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SERIES J: TRANSMISSION OF TELEVISION, SOUND
PROGRAMME AND OTHER MULTIMEDIA SIGNALS

Transport of MPEG-2 signals on packetised networks

Transport of MPEG-2 signals in SDH networks

ITU-T Recommendation J.132

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION J.132

TRANSPORT OF MPEG-2 SIGNALS IN SDH NETWORKS

Summary

This Recommendation provides the requirements for an equipment called "SDH network adapter" for the transport of MPEG-2 signals over SDH networks. It describes the necessary operations to adapt the MPEG-2 transport streams into a STM-1 or sub-STM-1 frame and the functional characteristics associated to this equipment.

Source

ITU-T Recommendation J.132 was prepared by ITU-T Study Group 9 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 18th of March 1998.

FOREWORD

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TRANSPORT OF MPEG-2 SIGNALS IN SDH NETWORKS

(Geneva, 1998)

1 Scope

This Recommendation specifies the transmission of MPEG-2 transport streams within SDH networks working at the G.707 hierarchical bit rate of 155 520 kbit/s or at a bit rate of 51 840 kbit/s. The use of any of these bit rates is optional, if however one or more rates are selected the complete specification applies. The definition of the network aspects of the transmission of MPEG-2 transport streams is based to the maximum extent on existing international standards.

The equipment considered in this Recommendation is the Network Adapter performing the adaptation between MPEG-2 transport streams and the interfaces of SDH networks.

The bit rates and the frames structures for STM-N signals, the SDH multiplexing structures and the different overheads of an STM-N frame (POH, SOH) are specified in Recommendation G.707.

The application of this Recommendation is restricted to a physical layer point-to-point connection without ATM connection functionality at intermediate points.

2 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 revisions; 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.

- EN 50083-9 (1998), *Cabled distribution systems for television, sound and interactive multimedia signals; Part 9: Interfaces for CATV/SMATV headends and similar professional equipment for DVB/MPEG-2 transport streams.*
- ETR 290 (1997), *Digital Video Broadcasting (DVB); Measurement guidelines for DVB systems.*
- ITU-R Recommendation F.750-3 (1997), *Architectures and functional aspects of radio-relay systems for SDH-based networks.*
- ITU-T Recommendation G.707 (1996), *Network node interface for the Synchronous Digital Hierarchy (SDH).*
- ITU-T Recommendation G.783 (1997), *Characteristics of Synchronous Digital Hierarchy (SDH) equipment functional blocks.*
- ITU-T Recommendation G.826 (1996), *Error performance parameters and objectives for international, constant bit-rate digital paths at or above the primary rate.*
- ITU-T Recommendation H.222.0 (1995) | ISO/IEC 13818-1:1996, *Information technology – Generic coding of moving pictures and associated audio information: Systems.*
- ITU-T Recommendation I.361 (1995), *B-ISDN ATM layer specification.*
- ITU-T Recommendation I.363.1 (1996), *B-ISDN ATM adaptation layer (AAL) specification – Type 1 AAL.*
- ITU-T Recommendation I.432 (1996), *B-ISDN user-network interface – Physical layer specification.*
- ITU-T Recommendation I.732 (1996), *Functional characteristics of ATM equipment.*

- ITU-T Recommendation J.82 (1996), *Transport of MPEG-2 constant bit-rate television signals in B-ISDN*.
- ITU-T Recommendation J.83 (1997), *Digital multi-programme systems for television, sound and data services for cable distribution*.
- ITU-T Recommendation M.2120 (1997), *Digital paths, section and transmission system fault detection and localization procedures*.
- ITU-T Recommendation Q.822 (1994), *Stage 1, stage 2 and stage 3 description for the Q3 interface – Performance management*.

3 Terms and definitions

This Recommendation defines the following terms.

3.1 fixed stuff: Bytes that are used to fill up unused data positions.

3.2 MPEG-2 Transport Stream (TS) packet: A data packet possessing a length of 188 bytes including 4 bytes of header information. The header contains MPEG related data.

3.3 RS coded MPEG-2 Transport Stream (TS) packet: A data packet possessing a length of 204 bytes. Bytes 1 to 188 contain an MPEG-2 transport stream packet. Bytes 189 to 204 contain the parity-check bytes for the error correction of the preceding bytes of this packet. These parity-check bytes are generated using a shortened Reed-Solomon Code RS (204, 188) as specified in Annex A/J.83.

4 Acronyms and abbreviations

This Recommendation uses the following abbreviations:

AAL	ATM Adaptation Layer
AIS	Alarm Indication Signal
ASI	Asynchronous Serial Interface
ATM	Asynchronous Transfer Mode
AU	Administrative Unit
AUG	Administrative Unit Group
BER	Bit Error Rate
C-n	Container-n
CRC	Cyclic Redundancy Check
CS	Convergence Sublayer
DEG	DEGraded
EBC	Error Block Count
EMF	Equipment Management Function
ES	Errored Second
FAS	Frame Alignment Signal
FEC	Forward Error Correction
GFC	Generic Flow Control
HEC	Header Error Control

HOVC	Higher Order Virtual Container
LCD	Loss of Cell Delineation
LMC	Lost and Misinserted Cells
LOF	Loss of Frame
LOM	Loss of Multiframe
LOP	Loss of Pointer
LOS	Loss of Signal
LOVC	Lower Order Virtual Container
LTI	Loss of Timing Inputs
MAA	MPEG ATM Adaptation
MP	Management Point
MPEG	Moving Pictures Experts Group
MPI	MPEG Physical Interface
MSA	Multiplex Section Adaptation
MSOH	Multiplex Section Overhead
MST	Multiplex Section Termination
NE	Network Element
PDU	Protocol Data Unit
PLM	Payload Label Mismatch
POH	Path Overhead
PT	Payload Type
RDI	Remote Defect Indication
REI	Remote Error Indication
RFI	Remote Failure Indication
RR	Radio Relay
RS	Reed-Solomon
RSOH	Regenerator Section Overhead
RST	Regenerator Section Termination
SAP	Service Access Point
SAR	Segmentation And Reassembly sublayer
SC	Sequence Count
SDH	Synchronous Digital Hierarchy
SETPI	Synchronous Equipment Timing Physical Interface
SETS	Synchronous Equipment Timing Source
SES	Severely Errored Second
SN	Sequence Number
SNI	Sequence Number Invalid

SOH	Section Overhead
SPI	Synchronous Parallel Interface; Synchronous Physical Interface
SSF	Server Signal Fail
SSI	Synchronous Serial Interface
STM	Synchronous Transport Module
TD	Transmit Degrade
TF	Transmit Fail
TIM	Trace Identifier Mismatch
TS	Transport Stream
TSLE	Transport Stream synchronization Loss Error
TU	Tributary Unit
UI	Unit Interval
UNEQ	UNEQuipped
VC	Virtual Container; Virtual Channel
VCI	Virtual Channel Identifier
VP	Virtual Path
VPE	Virtual Path Entity
VPI	Virtual Path Identifier
VPME	VP Multiplexing Entity
WTR	Wait to Restore

5 Conventions

Unless otherwise mentioned, in this Recommendation the following conventions hold true:

- The order of transmission of information in all diagrams is first from left to right and then from top to bottom. Within each byte or octet the most significant bit is transmitted first.
- The term "VC-n" is used for higher order VC (VC-3 and VC-4).
- The term "VC-m" is used for lower order VC (VC-3, VC-2, VC-12 and VC-11).

6 Network adapter overview

6.1 Functional description

The Network Adapter is an equipment which performs the adaptation of data structured as an MPEG-2 Transport Stream to the characteristics of an SDH link. The solution selected for the transmission of MPEG-2-TS packets, or optionally for the transmission of RS coded MPEG-2-TS packets, over SDH links is based on the use of ATM cells. Therefore, the adaptation of the transport of an MPEG-2-TS basically consists in:

- adaptation of MPEG-2-TS packets or RS coded MPEG-2-TS packets to ATM cells;
- adaptation of ATM cells to SDH framing.

NOTE – The processing of ATM VC level is not performed.

The normative references applicable to the adaptation unless specifically mentioned are given here below:

- the adaptation of MPEG-2-TS packets into ATM cells using an AAL type 1 shall be performed as described in Recommendation J.82. AAL type 1 is specified in Recommendation I.363.1, the ATM layer is specified in Recommendation I.361;
- the adaptation of ATM cells into SDH framing shall be performed as described in Recommendation G.707.

There is no normative reference for the adaptation of RS coded MPEG-2-TS packets to ATM cells. This adaptation shall be performed as described in Recommendation J.82 for MPEG-2-TS packets, with the only exception that the RS coded MPEG-2-TS packets are not aligned with the structure of the AAL1 interleaving matrix.

The Network Adapter is described as a group of functional blocks. The partitioning into functional blocks is based on existing Recommendations on SDH equipment (Recommendation G.783) and ATM equipment (Recommendation I.732). The equipment consists of the following blocks (see also Figure 1):

- MPEG Physical Interface (MPI);
- MPEG ATM Adaptation (MAA);
- Virtual Path Entity (VPE);
- VP Multiplexing Entity (VPME);
- VC-m Trail Termination (Sm_TT);
- VC-n layer to VC-m layer Adaptation (Sn/Sm_A);
- VC-n Trail Termination (Sn_TT);
- STM-1 Multiplex section to VC-n Adaptation (MS1/Sn_A);
- STM-1 Multiplex Section Trail Termination (MS1_TT);
- STM-1 Regenerator Section to STM-1 Multiplex Section Adaptation (RS1/MS1_A);
- STM-1 Regenerator Section Trail Termination (RS1_TT);
- STM-1 Optical or Electrical Section to STM-1 Regenerator Section Adaptation (OS1/RS1_A or ES1/RS1_A);
- STM-1 Optical or Electrical Section Trail Termination (OS1_TT or ES1_TT);
- Synchronous Equipment Timing Source (SETS);
- Synchronous Equipment Timing Physical Interface (SETPI);
- and Equipment Management Function (EMF).

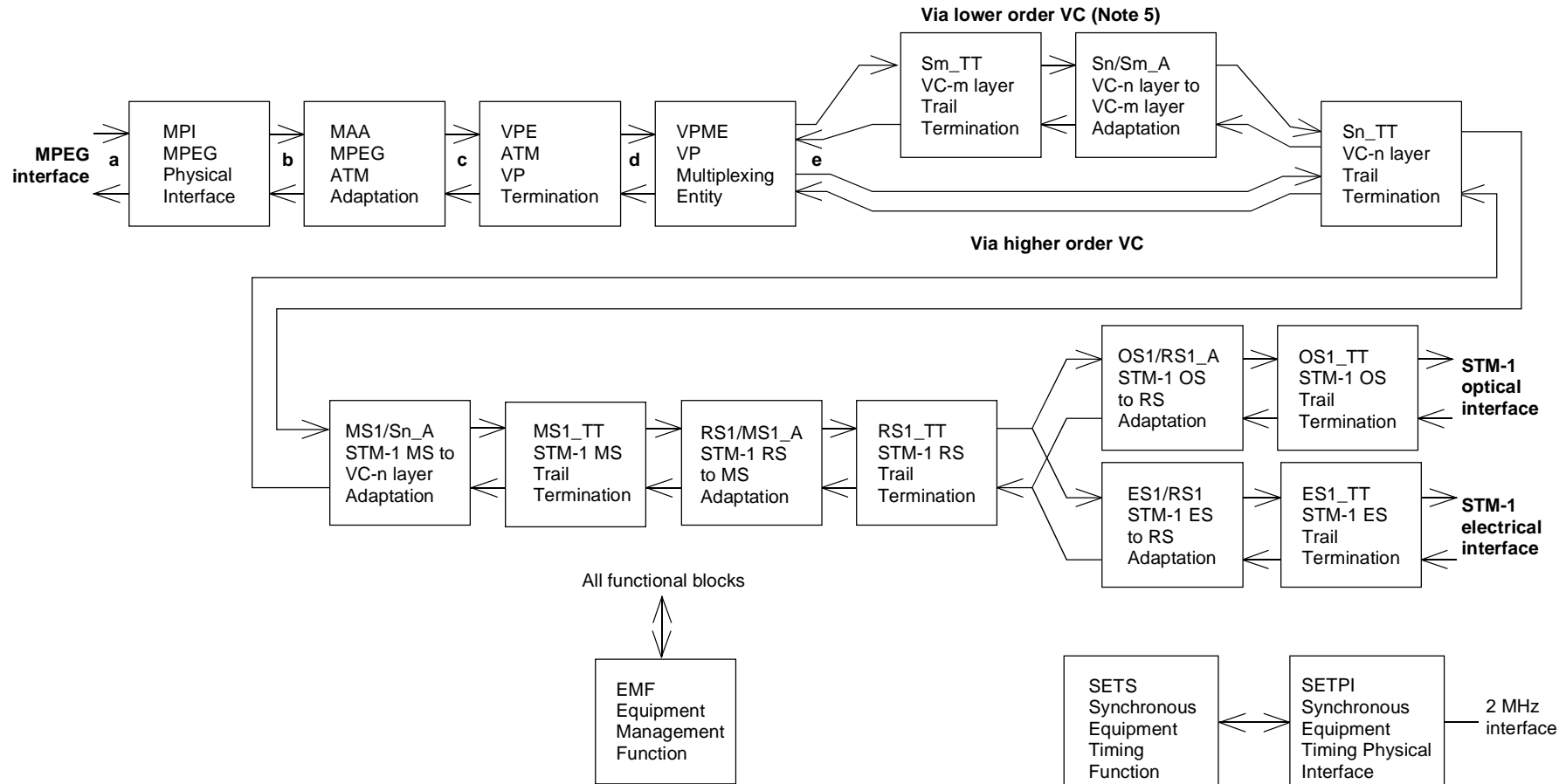
The present description is a functional description and does not imply any specific equipment implementation but it allows for the implementation of a separate transmitter and receiver as well as a combined transmitter/receiver.

The protocol stack used by this equipment is shown in Figure 2.

The following functional blocks are identified:

- *The MPEG-2-TS Physical Interface:* the Network Adapter accepts, at its input port, either an MPEG-2-TS consisting of consecutive MPEG-2-TS packets, or optionally an extended version of an MPEG-2-TS that already contains error protection as specified in Annex A/J.83 (RS coded MPEG-2-TS packets). Packets length of 188 bytes and optionally 204 bytes can be handled.
- *The MPEG ATM Adaptation:* this corresponds to the adaptation between the MPEG-2-TS respectively the RS coded MPEG-2-TS and the ATM cells via an AAL type 1. This adaptation, besides format adaptation, provides functions for the MPEG-2-TS clock transmission transparency (adaptive clock method) and information transparency using the clock and data recovery mechanism of AAL1. It is expected that under normal transmission conditions the received MPEG-2-TS will be quasi error free, corresponding to a Bit Error Rate (BER) of about 10^{-10} to 10^{-11} at the input of an MPEG-2 equipment at the receiver site. This requirement is in accordance with cable systems specified in Annex A/J.83.
- *The Virtual Path Entity:* the only function performed is the VP setting. It allows the simultaneous transmission of several independent MPEG-2-TS on one SDH link.

- *The VP Multiplexing Entity:* if different MPEG-2-TS have to be simultaneously transported, the ATM cells belonging to different VPs are multiplexed in the transmitter resp. demultiplexed in the receiver. If only one MPEG-2-TS has to be transported, only one VP is used. The adaptation to the useful bit rate offered by the SDH link is performed by adding resp. removing idle cells. At the receiver, this block also performs cell delineation and ATM cell header checking.
- *The VC-m Trail Termination:* this block generates and adds the error monitoring, the status and the control overhead information to lower order Virtual Containers (VC-11, VC-12, VC-2 or VC-3) at the transmitter site. In the receiver, the appropriate Virtual Containers are monitored for errors and the payload independent overhead information is extracted.
- *The VC-n to VC-m Adaptation:* in the transmitter, this function is responsible for the multiplexing of lower order VCs into a higher order VC, for the processing of the relevant pointers and for the setting of VC-n POH bytes H4 and C2. In the receiver, H4 and C2 are evaluated and the pointer information is used in order to ensure a correct demultiplexing of higher order VC-n contents into lower order VCs.
- *The VC-n Trail Termination:* this block generates and adds the error monitoring, the status and the control overhead information to a Higher Order VC-n at the transmitter site. In the receiver, the VC-n is monitored for errors and the payload independent overhead information is extracted.
- *The STM-1 Multiplex section to VC-n Adaptation:* in the transmitter, this function provides adaptation of Higher Order VC-n into AU-n, assembly of AUG, byte interleaving multiplexing and pointer generation. In the receiver, this function provides byte interleaving demultiplexing, disassembly of AUG, adaptation of AU-n into Higher Order VC-n and pointer interpretation.
- *The STM-1 Multiplex Section Trail Termination:* in the transmitter, this function generates and adds the error monitoring, status and control overhead information to the STM-1 MSOH. In the receiver, this function monitors the multiplex section for errors and extracts relevant overhead information from the MSOH.
- *The STM-1 Regenerator Section to STM-1 Multiplex Section Adaptation:* in the transmitter, this function provides adaptation of the multiplex section into the STM-1 regenerator section. In the receiver, this function provides the adaptation of the STM-1 regenerator section into the multiplex section.
- *The STM-1 Regenerator Section Trail Termination:* in the transmitter, this function completes the STM-1 signal by adding the frame alignment information, the section trace identifier and the parity control byte to the STM-1 RSOH and scrambles the signal. In the receiver, this function descrambles the STM-1 signal, monitors it for errors and extracts relevant overhead information from the RSOH.
- *The STM-1 Optical Section to STM-1 Regenerator Section Adaptation:* in the transmitter, this function provides the adaptation of the STM-1 signal into the optical physical section. In the receiver, this function regenerates the received signal and recovers bit timing and frame alignment.
- *The STM-1 Electrical Section to STM-1 Regenerator Section Adaptation:* in the transmitter, this function provides the CMI encoding of the STM-1 signal. In the receiver, this function recovers bit timing and frame alignment from the received signal and decodes the incoming STM-1 signal.
- *The STM-1 Optical Section Trail Termination:* in the transmitter, this function generates the optical STM-1 signal for the transmission over optical cable. In the receiver, this function recovers the optical STM-1 signal transmitted over the optical cable.
- *The STM-1 Electrical Section Trail Termination:* in the transmitter, this function generates the electrical STM-1 signal for the transmission over the electrical cable. In the receiver, this function recovers the electrical STM-1 signal transmitted over electrical cable.
- *The Synchronous Equipment Timing Source:* this function provides timing reference to other functions of an SDH equipment and represents the SDH network element clock.
- *The Synchronous Equipment Timing Physical Interface:* this function provides the interface between an external synchronization signal and the SETS. It also provides a 2 MHz synchronization output signal.
- *The Equipment Management Function:* this block manages all the other functional blocks. It ensures the Man Machine Interface.



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NOTE 1 – Block Sm_TT (termination of lower order VC-m): the allowed values for m are 11, 12, 2 or 3.

NOTE 2 – Block Sn_TT (termination of higher order VC-n): the allowed values for n are 3 or 4.

NOTE 3 – In case of the transport of ATM cells by a lower order VC-m, the blocks Sm_TT and Sn/Sm_A are necessary. If ATM cells are directly mapped into a higher order VC-n, only block Sn_TT is necessary, the blocks Sm_TT and Sn/Sm_A are not present in that case.

NOTE 4 – For the SDH Physical Interface, for the realization of the electrical interface the blocks ES1/RS1_A and ES1_TT are necessary, for the realization of the optical interface the blocks OS1/RS1_A and OS1_TT are necessary.

NOTE 5 – The use of VC-2-mc is for further study.

Figure 1/J.132 – Functional blocks of the Network Adapter

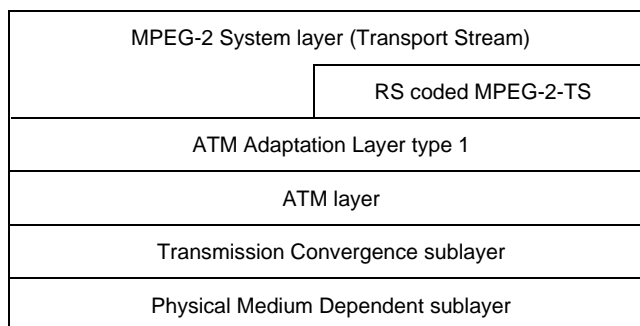


Figure 2/J.132 – Protocol stack for the adaptation process

The processing of the MPEG data for the transmission inside an SDH network can be done using several types of Virtual Containers depending on the wanted payload capacity. It is not mandatory to implement all types of VC processing inside the Network Adapter. If, however, one or more types of VC processing are selected as described in this Recommendation, the complete specification applies.

The transmission capacity at each VC bit rate for the MPEG-2-TS resp. the RS-coded MPEG-2-TS is given in Appendix III taking into account the RS (128, 124) code and the data amount of the SAR-PDU header.

6.2 SDH overhead information

The different overheads of an STM-N frame (POH, SOH) are specified in Recommendation G.707.

Therefore, in the context of the SDH network adapter described in this Recommendation, some specific overhead information are not used or are used with a particular value. When not used, the content of these bits or bytes is undefined at the transmitter side and is ignored at the receiver side. When used without additional information in this Recommendation, their content is set according to Recommendation G.707 and should be processed as described in Recommendation G.783.

Table 1 indicates for each SOH information if it is used in the context of the SDH network adapter and, if necessary, any setting of particular value.

Table 2 indicates for each VC-4 and VC-3 POH information if it is used in the context of the SDH network adapter and, if necessary, any setting of particular value.

Table 3 indicates for each VC-2, VC-12 and VC-11 POH information if it is used in the context of the SDH network adapter and, if necessary, any setting of particular value.

7 Detailed description of the basic functions

7.1 MPEG Physical Interface (MPI)

7.1.1 Basic characteristics

This function provides the interface between the Network Adapter and the MPEG-2-TS sources or receivers.

In order to prevent alarms being raised and failures being reported during set-up procedures or if the input port is not in use (in the case of a multi-port equipment), the MPI function shall have the ability to enable or disable fault case declaration. The MPI shall be either monitored (MON) or not monitored (NMON). The state MON or NMON is provisioned by the equipment manager to the MPI via the EMF function.

Table 1/J.132 – SOH information

SOH bytes	Usage	Particular value
A1, A2 – Framing	Yes	–
J0 – Section Trace	Yes (see RS1_TT)	–
B1 – BIP-8	Yes (see RS1_TT)	–
Z0 – Spare	No	–
E1, E2 – Orderwire	No	–
F1 – User channel	No	–
D1 D3 – RS DCC	No	–
D4 D12 – MS DCC	No	–
B2 – BIP-NX24	Yes (see MS1_TT)	–
K1, K2(b1-b5) – APS	No	–
K2(b6-b8) – RDI and AIS	Yes (see MS1_TT)	(Note 2)
M1 – REI	Yes (see MS1_TT)	(Note 2)
S1(b1-b4) – Spare	No	–
S1(b5-b8) – Synchronization status	No	(Note 1)

NOTE 1 – Bits 5 to 8 of byte S1 are defined for the signalling of the synchronization quality level. This functionality is not used in the SDH network adapter. The default value is for further study.

NOTE 2 – In case of unidirectional transmission where there is no associated multiplex section trail termination sink function, the RDI and REI shall be set to a logical "0". In case of unidirectional transmission where there is no associated multiplex section trail termination source function, the RDI and REI are ignored and only near-end performance monitoring is processed by the multiplex section trail termination sink function.

Table 2/J.132 – VC-4 and VC-3 POH

VC-4 and VC-3 POH bytes	Usage	Particular value
J1 – Path Trace	Yes (see S4_TT and S3_TT)	–
B3 – BIP-8	Yes (see S4_TT and S3_TT)	–
C2 – Signal Label	Yes (Note 1)	(Note 1)
G1 – REI + RDI + spare	Yes (see S4_TT and S3_TT)	(Note 3)
F2 – Path user channel	No	–
H4 – Position indicator	(Note 2)	(Note 2)
F3 – Path user channel	No	–
K3 – APS + spare	No	–
N1 – Network operator byte	No	–

NOTE 1 – C2 is a payload dependent information, i.e. it is processed in the adaptation function. When the ATM cells are directly mapped into VC-4 or VC-3 (i.e. VPME connected to S4_TT or S3_TT), byte C2 is processed in VPME: in this case, it shall be set to "13H" as specified in Recommendation G.707. When the VC-4 or VC-3 contains lower order VC (i.e. Sn_TT connected to Sn/Sm_A), byte C2 is processed in Sn/Sm_A function: in this case, it shall be set to "02H" as specified in Recommendation G.707.

NOTE 2 – H4 is a payload dependent information, i.e. it is processed in the adaptation function. When the ATM cells are directly mapped into VC-4 or VC-3 (i.e. VPME connected to S4_TT or S3_TT), byte H4 is processed in VPME: it is not used and its content is undefined. When the VC-4 or VC-3 contains lower order VC (i.e. Sn_TT connected to Sn/Sm_A), byte H4 is processed in Sn/Sm_A function: byte H4 contains a multiframe indicator identifying frames containing the TU-2, TU-12 and TU-11 pointers as described in 8.3.8/G.707 except the case of VC-4 payload containing VC-3 only (in this case, the H4 byte is not used and is undefined).

NOTE 3 – In case of unidirectional transmission where there is no associated trail termination sink function, the RDI and REI shall be set to a logical "0". In case of unidirectional transmission where there is no associated trail termination source function, the RDI and REI are ignored and only near-end performance monitoring is processed by the trail termination sink function.

Table 3/J.132 – VC-2, VC-12 and VC-11 POH

VC-2, VC-12 and VC-11 POH	Usage	Particular value
V5 bits 1-2 (BIP-2)	Yes (see Sm_TT)	–
V5 bit 3 (REI)	Yes (see Sm_TT)	(Note)
V5 bit 4 (RFI)	No	–
V5 bits 5-7 (signal label)	Yes (see VPME)	Set to "001" (Rec. G.707)
V5 bit 8 (RDI)	Yes (see Sm_TT)	(Note)
J2 (Path Trace)	Yes (see Sm_TT)	–
N2 (Network operator byte)	No	–
K4 (APS + spare)	No	–

NOTE – In case of unidirectional transmission where there is no associated trail termination sink function, the RDI and REI shall be set to a logical "0". In case of unidirectional transmission where there is no associated trail termination source function, the RDI and REI are ignored and only near-end performance monitoring is processed by the trail termination sink function.

7.1.1.1 Signal processing in the receiver (Signal flow from a to b in Figure 1)

a) Recovery of MPEG-2 packets

This function recovers the data bytes and their clock from the received signals.

The function also realizes the sync acquisition of the MPEG-2-TS packets, or optionally of the RS-coded MPEG-2-TS packets, on the basis of the method proposed in subclause 3.2 of ETR 290 (five consecutive correct sync bytes for sync acquisition; two or more consecutive corrupted sync bytes should indicate sync loss).

The function passes the recovered MPEG-2-TS packets or the RS coded MPEG-2-TS packets and the timing information to point b of Figure 1.

This function shall also detect the absence of valid input signals and the absence of clock.

If any of these defects is detected, a Loss of Signal (LOS) is reported to the EMF if the function is in MON state.

If a loss of synchronization of MPEG-2-TS packets or RS coded MPEG-2-TS packets is detected according to the procedure proposed in subclause 3.2 of ETR 290 (i.e. two or more consecutive corrupted sync bytes are found), a TS-sync_loss error on the input signal (TSLE_I) is reported at the EMF if the function is in MON state.

b) Performance monitoring

Errored blocks are detected on the basis of the transport_error_indicator present in the headers of the incoming MPEG-2-TS packets, in accordance to ETR 290. One second filters perform a simple integration of errored blocks by counting during one second interval. The function generates the following performance parameters concerning the input MPEG-2-TS signal received on the interface:

- N_EBC_I: every second, the number of errored blocks within that second is counted as the Near-End Error Block Count (N_EBC_I),
- N_DS_I: every second with at least one occurrence of TSLE_I or LOS (corresponding to the notion of Severely Disturbed Period introduced in ETR 290) shall be indicated as Near-End Defect Second (N_DS_I).

If the function is in the MON state, at the end of each one second interval, the contents of the N_EBC_I counter and of the N_DS_I indicator are reported to the EMF. Furthermore, on request of the EMF block, the MPI block evaluates and reports to the EMF the number of received MPEG-2-TS packets within one second (BC_I).

7.1.1.2 Signal processing in the transmitter (Signal flow from b to a in Figure 1)

a) *Generation of the signals at the MPEG Physical interface*

This function receives the data bytes provided at the reference point b of Figure 1 by the MAA block and recovers the synchronization of the MPEG-2-TS packets or optionally of the RS coded MPEG-2-TS packets on the basis of the method proposed in subclause 3.2 of ETR 290 (five consecutive correct sync bytes for sync acquisition; two or more consecutive corrupted sync bytes should indicate sync loss). Optionally, the type of packet (MPEG-2-TS packet or RS-coded MPEG-2-TS packet) is determined on the basis of the periodicity of the synchronization bytes. After the recovery of the packet structure and only in the case of a MPEG-2-TS packet structure, the function shall use the status indicator of the AAL-SAP (available at reference point b) to set the transport_error _indicator of the MPEG-2-TS packets.

The function generates the appropriate signals at the output interface.

If a loss of synchronization of MPEG-2-TS packets or optionally of the RS coded MPEG-2-TS packets is detected according to the procedure proposed in subclause 3.2 of ETR 290 (i.e. two or more consecutive corrupted sync bytes are found), a TS-sync_loss error for the output signal (TSLE_O) is reported at the EMF if the function is in MON state.

b) *Performance monitoring*

Errored blocks are detected on the basis of the transport_error_indicator present in the headers of the MPEG-2-TS packets regenerated in the MPI block, in accordance to ETR 290. One second filters perform a simple integration of errored blocks by counting during one second interval. The function generates the following performance parameters concerning the output MPEG-2-TS signal delivered by the interface:

- N_EBC_O: every second, the number of errored blocks within that second is counted as the Near-End Error Block Count (N_EBC_O),
- N_DS_O: every second with at least one occurrence of TSLE_O or LOS (corresponding to the notion of Severely Disturbed Period introduced in ETR 290) shall be indicated as Near-End Defect Second (N_DS_O).

If the function is in the MON state, at the end of each one second interval, the contents of the N_EBC_O counter and of the N_DS_O indicator are reported to the EMF. Furthermore, on request of the EMF block, the MPI block evaluates and reports at the EMF the number of received MPEG-2-TS packets within one second (BC_O).

7.1.2 Additional characteristics for System A (European system)

The physical characteristics of the interface shall follow the specification given in EN 50083-9. Three different types of interfaces are specified. They are called:

- Synchronous Parallel Interface (SPI),
- Synchronous Serial Interface (SSI),
- Asynchronous Serial Interface (ASI).

The interfaces use the MPEG-2-TS Packet structure (188 bytes) or the RS-coded packet structure (204 bytes). For the Synchronous Parallel Interface and the Synchronous Serial Interface, the 204-byte format may be used either for the transmission of 188-byte MPEG-2-TS packets with 16 dummy bytes, or for the transmission of 204-byte RS-coded packets.

7.1.2.1 Signal processing in the receiver

Data bytes and their clock are recovered from the received signals as specified below:

- For the Synchronous Parallel Interface, this recovery is based on the use of the Data (0-7), the DVALID, PSYNC and clock signals, as specified in subclause 4.1 of EN 50083-9.
- For the SSI interface, the processing includes optical receiver (for fibre-optic-based link) or coupling/impedance matching (for coaxial cable), amplifier/buffer, clock recovery and bi-phase decoding, serial-to-parallel conversion, as specified in Annex A of EN 50083-9.

- For the ASI interface, the processing includes optical receiver (for fibre-optic-based link) or coupling/impedance matching (for coaxial cable), amplifier/buffer, clock/data recovery and serial-to-parallel conversion, FC comma deletion, 8B/10B decoding, as specified in Annex B of EN 50083-9. In the next step, the recovery of the transport stream clock is performed (see Annex E of EN 50083-9: implementation guidelines and deriving clocks from the MPEG-2 packets for the ASI).

The packet size (188 bytes or 204 bytes) may be recovered from the received signals, on the basis of the PSYNC signal for the parallel interface, or on the basis of periodicity of the synchronization bytes for the serial interfaces. For the case of the Synchronous Parallel Interface and of the SSI interface, the decision between 204-byte format for MPEG-2-TS packets with 16 dummy bytes and 204-byte format for RS-coded MPEG-2-TS packets can be made:

- on the basis of the DVALID signal for the Synchronous Parallel Interface: a high level during the last 16 bytes indicates RS redundancy bytes (subclause 4.1.1 of EN 50083-9); or
- on the basis of the value of received synchronization bytes for the SSI interface: 47H indicates 204-byte format with 16 dummy bytes and B8H indicates 204-byte RS coded (subclause A.3.2 of EN 50083-9).

For the case of the ASI Interface, the following decision is taken: if the packet size is 204 bytes, it is an RS-coded MPEG-2 TS packet.

Dummy bytes are discarded by the MPI function in the case of the 204-byte format with 16 dummy bytes.

The function shall meet the electrical/optical characteristics, return loss and jitter requirements specified in EN 50083-9.

A Loss of Signal (LOS) is reported to the EMF if the function is in MON state if any of the following defects is detected: absence of valid input signals, absence of clock or a DVALID signal constantly low in the case of the Synchronous Parallel Interface.

7.1.2.2 Signal processing in the transmitter

The function determines the transmission format to be used at the output interface according to Table 4.

Table 4/J.132 – Transmission format of the output interface

Type of packets received by the MPI block	Transmission format on the physical interface	
MPEG-2-TS packets (188 bytes)	SPI, SSI:	188-byte packets or 204-byte packets with 16 dummy bytes, according to the parameter FORMAT provided by the EMF function.
	ASI:	188-byte packets.
RS-coded MPEG-2-TS packets (204 bytes)	SPI, SSI, ASI:	204-byte packets.

The function generates the appropriate signals at the output interface, according to the type of physical interface and to the transmission format selected:

- For the Synchronous Parallel Interface, the function generates the Data (0-7), the DVALID, PSYNC and clock signals, as specified in subclause 4.1 of EN 50083-9.
- For the SSI interface, the processing includes parallel-to-serial conversion, bi-phase coding, amplifier/buffer and optical emitter (for fibre-optic-based link) or coupling/impedance matching (for coaxial cable), as specified in Annex A of EN 50083-9.
- For the ASI interface, the processing includes 8B/10B coding, FC comma symbols insertion, parallel-to-serial conversion, amplifier buffer and optical emitter (for fibre-optic-based link) or coupling/impedance matching (for coaxial cable), as specified in Annex B of EN 50083-9.

The function shall meet the electrical/optical characteristics, return loss and jitter requirements specified in EN 50083-9.

7.2 MPEG ATM Adaptation (MAA)

The MPEG ATM Adaptation (MAA) utilizes the AAL type 1. The AAL type 1 is described in Recommendation I.363.1 where its functions are described for all corresponding applications. Specifically, the utilization of the AAL1 for the transport of MPEG-2 constant bit rate television signals is described in clause 7/J.82. As a result, the description of the MPEG ATM Adaptation is based on clause 7/J.82. The structure of AAL type 1 is given in Figure 3. The SAR-PDU (Segmentation And Reassembly-Protocol Data Unit) payload of 47 octets is headed by an SAR-PDU header of 8 bits. For the transmission, the payload data is protected by an FEC scheme.

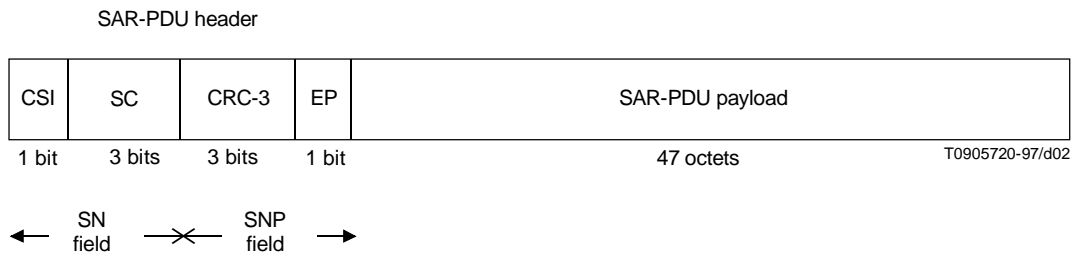


Figure 3/J.132 – Structure of AAL type 1

To prevent alarms being raised and failures being reported during set-up procedures, or if the input port is not in use (in the case of a multi-port equipment), the MAA function shall have the ability to enable or disable fault case declaration. The MAA shall either be monitored (MON) or not monitored (NMON). The state MON or NMON is provisioned by the equipment manager to the MAA via the EMF function.

7.2.1 Signal processing in the transmitter (Signal flow from b to c in Figure 1)

The MAA accepts signals from the MPI and conveys them to the VPE by using a transmitting AAL1. From the protocol stack point of view, signals are transported from the AAL-SAP (AAL-Service Access Point) to the ATM-SAP.

Functions to be performed are those of the AAL1-CS (Convergence Sublayer) and of the AAL1-SAR (Segmentation and Reassembly). The results of this function are used to set the appropriate fields of the SAR-PDU header. The SAR sublayer accepts a 47-octet block of data from the CS layer and prepends a one-octet SAR-PDU header.

a) Handling of user information (CS function)

In compliance with 7.1/J.82, the length of the AAL-SDU (Service Data Unit) is one octet.

b) Handling of lost and misinserted cells (SC field) (CS function)

In the transmitting CS this function is related to the Sequence Count (SC) processing. After processing, the 3-bit sequence count value is passed to the transmitting SAR in order to be inserted in the SC field of the SAR-PDU header (see 7.3/J.82).

c) Handling of the timing relationship (CS function)

As it is stated in 7.4/J.82, the adaptive clock method shall be used. In this method, no function is to be performed in the transmitting CS.

d) Forward error correction for SAR-PDU payload (CS function)

This function is performed by the method described in detail in 2.5.2.4.2/I.363.1. As stated in 7.5/J.82, this method shall be used.

Basically the method combines octet interleaving (the size of the interleaver is 128×47 octets), and FEC using RS (124, 128) codes.

In the transmitting CS, 4 octets of Reed-Solomon code are appended to 124 successive octets of incoming data from the AAL-SAP. The resulting 128-octet long blocks are then forwarded to the octet interleaver. See Figure 4 for the format of the interleaver matrix.

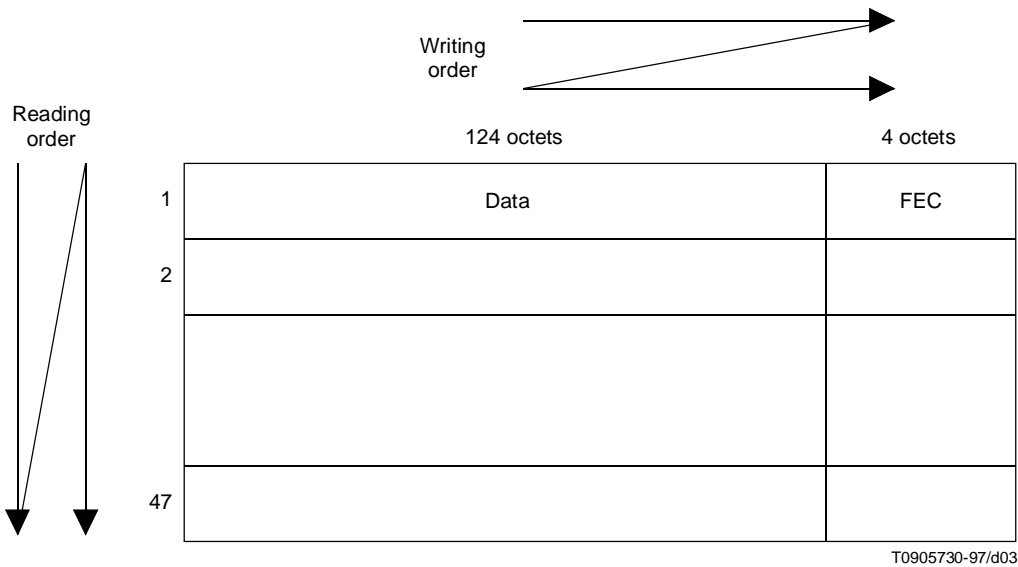


Figure 4/J.132 – Structure and format of the interleaver matrix

The octet interleaver is organized as a matrix of 128 columns and 47 rows. In the transmitting CS, the interleaver is operated as follows: at the input, incoming 128-octet long blocks are stored row by row (one block corresponding to one row); at the output, octets are read out column by column. The matrix has $128 \times 47 = 6016$ octets, corresponding to 128 SAR-PDU payloads. These 128 SAR-PDU payloads constitute one CS-PDU.

When MPEG-2-TS packets of 188 octets are transmitted by the MPI, then the interleaver contains exactly 31 MPEG-2-TS packets; in the case when RS coded MPEG-2-TS packets of 204 octets are transmitted, then the number of RS coded MPEG-2-TS packets contained in the interleaver is not an integer number. This has no impact on the processing.

Columns from the interleaver are then passed to the SAR where a SAR-PDU header is put in front of each of them.

e) *Synchronization of the CS-PDU (CS function)*

The CSI bit is used to synchronize the interleaving matrix, i.e. the CS-PDU. Following 7.5/J.82, the CSI bit is set to "1" for the first SAR-PDU payload of the CS-PDU.

f) *Protection of the sequence number field (SAR function)*

The first four bits of every SAR-PDU header form the Sequence Number (SN) field. This SN field is protected by a 3-bit CRC code following the calculation described in 2.4.2.2/I.363.1. The result of this calculation, the remainder of the division (modulo 2) by the generator polynomial $x^3 + x + 1$ of the product x^3 multiplied by the content of the SN field, is written into the CRC field.

g) *Protection of the SAR-PDU header (SAR function)*

The first seven bits of each SAR-PDU header are protected by an even parity check bit that is written into bit EP of the actual SAR-PDU header.

The AAL1 SAR passes 48-octet blocks to the VPE.

7.2.2 Signal processing in the receiver (Signal flow from c to b in Figure 1)

The MAA receives signals from the VPE block and conveys them to the MPI block by using a receiving AAL1. From the protocol stack point of view, signals are transported from the ATM-SAP (ATM-Service Access Point) to the AAL-SAP.

Functions to be performed are those of the AAL1-SAR (Segmentation and Reassembly) and of the AAL1-CS (Convergence Sublayer). The content of the SAR-PDU header is evaluated in order to specify relevant functions of the AAL1-SAR resp. of the AAL1-CS.

The MAA receives from the VPE 48-octet long blocks corresponding to cell payloads. The SAR separates the SAR-PDU header (one octet) and passes the 47-octet block of data to the receiving CS.

a) *Evaluation of the SNP field (CRC-3 field and EP bit) (SAR function)*

The SAR protocol is described in 2.4.2/I.363.1. After processing of the SNP field (Sequence Number Protection) the Sequence Count field and the CSI bit are passed to the receiving CS together with the SN check status indicator (valid or invalid). The use of the SN check status together with the considered processing is described in detail in 2.4.2.2/I.363.1 and in Table 1/I.363.1.

If the SN check status indicator has been set to invalid, a SNI (Sequence Number Invalid) indication is forwarded to the EMF.

b) *Handling of user information (CS function)*

In compliance with 7.1/J.82, the length of the AAL-SDU (Service Data Unit) is one octet and the status parameter is used. As mentioned in Recommendation I.361.1, the status parameter possesses two values: "valid" and "invalid". "Invalid" is used in the case where errors have been detected and have not been corrected [for the use of this parameter see description under e)].

c) *Handling of lost and misinserted cells (CS function)*

Detection of lost and misinserted cell events is performed by using the Sequence Count (SC) value transmitted by the receiving SAR. The CS processing for SC operation is described in detail in 2.5.2.1.2/I.363.1.

In the receiving AAL1-CS, the processing is as follows: the SC is processed in order to detect cell loss events. In case of a detected cell loss, 47 dummy octets are inserted in the signal flow in order to maintain bit count integrity. Detected misinserted cells are merely discarded.

Lost and Misinserted Cells (LMC) events are transmitted to the EMF.

d) *Handling of the timing relationship (CS function)*

The end-to-end synchronization function is performed by the adaptive clock method described in 2.5.2.2.2/I.363.1. A short description of the method is given in Appendix I. It is pointed out that the adaptive clock method does not need any external clock to be operated.

e) *Correction of bit errors and lost cells (CS function)*

In the receiving AAL1-CS, the mechanism in the interleaver is the inverse of that of the transmitting interleaver, i.e. the writing order is vertically and the reading order is horizontally. Information are stored in the receiving interleaver column by column. In the case of insertion of dummy octets, an indication is provided in order to enable the use of the erasure mode of the RS codes. After the whole interleaving matrix has been stored, it is read out block by block to the RS decoder where errors and erasures are corrected.

Correction capabilities are up to 4 cell losses in a group of 128 cells and up to 2 errored octets in a block of 128 octets. It ensures that under normal transmission condition, the received MPEG-2-TS flow is quasi error free.

If the RS decoder is unable to correct the errors, then the "status" indicator of the AAL-SAP shall be used (see 7.1/J.82) in order to signal this error. The indicator is passed to the MPI block and to the EMF.

7.3 Virtual Path Entity (VPE)

Among all the functions referenced in Recommendation I.732 for this functional block, only the VP setting is ensured. This function only concerns the signal flow from point c to point d in Figure 1. The ATM cell header that contains the virtual path identifier VPI is organized as shown in Figure 5.

8	7	6	5	4	3	2	1	bit byte
Generic Flow Control (GFC)				Virtual Path Identifier (VPI)				1
Virtual Path Identifier (VPI)				Virtual Channel Identifier (VCI)				2
Virtual Channel Identifier (VCI)								3
Virtual Channel Identifier (VCI)				Payload Type (PT) Field		CLP		4
Header Error Control (HEC)								5

Figure 5/J.132 – Structure of an ATM cell header

7.3.1 Signal processing in the transmitter (Signal flow from c to d in Figure 1)

VP setting

The VPI value is processed in accordance with the assigned values. As far as no VC related block is implemented in the Network Adapter, VC setting is also performed in this block to the fixed value 0020h. VPI value 00h is forbidden. Any other value may be used. However, it is suggested to use the VPI values listed in Table 5:

Table 5/J.132 – Default values for the setting of the VPI

Number of MPEG-2-TS to be simultaneously transported	MPEG-2-TS number	VPI value
1	MPEG-2-TS No. 1	11h
2	MPEG-2-TS No. 1 MPEG-2-TS No. 2	11h 12h
3	MPEG-2-TS No. 1 MPEG-2-TS No. 2 MPEG-2-TS No. 3	11h 12h 13h
4	MPEG-2-TS No. 1 MPEG-2-TS No. 2 MPEG-2-TS No. 3 MPEG-2-TS No. 4	11h 12h 13h 14h
5	MPEG-2-TS No. 1 ... MPEG-2-TS No. 4 MPEG-2-TS No. 5	11h ... 14h 15h
6	MPEG-2-TS No. 1 ... MPEG-2-TS No. 5 MPEG-2-TS No. 6	11h ... 15h 16h
7	MPEG-2-TS No. 1 ... MPEG-2-TS No. 6 MPEG-2-TS No. 7	11h ... 16h 17h
8	MPEG-2-TS No. 1 ... MPEG-2-TS No. 7 MPEG-2-TS No. 8	11h ... 17h 18h

The VPI values used are settable by the EMF. The default values used are in accordance with Table 5.

7.3.2 Signal processing in the receiver (Signal flow from d to c in Figure 1)

No function of the VPE is implemented in this direction.

7.4 Virtual Path Multiplexing Entity (VPME)

This functional block is responsible for the adaptation between an ATM cell structure and a SDH transmission path structure (VC-4, VC-3, VC-2, VC-12, VC-11). In addition, this block processes the payload dependent information in the Path Overhead (POH) of the several Virtual Containers: H4 and C2 bytes in case of ATM cells mapping into VC-4 or VC-3, and bits 5, 6 and 7 of V5 byte in case of ATM cells mapping into VC-2, VC-12 or VC-11.

The partitioning of the VPME into functional blocks as described below is in accordance with Recommendation I.732. The organization of the ATM cell header which content is partly set in this functional block is shown in Figure 5.

In order to prevent alarms being raised and failures being reported during path provisioning, the VPME function shall have the ability to enable or disable fault cause declaration. The Virtual Path Multiplexing Entity shall be either monitored (MON) or not monitored (NMON). The state MON or NMON is provisioned by the equipment manager to the VPME via the EMF function. The state of the VPME and the associated TTF shall be identical.

7.4.1 Signal processing in the transmitter (Signal flow from d to e in Figure 1)

a) *VP multiplexing*

This function enables individual cell flows to be logically combined into a single cell flow according to the VPI values.

b) *Congestion control*

This function is not used in this equipment. The cell loss priority bit CLP shall be set to "0" (corresponding to high cell priority in ATM terminology).

GFC: This function is not used in this equipment. The GFC field shall be set to "0000" (corresponding to uncontrolled equipment in ATM technology).

c) *PT field*

This function is not used in this equipment. The three bits of the PT field shall be set to "000".

d) *Cell rate decoupling*

Idle cells are inserted into the cell stream in order to match the rate of the SDH transmission path payload (i.e. the useful rate of the VC) in accordance with Recommendation I.432. The format of the idle cell shall be in accordance with Recommendation I.432. It is described on Figure 6.

Octet 1	00h	ATM cell header	
Octet 2	00h		
Octet 3	00h		
Octet 4	01h		
Octet 5	52h (valid HEC)		
Octets 6 to 53		6Ah	ATM cell information field

Figure 6/J.132 – Idle cell format

e) *HEC processing*

The HEC value for each cell is calculated and inserted into the HEC field. The method of HEC value calculation shall be in accordance with Recommendation I.432. Basically the HEC field is the remainder of the division (modulo 2) by the generator polynomial $x^8 + x^2 + x + 1$ of the product x^8 multiplied by the content of the header excluding the HEC field, to which is added the value 55h.

f) *Scrambling*

The information field of each cell is scrambled with a self-synchronizing scrambler $x^{43} + 1$. The operation of the scrambler shall be in accordance with Recommendation I.432.

g) *Cell stream mapping*

The cell stream shall be inserted into VC as specified in 10.2.2/G.707 in case of VC-4/VC-3, subclause 10.2.4/G.707 in case of VC-2 and 10.2.5/G.707 in case of VC-12/VC-11. The cell stream byte boundaries are aligned with the container byte boundaries.

h) *H4 byte (applicable only in case of ATM cells mapping into VC-4 or VC-3)*

This byte is undefined.

i) *C2 byte (applicable only in case of ATM cells mapping into VC-4 or VC-3)*

This byte shall be set to "13H" corresponding to ATM payload as specified in Table 7/G.707.

j) *Bits 5, 6 and 7 of V5 byte (applicable only in case of ATM cells mapping into VC-2, VC-12 or VC-11)*

These bits shall be set to "001" as specified in Recommendation G.707.

7.4.2 Signal processing in the receiver (Signal flow from e to d in Figure 1)

Data at point e) is a container with defined H4 and C2 bytes in case of C-4 and C-3 or with defined bits 5, 6 and 7 of V5 byte in case of C-2, C-12, C-11 or C-2-mc.

a) *H4 and C2 bytes (applicable only in case of ATM cells mapping into VC-4 or VC-3)*

H4 byte is ignored. C2 byte is used to detect PLM defect. The PLM defect detection criteria is defined in Recommendation G.783.

b) *Bits 5, 6 and 7 of V5 byte (applicable only in case of ATM cells mapping into VC-2, VC-12 or VC-11)*

These bits are used to detect PLM defect. The PLM defect detection criteria is defined in Recommendation G.783.

c) *Cell stream demapping*

The cell stream shall be extracted from the VC-4, VC-3, VC-2, VC-12 or VC-11 as specified in Recommendation G.707. The cell stream byte boundaries are aligned with the container byte boundaries.

d) *Cell delineation*

Cell delineation is performed on the continuous cell stream extract from the transmission path frames. The cell delineation algorithm shall be in accordance with Recommendation I.432. Basically it bases on the correlation between the header bits to be protected (32 bits) and the relevant control bits (8 bits) introduced in the header by the HEC. Cell delineation is deemed to be lost causing a LCD defect after 7 consecutive incorrect HECs. Cell delineation is deemed to be recovered after 6 consecutive correct HECs. If the function is in the MON state, the LCD defect is reported to the EMF.

e) *Descrambling*

The information field of each cell is descrambled with a self-synchronizing scrambler polynomial $x^{43} + 1$. The operation of the descrambler shall be in accordance with Recommendation I.432.

f) *HEC processing*

HEC verification and correction bases on the methods described in Recommendation I.432. The HEC correction mode may be activated/deactivated by the EMF. In case of cells determined to have an invalid and inconvertible HEC pattern, two options are possible. Either the invalid cells may be discarded (in accordance with Recommendation I.432) or the invalid cells may not be discarded (not in accordance with Recommendation I.432). The wanted option is selected by the EMF. Further information is given in Appendix II.

g) *Cell rate decoupling*

Idle cells are extracted from the cell stream. They are identified by the standardized pattern for the cell header.

h) *PT identification*

This function is not implemented. The corresponding bits are ignored.

i) *Cell header verification*

The receiving Network Adapter shall verify that the first four octets of the ATM cell header are recognizable as being a valid header pattern. Invalid header pattern are (p = any value) given on Figure 7.

GFC pppp	VPI 0000 0000	VCI 0000 0000 0000 0000	PT ppp	CLP 1
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Figure 7/J.132 – Invalid header pattern

Idle cells are discarded.

j) *GFC check*

This function is not implemented. The corresponding bits of the GFC field are ignored.

k) *VPI verification*

The receiving Network Adapter shall verify that the VPI of the received cell is valid. If the VPI is determined to be invalid (i.e. out of range or unassigned – see 7.3.1, item "VP setting"), the cell shall be discarded.

l) *Congestion control*

This function is not implemented. The corresponding bit CLP is ignored.

m) *VP demultiplexing*

This function enables the flow of cells which have to be logically separated into individual data flows according to their VP values.

7.5 Sm Trail Termination (Sm_TT)

Four types of Sm_TT exist for the following lower order VCs defined in Recommendation G.707:

- VC-3 Trail Termination (S3_TT).
- VC-2 Trail Termination (S2_TT).
- VC-12 Trail Termination (S12_TT).
- VC-11 Trail Termination (S11_TT).

The lower order VCs frame structures and POH are described in Recommendation G.707. Additional information on VC POH are given in 6.2.

The Sm_TT function is described in Recommendation G.783.

7.6 VC-n to VC-m Adaptation (Sn/Sm_A)

The lower order VCs frame structures and POH are described in Recommendation G.707. Additional information on VC POH are given in 6.2.

This function is specified in Recommendation G.783.

NOTE – The use of more than one LOVC is optional.

7.7 VC-n Trail Termination (Sn_TT)

Two types of Sn_TT exist for the following higher order VCs defined in Recommendation G.707:

- VC-4 Trail Termination (S4_TT).
- VC-3 Trail Termination (S3_TT).

The higher order VCs frame structures and POH are described in Recommendation G.707. Additional information on VC POH are given in 6.2.

This function is specified in Recommendation G.783.

7.8 STM-1 Multiplex section to VC-n layer Adaptation (MS1/Sn_A)

This function is specified in Recommendation G.783.

7.9 STM-1 Multiplex Section Trail Termination (MS1_TT)

The STM-1 frame structure and MSOH are described in Recommendation G.707. Additional information on SOH are given in 6.2.

This function is specified in Recommendation G.783.

7.10 STM-1 Regenerator Section to Multiplex Section Adaptation (RS1/MS1_A)

This function is specified in Recommendation G.783.

7.11 STM-1 Regenerator Section Trail Termination (RS1_TT)

The STM-1 frame structure and RSOH are described in Recommendation G.707. Additional information on SOH are given in 6.2.

This function is specified in Recommendation G.783.

7.12 STM-1 Optical Section to Regenerator Section Adaptation (OS1/RS1_A)

This function is specified in Recommendation G.783.

7.13 STM-1 Electrical Section to Regenerator Section Adaptation (ES1/RS1_A)

This function is specified in Recommendation G.783.

7.14 STM-1 Optical Section Trail Termination (OS1_TT)

This function is specified in Recommendation G.783.

7.15 STM-1 Electrical Section Trail Termination (ES1_TT)

This function is specified in Recommendation G.783.

7.16 Synchronous Equipment Timing Source (SETS)

This function provides timing reference to the following functions: VPME, Sn/Sm_A, MS1/Sn_A, RS1/MS1_A.

This function is specified in Recommendation G.783.

7.17 Synchronous Equipment Timing Physical Interface (SETPI)

The Synchronous Equipment Physical Interface function block provides the interface between the external 2048 kHz synchronization signal and the SETS.

This function is specified in Recommendation G.783.

This function is optional for the SDH network adapter.

To prevent alarms being raised and failures being reported during provisioning, the interface shall support port mode functionality described in Recommendation G.783.

7.18 Equipment Management Function (EMF)

The Equipment Management Function (EMF) provides the means through which the Network Element (NE) is managed by an external manager. The EMF interacts with the other basic functions by exchanging information across the MP (Management Points) reference points. The EMF contains a number of filters that provide a data reduction mechanism on the information received across the MP reference points.

The interface between the processing in the basic functions and the equipment management function is indicated by the dashed line in Figure 8 and represents the MP reference points. For performance monitoring, the signals passed over this interface are the 1 second Near (Far)-end Errored Block Counts (N_EBC, F_EBC) and the 1 second Near (Far)-end Defect Seconds (N_DS, F_DS). For fault management, the signals passed over this interface are the fault cause signal.

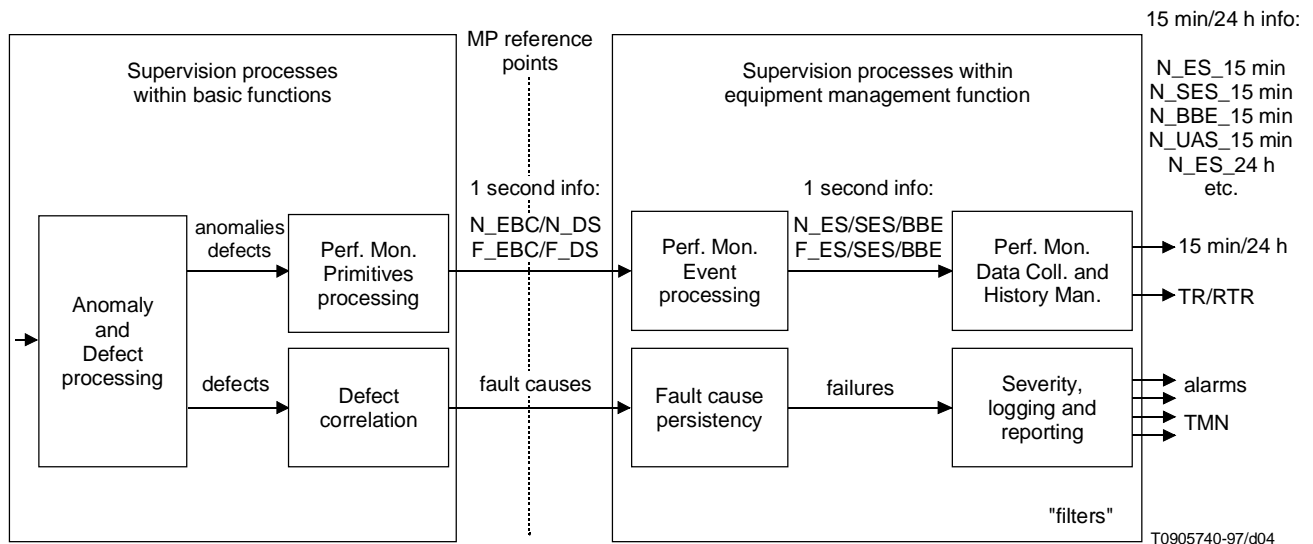


Figure 8/J.132 – Supervision process within equipment management function

The filtering functions provide a data reduction mechanism on the defect and performance monitoring primitives information presented at the MP reference points. Two types of techniques can be distinguished:

- The fault cause persistency filter will provide a persistency check on the fault causes that are reported across the MP reference points. In addition to the transmission failures listed in Table 6, hardware failures with signal transfer interruption are also reported at the input of the fault cause filter for further processing.
- The performance monitoring events processing processes the information available from the one second window and reported across the MP reference points in order to derive errored seconds and severely errored seconds, and background block errors (see Recommendation G.826).

NOTE – One second filters in the basic functions perform a simple integration of reported anomalies by counting during a one-second interval. In addition, defects are filtered by the one-second filter. At the end of each one-second period, the contents of the counters may be obtained by the EMF.

The information flows described in this subclause are functional. The existence of these information flows in the equipment will depend on the functionality provided by the equipment.

Table 6/J.132 – Basic function associated failure list

Basic functions	Failures
RR-SPI	LOS
RR-RST	LOF, TIM
RR-MST	AIS, RDI
RR-MSA	AIS, LOP
SETPI	LOS
SETS	LTI
ES1_TT	LOS
ES1/RS1_A	LOF
OS1_TT	TD, TF, LOS
OS1/RS1_A	LOF
RS1_TT	TIM
RS1/MS1_A	
MS1_TT	AIS, RDI, SSF, DEG
MS1/Sn_A (n = 3, 4)	AIS, LOP
Sn_TT (n = 3, 4)	TIM, UNEQ, DEG, RDI, SSF
Sm_TT (m = 11, 12, 2, 3)	TIM, UNEQ, DEG, RDI, SSF
Sn/Sm_A (n = 3, 4; m = 11, 12, 2, 3)	LOM, PLM, LOP, AIS
VPME	LCD, PLM
VPE	
MAA	STATUS, SNI, LMC
MPI	LOS, TSLE_I, TSLE_O
NOTE – The information flow over the MP reference points that arises from anomalies and defects detected in the SDH basic functions is described in specific details for each basic function in Recommendation G.783.	

Time-stamping

Events, performance reports and registers containing event counts that require time-stamping shall be time-stamped with a resolution of one second. The time shall be as indicated by the local real time clock of the NE. The required accuracy and precise details of the time-stamping of events/reports relative to UTC is the subject of further study (a maximum value in the range 1 to 10 seconds is being considered). The start of 15-minute and 24-hour counts should be accurate to within ± 10 seconds with respect to the NE clock.

7.18.1 Configuration

The information flow over the MP reference points that arises from configuration and provisioning data is given in Table 7. The information listed under "Set" refers to configuration and provisioning data that is passed from the EMF to the other basic functions. The information listed under "Get" refers to status reports made in response to a request from the EMF for such information.

Table 7/J.132 – Command, configuration information flow over MP

	GET	SET
RR-SPI	See ES1_TT and ES1/RS1_A	See ES1_TT and ES1/RS1_A
RR-RST	See RS1_TT and RS1/MS1_A	See RS1_TT and RS1/MS1_A
RR-MST	See MS1_TT	See MS1_TT
RR-MSA	See MS1/Sn_A	See MS1/Sn_A
ES1_TT, ES1/RS1_A, OS1_TT, OS1/RS1_A, RS1_TT, RS1/MS1_A, MS1_TT, MS1/Sn_A, Sn_TT, Sn/Sm_A, Sm_TT, SETPI, SETS	(Note 3)	(Note 3)
VPME	<ul style="list-style-type: none"> – Cell Discarded: Active or Not_Active – HEC correction mode: Active or Not_Active – VPI value 	<ul style="list-style-type: none"> – Supervision State: MON or NMON – Cell Discarded: Active or Not_Active – HEC correction mode: Active or Not_Active – Accepted signal label
VPE		<ul style="list-style-type: none"> – Supervision State: MON or NMON (Note 1) – VPI value
MAA		<ul style="list-style-type: none"> – Supervision State: MON or NMON (Note 1)
MPI	<ul style="list-style-type: none"> – Supervision State: MON or NMON – Number of packets per second – Option for system A (European system): FORMAT: 188 or 204 bytes packet with 16 dummy bytes (Note 2) 	<ul style="list-style-type: none"> – Supervision State: MON or NMON (Note 1) – Option for system A (European system): FORMAT: 188 or 204 bytes packet with 16 dummy bytes (Note 2)
NOTE 1 – For a given MPEG interface, MPI and associated MAA and VPE are in the same state.		
NOTE 2 – This status is only relevant for the selection of the transmission format (188 bytes or 204 with 16 dummy bytes) to be used at an output SSI or SPI interface for the delivery of MPEG-2-TS packets.		
NOTE 3 – The information flow over the MP reference points that arises from configuration and provisioning data is described in specific details for each SDH basic function in Recommendation G.783.		
NOTE 4 – These commands are applicable for selectors A and B.		

7.18.2 Fault (maintenance) management

Fault cause persistency filter

The equipment management function within the network element performs a persistency check on the fault causes before it declares a fault cause a failure. A transmission failure shall be declared if the fault cause persists continuously for 2.5 ± 0.5 seconds. The failure shall be cleared if the fault cause is absent continuously for 10 ± 0.5 seconds. Transmission failures associated with the basic functions are listed in Table 6.

Alarm history management

Alarm history management is concerned with the recording of alarms. Historical data shall be stored in registers in the NE. Each register contains all the parameters of an alarm message. Registers shall be readable on demand or periodically. The operator can define the operating mode of the registers as wrapping or stop when full. The operator may also flush the registers or stop recording at any time.

NOTE – Wrapping is the deletion of the earliest record to allow a new record when a register is full. Flushing is the deletion of all the records.

7.18.3 Performance management

Performance management consists of performance monitoring event processes, data collection and history processes along with thresholding and reporting functions. Performance monitoring consists of the first three items.

Within performance monitoring the concepts of "near-end" and "far-end" are used to refer to performance monitoring information associated with the two directions of transport in the case of a bidirectional transmission path. For a trail from A to Z:

- at node A the near-end information represents the performance of the unidirectional trail from Z to A, while the far-end information represents the performance of the unidirectional trail from A to Z;
- at node Z the near-end information represents the performance of the unidirectional trail from A to Z, while the far-end information represents the performance of the unidirectional trail from Z to A.

At either end of the trail (A or Z), the combination of near-end and far-end information present the performance of the two directions of the trail.

Performance monitoring event process

The performance monitoring event processing processes the information available from the performance monitoring primitives processing (basic functions) giving the performance primitives (EBC and DS) to derive the performance events (errored seconds, severely errored seconds and background block errors).

Near-end Performance Monitoring Event (NPME) function

Figure 9 presents the processes and their interconnect within the Near-end Performance Monitoring Event (NPME) function.

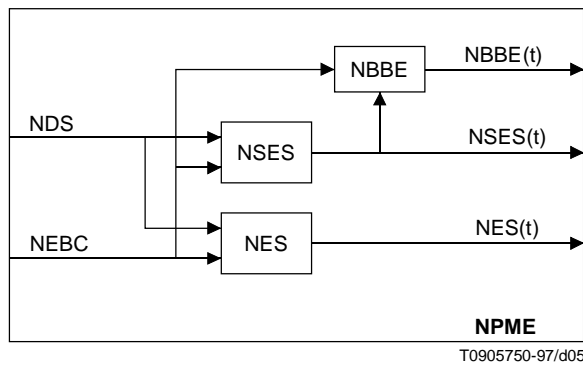


Figure 9/J.132 – Near-end Performance Monitoring Event (NPME) function

A Near-end Errored Second (NES) shall be generated if the defect second (NDS) is set or if the Near-end Errored Block Count (NEBC) is greater or equal to 1: $NES(t) \leftarrow (NDS = true) \text{ or } (NEBC \geq 1)$.

A Near-end Severely Errored Second (NSES) shall be generated if the Near-end Defect Second (NDS) is set or if the Near-end Errored Block Count (NEBC) is greater or equal to 30% of the blocks in a one-second period: $NSES(t) \leftarrow (NDS = true) \text{ or } (NEBC \geq "30\% \text{ of blocks in a one-second period}")$.

The number of Near-end Background Block Errors (NBBE) in a one-second period shall be equal to the Near-end Errored Block Count (NEBC) if the second is not a Near-end Severely Errored Second (NSES). Otherwise (NSES is set), NBBE shall be zero. $NBBE(t) \leftarrow NEBC (NSES = false) \text{ or } 0 (NSES = true)$.

Far-end Performance Monitoring Event (FPME) function

Figure 10 presents the processes and their interconnect within the Far-end Performance Monitoring Event (FPME) function.

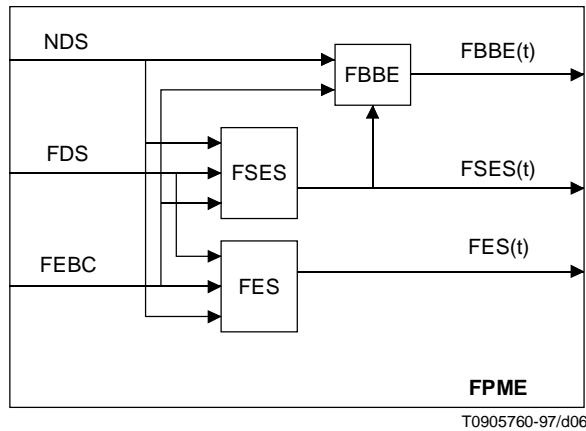


Figure 10/J.132 – Far-end Performance Monitoring Event (FPME) function

A Far-end Errored Second (FES) shall be generated if the Far-end Defect Second (FDS) is set or if the Far-end Errored Block Count (FEBC) is greater or equal to 1, and if that second is not a Near-end Defect Second (NDS): $FES(t) \leftarrow (NDS = \text{false}) \text{ and } [(FDS = \text{true}) \text{ or } (FEBC \geq 1)]$.

A far-end Severely Errored Second (FSES) shall be generated if the Far-end Defect Second (FDS) is set or if the Far-end Errored Block Count (FEBC) is greater or equal to 30% of the blocks in a one-second period, and that second is not a Near-end Defect Second (NDS): $FSES(t) \leftarrow (NDS = \text{false}) \text{ and } [(FDS = \text{true}) \text{ or } (FEBC \geq \text{"30\% of blocks in a one-second period"})]$.

The number of Far-end Background Block Errors (FBBE) in a one-second period shall be equal to the Far-end Errored Block Count (FEBC) if the second is not a Far-end Severely Errored Second (FSES), and if that second is not a Near-end Defect Second (NDS). Otherwise, FBBE shall be zero. $FBBE(t) \leftarrow FEBC (FSES = \text{false} \text{ and } NDS = \text{false}) \text{ or } 0 (FSES = \text{true} \text{ or } NDS = \text{true})$.

Performance data collection

Performance data collection refers to the event counting associated with each of the performance events BBE, ES, SES as defined in Recommendation G.826, and any additional performance parameter defined in this Recommendation. The performance data collection as specified in Recommendation M.2120 bases on information for each direction of transport independently. This type is further referred to as performance data collection for maintenance purposes. This type of collection counts the events over fixed time periods of 15 minutes and 24 hours. Counting is stopped during unavailable time. These counters operate as follows:

15-minute counter

The performance events (e.g. SES) are counted in a counter per event. These counters are called the current registers. At the end of the 15-minute period the contents of the current registers are transferred to the first of the recent registers, with a time-stamp to identify the 15-minute period (including the day), after which the current register shall be reset to zero. It is an option not to transfer the content of a current register to a recent register if this content is zero¹. It shall be possible to reset an individual current register to zero by means of an external command.

¹ A capability should be provided to insure that, in the absence of reports, the reporting process is functioning properly.

Any register the content of which is suspect shall be flagged, using the "suspect interval flag" provided in Recommendation Q.822. This flag shall be raised independently for far-end and near-end counts. Examples of conditions to raise this flag are provided in Recommendation Q.822.

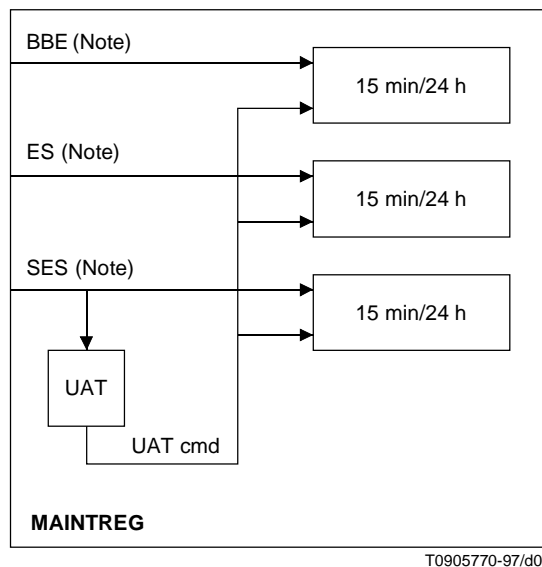
24-hour counter

The performance events (e.g. SES) are counted in a counter per event, independent of the 15-minute counters. These counters are called the current registers. It was agreed that it is up to the NE implementation to update the register counts. It is not required that it shall be done on a second by second basis. At the end of the 24-hour period the contents of the current registers are transferred to recent registers, with a time-stamp to identify the 24-hour period, after which the current register shall be reset to zero. It shall be possible to reset an individual current register to zero by means of an external command.

Any register the content of which is suspect shall be flagged, using the "suspect interval flag" provided in Recommendation Q.822. This flag shall be raised independently for far-end and near-end counts. Examples of conditions to raise this flag are provided in Recommendation Q.822.

Performance data collection during unavailable time

The onset and exit of unavailable time is defined in Annex A/G.826 and in Recommendation M.2120. A period of unavailable time begins at the onset of ten consecutive SES. These ten seconds are part of unavailable time. A period of available time begins at the onset of ten consecutive non-SES. These ten seconds are part of available time. Performance monitoring event counting for ES, SES, and BBE shall be inhibited during unavailable time. The unavailability of a single direction shall inhibit the counting for that direction only.



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NOTE – The determination of (un)available time introduces (functionally) a delay of 10 seconds. This delay should be considered when counting BBE, ES, SES.

Figure 11/J.132 – Performance monitoring data collection and history for maintenance purposes

Availability data collection

When a period of unavailability occurs, the beginning and ending of this period should be stored in a log in the NE, and as a consequence time-stamped. The NE should be able to store these data for at least 6 periods of unavailability.

Performance monitoring history

Performance history data are necessary to assess the recent performance of transmission systems. Such information can be used to sectionalize faults and to locate the source of intermittent errors. Historical data, in the form of performance monitoring event counts, may be stored in registers in the NE or in mediation devices associated with the NE. For specific applications, for example when only Quality of Service alarms are used, historical data may not be stored. All the history registers shall be time-stamped. The history registers operate as follows (see also Figure 11):

- *15-minute registers*

The history of the 15-minute monitoring is contained in a stack of 16 registers per monitored event. These registers are called the recent registers. Every 15 minutes, the contents of the current registers are moved to the first of the recent registers. When all 15-minute registers are used, the oldest information will be discarded.

- *24-hour registers*

The history of the 24-hour monitoring is contained in a single register per monitored event. This register is called the recent register. Every 24 hours, the contents of the current registers are moved to the recent register².

Performance data reporting

Performance data stored in the NE may be collected by the operator for analysis without affecting the content of the register.

Annex A

Transport within Sub-STM-1 at 51 Mbit/s

A method for the transmission of MPEG-2-TS packets respectively RS coded MPEG-2-TS packets using a data rate of 51 Mbit/s is described in this Annex. The data are transported within a VC-3 Container, that also can contain other Lower Order Virtual Containers, and the signal processing can be described using additional functional blocks. The description bases on functional blocks mentioned in ITU-R Recommendation F.750-3 where a sub-STM-1 transmission rate of 51 840 kbit/s is defined in order to connect Radio-Relay (RR) equipment, although this bit rate does not represent an SDH or a Network Node Interface bit rate.

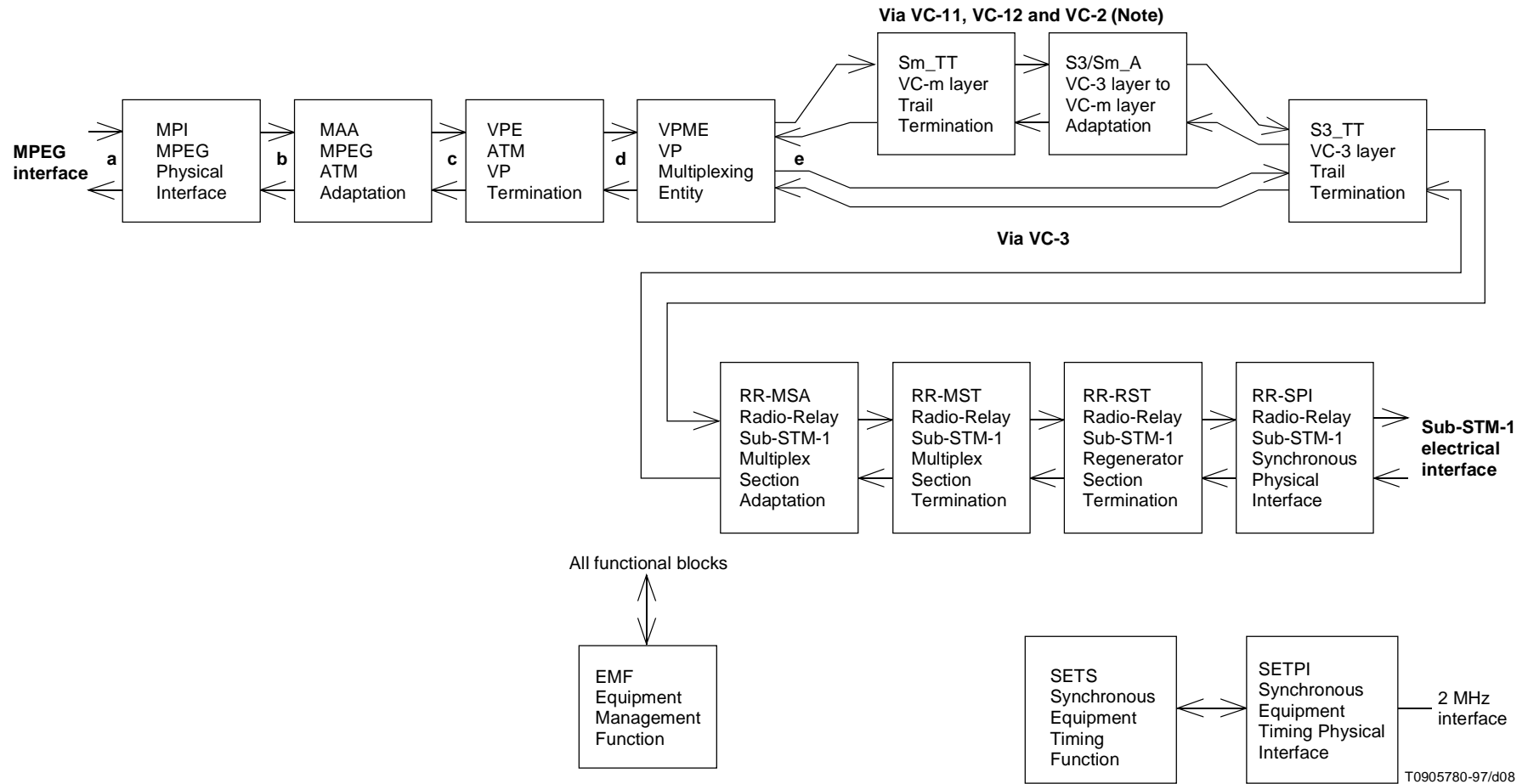
A.1 Functional description

The frame structure for a digital section operating at 51 840 kbit/s is specified in Annex A/G.707. This structure uses a Virtual Container-3 (VC-3) that is interrupted by two additional columns and a derivative of the STM-1 SOH which is called RR-SOH according to ITU-R Recommendation F.750-3 where such a frame structure is used for Radio-Relay (RR) Systems inside SDH-based networks. The contents of the RR-SOH is described in ITU-R Recommendation F.750-3. The RR-SOH is split up in two parts, the Regenerator Section Overhead (RR-RSOH) and the Multiplex Section Overhead (RR-MSOH) (see ITU-R Recommendation F.750-3). The multiplexing structure of LOVCs into a VC-3 is given in Recommendation G.707. A VC-3 can be used to transport VC-11s, VC-12s, VC-2s.

NOTE – The use of more than one LOVC is optional.

The functional blocks of the SDH network adapter with sub-STM-1 interface are shown in Figure A.1.

² This implies that all 24-hour data is discarded after 24 hours.



NOTE – The use of VC-2-mc is for further study.

Figure A.1/J.132 – Functional blocks for the transport at 51 Mbit/s

The functional blocks necessary for the processing of the data from MPI to S3_TT are identical to those already introduced in Figure 1. Therefore, in this Annex only the additional functional blocks dealing with the sub-STM-1 interface are described (from RR-MSA to RR-SPI).

NOTE – RR-MSA, RR-MST, RR-RST and RR-SPI are described in ITU-R Recommendation F.750-3 with reference to "old version" of ITU-T Recommendation G.783. This is why cross-references to ITU-R Recommendation F.750-3 are not used in the following subclauses. When ITU-R Recommendation F.750-3 will be aligned with the new approved version of Recommendation G.783, cross-references to ITU-R Recommendation F.750-3 will be used.

A.2 Radio-Relay Sub-STM-1 Multiplex Section Adaptation (RR-MSA)

The description of this block is identical to the MS1/S3_A function described in Recommendation G.783 except the input and output data that are at a bit rate of sub-STM-1. Moreover AU-3 grouping functionality is not performed.

A.3 Radio-Relay Sub-STM-1 Multiplex Section Termination (RR-MST)

The Sub-STM-1 frame structure is described in Recommendation G.707, RR-MSOH is described in ITU-R Recommendation F.750-3. The additional information on MSOH given in 6.2 are also applicable to RR-MSOH for sub-STM-1 interface in this Annex.

The description of this block is identical to the MS1_TT function described in Recommendation G.783 except the input and output data that are at a bit rate of sub-STM-1.

A.4 Radio-Relay Sub-STM-1 Regenerator Section Termination (RR-RST)

The Sub-STM-1 frame structure is described in Recommendation G.707, RR-RSOH is described in ITU-R Recommendation F.750-3. The additional information on RSOH given in 6.2 are also applicable to RR-RSOH for sub-STM-1 interface in this Annex.

The description of this block is identical to both RS1_TT and RS1/MS1_TT functions described in Recommendation G.783 except the input and output data that are at a bit rate of sub-STM-1.

A.5 Radio-Relay Sub-STM-1 Synchronous Physical Interface (RR-SPI)

The RR-SPI provides the interface between the electrical physical medium and the RR-RST function. This interface is specified for a data rate of 51 840 kbit/s.

The description of this block is identical to both ES1_TT and ES1/RS1_TT functions described in Recommendation G.783 except the following:

- the input and output data that are at a bit rate of sub-STM-1;
- the physical characteristics of the interface at 51 840 kbit/s are defined in Appendix 1 of ITU-R Recommendation F.750-3 (for this interface, the line code is B3ZS);
- the detection and clearance criteria for dLOS defect is for further study for sub-STM-1 electrical interface;
- jitter limits for this interface are for further study.

Appendix I

Mechanism of the adaptive clock method

The adaptive clock method is a general method for source clock frequency recovery. No explicit timing information of the source clock is transported by the network, the method is based on the fact that the amount of transmitted data is an indication of the source frequency, and this information can be used at the receiver to recover the source clock frequency.

The adaptive clock method is implemented at the receiving AAL. The implementation of the method is not standardized. One possible method to measure the amount of data is to use the fill level of the AAL user data buffer. The following is the general description of this method and does not preclude other adaptive clock methods.

The receiver writes the received data into a buffer, and then reads it out using a locally-generated clock. Therefore the fill level of the buffer depends on the source frequency and it is used to control the frequency of the local clock. Operations are the following: the fill level of the buffer is continuously measured and the measure is used to drive the phase-locked loop generating the local clock. The method maintains the fill level of the buffer around its medium position. To avoid buffer underflow or overflow, the fill level is maintained between two limits. When the level in the buffer goes to the lower limit, this means the frequency of the local clock is too high compared to the one of the source and so it has to be decreased; when the level in the buffer goes to upper limit, the frequency of the local clock is too low compared to the one of the source, and so it has to be increased.

It is pointed out that the compensation of cell delay variation is also performed by the adaptive clock method. However, a cell delay variation is not to be expected if no ATM network is to be crossed.

Appendix II

Enabling/disabling the Header Error Control functions

The Header error control functions of the ATM cells, as described in Recommendation I.432, can correct single errors and detect almost all multiple errors in the header. In an ATM network, when the HEC detects errors that it cannot correct, the whole cell is discarded and its payload is lost for an end-to-end connection.

When a FEC is applied on a link, it can generate error bursts if it fails to correct errors. In presence of error bursts, the single-bit correcting code of the HEC is unable to correct most errors encountered. In an error bursts environment the probability of discarding cells is proportional to the BER and not to the square of the BER as in a random error environment. Although bursts of errors due to error correction failures have different lengths and rate of occurrence according to the different FEC schemes, this behaviour would apply to all transmission systems using FEC.

Therefore for a given bit error probability, the discarded cell probability in presence of error bursts is definitely different from the discarded cell probability in presence of randomly distributed errors.

It is then recommended to disable the Header Error Control functions when using the ATM cell format for transporting an MPEG-2-TS over an SDH-network based on transmission systems using FEC (e.g. radio relays, satellites). This measure avoids unwanted and unnecessary degradation of the end-to-end quality.

Appendix III

Transmission capacity of the Network Adapter

Transmission capacity of the Network Adapter for MPEG-2-TSs resp. RS-coded MPEG-2-TSs using different Virtual Containers for the transmission inside an SDH network.

Type of container	Container capacity	Example of transmission capacity for MPEG-2-TSs resp. RS-coded MPEG-2-TSs
C-4	149 760 kbit/s	128 655 kbit/s
C-3	48 384 kbit/s	41 565 kbit/s
C-2	6 784 kbit/s	5 828 kbit/s
C-12	2 176 kbit/s	1 869 kbit/s
C-11	1 600 kbit/s	1 374 kbit/s
NOTE – Depending on the application, these figures may be slightly reduced.		

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