pair of wires is used for the provision of power to the B-NT1 via the T_B reference point.

The power sink is fed by either:

– a source under the responsibility of the user when requested by the network provider; or

– a power supply unit under the responsibility of the network provider connected to the mains electric supply in the customer premises.

The capability of the provision of power by the user side is available either:

– as an integral part of the B-NT2/B-TE; and/or

– physically separated from the B-NT2/B-TE as an individual power supply unit.

A power source capable to feed more than one B-NT1 should meet the requirements at each individual B-NT1 power feeding interface at the same point in time. A short circuit or overload condition in any B-NT1 should not affect the power feeding interface of the other B-NT1s.

6.2 Power available at B-NT1

The power available at the B-NT1 via the user-network interface should be at least 15 watts.

6.3 Feeding voltage

The feeding voltage at the B-NT1 should be in the range of −20 V to −57 V relative to ground.

6.4 Safety requirements

In principle, safety requirements are outside the scope of this Recommendation. However, in order to harmonize power source and sink requirements the following is required:

– The power source should be protected against short circuits and overload.

– The power sink of B-NT1 should not be damaged by an interchange of wires.

With respect to the feeding interface of the power source, which is regarded as a touchable part in the sense of IEC Publication 950 [12], the protection methods against electric shock specified in IEC Publication 950 [12] may be applied.

7 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

[1] ITU-T Recommendation G.825 (1993), *The control of jitter and wander within digital networks which are based on the Synchronous Digital Hierarchy (SDH)*.

[2] ITU-T Recommendation G.958 (1994), *Digital line systems based on the synchronous digital hierarchy for use on optical fibre cables*.

[3] CCITT Recommendation G.703 (1991), *Physical/electrical characteristics of hierarchical digital interfaces*.

[4] ITU-T Recommendation G.957 (1995), *Optical interfaces for equipments and systems relating to the synchronous digital hierarchy*.

[5] ITU-T Recommendation G.652 (1993), *Characteristics of a single-mode optical fibre cable*.

[6] IEC Publication 825 (1993), *Safety of laser products*.

[7] ITU-T Recommendation G.707 (1996), *Network node interface for the Synchronous Digital Hierarchy (SDH)*.

[8] ITU-T Recommendation I.361 (1995), *B-ISDN ATM Layer specification*.

[9] ITU-T Recommendation I.610 (1995), *B-ISDN operation and maintenance principles and functions*.

[10] ITU-T Recommendation G.826 (1996), *Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate*.

[11] ITU-T Recommendation G.783 (1994), *Characteristics of Synchronous Digital Hierarchy (SDH) equipment functional blocks*.

[12] IEC Publication 950 (1991), *Safety of information technology equipment, including electrical business equipment*.

8 Definitions

None.

9 Abbreviations

This Recommendation uses the following abbreviations.

AIS	Alarm Indication Signal
ATM	Asynchronous Transfer Mode
AU	Administrative Unit

BER	Bit Error Ratio
BIP	Bit Interleaved Parity
B-ISDN	Broadband Integrated Services Digital Network
B-NT1	Broadband Network Termination 1
B-NT2	Broadband Network Termination 2
B-TE	Broadband Terminal Equipment
B-UNI	Broadband User Network Interface
CATV	Community Antenna Television
CEC	Cell Error Control
CRC	Cyclic Redundancy Check
EDC	Error Detection Code
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
IEC	International Electrotechnical Commission
LCD	Loss of Cell Delineation
LOM	Loss of Maintenance Flow
LOS	Loss of Signal
MBS	Maximum Block Size
MPH	Management Physical Header
NIC	Number of Included Cells
NNI	Network Node Interface
NMB-EB	Number of Monitored Blocks Errored Blocks
NMB-EDC	Number of Monitored Blocks Error Detection Code
NRZ	Non Return to Zero
OAM	Operations, Administration and Maintenance
OCD	Out of Cell Delineation
PL	Physical Layer
POH	Path Overhead
RDI	Remote Defect Indication
SDH	Synchronous Digital Hierarchy
SOH	Section Overhead
STI	Surface Transfer Impedance
STM	Synchronous Transport Module
TEB	Total Errored Blocks
TP-AIS	Transmission Path Alarm Indication Signal
TP-FEBE	Transmission Path Far End Bit Error

TP-RDI	Transmission Path Remote Defect Indication
TFV	Terminal Failure Voltage
UNI	User Network Interface
VC	Virtual Container

10 Keywords

B-ISDN, UNI, user-network interface, ATM.

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