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Generic requirements of transport functionality of equipment;
Part 5-1: Plesiochronous Digital Hierarchy (PDH)
path layer functions

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Contents

Foreword

This draft European Telecommunication Standard (ETS) was produced by the Transmission and Multiplexing (TM) Technical Committee of the European Telecommunications Standards Institute (ETSI) in order to provide inter-vendor and inter-operator compatibility of Synchronous Digital Hierarchy (SDH) equipments, and is now submitted for the Public Enquiry phase of the ETSI standards approval procedure.

Proposed transposition dates	
Date of latest announcement of this ETS (doa):	3 months after ETSI publication
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This ETS consists of 8 parts as follows:

Part 1:   "Generic processes and performance" (ETS 300 417-1-1 [8]).

Part 2:   "Physical section layer functions" (ETS 300 417-2-1).

Part 3:   "STM-N regenerator and multiplex section layer functions" (ETS 300 417-3-1).

Part 4:   "SDH path layer functions" (ETS 300 417-4-1 [10]).

Part 5:   "PDH path layer functions" (ETS 300 417-5-1).

Part 6:   "Synchronization distribution layer functions" (ETS 300 417-6-1 [11]).

Part 7:   "Auxiliary layer functions" (ETS 300 417-7-1).

Part 8:   "Compound and major compound functions" (ETS 300 417-8-1).

Introduction

The atomic PDH path layer functions are defined below used in plesiochronous and synchronous operation. They describe the functionality of PDH multiplex equipments described in the ITU-T Recommendations G.751 [6] and G.742 [5] for signal hierarchies P4e, P31e and P22e. In addition they describe the functionality of synchronous PDH equipment described in ETS 300 167 [2] for P12s layer signals, and ETS 300 337 [9] for P31s and P4s signals.

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1 Scope

This European Telecommunication Standard (ETS) specifies a library of basic building blocks and a set of rules by which they are combined in order to describe a digital transmission equipment. The library comprises the functional building blocks needed to completely specify the generic functional structure of the European digital transmission hierarchy. Equipment which is compliant with this ETS shall be describable as an interconnection of a subset of these functional blocks contained within this ETS. The interconnections of these blocks shall obey the combination rules given. The generic functionality is described in the ETS 300 417-1-1 [8].

2 Normative References

This ETS incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references subsequent amendments to, or revisions of, any of these publications apply to this ETS only when incorporated in it by amendments or revisions. For undated references the latest edition of the publication referred to applies.

[1]	ETS 300 147 (1995): "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH); Multiplexing structure".
[2]	ETS 300 167 (1993): "Transmission and Multiplexing (TM); Functional characteristics of 2 048 kbit/s interfaces".
[3]	ITU-T Recommendation G.703 (1991): "Physical/electrical characteristics of hierarchical digital interfaces".
[4]	ITU-T Recommendation G.704 (1995): "Synchronous frame structures used at 1 544, 6 312, 2 048, 8 488 and 44 736 kbit/s hierarchical levels".
[5]	ITU-T Recommendation G.742 (1988): "Second order digital multiplex equipment operating at 8 448 kbit/s and using positive justification".
[6]	ITU-T Recommendation G.751 (1988): "Digital multiplex equipments operating at the third order bit rate of 34 368 kbit/s and the fourth order bit rate of 139 264 kbit/s and using positive justification".
[7]	ITU-T Recommendation G.823 (1988) modified according COM XVIII - R. report: "The control of jitter and wander within digital networks which are based on the 2 048 kbit/s hierarchy".
[8]	ETS 300 417-1-1 [8] (1996): "Transmission and Multiplexing (TM); Generic functional requirements for Synchronous Digital Hierarchy (SDH) equipment; Part 1-1: Generic processes and performance".
[9]	ETS 300 337 (1995): "Transmission and Multiplexing (TM); Generic frame structures for the transport of various signals (including Asynchronous Transfer Mode (ATM) cells and Synchronous Digital Hierarchy (SDH) elements) at the CCITT Recommendation G.702 hierarchical rates of 2 048 kbit/s, 34 368 kbit/s and 139 264 kbit/s".
[10]	prETS 300 417-4-1: "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 4-1: Synchronous Digital Hierarchy (SDH) path layer functions".
[11]	prETS 300 417-6-1: "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 6-1: Synchronization distribution layer functions".
[12]	DEN/TM-01016: "Transmission and Multiplexing (TM); Specifications for Asynchronous Transfer Mode (ATM) equipment".

[13]	ETS 300 166 (1993): "Transmission and Multiplexing (TM); Physical and electrical characteristics of hierarchical digital interfaces for equipment using the 2048 kbit/s - based plesiochronous or synchronous digital hierarchies".

3 Definitions, abbreviations and symbols

3.1 Definitions

The functional definitions are described in the ETS 300 417-1-1 [8].

3.2 Abbreviations

For the purposes of this ETS, the following abbreviations apply:

A	Adaptation function
AcSL	Accepted Signal Label
AcTI	Accepted Trace Identifier
AI	Adapted Information
AIS	Alarm Indication Signal
AP	Access Point
APId	Access Point Identifier
ATM	Asynchronous Transfer Mode
Avp	ATM VP layer
BIP	Bit Interleaved Parity
BIP-N	Bit Interleaved Parity, width N
BITS	Building Integrated Timing Supply
C	Connection function
CH	CHannel
CI	Characteristic Information
CK	ClocK
CM	Connection Matrix
CMI	Coded Mark Inversion
Co	Connection
CP	Connection Point
CRC	Cyclic Redundancy Check
CRC-N	Cyclic Redundancy Check, width N
Cs	supervisory-unequipped Connection function
CSES	Consecutive Severely Errored Seconds
CTF	Compound Timing Function
Ctrl	Control
D	Data
DCC	Data Communications Channel
DEC	DECrement
DEG	DEGraded
DEGTHR	DEGraded THReshold
DL	Data Link
DPRING	Dedicated Protection RING
DROP	Decreased Received Optical Power
DXC	Digital Cross Connect
E0	Electrical interface signal 64 kbit/s
E11	Electrical interface signal 1 544 kbit/s
E12	Electrical interface signal 2 048 kbit/s
E22	Electrical interface signal 8 448 kbit/s
E31	Electrical interface signal 34 368 kbit/s
E32	Electrical interface signal 44 736 kbit/s
E4	Electrical interface signal 139 264 kbit/s
EBC	Errored Block Count
EDC	Error Detection Code
EDCV	Error Detection Code Violation
EFS	Equipment Functional Specification
EQ	EQuipment
Ex	CCITT Recommendation G.703 [3] type Electrical signal, bit rate order x
ExSL	Expected Signal Label

ExTI	Expected Trace Identifier
F_B	Far-end Block
FAS	Frame Alignment Signal
FASE	Frame Alignment Signal Error
FO	Frame Offset information
FOP	Failure Of Protocol
FS	Frame Start signal
HDB3	High Density Bipolar of order 3
HDLC	High-level Data Link Control procedure
HO	Higher Order
HOVC	Higher Order Virtual Container
HP	Higher order Path
ID	IDentifier
IF	In Frame state
INC	INCrement
IOS	Intra-Office Section
IS	Intermediate System
ISDN	Integrated Services Digital Network
ISO	International Standardization Organization
LC	Link Connection
LO	Lower Order
LOF	Loss Of Frame
LOM	Loss Of Multiframe
LOP	Loss Of Pointer
LOS	Loss Of Signal
LOVC	Lower Order Virtual Container
LPx	Lower order Path for VC-x (x = 11, 12, 2, 3)
LT	Line Termination
M&CF	Management & Communication Function
MC	Matrix Connection
MI	Management Information
MON	MONitored
MP	Management Point
N.C.	Not Connected
N_B	Near-end Block
NC	Network Connection
NCI	No CRC-4 Multiframe indication
NDF	New Data Flag
NE	Network Element
NMON	Not MONitored
NNI	Network Node Interface
NU	National Use (bits, bytes)
OAM	Operation, Administration and Management
OFS	Out of Frame Second
OOF	Out Of Frame state
OS	Operations System
OS	Optical Section
OSC	OSCillator
OSI(x)	Open Systems Interconnection, layer x
OW	Order Wire
P	Protection
P0_31c	1 984 kbit/s layer
P0x	64 kbit/s layer (transparent)
P11x	1 544 kbit/s layer (transparent)
P12s	2 048 kbit/s PDH path layer with synchronous 125 µs frame structure according to ETS 300 167 [2]
P12x	2 048 kbit/s layer (transparent)
P22e	8 448 kbit/s PDH path layer with 4 plesiochronous 2 048 kbit/s
P22x	8 448 kbit/s layer (transparent)
P31e	34 368 kbit/s PDH path layer with 4 plesiochronous 8 448 kbit/s
P31s	34 368 kbit/s PDH path layer with synchronous 125 µs frame structure according to ETS 300 337 [9]
P31x	34 368 kbit/s layer (transparent)

P32x	44 736 kbit/s layer (transparent)
P4e	139 264 kbit/s PDH path layer with 4 plesiochronous 34 368 kbit/s
P4s	139 264 kbit/s PDH path layer with synchronous 125 µs frame structure according to ETS 300 337 [9]
P4x	139 264 kbit/s layer (transparent)
PDH	Plesiochronous Digital Hierarchy
PEC	PDH Equipment Clock
PJE	Pointer Justification Event
PLM	PayLoad Mismatch
PM	Performance Monitoring
Pn	Plesiochronous signal, Level n
POH	Path OverHead
PRC	Primary Reference Clock
PS	Protection Switching
PSC	Protection Switch Count
PTR	PoinTeR
PU	PDH Unit
QOS	Quality Of Service
RDI	Remote Defect Indicator
REI	Remote Error Indicator
RI	Remote Information
RLT	Regenerated Line Termination
RP	Remote Point
RS	Regenerator Section
RS1	STM-1 Regenerator Section
RS16	STM-16 Regenerator Section
RS4	STM-4 Regenerator Section
RSOH	Regenerator Section OverHead
RxSL	Received Signal Label
RxTI	Received Trace identifier
SASE	Stand-Alone Synchronization Equipment
SD	synchronization distribution layer, Signal Degrade
SEC	SDH Equipment Clock
SES	Severely Errored Second
SESR	Severely Errored seconds Ratio
SF	Signal Fail
Sk	Sink
SMF	Sub-Multi-Frame
SNC	Sub-Network Connection
SNC/I	Inherently monitored Sub-Network Connection protection
SNC/N	Non-intrusively monitored Sub-Network Connection protection
So	Source
SOH	Section OverHead
SPRING	Shared Protection RING
SSD	Server Signal Degrade
SSF	Server Signal Fail
SSM	Synchronization Status Message
SSU	Synchronization Supply Unit
TCP	Termination Connection Point
TD	Transmit Degrade
TF	Transmit Fail
TFAS	trail Trace identifier Frame Alignment Signal
TG	Timing Generator
TI	Timing Information
TIM	Trace Identifier Mismatch
TM	Transmission_Medium
TP	Timing Point
TPmode	Termination Point mode
TR	Threshold Report
TS	Time Slot
TSD	Trail Signal Degrade
TSF	Trail Signal Fail
TSL	Trail Signal Label

TT	Trail Termination function
TTI	Trail Trace Identifier
TTP	Trail Termination Point
TTs	Trail Termination supervisory function
TU	Tributary Unit
TUG	Tributary Unit Group
TUG-m	Tributary Unit Group, level m
TU-m	Tributary Unit, level m
TxSL	Transmitted Signal Label
TxTI	Transmitted Trace Identifier
UAS	UnAvailable Second
UNEQ	Unequipped
UNI	User Network Interface
USR	USeR channels
UVC	Unequipped VC
VC	Virtual Container
VC-n	Virtual Container, level n
VMR	Violation Monitoring and Removal
VP	Virtual Path
W	Working

3.3 Symbols and Diagrammatic Conventions

The symbols and diagrammatic conventions are described in the ETS 300 417-1-1 [8].

4   P4e path layer functions
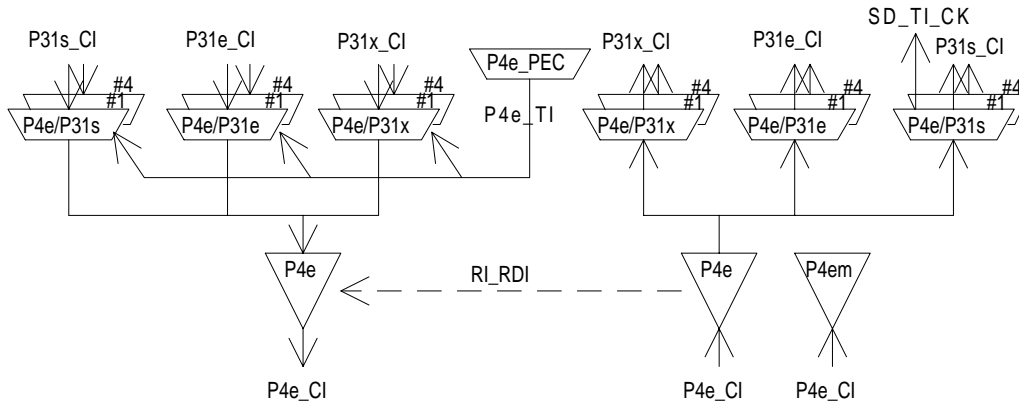
Figure 1: P4e path layer atomic functions

P4e layer CP

The Characteristic Information (CI) at this point is 139 264 kbit/s bit structured signal according to ITU-T Recommendation G.751 [6] with co-directional bit timing and the frame start information FS. The CI is structured to form a 2 928 bit long frame with 16 bit frame overhead containing 12 bit FAS, one bit RDI and a three bit user CI.

>   NOTE 1:   The bits for National Use (NU) in row 4, columns 2 to 4 of figure 2 are reserved for operator specific usage. Their processing is not within the province of this ETS.

P4e layer AP

The AI at this point is a multiplexed signal containing four $(728/2\,928) \times 139\,264$ kbit/s (see note 2) tributary signals (PU31) and $(3/2\,928) \times 139\,264$ kbit/s (see note 3) user CI (NU) with co-directional bit timing and frame start information.

>   NOTE 2:   This equations equals a bitrate of 34 625,748 633 879 8 kbit/s.

>   NOTE 3:   This equations equals a bitrate of 142,688 524 590 164 kbit/s.

The signal transported by an PU31 will be determined by the client layer application. Typical signals include:

-       a 34 368 kbit/s signal P31x_CI without an assumed structure and justification overhead bits;
-       a   34 368 kbit/s   signal   P31e_CI   with   a   frame   structure   according   to   ITU-T Recommendation G.751 [6] and justification overhead bits;
-       a 34 368 kbit/s signal P31s_CI with a frame structure according ETS 300 337 [9] and justification overhead bits.

	1	2	3	4
1	FAS	FAS	FAS	FAS
2	FAS	FAS	FAS	FAS
3	FAS	FAS	FAS	FAS
4	RDI	NU	NU	NU
5				
	P4e payload (728 x 4 bit)			
732				

	1	2	3	4
		NU	NU	NU
	PU31 #1	PU31 #2	PU31 #3	PU31 #4

Figure 2: P4e_CI_D (left) and P4e_AI_D (right) signals

1	P31
2	P31
	⋮
119	C
120	P31
121	P31
	⋮
241	C
242	P31
243	P31
	⋮
363	C
364	P31
365	P31
	⋮
485	C
496	P31
497	P31
	⋮
607	C
608	J
609	P31
610	P31
	⋮
728	

P31:   34 368 kbit/s data bit
C: justification control bit
J: justification opportunity bit

Figure 3: PU31 #i (i=1,2,3,4) of P4e_AI_D

4.1   P4e connection functions

For further study.

4.2   P4e trail termination functions

4.2.1   P4e trail termination source P4e_TT_So

Symbol:

P4e_AI

P4e
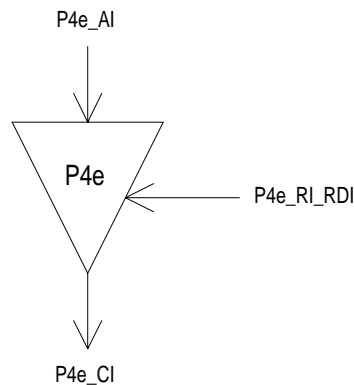
P4e_RI_RDI

P4e_CI

Figure 4: P4e_TT_So symbol

Interfaces:

Table 1: P4e_TT_So input and output signals

Input(s)	Output(s)
P4e_AI_D	P4e_CI_D
P4e_AI_CK	P4e_CI_CK
P4e_AI_FS	P4e_CI_FS
P4e_RI_RDI	

Processes:

This function adds the RDI information bit (figure 2) and the frame alignment signal into the frame overhead. The frame overhead is defined as the first 16 bits of this frame according the ITU-T Recommendation G.751 [6], section 1.5.2.

RDI: This bit represents the defect status of the associated P4e_TT_Sk. The RDI indication shall be set to "1" on activation of P4e_RI_RDI within 900 µs, determined by the associated P4e_TT_Sk function, and set to "0" within 900 µs on the P4e_RI_RDI removal.

Frame Alignment Signal (FAS): The function shall insert the 139 264 kbit/s frame alignment signal (111110100000) into the frame overhead.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

4.2.2 P4e trail termination sink P4e_TT_Sk

Symbol:
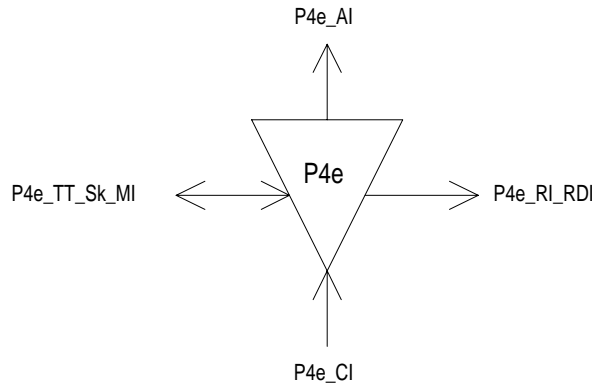
Figure 5: P4e_TT_Sk symbol

Interfaces:

Table 2: P4e_TT_Sk input and output signals

Input(s)	Output(s)
P4e_CI_D	P4e_AI_D
P4e_CI_CK	P4e_AI_CK
P4e_CI_FS	P4e_AI_FS
P4e_CI_SSF	P4e_AI_TSF
P4e_TT_So_MI_TPmode	P4e_TT_So_MI_cRDI
P4e_TT_So_MI_SSF_Reported	P4e_TT_So_MI_cSSF
P4e_TT_So_MI_RDI_Reported	

Processes:

This function recovers the RDI information bit (figure 2) of the frame overhead according to ITU-T Recommendation G.751 [6], section 1.5.2.

RDI: The information carried in the RDI bit shall be extracted to enable single ended maintenance of a bi-directional Trail (Path). The RDI (row 4, column 1) provides information as to the status of the remote receiver. A "1" indicates an RDI state, while a "0" indicates the normal, working state. The application process is described in ETS 300 417-1-1 [8], subclauses 7.4.11 and 8.2 (RDI).

Defects:

The function shall detect for dRDI defect according the specification in ETS 300 417-1-1 [8], subclause 8.2.1.

Consequent actions:

aTSF ← CI_SSF

aRDI ← CI_SSF

Defect correlations:

cRDI ← dRDI and MON and RDI_Reported

cSSF ← CI_SSF and MON and SSF_Reported

Performance monitoring:

The performance monitoring process shall be performed as specified in ETS 300 417-1-1 [8], subclause 8.2.4 through 8.2.7.

> NOTE: Whether or not performance monitoring is actually supported by a network element is determined by the presence of the element management performance monitoring functions.

A near-end block is errored (nN_B) if one or more FAS bits are errored.

pN_DS $\leftarrow$ aTSF or dEQ

pF_DS $\leftarrow$ dRDI

pN_EBC $\leftarrow$ Σ nN_B

4.3 P4e adaptation functions

4.3.1 P4e to P31x adaptation source P4e/P31x_A_So/i

Symbol:
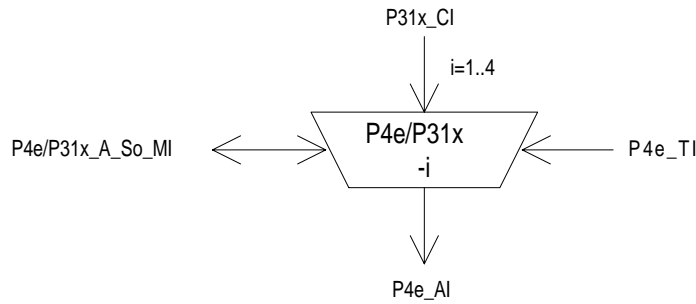
Figure 6: P4e/P31x_A_So symbol

Interfaces:

Table 3: P4e/P31x_A_So input and output signals

Input(s)	Output(s)
P31x_CI_D	P4e_AI_D
P31x_CI_CK	P4e_AI_CK
P4e_TI_CK	P4e_AI_FS
P4e_TI_FS	
P4e/P31x_A_So_MI_Active	

Processes:

This function maps one plesiochronous, 34 368 kbit/s, P31 information stream into the P4e frame (figure 2), according to ITU-T Recommendation G.751 [6], section 1.5.2. It takes P31x_CI, a bit-stream with a rate of 34 368 kbit/s ± 20 ppm, present at its input and inserts it into the PU31 #i having a capacity of 728 bits and the justification frame as depicted in figure 3. The function can be activated/deactivated when multiple payload adaptation functions are connected to the access point.

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (buffer) process. The data signal shall be written into the buffer under control of the associated input clock. The data signal shall be read out of the buffer under control of the P4e clock, frame position (P4e_TI), and justification decisions.

The justification decisions determine the phase error introduced by the P4e/P31x_A_So function. The amount of this phase error can be measured at the physical interfaces by monitoring the justification control bits C (figure 3). An example is given in ETS 300 417-4-1 [10], annex A.3.

Each justification decision results in a corresponding positive justification action. Upon a positive justification action, the reading of 1 data bit shall be cancelled once an no data is written at the justification opportunity bit J.

> NOTE: A requirement for maximum introduced phase error generated by the justification process is for further study.

Buffer size: In the presence of jitter specified by ITU-T Recommendation G.823 [7] and a frequency within the range 34 368 kbit/s ± 20 ppm, this justification process shall not introduce any errors. Any step in frequency within this range shall not cause any errors.

C bits - *Justification control generation:* The function shall generate the justification control (CCCCC) bits according the specification in ITU-T Recommendation G.751 [6]. It shall insert the justification control bits in the appropriate C bit positions.

PU-31 timeslot: The adaptation source function has access to a specific PU-31 of the P4e access point. The PU-31 is defined by the parameter i (i=1 to 4).

Figure 1 shows that more than one adaptation source function exists in this P4e layer that can be connected to one P4e access point. For such case, a subset of these adaptation source functions is allowed to be activated together. For this subset, access to the access point by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

An elastic store under/overflow defect (dUOF) is for further study.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

4.3.2 P4e to P31x Adaptation Sink P4e/P31x_A_Sk/i

Symbol:

Figure 7: P4e/P31x_A_Sk symbol

Interfaces:

Table 4: P4e/P31x_A_Sk input and output signals

Input(s)	Output(s)
P4e_AI_D	P31x_CI_D
P4e_AI_CK	P31x_CI_CK
P4e_AI_FS	P31x_CI_SSF
P4e_AI_TSF	
P4e/P31x_A_Sk_MI_Active	

Processes:

This function recovers one plesiochronous, 34 368 kbit/s, information stream P31 (figures 2 and 3) from the P4e frame according to ITU-T Recommendation G.751 [6], section 1.5.2. The function can be activated/deactivated when multiple payload adaptation functions are connected to the access point.

C bits - *Justification control interpretation:* The function shall perform justification control interpretation according ITU-T Recommendation G.751 [6] to recover the 34 368 kbit/s signal (P31) from the 139 264 kbit/s (P4e) payload signal. If the majority of the C bits is "0" the J bit shall be taken as a data bit, otherwise (majority of C bits is "1") J bit shall be taken as a justification bit and consequently ignored.

Smoothing & jitter limiting process: The function shall provide for a clock smoothing and elastic store (buffer) process. The 34 368 kbit/s data signal shall be written into the buffer under control of the associated (gapped) input clock. The data signal shall be read out of the buffer under control of a smoothed (equally spaced) 34 368 kHz $\pm$ 20 ppm clock (the rate is determined by the 34 Mbit/s signal at the input of the remote P4e/P31x_A_So).

The residual jitter caused by bit justifications (measured at the 34 368 kbit/s interface) shall such that the peak-to-peak jitter at the 34 368 kbit/s output (being a tributary) in the absence of input jitter shall not exceed 0,3 UI when measured in the frequency range up to 800 kHz.

When measured with an instrument incorporating a bandpass filter having a lower cut-off frequency of 10 kHz, a roll-off of 20 dB/decade and an upper limit of 800 kHz, the peak-to-peak output jitter shall not exceed 0,05 UI with a probability of 99,9 % during a measurement period of 10 s.

Buffer size: In the presence of jitter as specified by subclause 11.3.1.2 in ETS 300 417-1-1 [8] and a frequency within the range 34 368 kbit/s $\pm$ 20 ppm, this justification process shall not introduce any errors.

Following a step in frequency of the P31x signal transported by the P4e_AI (for example due to reception of P31x CI from a new P31x_TT_So at the far end or removal of all-ONEs (AIS) signal with a frequency offset) there will be a maximum recovery time of X seconds after which this process shall not generate any bit errors.

The value of X is for further study; a value of 1 second has been proposed.

PU-31 timeslot: The adaptation sink function has access to a specific PU-31 of the P4e access point. The PU-31 is defined by the parameter i (i=1 to 4).

Figure 1 shows that more than one adaptation sink function exists in this P4e layer that can be connected to one P4e access point. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D) and not report its status via the management point.

Defects: None.

Consequent Actions:

aAIS ←   AI_TSF

aSSF ←   AI_TSF

On declaration of aAIS the function shall output an all-ONEs (AIS) signal - complying to the frequency limits for this signal (a bit rate in range 34 368 kbit/s ± 20 ppm) - within 50 µs; on clearing of aAIS the function shall output normal data within 50 µs.

Defects Correlations: None.

Performance Monitoring: None.

4.3.3 P4e to P31e adaptation source P4e/P31e_A_So/i

Symbol:
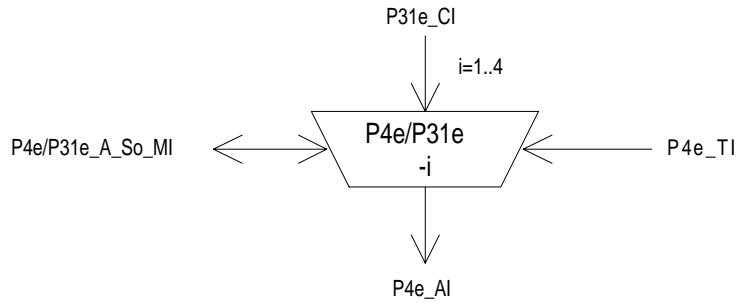
Figure 8: P4e/P31e_A_So symbol

Interfaces:

Table 5: P4e/P31e_A_So input and output signals

Input(s)	Output(s)
P31e_CI_D	P4e_AI_D
P31e_CI_CK	P4e_AI_CK
P31e_CI_FS	P4e_AI_FS
P4e_TI_CK	
P4e_TI_FS	
P4e/P31e_A_So_MI_Active	

Processes:

This function maps one plesiochronous, 34 368 kbit/s, P31 information stream into the P4e frame (figure 2), according to ITU-T Recommendation G.751 [6], section 1.5.2. It takes P31e_CI, a bit-stream with a rate of 34 368 kbit/s ± 20 ppm, present at its input and inserts it into the PU31 #i having a capacity of 728 bits and the justification frame as depicted in figure 3. The function can be activated/deactivated when multiple payload adaptation functions are connected to the access point.

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (buffer) process. The data signal shall be written into the buffer under control of the associated input clock. The data signal shall be read out of the buffer under control of the P4e clock, frame position (P4e_TI), and justification decisions.

The justification decisions determine the phase error introduced by the P4e/P31e_A_So function. The amount of this phase error can be measured at the physical interfaces by monitoring the justification control bits C (figure 3). An example is given in ETS 300 417-4-1 [10], annex A.3.

Each justification decision results in a corresponding positive justification action. Upon a positive justification action, the reading of 1 data bit shall be cancelled once an no data is written at the justification opportunity bit J.

> NOTE: A requirement for maximum introduced phase error generated by the justification process is for further study.

Buffer size: In the presence of jitter specified by ITU-T Recommendation G.823 [7] and a frequency within the range 34 368 kbit/s ± 20 ppm, this justification process shall not introduce any errors. Any step in frequency within this range shall not cause any errors.

C bits - *Justification control generation:* The function shall generate the justification control (CCCCC) bits according the specification in ITU-T Recommendation G.751 [6]. It shall insert the justification control bits in the appropriate C bit positions.

PU-31 timeslot: The adaptation source function has access to a specific PU-31 of the P4e access point. The PU-31 is defined by the parameter i (i=1 to 4).

Figure 1 shows that more than one adaptation source function exists in this P4e layer that can be connected to one P4e access point. For such case, a subset of these adaptation source functions is allowed to be activated together. For this subset, access to the access point by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

4.3.4 P4e to P31e adaptation sink P4e/P31e_A_Sk/i
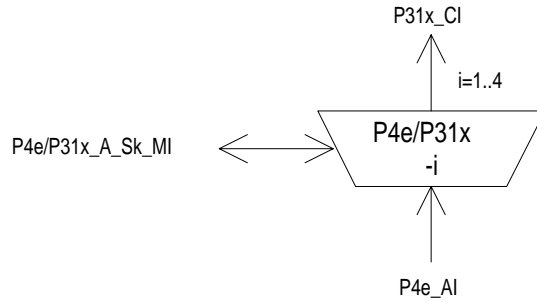
Symbol:
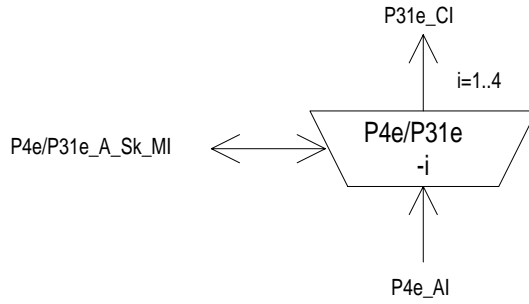
Figure 9: P4e/P31e_A_Sk symbol

Interfaces:

Table 6: P4e/P31e_A_Sk input and output signals

Input(s)	Output(s)
P4e_AI_D	P31e_CI_D
P4e_AI_CK	P31e_CI_CK
P4e_AI_FS	P31e_CI_FS
P4e_AI_TSF	P31e_CI_SSF
P4e/P31e_A_Sk_MI_Active	P4e/P31e_A_Sk_MI_cLOF
P4e/P31e_A_Sk_MI_AIS_Reported	P4e/P31e_A_Sk_MI_cAIS

Processes:

This function recovers one plesiochronous, 34 368 kbit/s, information stream P31 (figures 2 and 3) from the P4e frame according to ITU-T Recommendation G.751 [6], section 1.5.2. Further it recovers the frame start information for the P31 tributary signal. The function can be activated/deactivated when multiple payload adaptation functions are connected to the access point.

C bits - *Justification control interpretation:* The function shall perform justification control interpretation according ITU-T Recommendation G.751 [6] to recover the 34 368 kbit/s signal (P31) from the 139 264 kbit/s (P4e) payload signal. If the majority of the C bits is "0" the J bit shall be taken as a data bit, otherwise (majority of C bits is "1") J bit shall be taken as a justification bit and consequently ignored.

Smoothing & jitter limiting process: The function shall provide for a clock smoothing and elastic store (buffer) process. The 34 368 kbit/s data signal shall be written into the buffer under control of the associated (gapped) input clock. The data signal shall be read out of the buffer under control of a smoothed (equally spaced) 34 368 kHz $\pm$ 20 ppm clock (the rate is determined by the 34 Mbit/s signal at the input of the remote P4e/P31e_A_So).

The residual jitter caused by bit justifications is for further study.

Buffer size: In the presence of jitter as specified by subclause 11.3.1.2 in ETS 300 417-1-1 [8] and a frequency within the range 34 368 kbit/s $\pm$ 20 ppm, this justification process shall not introduce any errors.

Following a step in frequency of the P31e signal transported by the P4e_AI (for example due to reception of P31e CI from a new P31e_TT_So at the far end or removal of all-ONEs (AIS) signal with a frequency offset) there will be a maximum recovery time of X seconds after which this process shall not generate any bit errors.

The value of X is for further study; a value of 1 second has been proposed.

PU-31 timeslot: The adaptation sink function has access to a specific PU-31 of the P4e access point. The PU-31 is defined by the parameter i (i=1 to 4).

Figure 1 shows that more than one adaptation sink function exists in this P4e layer that can be connected to one P4e access point. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D) and not report its status via the management point.

Frame alignment: The function shall perform the frame alignment of the 34 368 kbit/s signal to recover the frame start information FS. The procedures to assume the loss and recovery of frame alignment shall be according the ITU-T Recommendation G.751 [6], section 1.4.3.

Defects:

The function shall detect a loss of frame defect (dLOF) when four consecutive frame alignment signals have been incorrectly received in their predicted positions. When frame alignment is lost, the dLOF defect shall be cleared when three consecutive frame alignment signals are detected.

The function shall detect an AIS defect (dAIS) according the specification in subclause 8.2.1.7 in ETS 300 417-1-1 [8], with $X = 4$, $Y = 1\ 536$, $Z = 5$.

Consequent Actions:

aAIS $\leftarrow$ dAIS or dLOF

aSSF $\leftarrow$ dAIS or dLOF

On declaration of aAIS the function shall output an all-ONEs (AIS) signal - complying to the frequency limits for this signal (a bit rate in range 34 368 kbit/s ± 20 ppm) - within 250 µs; on clearing of aAIS the function shall output normal data within 250 µs.

Defect Correlations:

cAIS $\leftarrow$ dAIS and (not AI_TSF) and AIS_Reported

cLOF $\leftarrow$ dLOF and not dAIS

Performance Monitoring: None.

4.3.5 P4e to P31s adaptation source P4e/P31s_A_So/i

Symbol:
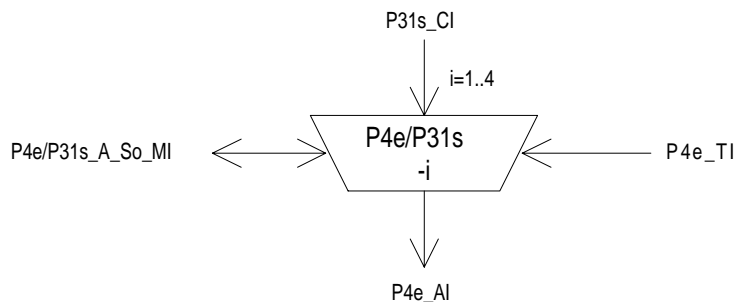
Figure 10: P4e/P31s_A_So symbol

Interfaces:

Table 7: P4e/P31s_A_So input and output signals

Input(s)	Output(s)
P31s_CI_D	P4e_AI_D
P31s_CI_CK	P4e_AI_CK
P4e_TI_CK	P4e_AI_FS
P4e_TI_FS	
P4e/P31s_A_So_MI_Active	

Processes:

This function maps one synchronous, 34 368 kbit/s, P31s information stream into the P4e frame (figure 2), according to ITU-T Recommendation G.751 [6], section 1.5.2. It takes P31s_CI, a bit-stream with a rate of 34 368 kbit/s ± 4,6 ppm (see note 1), present at its input and inserts it into the PU31 #i having a capacity of 728 bits and the justification frame as depicted in figure 3. The function can be activated/deactivated when multiple payload adaptation functions are connected to the access point.

> NOTE 1: The 34 368 Mbit/s with a 125 μs frame according ETS 300 337 [9] is nominally locked to a PRC.

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (buffer) process. The data signal shall be written into the buffer under control of the associated input clock. The data signal shall be read out of the buffer under control of the P4e clock, frame position (P4e_TI), and justification decisions.

The justification decisions determine the phase error introduced by the P4e/P31s_A_So function. The amount of this phase error can be measured at the physical interfaces by monitoring the justification control bits C (figure 3). An example is given in ETS 300 417-4-1 [10], annex A.3.

Each justification decision results in a corresponding positive justification action. Upon a positive justification action, the reading of 1 data bit shall be cancelled once an no data are written at the justification opportunity bit J.

> NOTE 2: A requirement for maximum introduced phase error generated by the justification process is for further study.

Buffer size: In the presence of jitter specified by ITU-T Recommendation G.823 [7] and a frequency within the range 34 368 kbit/s ± 4,6 ppm, this justification process shall not introduce any errors. Any step in frequency within this range shall not cause any errors.

C bits - *Justification control generation:* The function shall generate the justification control (CCCCC) bits according the specification in ITU-T Recommendation G.751 [6]. It shall insert the justification control bits in the appropriate C bit positions.

PU-31 timeslot: The adaptation source function has access to a specific PU-31 of the P4e access point. The PU-31 is defined by the parameter i (i=1 to 4).

Figure 1 shows that more than one adaptation source function exists in this P4e layer that can be connected to one P4e access point. For such case, a subset of these adaptation source functions is allowed to be activated together. For this subset, access to the access point by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

4.3.6 P4e to P31s adaptation sink P4e/P31s_A_Sk/i

Symbol:
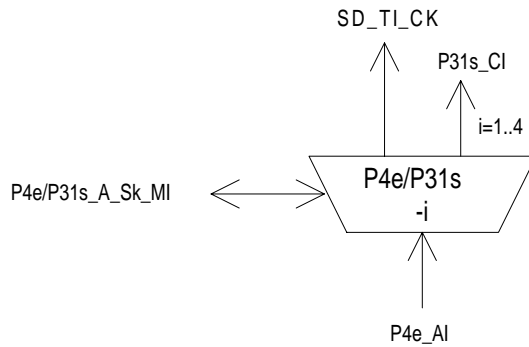
Figure 11: P4e/P31s_A_Sk symbol

Interfaces:

Table 8: P4e/P31s_A_Sk input and output signals

Input(s)	Output(s)
P4e_AI_D	P31s_CI_D
P4e_AI_CK	P31s_CI_CK
P4e_AI_FS	P31s_CI_FS
P4e_AI_TSF	P31s_CI_SSF
P4e/P31s_A_Sk_MI_Active	P4e/P31s_A_Sk_MI_cLOF
P4e/P31s_A_Sk_MI_AIS_Reported	P4e/P31s_A_Sk_MI_cAIS

Processes:

This function recovers one plesiochronous, 34 368 kbit/s, information stream P31 (figures 2 and 3) from the P4e frame according to ITU-T Recommendation G.751 [6], section 1.5.2. Further it recovers the frame start information for the P31 tributary signal. The function can be activated/deactivated when multiple payload adaptation functions are connected to the access point. It supplies the recovered timing signal to the synchronization distribution layer.

C bits - *Justification control interpretation:* The function shall perform justification control interpretation according ITU-T Recommendation G.751 [6] to recover the 34 368 kbit/s signal (P31) from the 139 264 kbit/s (P4e) payload signal. If the majority of the C bits is "0" the J bit shall be taken as a data bit, otherwise (majority of C bits is "1") J bit shall be taken as a justification bit and consequently ignored.

Smoothing & jitter limiting process: The function shall provide for a clock smoothing and elastic store (buffer) process. The 34 368 kbit/s data signal shall be written into the buffer under control of the associated (gapped) input clock. The data signal shall be read out of the buffer under control of a smoothed (equally spaced) 34 368 kHz $\pm$ 4,6 ppm clock (the rate is determined by the 34 Mbit/s signal at the input of the remote P4e/P31s_A_So).

The residual jitter caused by bit justifications is for further study.

Buffer size: In the presence of jitter as specified by subclause 11.3.1.2 in ETS 300 417-1-1 [8] and a frequency within the range 34 368 kbit/s $\pm$ 4,6 ppm, this justification process shall not introduce any errors.

Following a step in frequency of the P31s signal transported by the P4e_AI (for example due to reception of P31s CI from a new P31s_TT_So at the far end or removal of all-ONEs (AIS) signal with a frequency offset) there will be a maximum recovery time of X seconds after which this process shall not generate any bit errors.

The value of X is for further study; a value of 1 second has been proposed.

PU-31 timeslot: The adaptation sink function has access to a specific PU-31 of the P4e access point. The PU-31 is defined by the parameter i (i=1 to 4).

Figure 1 shows that more than one adaptation sink function exists in this P4e layer that can be connected to one P4e access point. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D) and not report its status via the management point.

Frame alignment: The function shall perform the frame alignment of the 34 368 kbit/s signal to recover the frame start information FS. The frame alignment shall be found by searching for the A1, A2 bytes contained in the 34 Mbit/s signal. The frame signal shall be continuously checked with the presumed frame start position for the alignment. Frame alignment is deemed to have been lost when either:

- four consecutive FAS are detected in error (i.e. ≥ 1 error in each FAS);
- 986 or more frames with one or more BIP8 violations (≥986 BIPV) are detected in a block of 1 000 frames (125 ms).

Frame alignment is deemed to have been recovered when three consecutive non-errored FAS are found.

Should a research for frame alignment be initiated either due to:

- a fortuitous FAS position being found once and not being found a second time in its expected position;
- exceeding the threshold which indicates false alignment.

then the new search for frame alignment should start 1 bit displaced forward from the position of the last indication of frame alignment.

NOTE: The above is required in order to avoid repeated alignment on to a simulation of the framing location.

FAS1: correct FAS found
FASc: correct consecutive FAS found
FASE: errored FAS
BIPV: BIP Violations
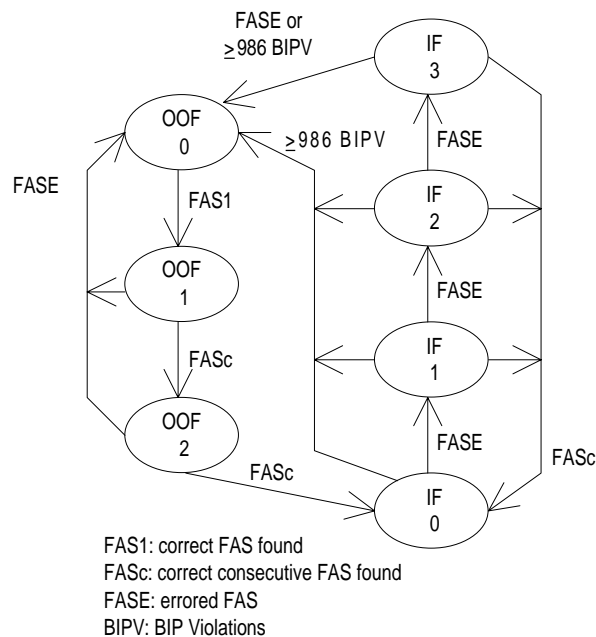
Figure 12: Frame alignment state diagram

Defects:

If the frame alignment state machine is in (one of) the OOF state(s), a 34 Mbit/s Loss Of Frame defect (dLOF) shall be detected. The dLOF defect shall be cleared when the frame alignment state machine is in (one of) the IF state(s).

The dAIS defect shall be detected as defined in ETS 300 417-1-1 [8], subclause 8.2.1.7 for 34 Mbit/s, with X = 7, Y = 8 592, Z = 8.

Consequent Actions:

aAIS ← dAIS or dLOF

aSSF ← dAIS or dLOF

On declaration of aAIS the function shall output an all-ONEs (AIS) signal - complying to the frequency limits for this interface - within 250 µs; on clearing of aAIS the function shall output normal data within 250 µs.

Defect Correlations:

cAIS ← dAIS and (not AI_TSF) and AIS_Reported

cLOF ← dLOF and (not dAIS)

Performance Monitoring: None.

4.4 P4e layer monitoring functions

4.4.1 P4e layer non-intrusive monitoring function P4em_TT_Sk

Symbol:
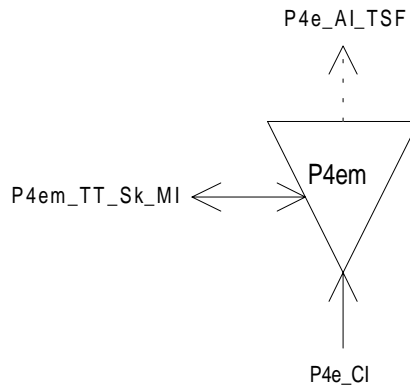
Figure 13: P4em_TT_Sk symbol

Interfaces:

Table 9: P4em_TT_Sk input and output signals

Input(s)	Output(s)
P4e_CI_D	P4e_AI_TSF
P4e_CI_CK	P4em_TT_So_MI_cRDI
P4e_CI_FS	P4em_TT_So_MI_cSSF
P4e_CI_SSF	
P4em_TT_So_MI_TPmode	
P4em_TT_So_MI_SSF_Reported	
P4em_TT_So_MI_RDI_Reported	

Processes:

This function recovers the RDI information bit (figure 2) of the frame overhead according to ITU-T Recommendation G.751 [6], section 1.5.2.

RDI: The information carried in the RDI bit shall be extracted to enable single ended maintenance of a bi-directional Trail (Path). The RDI (row 4, column 1) provides information as to the status of the remote receiver. A "1" indicates a Remote Defect Indication state, while a "0" indicates the normal, working state. The application process is described in ETS 300 417-1-1 [8], subclauses 7.4.11 and 8.2 (RDI).

Defects:

The function shall detect for dRDI defect according the specification in ETS 300 417-1-1 [8], subclause 8.2.1.

Consequent Actions:

aTSF ← CI_SSF

Defect Correlations:

cRDI ← dRDI and MON and RDI_Reported

cSSF ← CI_SSF and MON and SSF_Reported

Performance Monitoring:

The performance monitoring process shall be performed as specified in ETS 300 417-1-1 [8], subclause 8.2.4 through 8.2.7 (see note).

> NOTE: Whether or not performance monitoring is actually supported by a network element is determined by the presence of the element management performance monitoring functions.

A near-end block is errored (nN_B) if one or more FAS bits are errored.

pN_DS   ←   aTSF or dEQ

pF_DS   ←   dRDI

pN_EBC   ← Σ nN_B

4.5   P4e PDH equipment clock adaptation source P4e_PEC

Symbol:
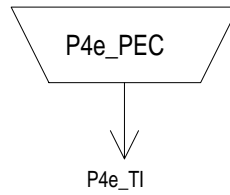
Figure 14: P4e_PEC_A_So symbol

Interfaces:

Table 10: P4e_PEC_A_So input and output signals

Input(s)	Output(s)
	P4e_TI_CK
	P4e_TI_FS

Processes:

This function performs the 140 Mbit/s clock and frame start signal generation to time the adaptation source functions in this layer.

Clock generation: The function shall generate the clock (bit) reference signal P4e_TI_CK for the P4e signal. The P4e_TI_CK bit rate shall be in range of 139 264 kbit/s ± 15 ppm.

Jitter limiter: The function shall generate the clock signal such that the peak-to-peak jitter at the 139 264 kbit/s output shall not exceed 0,05 UI when it is measured within the frequency range from 200 Hz to 3 500 kHz.

Frame Start signal generation: The function shall generate the frame start reference signal P4e_TI_FS for the P4e signal. The P4e_TI_FS signal shall be active once per 2 928 bits.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

5 P31e path layer functions
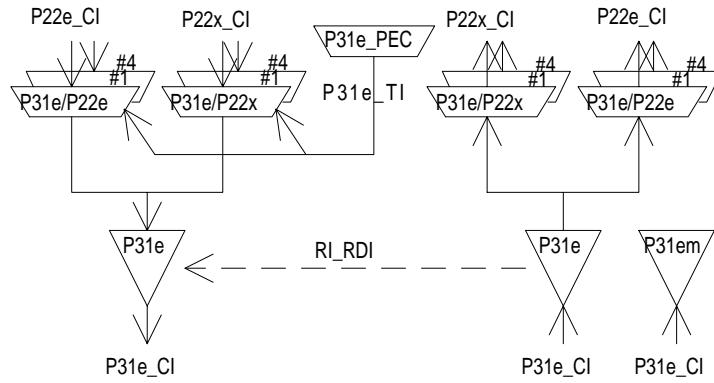
Figure 15: P31e path layer atomic functions

P31e layer CP.

The CI at this point is 34 368 kbit/s bit structured signal according to ITU-T Recommendation G.751 [6] with co-directional bit timing and the frame start information FS. The CI is structured to form a 1 536 bit long frame with 12 bit frame overhead containing 10 bit FAS, one bit RDI and one bit user CI.

> NOTE 1: The bit for National Use (NU) in row 3, column 4 of figure 16 are reserved for operator specific usage. Their processing is not within the province of this ETS.

P31e layer AP.

The AI at this point is a multiplexed signal containing four $(381/1\ 536) \times 34\ 368$ kbit/s (see note 2) tributary signals (PU22) and 22 375 bit/s User Characteristic Information (NU) with co-directional bit timing and frame start information.

> NOTE 2: This equation equals a bitrate of 8 524,875 kbit/s.

The signal transported by an PU22 will be determined by the client layer application. Typical signals include:

- a 8 448 kbit/s signal P22x_CI without an assumed structure and justification overhead bits;
- a 8 448 kbit/s signal P22e_CI with a frame structure according ITU-T Recommendation G.742 [5] and justification overhead bits.
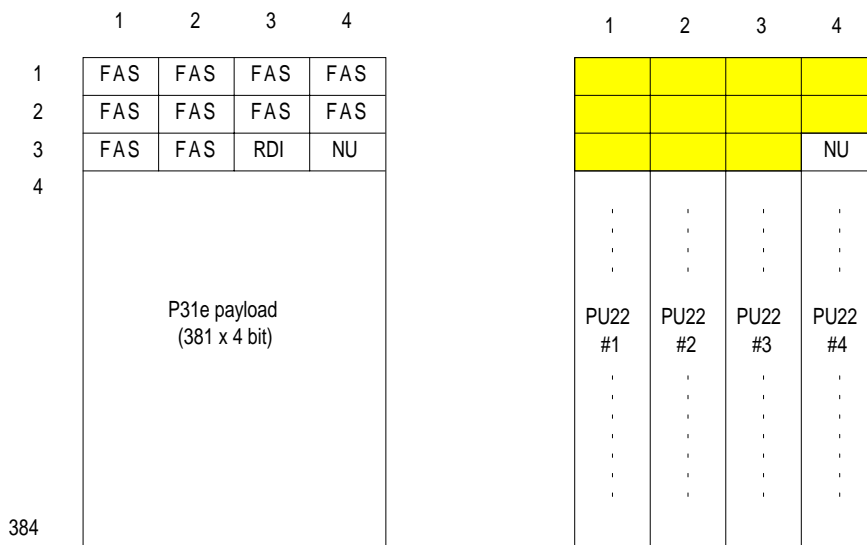
Figure 16: P31e_CI_D (left) and P31e_AI_D (right) signals

1	P22
2	P22
	⋮
94	C
95	P22
96	P22
	⋮
190	C
191	P22
192	P22
	⋮
286	C
287	J
288	P22
289	P22
	⋮
381	

P22:   8 448 kbit/s data bit
C: justification control bit
J: justification opportunity bit

Figure 17: PU22 #i (i=1,2,3,4) of P31e_AI_D

5.1 P31e connection functions

For further study.

5.2 P31e trail termination functions

5.2.1 P31e trail termination source P31e_TT_So

Symbol:

P31e_AI

P31e
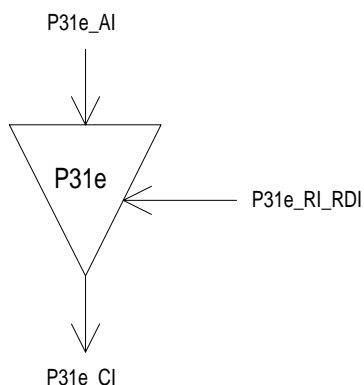
P31e_RI_RDI

P31e_CI

Figure 18: P31e_TT_So symbol

Interfaces:

Table 11: P31e_TT_So input and output signals

Input(s)	Output(s)
P31e_AI_D	P31e_CI_D
P31e_AI_CK	P31e_CI_CK
P31e_AI_FS	P31e_CI_FS
P31e_RI_RDI	

Processes:

This function adds the RDI information bit (figure 16) and the frame alignment signal into the frame overhead. The frame overhead is defined as the first 12 bits of this frame according the ITU-T Recommendation G.751 [6], section 1.4.2.

RDI: This bit represents the defect status of the associated P31e_TT_Sk. The RDI indication shall be set to "1" on activation of P31e_RI_RDI within 800 µs, determined by the associated P31e_TT_Sk function, and set to "0" within 800 µs on the P31e_RI_RDI removal.

Frame Alignment Signal (FAS): The function shall insert the 34 368 kbit/s frame alignment signal (1111010000) into the frame overhead.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

5.2.2 P31e trail termination sink P31e_TT_Sk

Symbol:
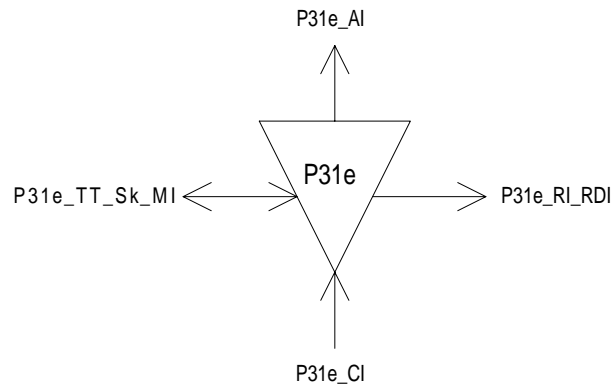
Figure 19: P31e_TT_Sk symbol

Interfaces:

Table 12: P31e_TT_Sk input and output signals

Input(s)	Output(s)
P31e_CI_D	P31e_AI_D
P31e_CI_CK	P31e_AI_CK
P31e_CI_FS	P31e_AI_FS
P31e_CI_SSF	P31e_AI_TSF
P31e_TT_So_MI_TPmode	P31e_TT_So_MI_cRDI
P31e_TT_So_MI_SSF_Reported	P31e_TT_So_MI_cSSF
P31e_TT_So_MI_RDI_Reported	

Processes:

This function recovers the RDI information bit (figure 16) of the frame overhead according to ITU-T Recommendation G.751 [6], section 1.4.2.

RDI: The information carried in the RDI bit shall be extracted to enable single ended maintenance of a bi-directional Trail (Path). The RDI (row 3, column 3) provides information as to the status of the remote receiver. A "1" indicates a Remote Defect Indication state, while a "0" indicates the normal, working state. The application process is described in ETS 300 417-1-1 [8], subclauses 7.4.11 and 8.2 (RDI).

Defects:

The function shall detect for dRDI defect according the specification in ETS 300 417-1-1 [8], subclause 8.2.1.

Consequent Actions:

aTSF ← CI_SSF

aRDI ← CI_SSF

Defect Correlations:

cRDI ← dRDI and MON and RDI_Reported

cSSF ← CI_SSF and MON and SSF_Reported

Performance Monitoring:

The performance monitoring process shall be performed as specified in ETS 300 417-1-1 [8], subclause 8.2.4 through 8.2.7 (see note).

> NOTE: Whether or not performance monitoring is actually supported by a network element is determined by the presence of the element management performance monitoring functions.

A near-end block is errored (nN_B) if one or more FAS bits are errored.

pN_DS   ←   aTSF or dEQ

pF_DS   ←   dRDI

pN_EBC   ←   Σ nN_B

5.3 P31e adaptation functions

5.3.1 P31e to P22x adaptation source P31e/P22x_A_So/i

Symbol:
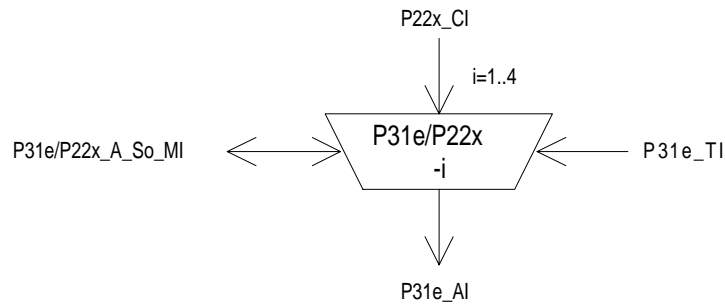
Figure 20: P31e/P22x_A_So symbol

Interfaces:

Table 13: P31e/P22x_A_So input and output signals

Input(s)	Output(s)
P22x_CI_D	P31e_AI_D
P22x_CI_CK	P31e_AI_CK
P31e_TI_CK	P31e_AI_FS
P31e_TI_FS	
P31e/P22x_A_So_MI_Active	

Processes:

This function maps one plesiochronous, 8 448 kbit/s, P22 information stream into the P31e frame (figure 16), according to ITU-T Recommendation G.751 [6], section 1.4.2. It takes P22x_CI, a bit-stream with a rate of 8 448 kbit/s ± 30 ppm, present at its input and inserts it into the PU22 #i having a capacity of 381 bits and the justification frame as depicted in figure 17. The function can be activated/deactivated when multiple payload adaptation functions are connected to the access point.

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (buffer) process. The data signal shall be written into the buffer under control of the associated input clock. The data signal shall be read out of the buffer under control of the P31e clock, frame position (P31e_TI), and justification decisions.

The justification decisions determine the phase error introduced by the P31e/P22x_A_So function. The amount of this phase error can be measured at the physical interfaces by monitoring the justification control bits C (figure 17). An example is given in ETS 300 417-4-1 [10], annex A.3.

Each justification decision results in a corresponding positive justification action. Upon a positive justification action, the reading of 1 data bit shall be cancelled once an no data are written at the justification opportunity bit J.

    NOTE: A requirement for maximum introduced phase error generated by the justification process is for further study.

Buffer size: In the presence of jitter specified by ITU-T Recommendation G.823 [7] and a frequency within the range 8 448 kbit/s ± 30 ppm, this justification process shall not introduce any errors. Any step in frequency within this range shall not cause any errors.

C bits - *Justification control generation:* The function shall generate the justification control (CCC) bits according the specification in ITU-T Recommendation G.751 [6]. It shall insert the justification control bits in the appropriate C bit positions.

PU-22 timeslot: The adaptation source function has access to a specific PU-22 of the P31e access point. The PU-22 is defined by the parameter i (i=1 to 4).

Figure 15 shows that more than one adaptation source function exists in this P31e layer that can be connected to one P31e access point. For such case, a subset of these adaptation source functions is allowed to be activated together. For this subset, access to the access point by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

5.3.2 P31e to P22x adaptation sink P31e/P22x_A_Sk/i

Symbol:

Figure 21: P31e/P22x_A_Sk symbol

Interfaces:

Table 14: P31e/P22x_A_Sk input and output signals

Input(s)	Output(s)
P31e_AI_D	P22x_CI_D
P31e_AI_CK	P22x_CI_CK
P31e_AI_FS	P22x_CI_SSF
P31e_AI_TSF	
P31e/P22x_A_Sk_MI_Active	

Processes:

This function recovers one plesiochronous, 8 448 kbit/s, information stream P22 (figures 16 and 17) from the P31e frame according to ITU-T Recommendation G.751 [6], section 1.4.2. The function can be activated/deactivated when multiple payload adaptation functions are connected to the access point.

C bits - *Justification control interpretation:* The function shall perform justification control interpretation according ITU-T Recommendation G.751 [6] to recover the 8 448 kbit/s signal (P22) from the 34 368 kbit/s (P31e) payload signal. If the majority of the C bits is "0" the J bit shall be taken as a data bit, otherwise (majority of C bits is "1") J bit shall be taken as a justification bit and consequently ignored.

Smoothing process: The function shall provide for a clock smoothing and elastic store (buffer) process. The 8 448 kbit/s data signal shall be written into the store under control of the associated (gapped) input clock. The data signal shall be read out of the store under control of a smoothed (equally spaced) 8 448 kHz $\pm$ 30 ppm clock (the rate is determined by the 8 Mbit/s signal at the input of the remote P31e/P22x_A_Sk).

The residual jitter caused by bit justifications (measured at the 8 448 kbit/s interface) shall such that the peak-to-peak jitter at the 8 448 kbit/s output (being a tributary) in the absence of input jitter shall not exceed 0,25 UI when measured in the frequency range up to 400 kHz.

When measured with an instrument incorporating a bandpass filter having a lower cut-off frequency of 3 kHz, a roll-off of 20 dB/decade and an upper limit of 400 kHz, the peak-to-peak output jitter shall not exceed 0,05 UI with a probability of 99,9 % during a measurement period of 10 s.

Buffer size: In the presence of jitter as specified by subclause 11.3.1.2 in ETS 300 417-1-1 [8] and a frequency within the range 8 448 kbit/s $\pm$ 30 ppm, this justification process shall not introduce any errors.

Following a step in frequency of the P22x signal transported by the P31e_AI (for example due to reception of P22x CI from a new P22x_TT_So at the far end or removal of all-ONEs (AIS) signal with a frequency offset) there will be a maximum recovery time of X seconds after which this process shall not generate any bit errors.

The value of X is for further study; a value of 1 second has been proposed.

PU-22 timeslot: The adaptation sink function has access to a specific PU-22 of the P31e access point. The PU-22 is defined by the parameter i (i=1 to 4).

Figure 15 shows that more than one adaptation sink function exists in this P31e layer that can be connected to one P31e access point. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D) and not report its status via the management point.

Defects: None.

Consequent Actions:

aAIS ←   AI_TSF

aSSF ←   AI_TSF

On declaration of aAIS the function shall output an all-ONEs (AIS) signal - complying to the frequency limits for this signal (a bit rate in range 8 448 kbit/s ± 30 ppm) - within 100 µs; on clearing of aAIS the function shall output normal data within 100 µs.

Defects Correlations: None.

Performance Monitoring: None.

5.3.3 P31e to P22e adaptation source P31e/P22e_A_So/i

Symbol:
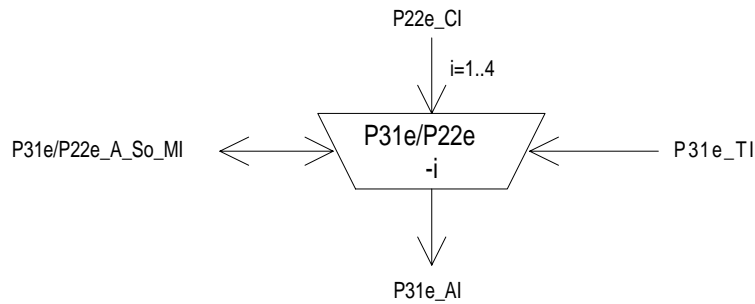
Figure 22: P31e/P22e_A_So symbol

Interfaces:

Table 15: P31e/P22e_A_So input and output signals

Input(s)	Output(s)
P22e_CI_D	P31e_AI_D
P22e_CI_CK	P31e_AI_CK
P22e_CI_FS	P31e_AI_FS
P31e_TI_CK	
P31e_TI_FS	
P31e/P22e_A_So_MI_Active	

Processes:

This function maps one plesiochronous, 8 448 kbit/s, P22 information stream into the P31e frame (figure 16), according to ITU-T Recommendation G.751 [6], section 1.4.2. It takes P22e_CI, a bit-stream with a rate of 8 448 kbit/s ± 30 ppm, present at its input and inserts it into the PU22 #ihaving a capacity of 381 bits and the justification frame as depicted in figure 17. The function can be activated/deactivated when multiple payload adaptation functions are connected to the access point.

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (buffer) process. The data signal shall be written into the buffer under control of the associated input clock. The data signal shall be read out of the buffer under control of the P31e clock, frame position (P31e_TI), and justification decisions.

The justification decisions determine the phase error introduced by the P31e/P22e_A_So function. The amount of this phase error can be measured at the physical interfaces by monitoring the justification control bits C (figure 17). An example is given in ETS 300 417-4-1 [10], annex A.3.

Each justification decision results in a corresponding positive justification action. Upon a positive justification action, the reading of 1 data bit shall be cancelled once an no data are written at the justification opportunity bit J.

> NOTE: A requirement for maximum introduced phase error generated by the justification process is for further study.

Buffer size: In the presence of jitter specified by ITU-T Recommendation G.823 [7] and a frequency within the range 8 448 kbit/s ± 30 ppm, this justification process shall not introduce any errors. Any step in frequency within this range shall not cause any errors.

C bits - *Justification control generation:* The function shall generate the justification control (CCC) bits according the specification in ITU-T Recommendation G.751 [6]. It shall insert the justification control bits in the appropriate C bit positions.

PU-22 timeslot: The adaptation source function has access to a specific PU-22 of the P31e access point. The PU-22 is defined by the parameter i (i=1 to 4).

Figure 15 shows that more than one adaptation source function exists in this P31e layer that can be connected to one P31e access point. For such case, a subset of these adaptation source functions is allowed to be activated together. For this subset, access to the access point by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

5.3.4 P31e to P22e adaptation sink P31e/P22e_A_Sk/i
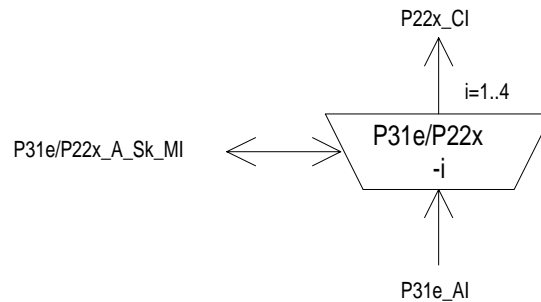
Symbol:
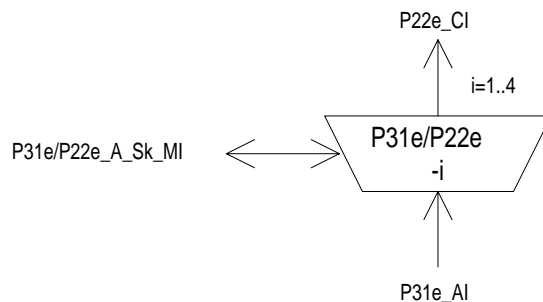
Figure 23: P31e/P22e_A_Sk symbol

Interfaces:

Table 16: P31e/P22e_A_Sk input and output signals

Input(s)	Output(s)
P31e_AI_D	P22e_CI_D
P31e_AI_CK	P22e_CI_CK
P31e_AI_FS	P22e_CI_FS
P31e_AI_TSF	P22e_CI_SSF
P31e/P22e_A_Sk_MI_Active	P31e/P22e_A_Sk_MI_cLOF
P31e/P22e_A_Sk_MI_AIS_Reported	P31e/P22e_A_Sk_MI_cAIS

Processes:

This function recovers one plesiochronous, 8 448 kbit/s, information stream P22 (figures 16 and 17) from the P31e frame according to ITU-T Recommendation G.751 [6], section 1.4.2. Further it recovers the Frame start information for the P22 tributary signal. The function can be activated/deactivated when multiple payload adaptation functions are connected to the access point.

C bits - *Justification control interpretation:* The function shall perform justification control interpretation according ITU-T Recommendation G.751 [6] to recover the 8 448 kbit/s signal (P22) from the 34 368 kbit/s (P31e) payload signal. If the majority of the C bits is "0" the J bit shall be taken as a data bit, otherwise (majority of C bits is "1") J bit shall be taken as a justification bit and consequently ignored.

Smoothing & jitter limiting process: The function shall provide for a clock smoothing and elastic store (buffer) process. The 8 448 kbit/s data signal shall be written into the buffer under control of the associated (gapped) input clock. The data signal shall be read out of the buffer under control of a smoothed (equally spaced) 8 448 kHz $\pm$ 30 ppm clock (the rate is determined by the 8 Mbit/s signal at the input of the remote P31e/P22e_A_So).

The residual jitter caused by bit justifications is for further study.

Buffer size: In the presence of jitter as specified by subclause 11.3.1.2 in ETS 300 417-1-1 [8] and a frequency within the range 8 448 kbit/s $\pm$ 30 ppm, this justification process shall not introduce any errors.

Following a step in frequency of the P22e signal transported by the P31e_AI (for example due to reception of P22e CI from a new P22e_TT_So at the far end or removal of all-ONEs (AIS) signal with a frequency offset) there will be a maximum recovery time of X seconds after which this process shall not generate any bit errors.

The value of X is for further study; a value of 1 second has been proposed.

PU-22 timeslot: The adaptation sink function has access to a specific PU-22 of the P31e access point. The PU-22 is defined by the parameter i (i=1 to 4).

Figure 15 shows that more than one adaptation sink function exists in this P31e layer that can be connected to one P31e access point. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D) and not report its status via the management point.

Frame alignment: The function shall perform the frame alignment of the 8 448 kbit/s signal to recover the frame start information FS. The procedures to assume the loss and recovery of frame alignment shall be according the ITU-T Recommendation G.751 [6], section 1.4.3.

Defects:

The function shall detect a loss of frame defect (dLOF) when four consecutive frame alignment signals have been incorrectly received in their predicted positions. When frame alignment is lost, the dLOF defect shall be cleared when three consecutive frame alignment signals are detected.

The function shall detect an AIS defect (dAIS) according the specification in subclause 8.2.1.7 in ETS 300 417-1-1 [8], with X = 4, Y = 848, Z = 5.

Consequent Actions:

aAIS ←   dAIS or dLOF

aSSF ←   dAIS or dLOF

On declaration of aAIS the function shall output an all-ONEs (AIS) signal - complying to the frequency limits for this signal (a bit rate in range 8 448 kbit/s ± 20 ppm) - within 250 µs; on clearing of aAIS the function shall output normal data within 250 µs.

Defect Correlations:

cAIS ←   dAIS and (not AI_TSF) and AIS_Reported

cLOF ←   dLOF and not dAIS

Performance Monitoring: None.

5.4 P31e layer monitoring functions

5.4.1 P31e layer non-intrusive monitoring function P31em_TT_Sk

Symbol:
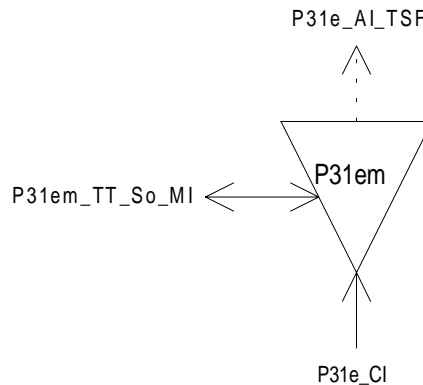
Figure 24: P31em_TT_Sk symbol

Interfaces:

Table 17: P31em_TT_Sk input and output signals

Input(s)	Output(s)
P31e_CI_D	P31e_AI_TSF
P31e_CI_CK	P31em_TT_So_MI_cRDI
P31e_CI_FS	P31em_TT_So_MI_cSSF
P31e_CI_SSF	
P31em_TT_So_MI_TPmode	
P31em_TT_So_MI_SSF_Reported	
P31em_TT_So_MI_RDI_Reported	

Processes:

This function recovers the RDI information bit (figure 16) of the frame overhead according to ITU-T Recommendation G.751 [6] subclause 1.4.2.

RDI: The information carried in the RDI bit shall be extracted to enable single ended maintenance of a bi-directional Trail (Path). The RDI (row 3, column 3) provides information as to the status of the remote receiver. A "1" indicates a Remote Defect Indication state, while a "0" indicates the normal, working state. The application process is described in ETS 300 417-1-1 [8], subclauses 7.4.11 and 8.2 (RDI).

Defects:

The function shall detect for dRDI defect according the specification in ETS 300 417-1-1 [8], subclause 8.2.1.

Consequent Actions:

aTSF ← CI_SSF

Defect Correlations:

cRDI ← dRDI and MON and RDI_Reported

cSSF ← CI_SSF and MON and SSF_Reported

Performance Monitoring:

The performance monitoring process shall be performed as specified in ETS 300 417-1-1 [8], subclause 8.2.4 through 8.2.7 (see note).

> NOTE: Whether or not performance monitoring is actually supported by a network element is determined by the presence of the element management performance monitoring functions.

A near-end block is errored (nN_B) if one or more FAS bits are errored.

pN_DS $\leftarrow$ aTSF or dEQ

pF_DS $\leftarrow$ dRDI

pN_EBC $\leftarrow$ Σ nN_B

5.5 P31e PDH equipment clock adaptation source P31e_PEC

Symbol:
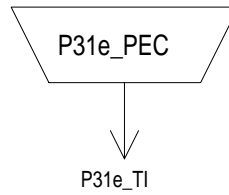
Figure 25: P31e_PEC_A_So symbol

Interfaces:

Table 18: P31e_PEC_A_So input and output signals

Input(s)	Output(s)
	P31e_TI_CK
	P31e_TI_FS

Processes:

This function performs the 34 Mbit/s clock and frame start signal generation to time the adaptation source functions in this layer.

Clock generation: The function shall generate the clock (bit) reference signal P31e_TI_CK for the P31e signal. The P31e_TI_CK bit rate shall be in range of 34 368 kbit/s ± 20 ppm.

Jitter limiter: The function shall generate the clock signal such that the peak-to-peak jitter at the 34 368 kbit/s output shall not exceed 0,05 UI when it is measured within the frequency range from 100 Hz to 800 kHz.

Frame Start signal generation: The function shall generate the frame start reference signal P31e_TI_FS for the P31e signal. The P31e_TI_FS signal shall be active once per 1 536 bits.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

6 P22e path layer functions
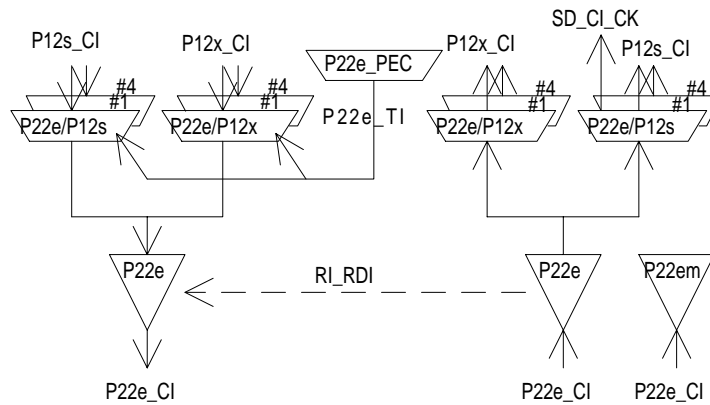
Figure 26: P22e atomic functions

P22e layer CP.

The CI at this point is 8 448 kbit/s bit structured signal according to ITU-T Recommendation G.742 [5] with co-directional bit timing and the frame start information FS. The CI is structured to form a 848 bit long frame with 12 bit frame overhead containing 10 bit FAS, one bit RDI and one bit user CI.

> NOTE 1: The bit for National Use (NU) in row 3, column 4 of figure 27 are reserved for operator specific usage. Their processing is not within the province of this ETS.

P22e layer AP.

The AI at this point is a multiplexed signal containing four $(209/848) \times 8\ 448$ kbit/s (see note 2) tributary signals and $(1/848) \times 8\ 448$ kbit/s (see note 3) User Characteristic Information (NU) with co-directional bit timing and frame start information.

> NOTE 2: This equation equals a bitrate of 2 082,113 207 547 kbit/s.

> NOTE 3: This equation equals a bitrate of 9,962 264 150 943 kbit/s.

The signal transported by an PU12 will be determined by the client layer application. Typical signals include:

- a 2 048 kbit/s signal P12x_CI without an assumed structure and justification overhead bits;
- a 2 048 kbit/s signal P12s_CI with a frame structure according ETS 300 167 [2] and justification overhead bits.

	1	2	3	4
1	FAS	FAS	FAS	FAS
2	FAS	FAS	FAS	FAS
3	FAS	FAS	RDI	NU
4				
	P22e payload (209 x 4 bit)			
212				

	1	2	3	4
				NU
	PU12 #1	PU12 #2	PU12 #3	PU12 #4
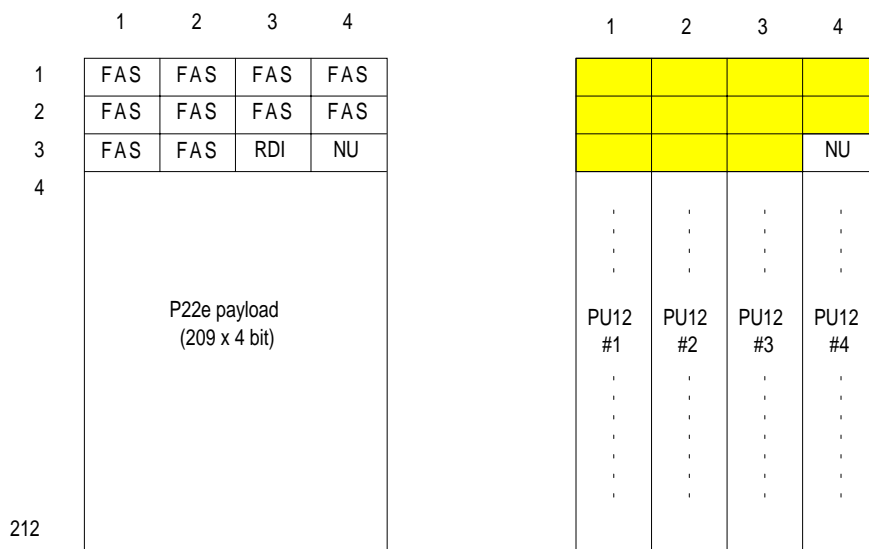
Figure 27: P22e_CI_D (left) and P22e_AI_D (right) signals

1	P12
2	P12
51	C
52	P12
53	P12
104	C
105	P12
106	P12
157	C
158	J
159	P12
160	P12
209	

P12: 2 048 kbit/s data bit
C: justification control bit
J: justification opportunity bit
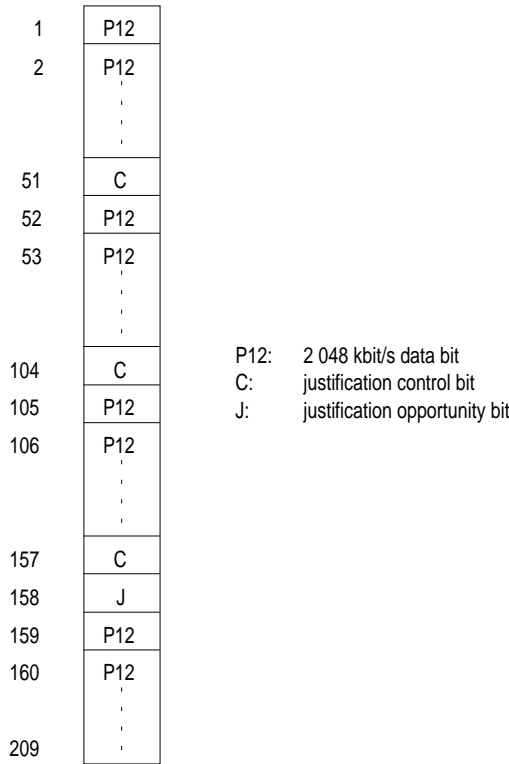
Figure 28: PU12 #i (i=1,2,3,4) of P22e_AI_D

6.1 P22e connection functions

For further study.

6.2 P22e trail termination functions

6.2.1 P22e trail termination source P22e_TT_So

Symbol:

```
                    P22e_AI
                       |
                       v

                    /     \
                   /       \
                  /  P22e   \ <——— P22e_RI_RDI
                  \         /
                   \       /
                    \     /
                       |
                       v
                    P22e_CI
```
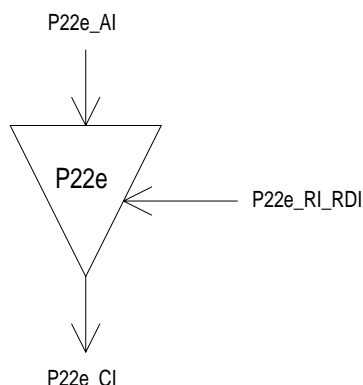
Figure 29: P22e_TT_So symbol

Interfaces:

Table 19: P22e_TT_So input and output signals

Input(s)	Output(s)
P22e_AI_D	P22e_CI_D
P22e_AI_CK	P22e_CI_CK
P22e_AI_FS	P22e_CI_FS
P22e_RI_RDI	

Processes:

This function adds the RDI information bit (figure 27) and the frame alignment signal into the frame overhead. The frame overhead is defined as the first 12 bits of this frame according the ITU-T Recommendation G.742 [5], section 5.

RDI: This bit represents the defect status of the associated P22e_TT_Sk. The RDI indication shall be set to "1" on activation of P22e_RI_RDI within 600 µs, determined by the associated P22e_TT_Sk function, and set to "0" within 600 µs on the P22e_RI_RDI removal.

Frame Alignment Signal (FAS): The function shall insert the 8 448 kbit/s frame alignment signal (1111010000) into the frame overhead.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

6.2.2 P22e trail termination sink P22e_TT_Sk

Symbol:
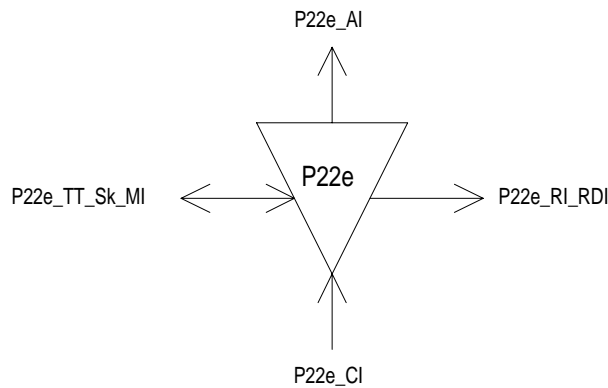
Figure 30: P22e_TT_Sk symbol

Interfaces:

Table 20: P22e_TT_Sk input and output signals

Input(s)	Output(s)
P22e_CI_D	P22e_AI_D
P22e_CI_CK	P22e_AI_CK
P22e_CI_FS	P22e_AI_FS
P22e_CI_SSF	P22e_AI_TSF
P22e_TT_So_MI_TPmode	P22e_TT_So_MI_cRDI
P22e_TT_So_MI_SSF_Reported	P22e_TT_So_MI_cSSF
P22e_TT_So_MI_RDI_Reported	

Processes:

This function recovers the RDI information bit (figure 27) of the frame overhead according to ITU-T Recommendation G.742 [5], section 5.

RDI: The information carried in the RDI bit shall be extracted to enable single ended maintenance of a bi-directional Trail (Path). The RDI (row 3, column 3) provides information as to the status of the remote receiver. A "1" indicates a Remote Defect Indication state, while a "0" indicates the normal, working state. The application process is described in ETS 300 417-1-1 [8], subclauses 7.4.11 and 8.2 (RDI).

Defects:

The function shall detect for dRDI defect according the specification in ETS 300 417-1-1 [8], subclause 8.2.1.

Consequent Actions:

aTSF ← CI_SSF

aRDI ← CI_SSF

Defect Correlations:

cRDI ← dRDI and MON and RDI_Reported

cSSF ← CI_SSF and MON and SSF_Reported

Performance Monitoring:

The performance monitoring process shall be performed as specified in ETS 300 417-1-1 [8], subclause 8.2.4 through 8.2.7 (see note).

> NOTE: Whether or not performance monitoring is actually supported by a network element is determined by the presence of the element management performance monitoring functions.

A near-end block is errored (nN_B) if one or more FAS bits are errored.

pN_DS   ←   aTSF or dEQ

pF_DS   ←   dRDI

pN_EBC   ← Σ nN_B

6.3 P22e adaptation functions

6.3.1 P22e to P12x adaptation source P22e/P12x_A_So/i

Symbol:
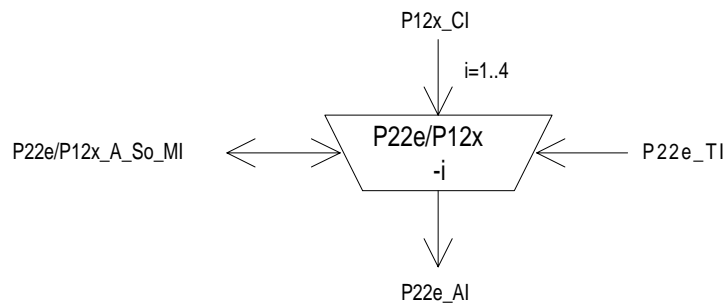
Figure 31: P22e/P12x_A_So symbol

Interfaces:

Table 21: P22e/P12x_A_So input and output signals

Input(s)	Output(s)
P12x_CI_D	P22e_AI_D
P12x_CI_CK	P22e_AI_CK
P22e_TI_CK	P22e_AI_FS
P22e_TI_FS	
P22e/P12x_A_So_MI_Active	

Processes:

This function maps one plesiochronous, 2 048 kbit/s, P12 information stream into the P22e frame (figure 27), according to ITU-T Recommendation G.742 [5], section 5. It takes P12x_CI, a bit-stream with a rate of 2 048 kbit/s ± 50 ppm, present at its input and inserts it into the PU12 #i having a capacity of 209 bits and the justification frame as depicted in figure 28. The function can be activated/deactivated when multiple payload adaptation functions are connected to the access point.

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (buffer) process. The data signal shall be written into the buffer under control of the associated input clock. The data signal shall be read out of the buffer under control of the P22e clock, frame position (P22e_TI), and justification decisions.

The justification decisions determine the phase error introduced by the P22e/P12x_A_So function. The amount of this phase error can be measured at the physical interfaces by monitoring the justification control bits C (figure 28). An example is given in ETS 300 417-4-1 [10], annex A.3.

Each justification decision results in a corresponding positive justification action. Upon a positive justification action, the reading of 1 data bit shall be cancelled once an no data are written at the justification opportunity bit J.

    NOTE: A requirement for maximum introduced phase error generated by the justification process is for further study.

Buffer size: In the presence of jitter specified by ITU-T Recommendation G.823 [7] and a frequency within the range 2 048 kbit/s ± 50 ppm, this justification process shall not introduce any errors. Any step in frequency within this range shall not cause any errors.

C bits - *Justification control generation:* The function shall generate the justification control (CCC) bits according the specification in ITU-T Recommendation G.742 [5]. It shall insert the justification control bits in the appropriate C bit positions.

PU-12 timeslot: The adaptation source function has access to a specific PU-12 of the P22e access point. The PU-12 is defined by the parameter i (i=1 to 4).

Figure 26 shows that more than one adaptation source function exists in this P22e layer that can be connected to one P22e access point. For such case, a subset of these adaptation source functions is allowed to be activated together. For this subset, access to the access point by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

6.3.2 P22e to P12x adaptation sink P22e/P12x_A_Sk/i

Symbol:
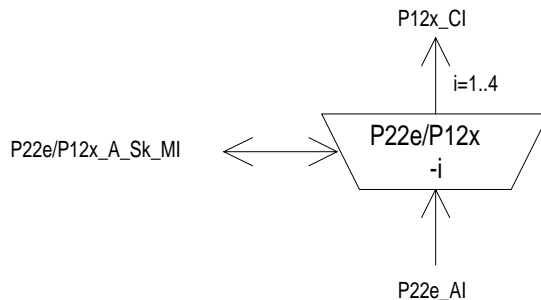
Figure 32: P22e/P12x_A_Sk symbol

Interfaces:

Table 22: P22e/P12x_A_Sk input and output signals

Input(s)	Output(s)
P22e_AI_D	P12x_CI_D
P22e_AI_CK	P12x_CI_CK
P22e_AI_FS	P12x_CI_SSF
P22e_AI_TSF	
P22e/P12x_A_Sk_MI_Active	

Processes:

This function recovers one plesiochronous, 2 048 kbit/s, information stream P12 (figures 27 and 28) from the P22e frame according to ITU-T Recommendation G.742 [5], section 5. The function can be activated/deactivated when multiple payload adaptation functions are connected to the access point.

C bits - *Justification control interpretation:* The function shall perform justification control interpretation according ITU-T Recommendation G.742 [5] to recover the 2 048 kbit/s signal (P12) from the 8 448 kbit/s (P22e) payload signal. If the majority of the C bits is "0" the J bit shall be taken as a data bit, otherwise (majority of C bits is "1") J bit shall be taken as a justification bit and consequently ignored.

Smoothing and jitter limiting process: The function shall provide for a clock smoothing and elastic store (buffer) process. The 2 048 kbit/s data signal shall be written into the store under control of the associated (gapped) input clock. The data signal shall be read out of the store under control of a smoothed (equally spaced) 2 048 kHz $\pm$ 50 ppm clock (the rate is determined by the 2 Mbit/s signal at the input of the remote P22e/P12x_A_Sk).

The residual jitter caused by bit justifications (measured at the 2 048 kbit/s interface) shall such that the peak-to-peak jitter at the 2 048 kbit/s output (being a tributary) in the absence of input jitter shall not exceed 0,25 UI when measured in the frequency range up to 100 kHz.

When measured with an instrument incorporating a bandpass filter having a lower cut-off frequency of 18 kHz, a roll-off of 20 dB/decade and an upper limit of 100 kHz, the peak-to-peak output jitter shall not exceed 0,05 UI with a probability of 99,9 % during a measurement period of 10 s.

> NOTE: For interfaces meeting the national high Q option, detailed in ITU-T Recommendation G.703 [3], the lower cut-off frequency for the above measurement should be 700 Hz.

Buffer size: In the presence of jitter as specified by subclause 11.3.1.2 in ETS 300 417-1-1 [8] and a frequency within the range 2 048 kbit/s $\pm$ 50 ppm, this justification process shall not introduce any errors.

Following a step in frequency of the P12x signal transported by the P22e_AI (for example due to reception of P12x CI from a new P12x_TT_So at the far end or removal of all-ONEs (AIS) signal with a frequency

offset) there will be a maximum recovery time of X seconds after which this process shall not generate any bit errors.

The value of X is for further study; a value of 1 second has been proposed.

PU-12 timeslot: The adaptation sink function has access to a specific PU-12 of the P22e access point. The PU-12 is defined by the parameter i (i=1 to 4).

Figure 26 shows that more than one adaptation sink function exists in this P22e layer that can be connected to one P22e access point. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D) and not report its status via the management point.

Defects: None.

Consequent Actions:

aAIS $\leftarrow$ AI_TSF

aSSF $\leftarrow$ AI_TSF

On declaration of aAIS the function shall output an all-ONEs (AIS) signal - complying to the frequency limits for this signal (a bit rate in range 2 048 kbit/s ± 50 ppm) - within 200 µs; on clearing of aAIS the function shall output normal data within 200 µs.

Defects Correlations: None.

Performance Monitoring: None.

6.3.3 P22e to P12s adaptation source P22e/P12s_A_So/i

Symbol:
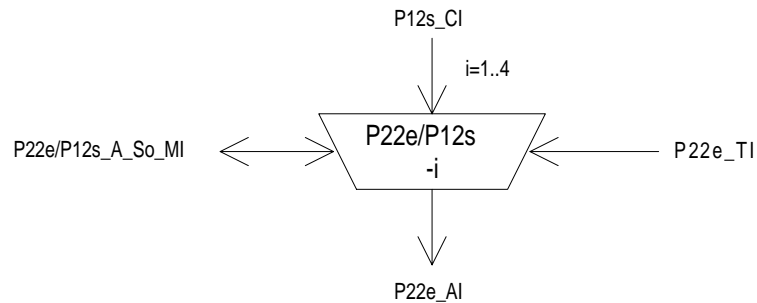
Figure 33: P22e/P12s_A_So symbol

Interfaces:

Table 23: P22e/P12s_A_So input and output signals

Input(s)	Output(s)
P12s_CI_D	P22e_AI_D
P12s_CI_CK	P22e_AI_CK
P22e_TI_CK	P22e_AI_FS
P22e_TI_FS	
P22e/P12s_A_So_MI_Active	

Processes:

This function maps one synchronous, 2 048 kbit/s, P12s information stream into the P22e frame (figure 27), according to ITU-T Recommendation G.742 [5], section 5. It takes P12s_CI, a bit-stream with a rate of 2 048 kbit/s ± 4,6 ppm (see note 1), present at its input and inserts it into the PU12 #i having a capacity of 209 bits and the justification frame as depicted in figure 28. The function can be activated/deactivated when multiple payload adaptation functions are connected to the access point.

NOTE 1: The 2 048 kbit/s with a 125 μs frame according ETS 300 167 [2] is nominally locked to a PRC.

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (buffer) process. The data signal shall be written into the buffer under control of the associated input clock. The data signal shall be read out of the buffer under control of the P22e clock, frame position (P22e_TI), and justification decisions.

The justification decisions determine the phase error introduced by the P22e/P12s_A_So function. The amount of this phase error can be measured at the physical interfaces by monitoring the justification control bits C (figure 28). An example is given in ETS 300 417-4-1 [10], annex A.3.

Each justification decision results in a corresponding positive justification action. Upon a positive justification action, the reading of 1 data bit shall be cancelled once an no data are written at the justification opportunity bit J.

NOTE 2: A requirement for maximum introduced phase error generated by the justification process is for further study.

Buffer size: In the presence of jitter specified by ITU-T Recommendation G.823 [7] and a frequency within the range 2 048 kbit/s ± 4,6 ppm, this justification process shall not introduce any errors. Any step in frequency within this range shall not cause any errors.

C bits - *Justification control generation:* The function shall generate the justification control (C) bits according the specification in ITU-T Recommendation G.742 [5]. It shall insert the justification control bits in the appropriate C bit positions.

PU-12 timeslot: The adaptation source function has access to a specific PU-12 of the P22e access point. The PU-12 is defined by the parameter i (i=1 to 4).

Figure 26 shows that more than one adaptation source function exists in this P22e layer that can be connected to one P22e access point. For such case, a subset of these adaptation source functions is allowed to be activated together. For this subset, access to the access point by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

**6.3.4   P22e to P12s adaptation sink P22e/P12s_A_Sk/i**

Symbol:
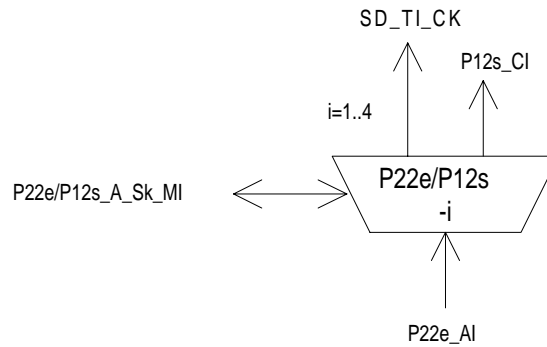
Figure 34: P22e/P12s_A_Sk symbol

Interfaces:

Table 24: P22e/P12s_A_Sk input and output signals

Input(s)	Output(s)
P22e_AI_D	P12s_CI_D
P22e_AI_CK	P12s_CI_CK
P22e_AI_FS	P12s_CI_SSF
P22e_AI_TSF	P12s_CI_FS
P22e/P12s_A_Sk_MI_Active	P12s_CI_MFS
P22e/P12s_A_Sk_MI_AIS_Reported	P12s_CI_LOM
P22e/P12s_A_Sk_MI_CRC4mode	P22e/P12s_A_Sk_MI_cLOF
	P22e/P12s_A_Sk_MI_cAIS
	P22e/P12s_A_Sk_MI_NCI

Processes:

This function recovers one synchronous, 2 048 kbit/s, information stream P12s (figures 27 and 28) from the P22e frame according to ITU-T Recommendation G.742 [5], section 5. Further it recovers the frame start information for the P12s tributary signal. The function can be activated/deactivated when multiple payload adaptation functions are connected to the access point. It supplies the recovered timing signal to the synchronization distribution layer.

C bits - *Justification control interpretation:*   The function shall perform justification control interpretation according ITU-T Recommendation G.742 [5] to recover the 2 048 kbit/s signal (P12) from the 8 448 kbit/s (P22e) payload signal. If the majority of the C bits is "0" the J bit shall be taken as a data bit, otherwise (majority of C bits is "1") J bit shall be taken as a justification bit and consequently ignored.

Smoothing and jitter limiting process: The function shall provide for a clock smoothing and elastic store (buffer) process. The 2 048 kbit/s data signal shall be written into the store under control of the associated (gapped) input clock. The data signal shall be read out of the store under control of a smoothed (equally spaced) 2 048 kHz ± 4,6 ppm clock (the rate is determined by the 2 Mbit/s signal at the input of the remote P22e/P12s_A_Sk).

The residual jitter caused by bit justifications is for further study.

NOTE 1:   For interfaces meeting the national high Q option, detailed in ITU-T Recommendation G.703 [3], the lower cut-off frequency for the above measurement should be 700 Hz.

Buffer size: In the presence of jitter as specified by subclause 11.3.1.2 in ETS 300 417-1-1 [8] and a frequency within the range 2 048 kbit/s ± 4,6 ppm, this justification process shall not introduce any errors.

Following a step in frequency of the P12s signal transported by the P22e_AI (for example due to reception of P12s CI from a new P12s_TT_So at the far end or removal of all-ONEs (AIS) signal with a frequency

offset) there will be a maximum recovery time of X seconds after which this process shall not generate any bit errors.

The value of X is for further study; a value of 1 second has been proposed.

PU-12 timeslot: The adaptation sink function has access to a specific PU-12 of the P22e access point. The PU-12 is defined by the parameter i (i=1 to 4).

Figure 26 shows that more than one adaptation sink function exists in this P22e layer that can be connected to one P22e access point. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D) and not report its status via the management point.

Basic frame and CRC-4 Multiframe alignment: The function shall recover the (250 µs) basic frame and (2 ms) CRC-4 multiframe phase. The process shall operate as specified by ETS 300 167 [2].

> NOTE 2:   Enhancement of the frame alignment process is under study.

The frame start reference (FS) shall be maintained during the OOF state and only updated upon successful transition form OOF to the IF state.

Defects:

The function shall detect dLOF defect as specified by ETS 300 167 [2].

The function shall clear dLOF defect as specified by ETS 300 167 [2].

The function shall report NCI status in the automatic CRC-4 interworking mode as specified by ETS 300 167 [2].

> NOTE 3:   Enhancement of the frame alignment process in ETS 300 167 [2] is under study.

The dAIS defect shall be detected as defined in ETS 300 417-1-1 [8], subclause 8.2.1.7 for 2 Mbit/s, with X = 2, Y = 512, Z = 3.

Consequent Actions:

aAIS ←   dAIS or dLOF

aSSF ←   dAIS or dLOF

On declaration of aAIS the function shall output an all-ONEs (AIS) signal - complying to the frequency limits for this interface - within 250 µs; on clearing of aAIS the function shall output normal data within 250 µs.

Defect Correlations:

cAIS ←   dAIS and (not AI_TSF) and AIS_Reported

cLOF ←   dLOF and (not dAIS) and (not AI_TSF)

Performance Monitoring: None.

6.4 P22e layer monitoring functions

6.4.1 P22e layer non-intrusive monitoring function P22em_TT_Sk

Symbol:

P22e_AI_TSF

P22em_TT_Sk_MI ⟷ P22em
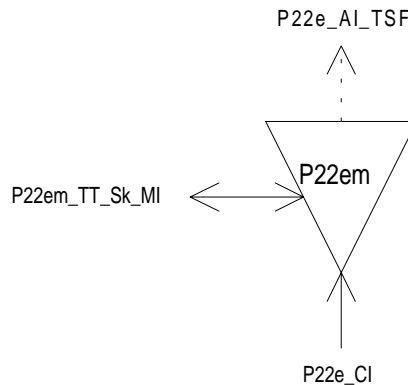
P22e_CI

Figure 35: P22em_TT_Sk symbol

Interfaces:

Table 25: P22em_TT_Sk input and output signals

Input(s)	Output(s)
P22e_CI_D	P22e_AI_TSF
P22e_CI_CK	P22e_TT_So_MI_cRDI
P22e_CI_FS	P22e_TT_So_MI_cSSF
P22e_CI_SSF	
P22em_TT_So_MI_TPmode	
P22em_TT_So_MI_SSF_Reported	
P22em_TT_So_MI_RDI_Reported	

Processes:

This function recovers the RDI information bit (figure 27) of the frame overhead according to ITU-T Recommendation G.742 [5], section 5.

RDI: The information carried in the RDI bit shall be extracted to enable single ended maintenance of a bi-directional Trail (Path). The RDI (row 3, column 3) provides information as to the status of the remote receiver. A "1" indicates an RDI state, while a "0" indicates the normal, working state. The application process is described in ETS 300 417-1-1 [8], subclauses 7.4.11 and 8.2 (RDI).

Defects:

The function shall detect for dRDI defect according the specification in ETS 300 417-1-1 [8], subclause 8.2.1.

Consequent Actions:

aTSF ← CI_SSF

Defect Correlations:

cRDI ← dRDI and MON and RDI_Reported

cSSF ← CI_SSF and MON and SSF_Reported

Performance Monitoring:

The performance monitoring process shall be performed as specified in ETS 300 417-1-1 [8], subclause 8.2.4 through 8.2.7 (see note).

NOTE: Whether or not performance monitoring is actually supported by a network element is determined by the presence of the element management performance monitoring functions.

A near-end block is errored (nN_B) if one or more FAS bits are errored.

pN_DS   ←   aTSF or dEQ

pF_DS   ←   dRDI

pN_EBC   ←   Σ nN_B

6.5 P22e PDH equipment clock adaptation source P22e_PEC

Symbol:
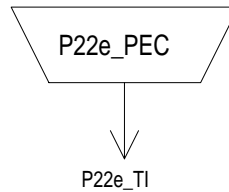
Figure 36: P22e_PEC_A_So symbol

Interfaces:

Table 26: P22e_PEC_A_So input and output signals

Input(s)	Output(s)
	P22e_TI_CK P22e_TI_FS

Processes:

This function performs the 8 Mbit/s clock and frame start signal generation to time the adaptation source functions in this layer.

Clock generation: The function shall generate the clock (bit) reference signal P22e_TI_CK for the P22e signal. The P22e_TI_CK bit rate shall be in range of 8 448 kbit/s ± 30 ppm.

Jitter limiter: The function shall generate the clock signal such that the peak-to-peak jitter at the 8 448 kbit/s output shall not exceed 0,05 UI when it is measured within the frequency range from 20 Hz to 400 kHz.

Frame Start signal generation: The function shall generate the frame start reference signal P22e_TI_FS for the P22e signal. The P22e_TI_FS signal shall be active once per 848 bits.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

7 P12s path layer functions
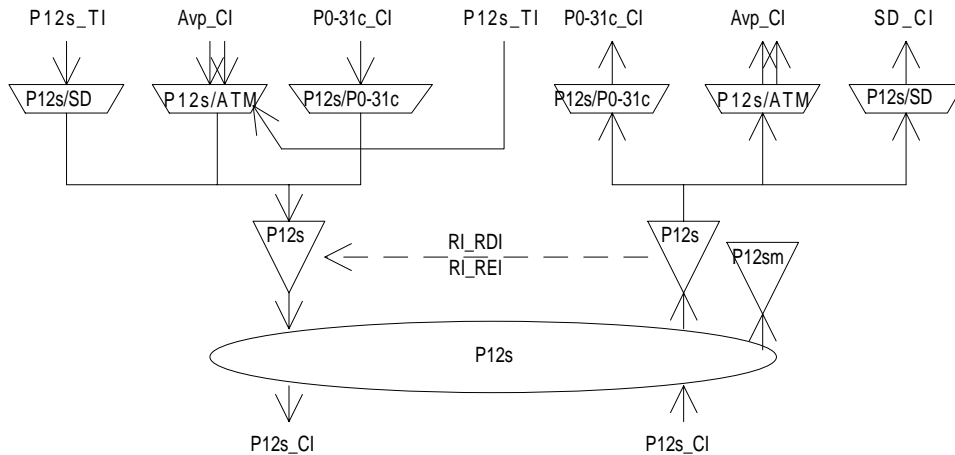
Figure 37: P12s Atomic Functions

P12s layer CP

The CI at this point is a synchronous 2 048 kbit/s byte structured signal according ETS 300 167 [2] with co-directional bit timing and the frame start information FS. The CI is structured:

- either as a 2×256 bit long (basic) frame with 2x8 bit frame overhead containing a FAS, RDI (A bit), and User Characteristic Information (S_i and S_a bits);

- or as a 16x256 bit long (multi) frame with 16x8 bit frame overhead containing a FAS, CRC-4 MFAS, CRC-4 code, RDI (A bit), REI (E bits), User characteristic information (S_a bits), and (optionally) a Synchronization Status Message channel.

The figures 38 and 40 below depict the basic frame, multiframe and overhead structure.

P12s layer AP

The signal transported by a P12s will be determined by the client layer application. Typical signals include:

- a 1 984 kbit/s signal P0-31c_CI with unspecified content (to be passed through transparently);
- an ATM 1 920 kbit/s cell stream signal according ETS 300 337 [9].

    NOTE: Many more compositions exist which are not addressed in this version of this ETS.

In addition, the AI may contain:

- a 4 bit Synchronization Status Message (SSM), located in one of the five S_a bits. This interface is used to pass timing synchronization information.

		1	2	3	4	5	6	7	8
	TS0	Si				FAS			
	TS1								
	:	2 048 kbit/s payload (31 bytes)							
	TS31								
	TS0	Si	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
	TS1								
	:	2 048 kbit/s payload (31 bytes)							
	TS31								

Figure 38: Basic frame overhead structure of the P12s_CI_D signal

		1	2	3	4	5	6	7	8
	TS0								
	TS1								
	:	2 048 kbit/s payload (31 bytes)							
	TS31								
	TS0				Sa4	Sa5	Sa6	Sa7	Sa8
	TS1								
	:	2 048 kbit/s payload (31 bytes)							
	TS31								

Figure 39: Basic frame overhead structure of the P12s_AI_D signal

		1	2	3	4	5	6	7	8				1	2	3	4	5	6	7	8
	TS0	C1	FAS									TS0	C1	FAS						
Frame	TS1										Frame	TS1								
0		2 048 kbit/s payload (31 bytes)									8		2 048 kbit/s payload (31 bytes)							
	TS31											TS31								
	TS0	MFAS	1	A	Sa41	Sa51	Sa61	Sa71	Sa81			TS0	MFAS	1	A	Sa41	Sa51	Sa61	Sa71	Sa81
Frame	TS1										Frame	TS1								
1		2 048 kbit/s payload (31 bytes)									9		2 048 kbit/s payload (31 bytes)							
	TS31											TS31								
	TS0	C2				FAS						TS0	C2	FAS						
Frame	TS1										Frame	TS1								
2		2 048 kbit/s payload (31 bytes)									10		2 048 kbit/s payload (31 bytes)							
	TS31											TS31								
	TS0	MFAS	1	A	Sa42	Sa52	Sa62	Sa72	Sa82			TS0	MFAS	1	A	Sa42	Sa52	Sa62	Sa72	Sa82
Frame	TS1										Frame	TS1								
3		2 048 kbit/s payload (31 bytes)									11		2 048 kbit/s payload (31 bytes)							
	TS31											TS31								
	TS0	C3				FAS						TS0	C3	FAS						
Frame	TS1										Frame	TS1								
4		2 048 kbit/s payload (31 bytes)									12		2 048 kbit/s payload (31 bytes)							
	TS31											TS31								
	TS0	MFAS	1	A	Sa43	Sa53	Sa63	Sa73	Sa83			TS0	E	1	A	Sa43	Sa53	Sa63	Sa73	Sa83
Frame	TS1										Frame	TS1								
5		2 048 kbit/s payload (31 bytes)									13		2 048 kbit/s payload (31 bytes)							
	TS31											TS31								
	TS0	C4				FAS						TS0	C4	FAS						
Frame	TS1										Frame	TS1								
6		2 048 kbit/s payload (31 bytes)									14		2 048 kbit/s payload (31 bytes)							
	TS31											TS31								
	TS0	MFAS	1	A	Sa44	Sa54	Sa64	Sa74	Sa84			TS0	E	1	A	Sa44	Sa54	Sa64	Sa74	Sa84
Frame	TS1										Frame	TS1								
7		2 048 kbit/s payload (31 bytes)									15		2 048 kbit/s payload (31 bytes)							
	TS31											TS31								

Figure 40: CRC-4 multiframe structure of the P12s_CI_D signal (with 4 bit code Sa structure)

		1	2	3	4	5	6	7	8				1	2	3	4	5	6	7	8
	TS0	C1	FAS									TS0	C1	FAS						
Frame	TS1										Frame	TS1								
0		2 048 kbit/s payload (31 bytes)									8		2 048 kbit/s payload (31 bytes)							
	TS31											TS31								
	TS0	MFAS	1	A	Sa4	Sa5	Sa6	Sa7	Sa8			TS0	MFAS	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
Frame	TS1										Frame	TS1								
1		2 048 kbit/s payload (31 bytes)									9		2 048 kbit/s payload (31 bytes)							
	TS31											TS31								
	TS0	C2				FAS						TS0	C2	FAS						
Frame	TS1										Frame	TS1								
2		2 048 kbit/s payload (31 bytes)									10		2 048 kbit/s payload (31 bytes)							
	TS31											TS31								
	TS0	MFAS	1	A	Sa4	Sa5	Sa6	Sa7	Sa8			TS0	MFAS	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
Frame	TS1										Frame	TS1								
3		2 048 kbit/s payload (31 bytes)									11		2 048 kbit/s payload (31 bytes)							
	TS31											TS31								
	TS0	C3				FAS						TS0	C3	FAS						
Frame	TS1										Frame	TS1								
4		2 048 kbit/s payload (31 bytes)									12		2 048 kbit/s payload (31 bytes)							
	TS31											TS31								
	TS0	MFAS	1	A	Sa4	Sa5	Sa6	Sa7	Sa8			TS0	E	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
Frame	TS1										Frame	TS1								
5		2 048 kbit/s payload (31 bytes)									13		2 048 kbit/s payload (31 bytes)							
	TS31											TS31								
	TS0	C4				FAS						TS0	C4	FAS						
Frame	TS1										Frame	TS1								
6		2 048 kbit/s payload (31 bytes)									14		2 048 kbit/s payload (31 bytes)							
	TS31											TS31								
	TS0	MFAS	1	A	Sa4	Sa5	Sa6	Sa7	Sa8			TS0	E	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
Frame	TS1										Frame	TS1								
7		2 048 kbit/s payload (31 bytes)									15		2 048 kbit/s payload (31 bytes)							
	TS31											TS31								

Figure 41: CRC-4 multiframe structure of the P12s_CI_D signal (without 4 bit code Sa structure)

		1	2	3	4	5	6	7	8
	TS0								
Frame	TS1								
0		2 048 kbit/s payload (31 bytes)							
	TS31								
	TS0				Sa4 1	Sa5 1	Sa6 1	Sa7 1	Sa8 1
Frame	TS1								
1		2 048 kbit/s payload (31 bytes)							
	TS31								
	TS0								
Frame	TS1								
2		2 048 kbit/s payload (31 bytes)							
	TS31								
	TS0				Sa4 2	Sa5 2	Sa6 2	Sa7 2	Sa8 2
Frame	TS1								
3		2 048 kbit/s payload (31 bytes)							
	TS31								
	TS0								
Frame	TS1								
4		2 048 kbit/s payload (31 bytes)							
	TS31								
	TS0				Sa4 3	Sa5 3	Sa6 3	Sa7 3	Sa8 3
Frame	TS1								
5		2 048 kbit/s payload (31 bytes)							
	TS31								
	TS0								
Frame	TS1								
6		2 048 kbit/s payload (31 bytes)							
	TS31								
	TS0				Sa4 4	Sa5 4	Sa6 4	Sa7 4	Sa8 4
Frame	TS1								
7		2 048 kbit/s payload (31 bytes)							
	TS31								

Figure 42: 4 bit S_{ax} structure in "CRC-4 submultiframe" of the P12s_AI_D signal

7.1 P12s connection functions

For further study.

7.2   P12s trail termination functions

7.2.1   P12s trail termination source P12s_TT_So

Symbol:
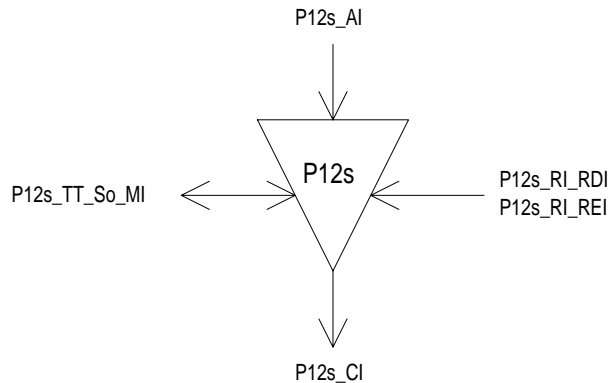
Figure 43: P12s_TT_So symbol

Interfaces:

Table 27: P12s_TT_So input and output signals

Input(s)	Output(s)
P12s_AI_D	P12s_CI_D
P12s_AI_CK	P12s_CI_CK
P12s_AI_FS	P12s_CI_FS
P12s_AI_AISinsert	
P12s_RI_RDI	
P12s_RI_REI	

Processes:

This function adds to P12s_AI the RDI information bit (figures 38 and 40), the frame alignment signal, the CRC-4 multiframe alignment signal, the CRC-4 code, and REI information into the frame overhead. The frame overhead is defined in ETS 300 167 [2].

A: This bit represents the defect status of the associated P12s_TT_Sk. The RDI indication shall be set to "1" on activation of P12s_RI_RDI within 100 ms, determined by the associated P12s_TT_Sk function, and set to "0" within 100 ms on the P12s_RI_RDI removal.

FAS - *Frame Alignment Signal (FAS):* The function shall insert the 2 048 kbit/s frame alignment signal "0011011" in bits 2 to 8 of TS0 in even frames, and "1" in bit 2 of TS0 in odd frames as defined in ETS 300 167 [2].

S_i - *TimeSlot 0, bit 1:* The function shall generate the CRC-4 multiframe and perform the MFAS, E bit and $C_1C_2C_3C_4$ processes as defined below.

S_i - **MFAS** - *CRC-4 Multiframe Alignment Signal:* The function shall insert the CRC-4 multiframe alignment signal "001011" in bit 1 of TS0 in frames 1,3,5,7,9,11 of the 16 frame CRC-4 multiframe as defined in ETS 300 167 [2].

S_i - **E:** Each of the two E bits shall be set to a REI value from the associated P12s_TT_Sk function conveyed via RI_REI within 1 second after RI_REI reception.

S_i - $C_1C_2C_3C_4$**:** The function shall compute the CRC-4 code value of the 2 Mbit/s signal according subclause 2.3.3.5 in ITU-T Recommendation G.704 [4]. The computed value shall be inserted in the C_1 to C_4 bits of the following SubMultiFrame.

Defects: None.

Consequent Actions: None.

On activation of AI_AISinsert the function shall output an all-ONEs (AIS) signal, within the frequency range of 2 048 kbit/s ± 50 ppm, within 250 µs; on deactivation of AI_AISinsert the function shall output normal data within 250 µs.

> NOTE 1:   if AI_AISinsert is not connected, AI_AISinsert is assumed to be inactive, and all-ONEs (AIS) will not be output.

> NOTE 2:   A 2 Mbit/s E12 interface may be used to pass timing synchronization information. If the signal does not support the Synchronization Status Message (SSM) it should be shutdown (i.e. all-ONEs (AIS) insertion) when the synchronization timing source has a quality level less or equal than a minimum provisioned level. The function P12s/SD_A_So is used to control AIS injection via the AI_AISinsert signal if required. The full specification is contained in ETS 300 417-6-1 [11].

Defect Correlations: None.

Performance Monitoring: None.

7.2.2 P12s trail termination sink P12s_TT_Sk

Symbol:
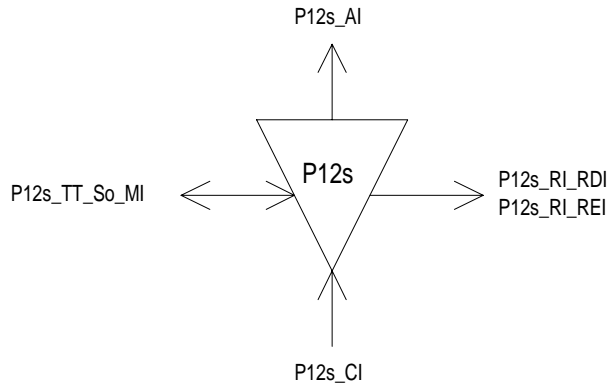
Figure 44: P12s_TT_Sk symbol

Interfaces:

Table 28: P12s_TT_Sk input and output signals

Input(s)	Output(s)
P12s_CI_D	P12s_AI_D
P12s_CI_CK	P12s_AI_CK
P12s_CI_FS	P12s_AI_FS
P12s_CI_SSF	P12s_AI_MFS
P12s_CI_LOM	P12s_AI_TSF
	P12s_AI_TSD
	P12s_RI_RDI
P12s_TT_Sk_MI_TPmode	P12s_RI_REI
P12s_TT_Sk_MI_SSF_Reported	P12s_TT_Sk_MI_cSSF
P12s_TT_Sk_MI_RDI_Reported	P12s_TT_Sk_MI_cDEG
P12s_TT_Sk_MI_DEGM	P12s_TT_Sk_MI_cRDI
P12s_TT_Sk_MI_DEGTHR	P12s_TT_Sk_MI_RNCI
P12s_TT_Sk_MI_1second	P12s_TT_Sk_MI_pN_EBC
P12s_TT_Sk_MI_CRC4mode	P12s_TT_Sk_MI_pN_DS
	P12s_TT_Sk_MI_pF_EBC
	P12s_TT_Sk_MI_pF_DS

Processes:

This function monitors a P12s for errors, and recovers the trail termination status. It extracts the payload independent overhead bits ($C_1C_2C_3C_4$, A, E) from the P12s layer CI and outputs the P12s_AI.

$C_1C_2C_3C_4$: CRC-4 is computed for each bit of the preceding P12s submultiframe and compared with bits $C_1C_2C_3C_4$ recovered from the current submultiframe. A difference between the computed and recovered $C_1C_2C_3C_4$ values is taken as evidence of one or more errors (nN_B) in the computation block.

A, E: The information carried in the A and E bits (RDI, REI) is extracted to enable single ended maintenance of a bi-directional Trail (Path). The REI (nF_B) is used to monitor the error performance of the other direction of transmission, and the RDI provides information as to the status of the remote receiver. A "1" indicates an RDI state, while a "0" indicates the normal, working state. The application process is described in ETS 300 417-1-1 [8], subclauses 7.4.2 (REI), 7.4.11 and 8.2 (RDI).

Defects:

The function shall detect for dDEG and dRDI defects according the specification in ETS 300 417-1-1 [8], subclause 8.2.1.

The function shall detect a CRC-4 multiframe generator/detector status (MI_RNCI) if (pF_EBC > 990 and pF_DS = false) for five consecutive seconds. The MI_RNCI status shall be cleared if (pF_EBC < 990 or pF_DS = true) for five consecutive seconds.

> NOTE 1: This defect is defined only when the frame alignment process in the associated <server>/P12s_A_Sk function operates in the automatic CRC4 interworking mode.

Consequent Actions:

aTSF ← CI_SSF

aRDI ← CI_SSF

aTSD ← dDEG

aREI ← "#EDCV"

Defect Correlations:

cDEG ← dDEG and MON

cRDI ← dRDI and MON and RDI_Reported

cSSF ← CI_SSF and MON and SSF_Reported

Performance Monitoring:

The performance monitoring process shall be performed as specified in ETS 300 417-1-1 [8], subclause 8.2.4 through 8.2.7 (see note 2).

> NOTE 2: Whether or not performance monitoring is actually supported by a network element is determined by the presence of the element management performance monitoring functions.

The function shall support the option to perform performance monitoring on frame alignment signal errors (FASE) or on CRC-4 violations. This shall be controlled via MI_CRC4mode. For the case CRC4mode is false, a near-end block is errored (nN_B) if one or more FAS bits are errored.

> NOTE 3: The performance monitoring option can be selected independently from the frame alignment process mode (CRC-4 interworking) in the <server>/P12s_A_Sk function. When automatic CRC-4 interworking would have been selected in that adaptation function and CRC4mode would be set to true in this P12s_TT_Sk, the reception of a signal without CRC-4 multiframe would result in the declaration of defect seconds (pN_DS is 1) via the signal CI_LOM.

pN_DS ← aTSF or (CI_LOM and CRC4mode) or dEQ

pF_DS ← dRDI

pN_EBC ← ΣnN_B

pF_EBC ← ΣnF_B (applicable only when CRC-4 mode provisioned)

7.3 P12s adaptation functions

7.3.1 P12s to P0-31c adaptation source P12s/P0-31c_A_So

Symbol:
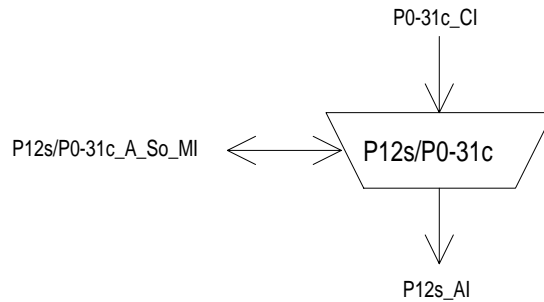
Figure 45: P12s/P0-31c_A_So symbol

Interfaces:

Table 29: P12s/P0-31c_A_So input and output signals

Input(s)	Output(s)
P0-31c_CI_D	P12s_AI_D
P0-31c_CI_CK	P12s_AI_CK
P0-31c_CI_FS	P12s_AI_FS
P0-31c_CI_TSF	
P12s/P0-31c_A_So_MI_Active	

Processes:

This function passes a 1 984 kbit/s signal without further processing into the appropriate 31 timeslots (TS1 to TS31) of a P12s signal.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

7.3.2   P12s to P0-31c adaptation sink P12s/P0-31c_A_Sk

Symbol:

P0-31c_CI

P12s/P0-31c_A_Sk_MI ⟷ P12s/P0-31c
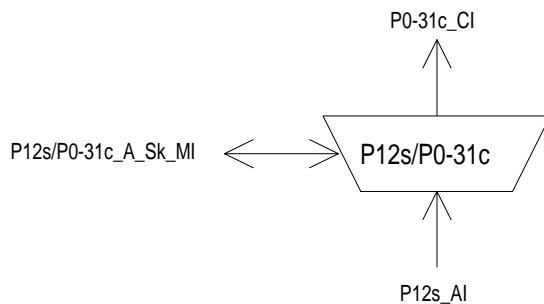
P12s_AI

Figure 46: P12s/P0-31c_A_Sk symbol

Interfaces:

Table 30: P12s/P0-31c_A_Sk input and output signals

Input(s)	Output(s)
P12s_AI_D	P0-31c_CI_D
P12s_AI_CK	P0-31c_CI_CK
P12s_AI_FS	P0-31c_CI_FS
P12s_AI_TSF	P0-31c_CI_SSF
P12s/P0-31c_A_Sk_MI_Active	

Processes:

The function extracts the 1 984 kbit/s synchronous signal from the TS1 through TS31 of the P12s_AI (figures 39 and 42).

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

7.3.3 P12s to SD adaptation source P12s/SD_A_So

Two types of P12s/SD_A_So functions exist:

1) type 1 supporting SSM;
2) type 2 not supporting SSM.

Network elements that do not support SSM will offer type 2 functions only.

The specification of these functions will be in ETS 300 417-6-1 [11].

7.3.4 P12s to SD adaptation sink P12s/SD_A_Sk

The specification of this function will be in ETS 300 417-6-1 [11].

7.3.5 P12s to ATM VP compound adaptation source P12s/ATM_A_So

The specification of this function will be addressed under work item DEN/TM-01016 [12].

7.3.6 P12s to ATM VP compound adaptation sink P12s/ATM_A_Sk

The specification of this function will be addressed under work item DEN/TM-01016 [12].

7.4 P12s layer monitoring functions

7.4.1 P12s layer non-intrusive monitoring function P12sm_TT_Sk

Symbol:

```
                              P12s_AI_TSF

                                 /\
                                 :
                                 :
                              _____
                              \       /
                               \     /
   P12sm_TT_Sk_MI  <------->    \ P12sm /
                                 \   /
                                  \ /
                                   X

                              P12s_CI
```
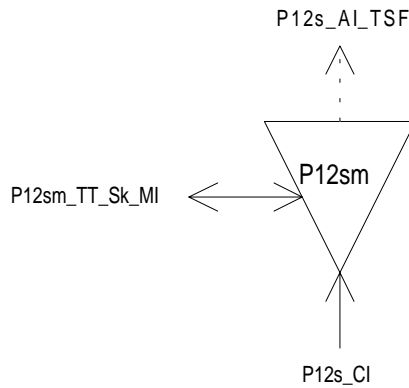
Figure 47: P12sm_TT_Sk symbol

Interfaces:

Table 31: P12sm_TT_Sk input and output signals

Input(s)	Output(s)
P12s_CI_D	P12s_AI_TSF
P12s_CI_CK	P12s_AI_TSD
P12s_CI_FS	P12s_TT_Sk_MI_cSSF
P12s_CI_SSF	P12s_TT_Sk_MI_cDEG
P12s_CI_LOM	P12s_TT_Sk_MI_cRDI
	P12s_TT_Sk_MI_RNCI
	P12s_TT_Sk_MI_pN_EBC
P12s_TT_Sk_MI_TPmode	P12s_TT_Sk_MI_pN_DS
P12s_TT_Sk_MI_SSF_Reported	P12s_TT_Sk_MI_pF_EBC
P12s_TT_Sk_MI_RDI_Reported	P12s_TT_Sk_MI_pF_DS
P12s_TT_Sk_MI_DEGM	
P12s_TT_Sk_MI_DEGTHR	
P12s_TT_Sk_MI_1second	
P12s_TT_Sk_MI_CRC4mode	

Processes:

This function monitors a P12s for errors, and recovers the trail termination status. It extracts the payload independent overhead bits ($C_1C_2C_3C_4$, A, E) from the P12s layer characteristic.

$C_1C_2C_3C_4$: CRC-4 is computed for each bit of the preceding P12s submultiframe and compared with bits $C_1C_2C_3C_4$ recovered from the current submultiframe. A difference between the computed and recovered $C_1C_2C_3C_4$ values is taken as evidence of one or more errors (nN_B) in the computation block.

A, E: The information carried in the A and E bits (RDI, REI) is extracted to enable single ended maintenance of a bi-directional Trail (Path). The REI (nF_B) is used to monitor the error performance of the other direction of transmission, and the RDI provides information as to the status of the remote receiver. A "1" indicates a Remote Defect Indication state, while a "0" indicates the normal, working state. The application process is described in ETS 300 417-1-1 [8], subclauses 7.4.2 (REI), 7.4.11 and 8.2 (RDI).

Defects:

The function shall detect for dDEG and dRDI defects according the specification in ETS 300 417-1-1 [8], subclause 8.2.1.

The function shall detect a CRC-4 multiframe generator/detector status (MI_RNCI) if (pF_EBC > 990 and pF_DS = false) for five consecutive seconds. The MI_RNCI status shall be cleared if (pF_EBC < 990 or pF_DS = true) for five consecutive seconds.

> NOTE 1: This defect is defined only when the frame alignment process in the associated <server>/P12s_A_Sk function operates in the automatic CRC4 interworking mode.

Consequent Actions:

aTSF ←   CI_SSF

aTSD ←   dDEG

Defect Correlations:

cDEG ←   dDEG and MON

cRDI ←   dRDI and MON and RDI_Reported

cSSF ←   CI_SSF and MON and SSF_Reported

Performance Monitoring:

The performance monitoring process shall be performed as specified in ETS 300 417-1-1 [8], subclause 8.2.4 through 8.2.7 (see note 2).

> NOTE 2: Whether or not performance monitoring is actually supported by a network element is determined by the presence of the element management performance monitoring functions.

The function shall support the option to perform performance monitoring on frame alignment signal errors (FASE) or on CRC-4 violations. This shall be controlled via MI_CRC4mode. For the case CRC4mode is false, a near-end block is errored (nN_B) if one or more FAS bits are errored.

> NOTE 3: The performance monitoring option can be selected independently from the frame alignment process mode (CRC-4 interworking) in the <server>/P12s_A_Sk function. When automatic CRC-4 interworking would have been selected in that adaptation function and CRC4mode would be set to true in this P12s_TT_Sk, the reception of a signal without CRC-4 multiframe would result in the declaration of defect seconds (pN_DS is 1) via the signal CI_LOM.

pN_DS   ←   aTSF or (CI_LOM and CRC4mode) or dEQ

pF_DS   ←   dRDI

pN_EBC   ←   ΣnN_B

pF_EBC   ←   ΣnF_B (applicable only when CRC-4 mode provisioned)

8 P31s path layer functions
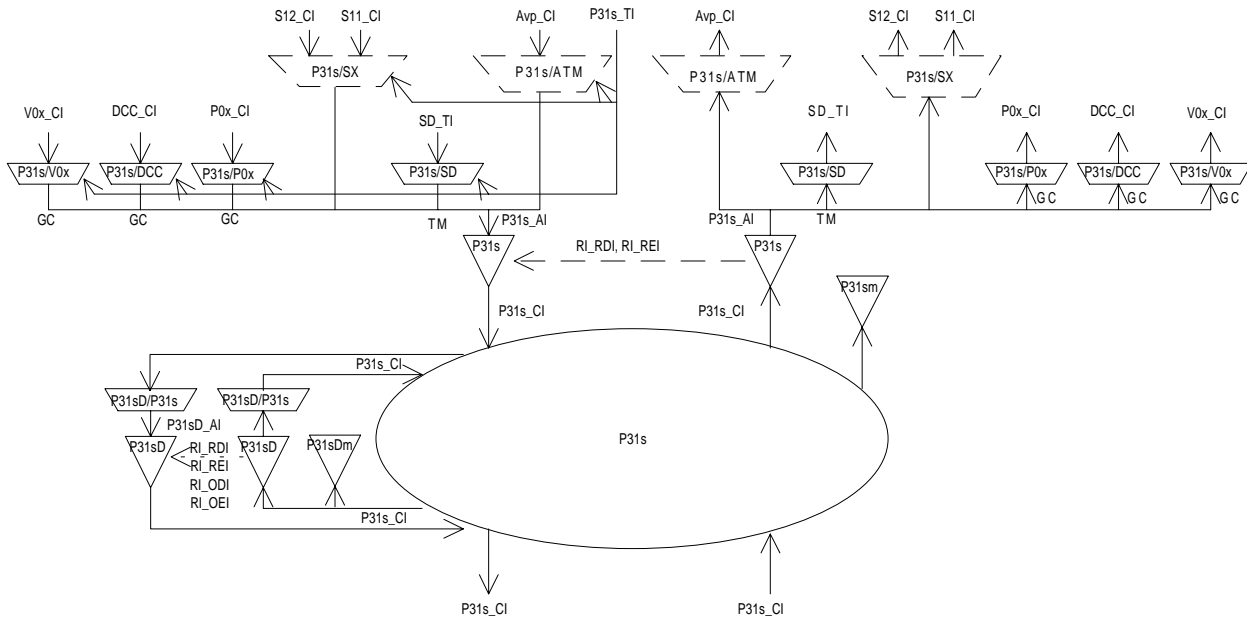
Figure 48: P31s path layer atomic functions

P31s layer CP

The Characteristic Information (CI) at this point is octet structured with an 125 µs frame (figure 49). Its format is characterized as P31s_AI plus the P31s trail termination overhead in the TR, EM, and MA locations as defined in ETS 300 337 [9]. For the case the signal has passed the tandem connection sublayer, P31s_CI has defined P31s tandem connection trail termination overhead in location NR.

> NOTE 1: NR will be undefined when the signal P31s_CI has not been processed in a tandem connection adaptation and trail termination function. NR definition is under study by ETSI TM3.

> NOTE 2: An unequipped P31s signal is for further study.

P31s layer AP

The Adaptation Information (AI) at this point is octet structured with an 125 µs frame (figure 49). It represents adapted client layer information comprising 530 bytes of client layer information, the signal label bits in byte MA, the multiframe indicator in byte MA, the timing marker bit in byte MA, and a 64 kbit/s general communication channel in byte GC.

> NOTE 3: GC will be undefined when no GC byte adaptation source function is connected to the AP.

> NOTE 4: Bits 6,7 of byte MA will be undefined when the P31s transports an ATM signal.

The composition of the payload transported by an P31s will be determined by the client layer application. Typical compositions of the payload include:

- a TU-12 structured signal;
- an ATM 33 920 kbit/s cell stream signal.
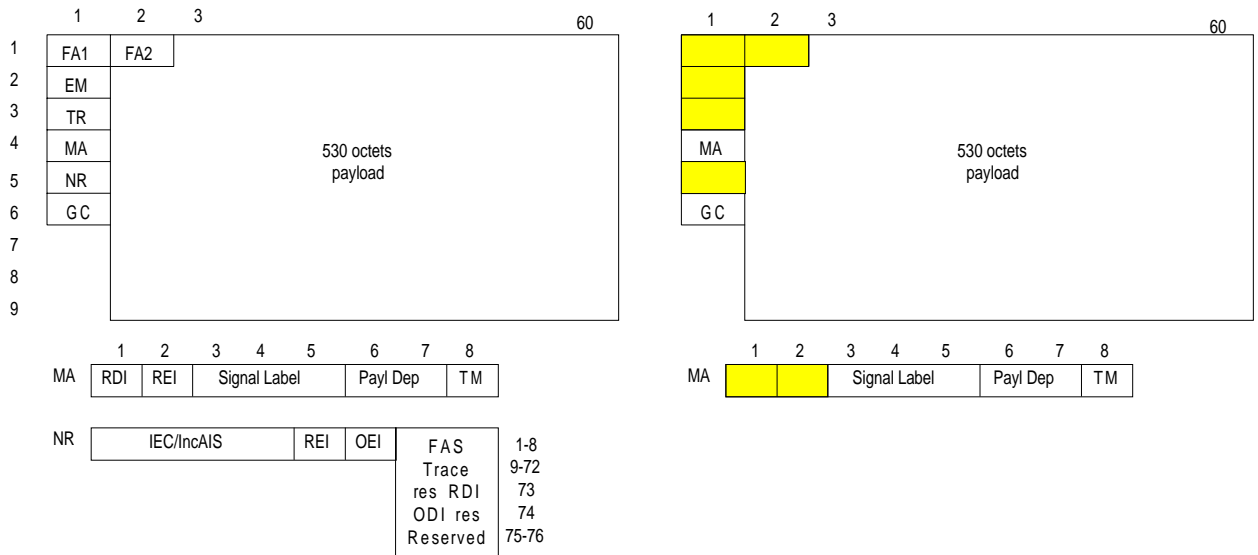
Figure 49: P31s_CI_D (left) and P31s_AI_D (right)

8.1 P31s connection functions

For further study.

8.2 P31s trail termination functions

8.2.1 P31s trail termination source P31s_TT_So

Symbol:
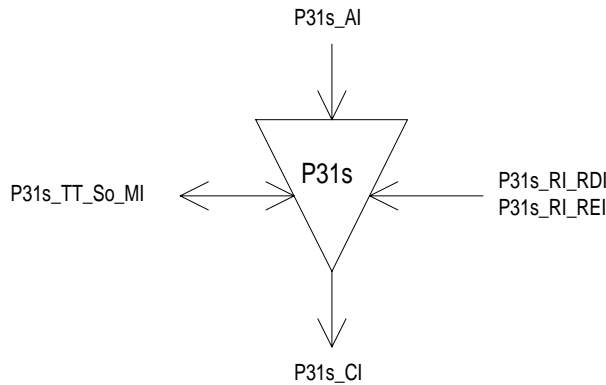
Figure 50: P31s_TT_So symbol

Interfaces:

Table 32: P31s_TT_So input and output signals

Input(s)	Output(s)
P31s_AI_D	P31s_CI_D
P31s_AI_CK	P31s_CI_CK
P31s_AI_FS	P31s_CI_FS
P31s_RI_RDI	
P31s_RI_REI	
P31s_TT_So_MI_TxTI	

Processes:

This function adds error monitoring, status overhead bytes, trace identifier and the frame alignment signal to the P31s_AI presented at its input, to form the P31s layer Characteristic Information. The processing of the trail termination overhead bytes is defined as follows:

TR: In this byte the function shall insert the Transmitted Trail Trace Identifier TxTI. Its format is described in ETS 300 417-1-1 [8], subclause 7.1.

MA[1]: Bit 1, a RDI indication, shall be set to "1" on activation of the RI_RDI within 250 μs, determined by the associated P31s_TT_Sk function, and set to "0" within 250 μs on clearing of RI_RDI.

MA[2]: Bit 2, a REI (Remote Error Indication) indication, shall be set to "1" on declaration of RI_REI - determined by the associated P31s_TT_Sk function if one or more errors were detected by the BIP-8 process - and shall be otherwise set to zero.

EM: In this byte the function shall insert the BIP-8 EDC with even bit parity. Each bit n of current EM is computed to provide even parity over the nth bit of every byte in the previous frame of the Characteristic Information P31s_CI, i.e. EM is calculated over the entire previous P31s signal. Further reference is provided in ETS 300 417-1-1 [8], subclause 7.3 and ETS 300 337 [9].

FA1FA2 - *Frame Alignment Signal (FAS):* The function shall insert the 34 368 kbit/s 125 μs frame alignment signal FA1FA2 into the frame overhead as defined in ETS 300 337 [9] and depicted in figure 49.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

8.2.2 P31s trail termination sink P31s_TT_Sk

Symbol:
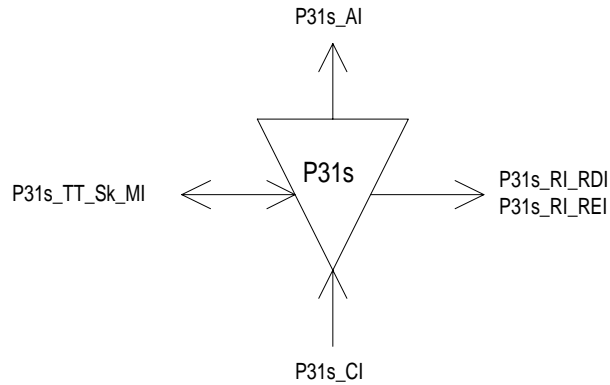
Figure 51: P31s_TT_Sk symbol

Interfaces:

Table 33: P31s_TT_Sk input and output signal

Input(s)	Output(s)
P31s_CI_D	P31s_AI_D
P31s_CI_CK	P31s_AI_CK
P31s_CI_FS	P31s_AI_FS
P31s_CI_SSF	P31s_AI_TSF
P31s_TT_Sk_MI_TPmode	P31s_AI_TSD
P31s_TT_Sk_MI_SSF_Reported	P31s_TT_Sk_MI_cTIM
P31s_TT_Sk_MI_ExTI	P31s_TT_Sk_MI_cUNEQ
P31s_TT_Sk_MI_RDI_Reported	P31s_TT_Sk_MI_cDEG
P31s_TT_Sk_MI_DEGTHR	P31s_TT_Sk_MI_cRDI
P31s_TT_Sk_MI_DEGM	P31s_TT_Sk_MI_cSSF
P31s_TT_Sk_MI_1second	P31s_TT_Sk_MI_AcTI
P31s_TT_Sk_MI_TIMdis	P31s_RI_RDI
	P31s_RI_REI
	P31s_TT_Sk_MI_pN_EBC
	P31s_TT_Sk_MI_pF_EBC
	P31s_TT_Sk_MI_pN_DS
	P31s_TT_Sk_MI_pF_DS

Processes:

This function monitors for 34 Mbit/s frame errors and recovers the trail termination status as defined in ETS 300 337 [9]. It extracts the payload independent overhead bytes EM, TR, MA bits 1, 2 from the P31s layer Characteristic information:

EM: Even bit parity (BIP-8) shall be computed for each bit n of every byte of the preceding frame and compared with bit n of EM recovered from the current frame (n=1 to 8 inclusive). A difference between the computed and recovered EM values shall be taken as evidence of one or more errors (nN_B) in the computation block.

TR: The 16 byte Trail Trace Identifier (TTI) shall be recovered from the TR byte and shall be made available for network management purposes. The application and the acceptance and mismatch detection process shall be performed as described in the ETS 300 417-1-1 [8], subclauses 7.1, and 8.2.1.3.

MA[1-2]: The relevant information carried in the MA byte (RDI in bit 1, REI in bit 2) shall be extracted to enable single ended maintenance of a bi-directional Trail. The REI (nF_B) shall be used to monitor the error performance of the reverse direction of transmission; the RDI provides information as to the status of the remote receiver. A "1" indicates a RDI state, while a "0" indicates the normal working state. The

application process shall be performed as specified in ETS 300 417-1-1 [8], subclauses 7.4.2 (REI), 7.4.11 and 8.2 (RDI).

MA[3-5]: The information in the signal label bits shall be extracted to allow unequipped P31s defect detection.

Defects:

The detection and removal conditions and processes for dUNEQ, dDEG, dRDI and dTIM are described in ETS 300 417-1-1 [8], subclause 8.2.1.

Consequent Actions:

aAIS   ← dUNEQ or dTIM

aRDI   ← CI_SSF or dUNEQ or dTIM

aTSF   ← CI_SSF or dUNEQ or dTIM

aTSD   ← dDEG

aREI   ← "#EDCV"

On declaration of an aAIS the function shall output an all ONEs signal within 250 μs; on clearing of aAIS the function shall output normal data within 250 μs.

Defect Correlations:

cUNEQ ← MON and dUNEQ

cTIM   ← MON and dTIM (and not dUNEQ)

cDEG   ← MON and dDEG and (not dUNEQ) and (not dTIM)

cRDI   ← MON and dRDI and (not dTIM) and (not dUNEQ) and RDI_Reported

cSSF   ← MON and CI_SSF and SSF_Reported

It shall be an option to report SSF as a fault cause. This is controlled by means of the parameter SSF_Reported. The default shall be SSF_Reported = false.

It shall be an option to report RDI as a fault cause. This is controlled by means of the parameter RDI_Reported. The default shall be RDI_Reported = false.

Performance Monitoring:

The performance monitoring process shall be performed as specified in ETS 300 417-1-1 [8], subclause 8.2.4 through 8.2.7.

pN_DS   ←   aTSF or dEQ

pF_DS   ←   dRDI

pN_EBC   ← ΣnN_B

pF_EBC   ← ΣnF_B

8.3 P31s adaptation functions

8.3.1 P31s layer to VC-12, VC-11 layer compound adaptation source function P31s/SX_A_So

Symbol:
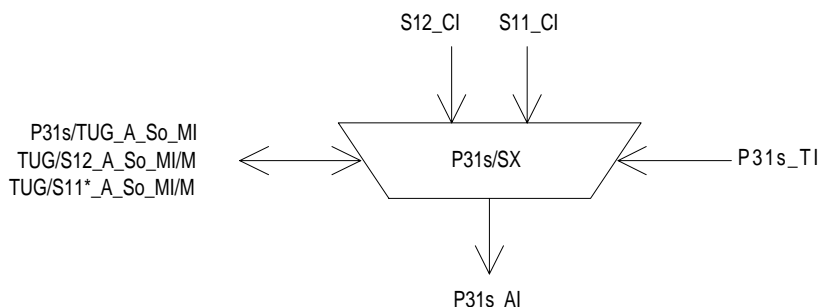
Figure 52: P31s/SX_A_So symbol

Interfaces:

Table 34: P31s/SX_A_So input and output signals

Input(s)	Output(s)
P31s/TUG_A_So_MI P31s_TI maximum 14 inputs: S12_CI TUG/S12_A_So_MI/M maximum 14 inputs: S11_CI TUG/S11*_A_So_MI/M	P31s_AI

Processes:

The P31s/SX_A_So compound function provides adaptation from the VC-12/11 layers to the P31s layer. This process is performed by a combination of several atomic functions as shown in figure 53. The P31s/TUG_A_So function performs the P31s layer specific signal label and multiframe processing, while the TUG/S12_A_So and TUG/S11*_A_So functions perform the lower order VC specific frequency justification and bitrate adaptation. Each of these TUG/Sm_A_So functions is characterized by the parameter M, which define the number of the TU within the P31s the function has access to (TU numbering scheme according to ETS 300 337 [9], subclause 5.3). According to the TUG multiplex structures supported by the NE, a variety of possible combinations of these TUG/Sm_A_So functions exists. Table 35 lists all possible TUG/Sm_A_So functions within a P31s/SX_A_So compound functions.
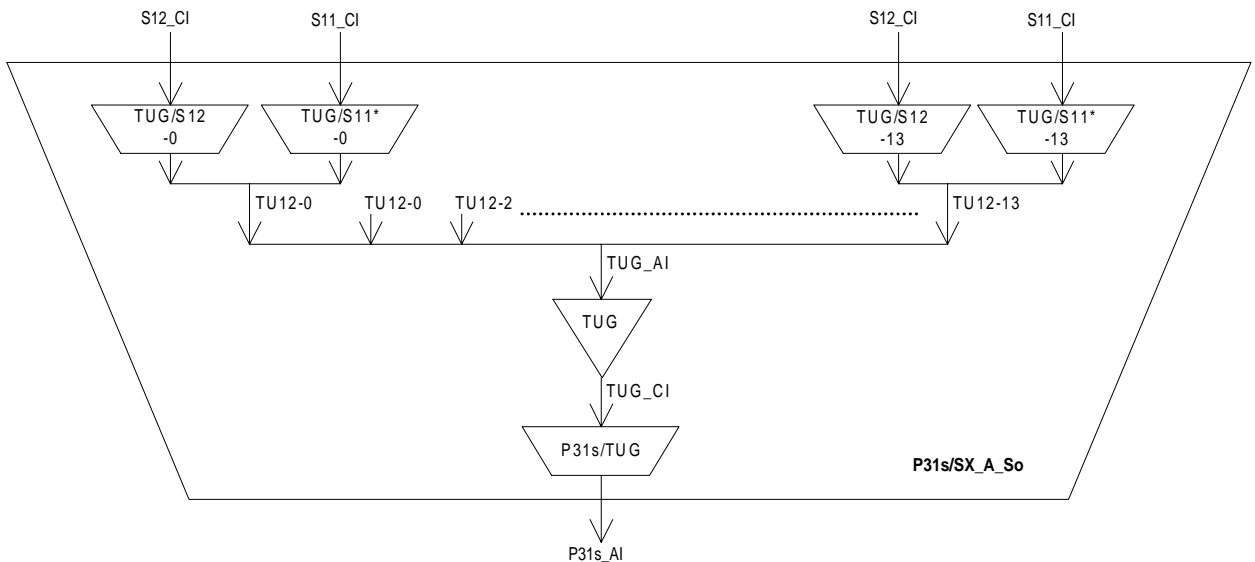
Figure 53: P31s/SX_A_So compound function with set of P31s/Sm_A_So atomic functions

Table 35: Possible TUG/Sm_A_So functions of a P31s/SX_A_So compound function

Atomic function	TU-12 number M
TUG/S12_A_So/M	0 to 13
TUG/S11*_A_So/M	0 to 13

For specific implementations only a subset of these TUG/Sm_A_So functions may be used (e.g. a terminal multiplexer with fixed 2 Mbit/s access has 14 TUG/S12_A_So functions). If a flexible TUG multiplex structure is supported, several TUG/Sm_A_So functions may have access to the same TU timeslot. For such case, only one of these adaptation source functions is allowed to be activated. This is controlled by the equipment management function by activating/deactivating the functions according to the configured TUG multiplex structure.

NOTE 1: The P31s/TUG_A_So, TUG_T_So and TUG/Sm_A_So (m = 12, 11*) defined in the following subclauses can only be used in a P31s/SX_A_So compound function. These functions can not be used as stand alone functions.

NOTE 2: The TUG is a virtual sub-layer only applicable in a P31s/SX_A compound function.

NOTE 3: The number of TUG/Sm_A (m=12,11*) functions that is active shall completely fill the P31s payload.

8.3.1.1 P31s layer to TUG adaptation source function P31s/TUG_A_So

Symbol:
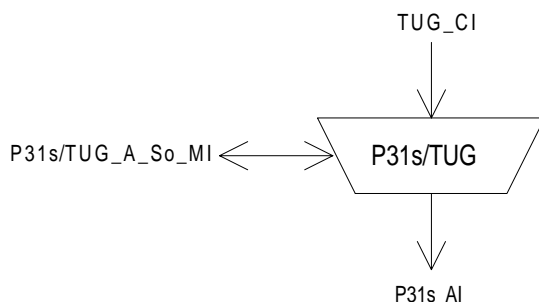
Figure 54: P31s/TUG_A_So symbol

Interfaces:

Table 36: P31s/TUG_A_So input and output signals

Input(s)	Output(s)
TUG_CI_D	P31s_AI_D
TUG_CI_CK	P31s_AI_CK
TUG_CI_FS	P31s_AI_FS
TUG_CI_MFS	
P31s/TUG_A_So_MI_Active	

NOTE: The P31s/TUG_A_So functions can only be used in a P31s/SX_A_So compound function. It can not be used as a standalone function.

Processes:

The function adds two payload specific signals (bits MA[3-5] and MA[6-7]) to the P31s POH and fixed stuff (R) bytes to the P31s payload (figure 56).

MA[3-5]: In this byte the function shall insert code "011" (TU-12 structure) as defined in ETS 300 337 [9].

MA[6-7]: The value of the multiframe indicator bits shall be set as specified by ETS 300 337 [9], 500 µs TU multiframe sequence, and aligned with TUG_CI_MFS.

					TU multiframe indicator		
1	2	3	4	5	6	7	8

Figure 55: TU multiframe indicator bits in byte MA

R - *Fixed Stuff bytes:* The fixed stuff bytes R are undefined.
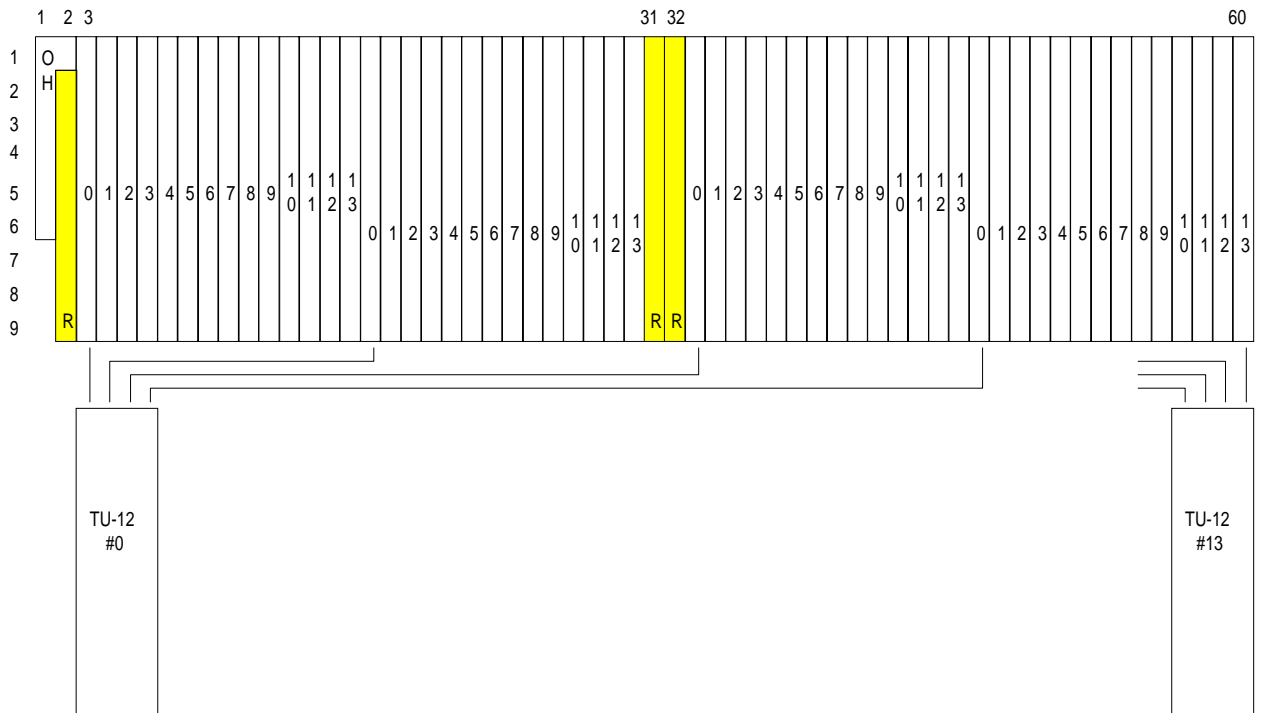
Figure 56: P31s payload (TU-12s and fixed stuff "R" bytes) and TU-12 numbering scheme

Figure 48 shows that more than one adaptation source function exists in a P31s layer that can be connected to one P31s access point. For such case, only one of these adaptation source functions is allowed to be activated. Access to the access point by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

8.3.1.2   TUG termination source function TUG_T_So

Symbol:

```
                        TUG_AI
                          │
                          ▼
                    ╲           ╱
                     ╲   TUG   ╱
                      ╲       ╱
                       ╲     ╱
                        ╲   ╱
                         ╲ ╱
                          ▼
                        TUG_CI
```
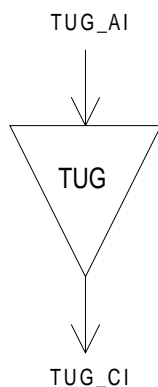
Figure 57: TUG_T_So symbol

Interfaces:

Table 37: TUG_T_So input and output signals

Input(s)	Output(s)
TUG_AI_D	TUG_CI_D
TUG_AI_CK	TUG_CI_CK
TUG_AI_FS	TUG_CI_FS
TUG_AI_MFS	TUG_CI_MFS

NOTE: The TUG_T_So functions can only be used in a P31s/SX_A_So compound function. It can not be used as a standalone function.

Processes: None.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

8.3.1.3 TUG to VC-12 layer adaptation source function TUG/S12_A_So/M

Symbol:

Figure 58: TUG/S12_A_So symbol

Interfaces:

Table 38: TUG/S12_A_So input and output signals

Input(s)	Output(s)
S12_CI_D	TUG_AI_D
S12_CI_CK	TUG_AI_CK
S12_CI_FS	TUG_AI_FS
S12_CI_SSF	
P31s_TI_CK	
P31s_TI_FS	
P31s_TI_MFS	
TUG/S12_A_So_MI_Active	

NOTE 1: The TUG/S12_A_So functions can only be used in a P31s/SX_A_So compound function. It can not be used as a standalone function.

Processes:

This function provides frequency justification and bitrate adaptation for a VC-12 signal, represented by a nominally $(140 \times 64 / 4) = 2\,240$ kbit/s information stream with a frequency accuracy within $\pm$ 4,6 ppm and the related frame phase, to be multiplexed into a P31s signal via a TU-12.

The (500 µs) frame phase of the VC-12 is coded in the related TU-12 pointer. Frequency justification, if required, is performed by pointer adjustments. The accuracy of this coding process is specified below. Refer to annex A of ETS 300 417-4-1 [10].

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (buffer) process. The data and frame start signals shall be written into the buffer under control of the associated input clock. The data and frame start signals shall be read out of the buffer under control of the P31s clock, frame position, and justification decision.

The justification decisions determine the phase error introduced by the TUG/S12_A_So function. The amount of this phase error can be measured at the physical interfaces by monitoring the TU-12 pointer actions. An example is given in annex A.2 of ETS 300 417-4-1 [10].

Each justification decision results in a corresponding negative/positive justification action. Upon a positive justification action, the reading of 8 data bits shall be cancelled once and no data are written at the justification opportunity position V3+1(figure 59). Upon a negative justification action, an extra 8 data bits shall be read out once into the justification opportunity position V3.

NOTE 2: A requirement for maximum introduced phase error cannot be defined until a reference path is defined from which the requirements for network elements can be deduced. Such a requirement would also limit excessive phase error caused by pointer processors under fixed frequency offset conditions.

Buffer size: For further study.

	1	2	3	13		27		43		57	60
1				V1							
2											
3											
4	01*										
5											
6											
7											
8											
9											
1				V2							
2											
3											
4	10*										
5											
6											
7											
8											
9											
1				V3		V3+1					
2											
3											
4	11*										
5											
6											
7											
8											
9											
1				V4							
2											
3											
4	00*										
5											
6											
7											
8											
9											

	indicates the 144 bytes belonging to the TU-12 (10)
	01*, 10*, 11*, and 00* indicate code value in bits MA[6-7]

Figure 59: TUG_AI_D/10 signal

The TU-12 pointer is carried in bytes V1 and V2 of payload specific OH per 500 μs multiframe (figure 59). The TU-12 pointer is aligned in the P31s payload in fixed positions relative to the P31s frame and multiframe. The format of the TU-12 pointer and its location in the frame/multiframe are defined in ETS 300 337 [9].

V1, V2 - *Pointer generation:* The function shall generate the TU-12 pointer as is described in ETS 300 417-1-1 [8], annex A: Pointer Generation. It shall insert the pointer in the appropriate V1, V2 positions with the SS field set to 10 to indicate TU-12.

NOTE 3: The byte V4 is undefined.

TU-12 timeslot: The adaptation source function has access to a specific TU-12 of the TUG access point. The TU-12 is defined by the parameter M (M=0 to 13).

Figure 53 shows that more than one adaptation source function exists in the TUG virtual sub-layer that can be connected to one TUG access point. For such case, a subset of these adaptation source functions

is allowed to be activated together, but only one adaptation source function may have access to a specific TU timeslot. Access to the same TU timeslot by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions:

aAIS ←   CI_SSF

On declaration of aAIS the function shall output an all-ONEs signal within 1 ms; on clearing of aAIS the function shall output normal data within 1 ms.

>   NOTE 4:   If CI_SSF is not connected (when connected to a S12_TT_So), CI_SSF is assumed to be false.

Defect Correlations: None.

Performance Monitoring: None.

8.3.1.4   **TUG to VC-11 layer adaptation source function TUG/S11_A_So/M**

Symbol:
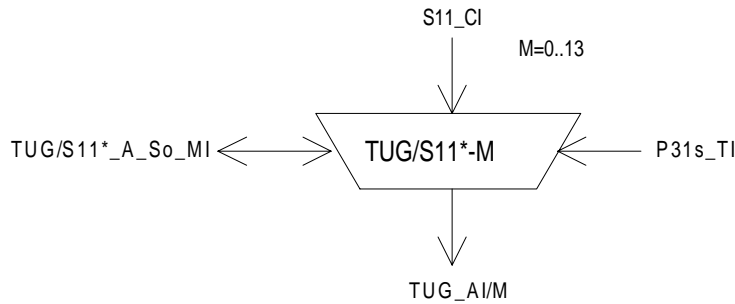
Figure 60: TUG/S11*_A_So symbol

Interfaces:

Table 39: TUG/S11_A_So input and output signals

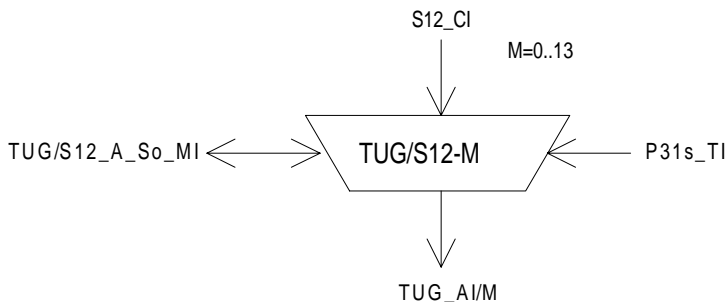| Input(s)	Output(s)
S11_CI_D	TUG_AI_D
S11_CI_CK	TUG_AI_CK
S11_CI_FS	TUG_AI_FS
S11_CI_SSF	
P31s_TI_CK	
P31s_TI_FS	
P31s_TI_MFS	
TUG/S11*_A_So_MI_Active	

    NOTE 1:   The TUG/S11*_A_So functions can only be used in a P31s/SX_A_So compound
               function. It can not be used as a standalone function.

Processes:

This function provides frequency justification and bitrate adaptation for a VC-11 signal, represented by a nominally $(104 \times 64 / 4) = 1\ 664$ kbit/s information stream with a frequency accuracy within $\pm 4{,}6$ ppm and the related frame phase, to be multiplexed into a VC-4 signal. The VC-11 is transported within a TU-12; 9 bytes of fixed stuff (figure 61) are added per 125 μs to the VC-11 as specified by ETS 300 147 [1] to map the VC-11 into the TU-12 payload (see note 2).

    NOTE 2:   Mapping a VC-11 into a TU-12 allows the VC-11 signal to be transported in a VC-12
               based network (via S12_C and TUG/S12_A functions) and to non-intrusively monitor
               this VC-11 by means of a VC-12 non-intrusive monitor (S12m_TT_Sk). The
               TUG/S11*_A function will be used at the junction of VC-11 and VC-12 networks.

The (500 μs) frame phase of the VC-11 is coded in the related TU-12 pointer. Frequency justification, if required, is performed by pointer adjustments. The accuracy of this coding process is specified below. Refer to annex A of ETS 300 417-4-1 [10].

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (buffer) process. The data and frame start signals shall be written into the buffer under control of the associated input clock. The data and frame start signals shall be read out of the buffer under control of the P31s clock, frame position, and justification decision.

The justification decisions determine the phase error introduced by the TUG/S11*_A_So function. The amount of this phase error can be measured at the physical interfaces by monitoring the TU-12 pointer actions. An example is given in annex A.2 of ETS 300 417-4-1 [10].

Each justification decision results in a corresponding negative/positive justification action. Upon a positive justification action, the reading of 8 data bits shall be cancelled once and no data are written at the justification opportunity position V3+1(figure 61). Upon a negative justification action, an extra 8 data bits shall be read out once into the justification opportunity position V3.

> NOTE 3: A requirement for maximum introduced phase error cannot be defined until a reference path is defined from which the requirements for network elements can be deduced. Such a requirement would also limit excessive phase error caused by pointer processors under fixed frequency offset conditions.

Buffer size: For further study.

	1	2	3	13		27		43		57	60
1				V1				R*			
2								R*			
3								R*			
4	01*							R*		V5	
5						R*					
6						R*					
7						R*					
8						R*					
9						R*					
1				V2				R*			
2								R*			
3								R*			
4	10*							R*		J2	
5						R*					
6						R*					
7						R*					
8						R*					
9						R*					
1				V3		V3+1		R*			
2								R*			
3								R*			
4	11*							R*		N2	
5						R*					
6						R*					
7						R*					
8						R*					
9						R*					
1				V4				R*			
2								R*			
3								R*			
4	00*							R*		K4	
5						R*					
6						R*					
7						R*					
8						R*					
9						R*					

indicates the 144 bytes belonging to the TU-12 (10)
01*, 10*, 11*, and 00* indicate code value in bits MA[6-7]   R* indicates fixed stuff with even parity   The positions of the V5, J2, N2, K4 and R* bytes is relative to the position of the VC-11 in the TU-12. The start of the VC-11 (V5 byte) is defined by the TU-12 pointer.

Figure 61: TUG_AI_D/10 signal

The TU-12 pointer is carried in bytes V1 and V2 of payload specific OH per 500 µs multiframe (figure 61). The TU-12 pointer is aligned in the P31s payload in fixed positions relative to the P31s frame and multiframe. The format of the TU-12 pointer and its location in the frame/multiframe are defined in ETS 300 337 [9].

V1, V2 - *Pointer generation:* The function shall generate the TU-12 pointer as is described in ETS 300 417-1-1 [8], annex A: Pointer Generation. It shall insert the pointer in the appropriate V1, V2 positions with the SS field set to 10 to indicate TU-12.

NOTE 4: The byte V4 is undefined.

TU-12 timeslot: The adaptation source function has access to a specific TU-12 of the TUG access point. The TU-12 is defined by the parameter M (M=0 to 13).

Figure 53 shows that more than one adaptation source function exists in the TUG virtual sub-layer that can be connected to one TUG access point. For such case, a subset of these adaptation source functions is allowed to be activated together, but only one adaptation source function may have access to a specific TU timeslot. Access to the same TU timeslot by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions:

aAIS ←   CI_SSF

On declaration of aAIS the function shall output an all-ONEs signal within 1 ms; on clearing of aAIS the function shall output normal data within 1 ms.

NOTE 5: If CI_SSF is not connected (when connected to a S11_TT_So), CI_SSF is assumed to be false.

Defect Correlations: None.

Performance Monitoring: None.

8.3.2 P31s layer to VC-12, VC-11 layer compound adaptation sink function P31s/SX_A_Sk

Symbol:
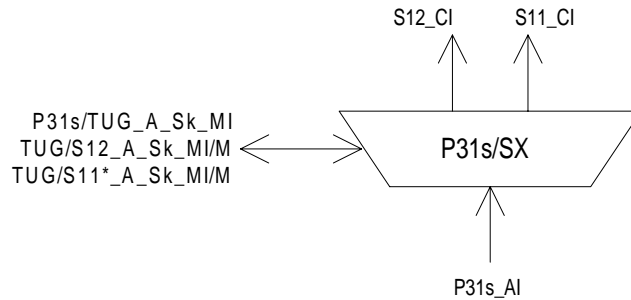
Figure 62: P31s/TUG_A_Sk symbol

Interfaces:

Table 40: P31s/TUG_A_Sk input and output signals

Input(s)	Output(s)
P31s_AI P31s/TUG_A_Sk_MI maximum 14 inputs: TUG/S12_A_Sk_MI/M maximum 14 inputs: TUG/S11*_A_Sk_MI/M	P31s/TUG_A_Sk_MI maximum 14 outputs: S12_CI TUG/S12_A_Sk_MI/M maximum 14 outputs: S11_CI TUG/S11*_A_Sk_MI/M

Processes:

The P31s/SX_A_Sk compound function provides adaptation from the P31s layer to the VC-12/11 layers. This process is performed by a combination of several atomic functions as shown in figure 63. The P31s/TUG_A_Sk function performs the P31s layer specific signal label and multiframe processing, while the TUG/S12_A_Sk and TUG/S11*_A_Sk functions perform the lower order VC specific frequency justification and bitrate adaptation. Each of these TUG/Sm_A_Sk functions is characterized by the parameter M, which define the number of the TU within the P31s the function has access to (TU numbering scheme according to ETS 300 337 [9], subclause 5.3). According to the TUG multiplex structures supported by the NE, a variety of possible combinations of these TUG/Sm_A_Sk functions exists. Table 41 lists all possible TUG/Sm_A_Sk functions within a P31s/SX_A_Sk compound function.
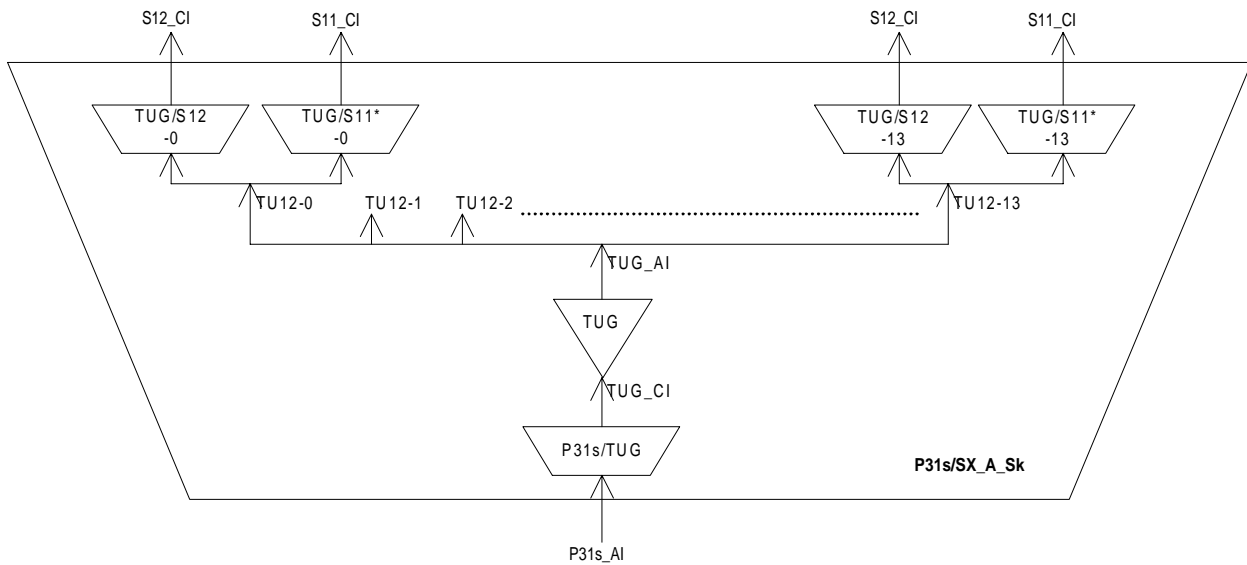
Figure 63: P31s/SX_A_Sk compound function with set of P31s/Sm_A_Sk atomic functions

Table 41: Possible TUG/Sm_A_Sk functions of a P31s/SX_A_Sk compound function

Atomic function	TU-12 number M
TUG/S12_A_Sk/M	0 to 13
TUG/S11*_A_Sk/M	0 to 13

For specific implementations only a subset of these TUG/Sm_A_Sk functions may be used (e.g. a terminal multiplexer with fixed 2 Mbit/s access has 14 TUG/S12_A_Sk functions). If a flexible TUG multiplex structure is supported, several TUG/Sm_A_Sk functions may have access to the same TU timeslot. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults (e.g. cLOP) to be detected and reported. To prevent this an adaptation sink function can be deactivated. This is controlled by the equipment management function by activating/deactivating the functions according to the configured TUG multiplex structure.

NOTE 1:   The P31s/TUG_A_Sk, TUG_T_Sk and TUG/Sm_A_Sk (m = 12, 11*) defined in the following subclauses can only be used in a P31s/SX_A_Sk compound function. These functions can not be used as stand alone functions.

NOTE 2:   The TUG is a virtual sub-layer only applicable in a P31s/SX_A compound function.

8.3.2.1 P31s layer to TUG adaptation sink function P31s/TUG_A_Sk

Symbol:

TUG_CI

P31s/TUG_A_Sk_MI ⟷ P31s/TUG
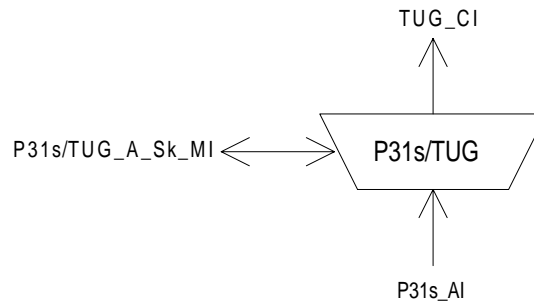
P31s_AI

Figure 64: P31s/TUG_A_Sk symbol

Interfaces:

Table 42: P31s/TUG_A_Sk input and output signals

Input(s)	Output(s)
P31s_AI_D	TUG_CI_D
P31s_AI_CK	TUG_CI_CK
P31s_AI_FS	TUG_CI_FS
P31s_AI_TSF	TUG_CI_MFS
P31s/TUG_A_Sk_MI_Active	TUG_CI_SSF
	P31s/TUG_A_Sk_MI_cPLM
	P31s/TUG_A_Sk_MI_cLOM

NOTE: The P31s/TUG_A_Sk functions can only be used in a P31s/SX_A_Sk compound function. It can not be used as a standalone function.

Processes:

The function monitors two payload specific signals (bits MA[3-5] and MA[6-7]) of the P31s POH.

MA[3-5]: The function shall compare the content of the accepted MA[3-5] bits with the expected value code "011" (TU-12 structure) as a check on consistency between the provisioning operation at each end. The application, acceptance and mismatch detection processes are described in ETS 300 417-1-1 [8], subclauses 7.2 and 8.1.2.

MA[6-7]: the function shall recover the 500 µs (multi)frame start phase performing multi-frame alignment on bits 6 and 7 of byte MA. Out-of-multiframe (OOM) shall be assumed once when an error is detected in the MA bit 6 and 7 sequence. Multiframe alignment shall be assumed to be recovered, and the in-multiframe (IM) state shall be entered, when in four consecutive P31s frames an error free MA sequence is found.

Figure 48 shows that more than one adaptation sink function exists in this P31s layer that can be connected to one P31s access point. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults (e.g. cPLM) to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall activate the SSF signal at its output and not report its status via the management point.

Defects:

The function shall detect for the dPLM defect according ETS 300 417-1-1 [8], subclause 8.2.1.

If the multiframe alignment process is in the OOM state and the MA[6-7] multiframe is not recovered within X ms, a dLOM defect shall be declared. Once in a dLOM state, this state shall be exited when the multiframe is recovered (multiframe alignment process enter the IM state). X shall be a value in the range 1 to 5 (ms). X is not configurable.

Consequent Actions:

aSSF ←   dPLM or dLOM

Defect Correlations:

cPLM ←   dPLM and (not AI_TSF)

cLOM ←   dLOM and (not AI_TSF) and (not dPLM)

Performance Monitoring: None.

8.3.2.2 TUG termination sink function TUG_T_Sk

Symbol:


```
            TUG_AI
              ↑
           ╱  │  ╲
          ╱   │   ╲
         │   TUG   │
          ╲       ╱
           ╲  ↑  ╱
              │
            TUG_CI
```
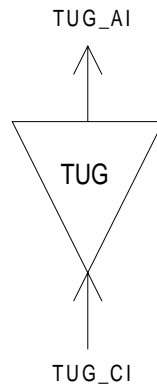
Figure 65: TUG_T_Sk symbol

Interfaces:

Table 43: TUG_T_Sk input and output signals

Input(s)	Output(s)
TUG_CI_D	TUG_AI_D
TUG_CI_CK	TUG_AI_CK
TUG_CI_FS	TUG_AI_FS
TUG_CI_SSF	TUG_AI_TSF

NOTE: The TUG_T_Sk functions can only be used in a P31s/SX_A_Sk compound function. It can not be used as a standalone function.

Processes: None.

Defects: None.

Consequent Actions:

aTSF ← CI_SSF

Defect Correlations: None.

Performance Monitoring: None.

8.3.2.3   TUG to VC-12 layer adaptation sink function TUG/S12_A_Sk/M

Symbol:
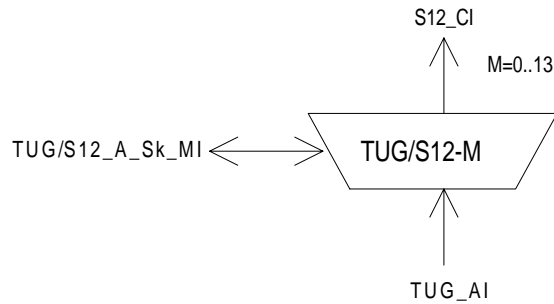
Figure 66: TUG/S12_A_Sk symbol

Interfaces:

Table 44: TUG/S12_A_Sk input and output signals

Input(s)	Output(s)
TUG_AI_D	S12_CI_D
TUG_AI_CK	S12_CI_CK
TUG_AI_FS	S12_CI_FS
TUG_AI_TSF	S12_CI_SSF
TUG/S12_A_Sk_MI_AIS_Reported	TUG/S12_A_Sk_MI_cLOP
TUG/S12_A_Sk_MI_Active	TUG/S12_A_Sk_MI_cAIS

> NOTE: The TUG/S12_A_Sk functions can only be used in a P31s/SX_A_Sk compound function. It can not be used as a standalone function.

Processes:

This function recovers VC-12 data with frame phase information from a TU-12.

V1, V2 - *TU-12 pointer interpretation:* The function shall perform TU-12 pointer interpretation as specified in annex B in ETS 300 417-1-1 [8] to recover the VC-12 frame phase within a TU-12 of a P31s.

TU-12 timeslot: The adaptation sink function has access to a specific TU-12 of the TUG access point. The TU-12 is defined by the parameter M (M=0 to 13).

Figure 63 shows that more than one adaptation sink function exists in this TUG virtual sub-layer that can be connected to one TUG access point. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults (e.g. cLOP) to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D) and not report its status via its management point.

Defects:

The function shall detect for dAIS and dLOP defect according the algorithm described under the pointer interpreter process in ETS 300 417-1-1 [8], annex B, Pointer Interpretation.

Consequent Actions:

aAIS ←   dAIS or dLOP or AI_TSF

aSSF ←   dAIS or dLOP or AI_TSF

On declaration of aAIS the function shall output all ONEs signal within 1 ms; on clearing of aAIS the function shall output the recovered data within 1 ms.

Defect Correlations:

cAIS ←   dAIS and (not AI_TSF) and AIS_Reported

cLOP ←   dLOP and (not AI_TSF)

It shall be an option to report AIS as a fault cause. This is controlled by means of the parameter AIS_Reported. The default shall be AIS_Reported = false.

Performance Monitoring: None**.**

8.3.2.4   TUG to VC-11 layer adaptation sink function TUG/S11*_A_Sk/M

Symbol:
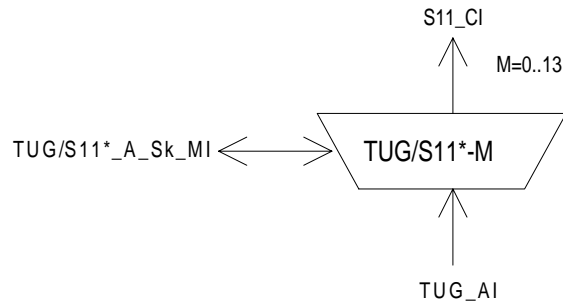
Figure 67: TUG/S11*_A_Sk symbol

Interfaces:

Table 45: TUG/S11*_A_Sk input and output signals

Input(s)	Output(s)
TUG_AI_D	S11_CI_D
TUG_AI_CK	S11_CI_CK
TUG_AI_FS	S11_CI_FS
TUG_AI_TSF	S11_CI_SSF
TUG/S11*_A_Sk_MI_AIS_Reported	TUG/S11*_A_Sk_MI_cLOP
TUG/S11*_A_Sk_MI_Active	TUG/S11*_A_Sk_MI_cAIS

> NOTE: The TUG/S11*_A_Sk functions can only be used in a P31s/SX_A_Sk compound
> function. It can not be used as a standalone function.

Processes:

This function recovers VC-11 data with frame phase information from a TU-12.

V1, V2 - *TU-12 pointer interpretation:* The function shall perform TU-12 pointer interpretation as specified in annex B in ETS 300 417-1-1 [8] to recover the VC-12 frame phase within a TU-12 of a P31s.

TU-12 timeslot: The adaptation sink function has access to a specific TU-12 of the TUG access point. The TU-12 is defined by the parameter M (M=0 to 13).

Figure 63 shows that more than one adaptation sink function exists in this TUG virtual sub-layer that can be connected to one TUG access point. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults (e.g. cLOP) to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D) and not report its status via its management point.

Defects:

The function shall detect for dAIS and dLOP defect according the algorithm described under the pointer interpreter process in ETS 300 417-1-1 [8], annex B, Pointer Interpretation.

Consequent Actions:

aAIS ← dAIS or dLOP or AI_TSF

aSSF ← dAIS or dLOP or AI_TSF

On declaration of aAIS the function shall output all ONEs signal within 1 ms; on clearing of aAIS the function shall output the recovered data within 1 ms.

Defect Correlations:

cAIS ← dAIS and (not AI_TSF) and AIS_Reported

cLOP ← dLOP and (not AI_TSF)

It shall be an option to report AIS as a fault cause. This is controlled by means of the parameter AIS_Reported. The default shall be AIS_Reported = false.

Performance Monitoring: None**.**

8.3.3   P31s layer to P0x layer adaptation source P31s/P0x_A_So

Symbol:

P0x_CI

P31s/P0x_A_So_MI ⟶ P31s/P0x ⟵ P31s_TI
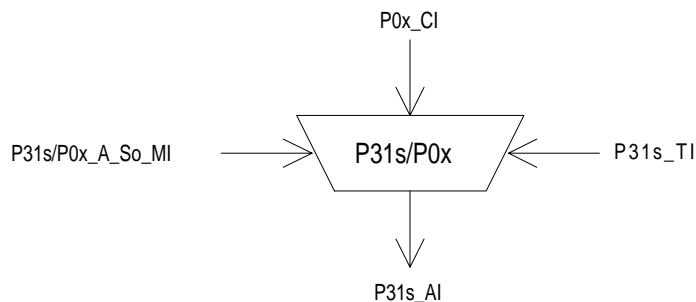
P31s_AI

Figure 68: P31s/P0x_A_So symbol

Interfaces:

Table 46: P31s/P0x_A_So input and output signals

Input(s)	Output(s)
P0x_CI_D P0x_CI_CK P0x_CI_FS P31s_TI_CK P31s_TI_FS P31s/P0x_A_So_MI_Active	P31s_AI_D

Processes:

This function provides the multiplexing of a 64 kbit/s information stream into the P31s_AI using slip buffering. It takes P0x_CI, defined in ETS 300 166 [13] as an octet structured bit-stream with a rate of 64 kbit/s ± 100 ppm, present at its input and inserts it into the P31s POH byte GC as defined in ETS 300 337 [9] and depicted in figure 49.

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (slip buffer) process. The data signal shall be written into the buffer under control of the associated input clock. The data shall be read out of the buffer under control of the P31s clock, frame position (P31s_TI), and justification decisions.

Each justification decision results in a corresponding negative/positive justification (slip) action. Upon a positive justification (slip) action, the reading of one 64 kbit/s octet (8 bits) shall be cancelled once. Upon a negative justification (slip) action, the same 64 kbit/s octet (8 bits) shall be read out a second time.

Buffer size: The elastic store (slip buffer) size shall be at least 2 octets.

Figure 48 shows that more than one adaptation source function exists in this P31s layer that can be connected to access point accessing the GC byte. For such case, one of these adaptation source functions is allowed to be activated. Access to the GC byte by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

8.3.4 P31s layer to P0x layer adaptation sink P31s/P0x_A_Sk

Symbol:
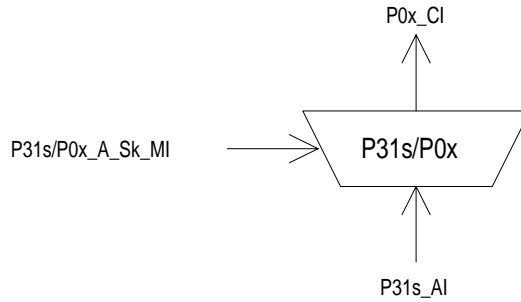
Figure 69: P31s/P0x_A_Sk symbol

Interfaces:

Table 47: P31s/P0x_A_Sk input and output signals

Input(s)	Output(s)
P31s_AI_D	P0x_CI_D
P31s_AI_CK	P0x_CI_CK
P31s_AI_FS	P0x_CI_FS
P31s_AI_TSF	
P31s/P0x_A_Sk_MI_Active	

Processes:

The function extracts the general communications channel byte GC from the P31s layer Characteristic Information. The recovered byte provides a 64 kbit/s channel for the client (user).

Smoothing and jitter limiting process: The function shall provide for a clock smoothing and elastic store (buffer) process. The data signal shall be written into the buffer under control of the associated (gapped) input clock. The data signal shall be read out of the buffer under control of a smoothed (equally spaced) 64 kHz clock (the rate is determined by the P31s signal generated at the remote node containing P31s/P0x_A_So). The residual jitter caused by pointer adjustments (measured at the 64 kbit/s interface) shall be within the limits specified in TBD.

Buffer size: In the presence of jitter as specified by TBD and a frequency within the range 64 kbit/s $\pm$ 4,6 ppm, this justification process shall not introduce any errors.

Following a step in frequency of the P0x signal transported by the P31s_AI (for example due to a frequency step of the server P31s signal, or removal of all-ONEs (AIS) signal with a frequency offset) there will be a maximum recovery time of X seconds after which this process shall not generate any bit errors.

The value of X is for further study; a value of 1 second has been proposed.

Figure 48 shows that more than one adaptation sink function exists in this P31s layer that can be connected to access point accessing the GC byte. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D).

Defects: None.

Consequent Actions:

aAIS ←   AI_TSF

On declaration of aAIS the function shall output an all-ONEs (AIS) signal - complying to the frequency limits for this signal (a bit rate in range 64 kbit/s ± 100 ppm) - within 1 ms; on clearing of aAIS the function shall output normal data within 1 ms.

Defect Correlations: None.

Performance Monitoring: None.

8.3.5   P31s to V0x adaptation source P31s/V0x_A_So

Symbol:
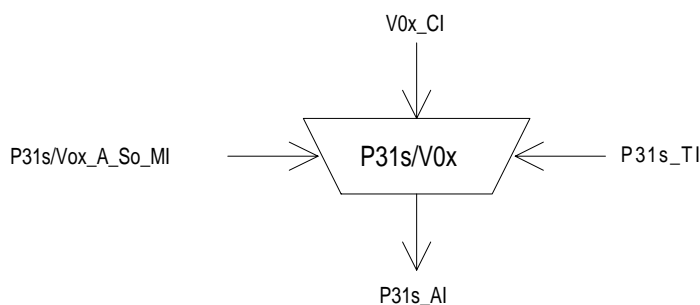
Figure 70: P31s/V0x_A_So symbol

Interfaces:

Table 48: P31s/V0x_A_So input and output signals

Input(s)	Output(s)
V0x_CI_D	P31s_AI_D
P31s_TI_CK	V0x_CI_CK
P31s_TI_FS	
P31s/V0x_A_So_MI_Active	

Processes:

This function multiplexes the V0x_CI data (64 kbit/s) into the byte location GC as defined in ETS 300 337 [9] and depicted in figure 49.

Figure 48 shows that more than one adaptation source function exists in this P31s layer that can be connected to access point accessing the GC byte. For such case, one of these adaptation source functions is allowed to be activated. Access to the GC byte by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

8.3.6 P31s to V0x adaptation sink P31s/V0x_A_Sk

Symbol:
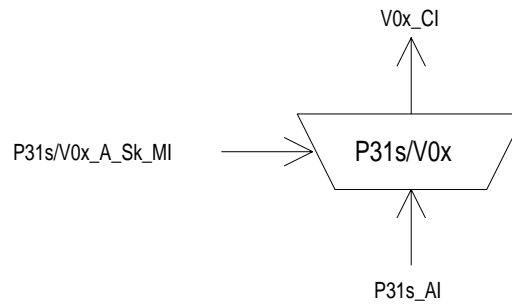
Figure 71: P31s/V0x_A_Sk symbol

Interfaces:

Table 49: P31s/V0x_A_Sk input and output signals

Input(s)	Output(s)
P31s_AI_D	V0x_CI_D
P31s_AI_CK	V0x_CI_CK
P31s_AI_FS	V0x_CI_SSF
P31s_AI_TSF	
P31s/V0x_A_Sk_MI_Active	

Processes:

This function separates user channel data from P31s Overhead (byte GC) as defined in ETS 300 337 [9] and depicted in figure 49.

Figure 48 shows that more than one adaptation sink function exists in this P31s layer that can be connected to access point accessing the GC byte. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D).

Defects: None.

Consequent Actions:

aSSF ← AI_TSF

On declaration of aAIS the function shall output an all-ONEs (AIS) signal - complying to the frequency limits for this signal (a bit rate in range 64 kbit/s ± TBD ppm) - within 1 ms; on clearing of aAIS the function shall output normal data within 1 ms.

Defect Correlations: None.

Performance Monitoring: None.

8.3.7 P31s to DCC adaptation source P31s/DCC_A_So

Symbol:
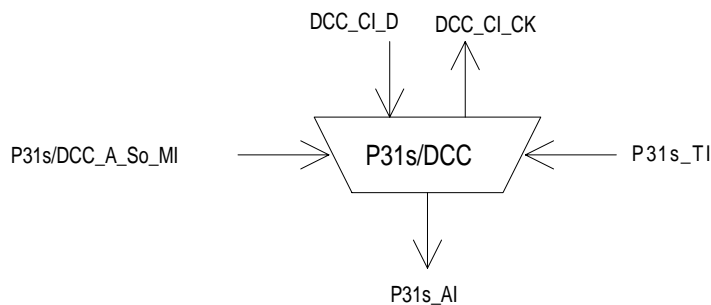
Figure 72: P31s/DCC_A_So symbol

Interfaces:

Table 50: P31s/DCC_A_Sk input and output signals

Input(s)	Output(s)
DCC_CI_D	P31s_AI_D
P31s_TI_CK	DCC_CI_CK
P31s_TI_FS	
P31s/DCC_A_So_MI_Active	

Processes:

The function multiplexes the DCC CI data (64 kbit/s) into the byte location GC as defined in ETS 300 337 [9] and depicted in figure 49.

> NOTE: DCC transmission can be "disabled" when the matrix connection in the connected DCC_C function is removed.

Figure 48 shows that more than one adaptation source function exists in this P31s layer that can be connected to access point accessing the GC byte. For such case, one of these adaptation source functions is allowed to be activated. Access to the GC byte by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

8.3.8 P31s to DCC adaptation sink P31s/DCC_A_Sk

Symbol:
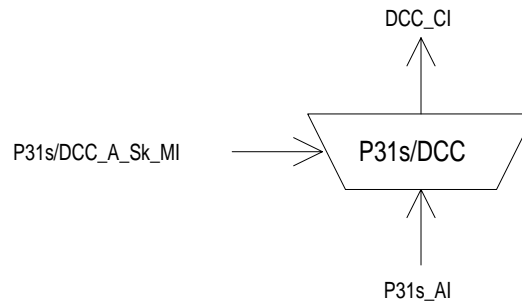
Figure 73: P31s/DCC_A_Sk symbol

Interfaces:

Table 51: P31s/DCC_A_Sk input and output signals

Input(s)	Output(s)
P31s_AI_D	DCC_CI_D
P31s_AI_CK	DCC_CI_CK
P31s_AI_FS	DCC_CI_SSF
P31s_AI_TSF	
P31s/DCC_A_Sk_MI_Active	

Processes:

The function separates DCC data from P31s Overhead (byte GC) as defined in ETS 300 337 [9] and depicted in figure 49.

> NOTE: DCC processing can be "disabled" when the matrix connection in the connected DCC_C function is removed.

Figure 48 shows that more than one adaptation sink function exists in this P31s layer that can be connected to access point accessing the GC byte. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D).

Defects: None.

Consequent Actions:

aSSF ← AI_TSF

Defect Correlations: None.

Performance Monitoring: None.

8.3.9 P31s to SD adaptation source P31s/SD_A_So

The specification of this function will be addressed in ETS 300 417-6-1 [11].

8.3.10 P31s to SD adaptation sink P31s/SD_A_Sk

The specification of this function will be addressed in ETS 300 417-6-1 [11].

8.3.11 P31s to ATM VP compound adaptation source P31s/ATM_A_So

The specification of this function will be addressed under work item DEN/TM-01016 [12].

8.3.12 P31s to ATM VP compound adaptation sink P31s/ATM_A_Sk

The specification of this function will be addressed under work item DEN/TM-01016 [12].

8.4 P31s layer monitoring functions

8.4.1 P31s non-intrusive monitoring function P31sm_TT_Sk

Symbol:

P31s_AI_TSD
P31s_AI_TSF

P31sm_TT_Sk_MI ⟶ P31sm

P31s_CI
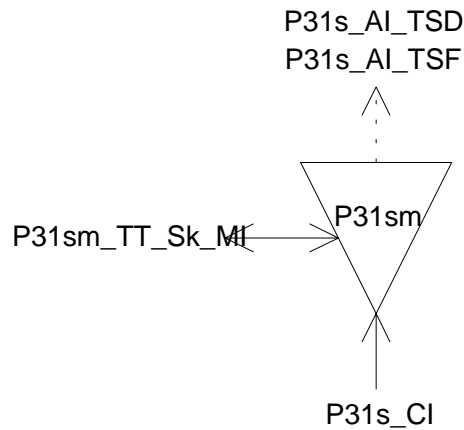
Figure 74: P31sm_TT_Sk symbol

Interfaces:

Table 52: P31sm_TT_Sk input and output signal

Input(s)	Output(s)
P31sm_CI_D	P31sm_AI_TSF
P31sm_CI_CK	P31sm_AI_TSD
P31sm_CI_FS	P31sm_TT_Sk_MI_cTIM
P31sm_CI_SSF	P31sm_TT_Sk_MI_cUNEQ
P31sm_TT_Sk_MI_TPmode	P31sm_TT_Sk_MI_cDEG
P31sm_TT_Sk_MI_SSF_Reported	P31sm_TT_Sk_MI_cRDI
P31sm_TT_Sk_MI_ExTI	P31sm_TT_Sk_MI_cSSF
P31sm_TT_Sk_MI_RDI_Reported	P31sm_TT_Sk_MI_AcTI
P31sm_TT_Sk_MI_DEGTHR	P31sm_TT_Sk_MI_pN_EBC
P31sm_TT_Sk_MI_DEGM	P31sm_TT_Sk_MI_pF_EBC
P31sm_TT_Sk_MI_1second	P31sm_TT_Sk_MI_pN_DS
P31sm_TT_Sk_MI_TIMdis	P31sm_TT_Sk_MI_pF_DS

NOTE 1: This non-intrusive monitor trail termination sink function has no associated source function.

Processes:

This function monitors for 34 Mbit/s frame errors and recovers the trail termination status as defined in ETS 300 337 [9]. It extracts the payload independent overhead bytes EM, TR, MA bits 1, 2 from the P31sm layer Characteristic information:

EM: Even bit parity (BIP-8) shall be computed for each bit n of every byte of the preceding frame and compared with bit n of EM recovered from the current frame (n=1 to 8 inclusive). A difference between the computed and recovered EM values shall be taken as evidence of one or more errors (nN_B) in the computation block.

TR: The 16 byte Trail Trace Identifier (TTI) shall be recovered from the TR byte and shall be made available for network management purposes. The application and the acceptance and mismatch detection process shall be performed as described in the ETS 300 417-1-1 [8], subclauses 7.1 and 8.2.1.3.

MA[1-2]: The relevant information carried in the MA byte (RDI in bit 1, REI in bit 2) shall be extracted to enable single ended maintenance of a bi-directional Trail. The REI (nF_B) shall be used to monitor the error performance of the reverse direction of transmission; the RDI provides information as to the status of the remote receiver. A "1" indicates a RDI state, while a "0" indicates the normal working state. The application process shall be performed as specified in ETS 300 417-1-1 [8], subclauses 7.4.2 (REI), 7.4.11 and 8.2 (RDI).

MA[3-5]: The information in the signal label bits shall be extracted to allow unequipped P31s and P31s-AIS defect detection.

Defects:

The detection and removal conditions and processes for dUNEQ, dDEG, dRDI and dTIM are described in ETS 300 417-1-1 [8], subclause 8.2.1 with the condition "aSSF" read as "aSSF or VC dAIS". To use the function within e.g. a tandem connection (see note 2), it shall be possible to disable the trace id mismatch detection (TIMdis).

> NOTE 2: Presumably, in such case the Trace Id. will be unknown to the tandem connection operator.

P31s AIS:
The function shall detect for an AIS condition by monitoring the P31s PSL for code "111". If 5 consecutive frames contain the "111" pattern in bits 3 to 5 of the MA byte a dAIS defect shall be detected. dAIS shall be cleared if in 5 consecutive frames any pattern other than the "111" is detected in bits 3 to 5 of the MA byte.

Consequent Actions:

aTSF   ← CI_SSF or dAIS or dUNEQ or dTIM

aTSD   ← dDEG

Defect Correlations:

cUNEQ   ← MON and dUNEQ

cTIM   ← MON and dTIM (and not dUNEQ)

cDEG   ← MON and dDEG and (not dUNEQ) and (not dTIM)

cRDI   ← MON and dRDI and (not dTIM) and (not dUNEQ) and RDI_Reported

cSSF   ← MON and (CI_SSF or dAIS) and SSF_Reported

It shall be an option to report SSF as a fault cause. This is controlled by means of the parameter SSF_Reported. The default shall be SSF_Reported = false.

It shall be an option to report RDI as a fault cause. This is controlled by means of the parameter RDI_Reported. The default shall be RDI_Reported = false.

Performance Monitoring:

The performance monitoring process shall be performed as specified in ETS 300 417-1-1 [8], subclause 8.2.4 through 8.2.7.

pN_DS   ←   aTSF or dEQ

pF_DS   ←   dRDI

pN_EBC   ←   ΣnN_B

pF_EBC   ←   ΣnF_B

> NOTE 3:   pF_DS/pF_EBC represent the performance of the total trail while pN_DS/pN_EBC represents only part of the trail up to the point of the non-intrusive monitor.

8.5 P31s layer trail protection functions

For further study.

8.6 P31s tandem connection sublayer functions

8.6.1 P31s tandem connection trail termination source function (P31sD_TT_So)

Symbol:
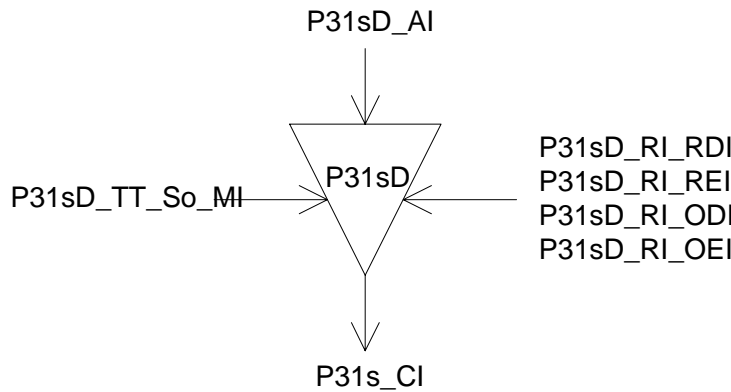
Figure 75: P31sD_TT_So symbol

Interfaces:

Table 53: P31sD_TT_So input and output signals

Input(s)	Output(s)
P31sD_AI_D	P31s_CI_D
P31sD_AI_CK	P31s_CI_CK
P31sD_AI_FS	P31s_CI_FS
P31sD_AI_SF	
P31sD_RI_RDI	
P31sD_RI_REI	
P31sD_RI_ODI	
P31sD_RI_OEI	
P31sD_TT_So_MI_TxTI	

Processes:

NR[8][73] (see note 1): The function shall insert the TC RDI code within 1 multiframe (9,5 ms) after the RDI request generation (RI_RDI)) in the tandem connection trail termination sink function. It ceases TC RDI code insertion within 1 multiframe (9,5 ms) after the TC RDI request has cleared.

> NOTE 1: NR[x][y] refers to bit x (x = 7,8) of byte NR in frame y (y=1 to 76) of the 76 frame multiframe.

NR[5]: The function shall insert the RI_REI value in the REI bit in the following frame.

NR[7][74]: The function shall insert the ODI code within 1 multiframe (9,5 ms) after the ODI request generation (aODI)) in the tandem connection trail termination sink function. It ceases ODI code insertion at the first opportunity after the ODI request has cleared.

NR[6]: The function shall insert the RI_OEI value in the OEI bit in following frame.

NR[7-8]: The function shall insert in the multiframed NR[7-8] channel:

- the Frame Alignment Signal (FAS) "1111 1111 1111 1110" in FAS bits in frames 1 to 8;
- the TC trace identifier, received via MI_TxTI, in the TC-TI bits in frames 9 to 72;
- the TC RDI (NR[8][73]) and ODI (NR[7][74]) signals; and
- all-0s in the six reserved bits in frames 73 to 76.

NR[1-4]: Even BIP-8 shall be computed for each bit n of every byte of the preceding incoming P31s frame (P31s_AI) including EM byte and compared with byte EM recovered from the current frame. A difference between the computed and recovered BIP-8 values shall be taken as evidence of one or more errors in the computation block, and shall be inserted in bits 1 to 4 of byte NR (figure 76, table 54). If AI_SF is true, code "1110" shall be inserted in bits 1 to 4 of byte NR instead of the number of incoming BIP-8 violations.
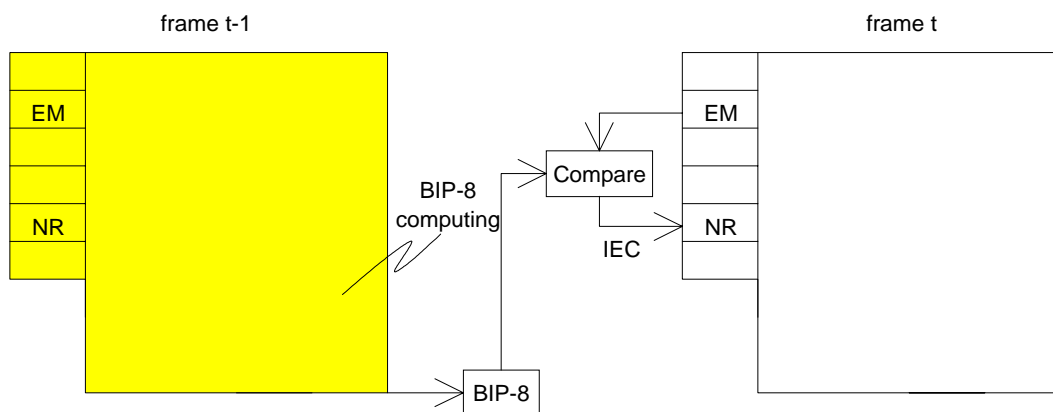
Figure 76: TC IEC computing and insertion

Table 54: IEC code generation

Number of BIP-8 violations	NR[1]	NR[2]	NR[3]	NR[4]
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
0	1	0	0	1

EM: The function shall compensate the P31s BIP8 (in EM) according the following rule:

Since the BIP-8 parity check is taken over the P31s (including NR), writing into NR at the P31sD_TT_So will affect the P31s path parity calculation. Unless this is compensated for, a device which monitors P31s path parity within the Tandem Connection (e.g., a non-intrusive monitor) may incorrectly count errors. The BIP-8 parity bits should always be consistent with the current state of the P31s. Therefore, whenever NR is written, BIP-8 shall be modified to compensate for the change in the NR value. Since the BIP-8 value in a given frame reflects a parity check over the previous frame (including the BIP-8 bits in that frame), the changes made to the BIP-8 bits in the previous frame shall also be considered in the compensation of BIP-8 for the current frame. Therefore, the following equation shall be used for BIP-8 compensation:

$$EM[i]'(t) = EM[i](t-1) \oplus EM[i]'(t-1) \oplus NR[i](t-1) \oplus NR[i]'(t-1) \oplus EM[i](t)$$

Where:

- EM[i] = the existing EM[i] value in the incoming signal;
- EM[i]' = the new (compensated) EM[i] value;
- NR[i] = the existing NR[i] value in the incoming signal;
- NR[i]' = the new value written into the NR[i] bit ;
- $\oplus$ = exclusive OR operator;
- t = the time of the current frame;
- t-1 = the time of the previous frame.

Figure 77: EM[i], i=1 to 8 compensating process

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

8.6.2   P31s tandem connection trail termination sink function (P31sD_TT_Sk)

Symbol:
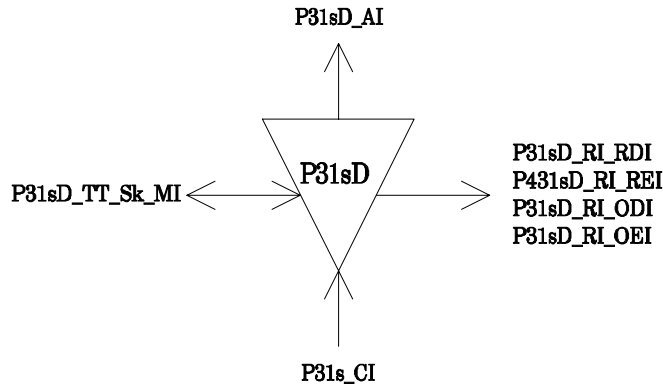
Figure 78: P31sD_TT_Sk symbol

Interfaces:

Table 55: P31sD_TT_Sk input and output signals

Input(s)	Output(s)
P31s_CI_D	P31sD_AI_D
P31s_CI_CK	P31sD_AI_CK
P31s_CI_FS	P31sD_AI_FS
P31s_CI_SSF	P31sD_AI_TSF
P31sD_TT_Sk_MI_ExTI	P31sD_AI_TSD
P31sD_TT_Sk_MI_SSF_Reported	P31sD_AI_OSF
P31sD_TT_Sk_MI_RDI_Reported	P31sD_TT_Sk_MI_cLTC
P31sD_TT_Sk_MI_ODI_Reported	P31sD_TT_Sk_MI_cTIM
P31sD_TT_Sk_MI_TIMdis	P31sD_TT_Sk_MI_cUNEQ
P31sD_TT_Sk_MI_DEGM	P31sD_TT_Sk_MI_cDEG
P31sD_TT_Sk_MI_DEGTHR	P31sD_TT_Sk_MI_cRDI
P31sD_TT_Sk_MI_1second	P31sD_TT_Sk_MI_cSSF
	P31sD_TT_Sk_MI_cODI
	P31sD_TT_Sk_MI_AcTI
	P31sD_RI_RDI
	P31sD_RI_REI
	P31sD_RI_ODI
	P31sD_RI_OEI
	P31sD_TT_Sk_MI_pN_EBC
	P31sD_TT_Sk_MI_pF_EBC
	P31sD_TT_Sk_MI_pN_DS
	P31sD_TT_Sk_MI_pF_DS
	P31sD_TT_Sk_MI_pON_EBC
	P31sD_TT_Sk_MI_pOF_EBC
	P31sD_TT_Sk_MI_pON_DS
	P31sD_TT_Sk_MI_pOF_DS

Processes:

TC EDC violations: Even bit parity shall be computed for each bit n of every byte of the preceding P31s and compared with bit n of EM recovered from the current frame (n=1 to 8 inclusive). A difference between the computed and recovered EM values shall be taken as evidence of one or more errors in the computation block (nON_B). The magnitude (absolute value) of the difference between this calculated number of errors and the number of errors written into the IEC (see table 56) at the trail termination source shall be used to determine the error performance of the tandem connection for each transmitted P31s (figure 79). If this magnitude of the difference is one or more, an errored TC block is detected (nN_B).

NOTE 1:   The EM data and the IEC read in the current frame both apply to the previous frame.

Table 56: IEC code interpretation

NR[1]	NR[2]	NR[3]	NR[4]	IEC code interpretation
0	0	0	0	0 errors
0	0	0	1	1 error
0	0	1	0	2 errors
0	0	1	1	3 errors
0	1	0	0	4 errors
0	1	0	1	5 errors
0	1	1	0	6 errors
0	1	1	1	7 errors
1	0	0	0	8 errors
1	0	0	1	0 errors
1	0	1	0	0 errors
1	0	1	1	0 errors
1	1	0	0	0 errors
1	1	0	1	0 errors
1	1	1	0	0 errors
1	1	1	1	0 errors

Figure 79: P31sD and P31s BIP-8 computing and comparison

NR[1-4]: The function shall extract the Incoming Error Code (IEC). It shall accept the received code without further processing.

NR[7-8][9-72]: The Received Trail Trace Identifier RxTI shall be recovered from the tandem connection trail trace identifier overhead and shall be made available as AcTI for network management purposes. The application and acceptance process shall be performed as specified in ETS 300 417-1-1 [8], subclauses 7.1, and 8.2.1.3. The mismatch detection process shall be as specified below.

The trace identifier process in this function is required to support "mode 1" (ETS 300 417-1-1 [8], subclause 7.1) operation only. "Old" tandem connection equipment does not exist.

NR[1-4]: The function shall extract the Incoming AIS code.

NR[5], NR[8][73]: The information carried in the REI, RDI bits in byte NR shall be extracted to enable single ended maintenance of a bi-directional tandem connection Trail. The REI (nF_B) shall be used to monitor the error performance of the other direction of transmission, and the RDI shall be used to provide information as to the status of the remote receiver. A "1" indicates a Remote Defect Indication state, while a "0" indicates the normal, working state. The application process shall be performed as specified in ETS 300 417-1-1 [8], subclauses 7.4.2 (REI), 7.4.11 and 8.2 (RDI).

NR[6], NR[7][74]: The information carried in the OEI, ODI bits in byte NR shall be extracted to enable single ended (intermediate) maintenance of a the P31s egressing the tandem connection Trail. The OEI (nOF_B) shall be used to monitor the error performance of the other direction of transmission, and the ODI shall be used to provide information as to the status of the remote receiver. A "1" indicates a Outgoing Defect Indication state, while a "0" indicates the normal, working state. The application process shall be performed equivalent to the remote maintenance case, as specified in ETS 300 417-1-1 [8], subclauses 7.4.2 (REI/OEI), 7.4.11 and 8.2 (RDI/ODI).

NR[7-8] - *Multiframe alignment:* The function shall perform a multiframe alignment on bits 7 and 8 of byte NR to recover the TTI, RDI, and ODI signals transported within the multiframed bits. The multiframe alignment shall be found by searching for the pattern "1111 1111 1111 1110" within the bits 7 and 8 of byte NR. The signal shall be continuously checked with the presumed multiframe start position for the alignment.

Frame alignment is deemed to have been lost (entering Out Of Multiframe (OOM) state) when two consecutive FAS are detected in error (i.e. ≥ 1 error in each FAS);

Frame alignment is deemed to have been recovered (entering In Multiframe (IM) state) when one non-errored FAS is found.

NR: The function shall terminate NR channel by inserting an all-ZEROs pattern.

EM: The function shall compensate the P31s BIP8 in byte EM according the algorithm defined in P31sD_TT_So.

Defects:

TC Unequipped (dUNEQ):
The function shall detect for an unequipped Tandem Connection (UNEQ) condition by monitoring byte NR for code "00000000". The algorithm shall be according subclause 8.2.1.2 in ETS 300 417-1-1 [8], in which "accepted TSL" shall be read as "accepted NR byte".

TC Loss of Tandem Connection (dLTC):
The function shall detect for the presence/absence of the tandem connection overhead in the byte NR by evaluating the multiframe alignment signal in bits 7 and 8 of byte NR. The loss of tandem connection defect (dLTC) shall be detected if the multiframe alignment process is in the OOM state. The dLTC shall be cleared if the multiframe alignment process is in the IM state.

TC Connectivity (Trace Identifier) (dTIM):
The function shall detect for a TC mis-connection condition by monitoring the TC trace identifier. The Trace Identifier Mismatch defect (dTIM) shall be detected and cleared within a maximum period of 1 s in the absence of bit errors.

The defect detection process and its operation during the presence of bit errors is for further study.

The defect shall be suppressed during the receipt of SSF.

It shall be possible to disable the trace identifier mismatch defect detection (TIMdis).

TC Signal Degrade (dDEG):
The function shall detect for a TC signal degrade defect condition by monitoring for TC BIP-8 violations. The algorithm shall be according subclause 8.2.1.4 in ETS 300 417-1-1 [8].

TC Remote Defect (dRDI):
The function shall detect for a TC remote defect indication defect condition by monitoring the TC RDI signal. The algorithm shall be according subclause 8.2.1.5 in ETS 300 417-1-1 [8].

TC Remote Outgoing P31s Defect (dODI):
The function shall detect for a TC remote outgoing P31s defect indication defect condition by monitoring the TC ODI signal. The algorithm shall be according subclause 8.2.1.5 in ETS 300 417-1-1 [8].

Incoming AIS (dIncAIS):
The function shall detect for a tandem connection incoming AIS condition by monitoring the IEC bits in byte NR for code "1110". If 5 consecutive frames contain the "1110" pattern in the IEC bits a dIncAIS defect shall be detected. dIncAIS shall be cleared if in 5 consecutive frames any pattern other than the "1110" is detected in the IEC bits.

> NOTE 2: Bits 1 to 4 of byte NR support two applications: conveying the incoming error information (table 56) and conveying the incoming AIS information to the TC tail end. Codes 0000 to 1101, 1111 represent IncAIS is false, code 1110 represents IncAIS is true.

Consequent Actions:

The function shall perform the following consequent actions (refer to subclause 8.2.2 in ETS 300 417-1-1 [8]):

aAIS   ←   dUNEQ or dTIM or dLTC

aTSF   ←   CI_SSF or dUNEQ or dTIM or dLTC

aTSD   ←   dDEG

aRDI   ←   CI_SSF or dUNEQ or dTIM or dLTC

aREI   ←   nN_B

aODI   ←   CI_SSF or dUNEQ or dTIM or dIncAIS or dLTC

aOEI   ←   nON_B

aOSF   ←   CI_SSF or dUNEQ or dTIM or dLTC or dIncAIS

The function shall insert the all-ONEs (AIS) signal within 250 µs after AIS request generation (aAIS), and cease the insertion within 250 µs after the AIS request has cleared.

Defect Correlations:

The function shall perform the following defect correlations (refer to subclause 8.2.3 in ETS 300 417-1-1 [8]):

cUNEQ ←   MON and dUNEQ

cLTC   ←   MON and (not dUNEQ) and dLTC

cTIM   ←   MON and (not dUNEQ) and (not dLTC) and dTIM

cDEG   ←   MON and (not dTIM) and (not dLTC) and dDEG

cSSF   ←   MON and CI_SSF and SSF_reported

cRDI   ←   MON and (not dUNEQ) and (not dTIM) and (not dLTC) and dRDI and RDI_Reported

cODI   ←   MON and (not dUNEQ) and (not dTIM) and (not dLTC) and dODI and ODI_Reported

It shall be an option to report SSF as a fault cause. This is controlled by means of the parameter SSF_Reported. The default shall be SSF_Reported = false.

It shall be an option to report RDI as a fault cause. This is controlled by means of the parameter RDI_Reported. The default shall be RDI_Reported = false.

It shall be an option to report ODI as a fault cause. This is controlled by means of the parameter ODI_Reported. The default shall be ODI_Reported = false.

Performance Monitoring:

The following TC error performance parameters shall be counted for each 1-second period (refer to subclauses 8.2.4 to 8.2.7 in ETS 300 417-1-1 [8]):

$pN\_DS \leftarrow aTSF$ or dEQ

$pF\_DS \leftarrow dRDI$

$pN\_EBC \leftarrow \Sigma nN\_B$

$pF\_EBC \leftarrow \Sigma nF\_B$

$pON\_DS \leftarrow aODI$ or dEQ

$pOF\_DS \leftarrow dODI$

$pON\_EBC \leftarrow \Sigma nON\_B$

$pOF\_EBC \leftarrow \Sigma nOF\_B$

pN_EBC and pN_DS do not represent the actual performance monitoring support within an equipment. For that, these pN_DS/pN_EBC signals shall be connected to performance monitoring functions within the element management function. Similar for the far-end signals pF_EBC and pF_DS and for pON_EBC/pON_DS, pOF_EBC/pOF_DS.

8.6.3 **P31s tandem connection to p31s adaptation source function (P31sD/P31s_A_So)**

Symbol:

P31s_CI

P31sD/P31s ← P31s_TI
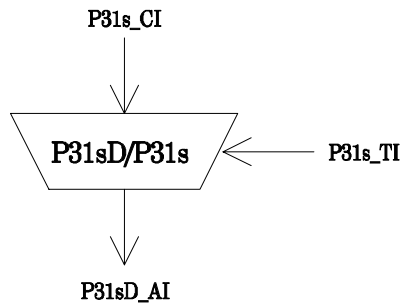
P31sD_AI

Figure 80: P31sD/P31s_A_So symbol

Interfaces:

Table 57: P31sD/P31s_A_So input and output signals

Input(s)	Output(s)
P31s_CI_D	P31sD_AI_D
P31s_CI_CK	P31sD_AI_CK
P31s_CI_FS	P31sD_AI_FS
P31s_CI_SSF	P31sD_AI_SF
P31s_TI_CK	

Processes:

NOTE 1:   The function has no means to verify the existence of a tandem connection within the incoming signal. Nested tandem connections are not supported.

The function shall replace the incoming P31s signal (P31s_CI) by a local generated P31s frame with valid FA1 and FA2 bytes and all ONEs for all other bytes (i.e. enter "holdover") if an all-ONEs (AIS) P31s is received (i.e. if CI_SSF is TRUE).

NOTE 2:   The local frame start is generated with the P31s_TI timing.

Defects: None.

Consequent Actions:

AI_SF← CI_SSF

Defect Correlations: None.

Performance Monitoring: None.

8.6.4   P31s tandem connection to p31s adaptation sink function (P31sD/P31s_A_Sk)

Symbol:

P31s_CI
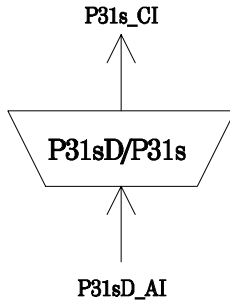
P31sD/P31s

P31sD_AI

Figure 81: P31sD/P31s_A_Sk symbol

Interfaces:

Table 58: P31sD/P31s_A_Sk input and output signals

Input(s)	Output(s)
P31sD_AI_D	P31s_CI_D
P31sD_AI_CK	P31s_CI_CK
P31sD_AI_FS	P31s_CI_FS
P31sD_AI_OSF	P31s_CI_SSF

Processes:

The function shall restore the invalid frame start condition (i.e. output aSSF = true) if that existed at the ingress of the tandem connection.

> NOTE: In addition, the invalid frame start condition is activated on a tandem connection connectivity defect condition that causes all-ONEs (AIS) insertion in the P31sD_TT_Sk.

Defects: None.

Consequent Actions:

aAIS ←   AI_OSF

aSSF ←   AI_OSF

The function shall insert the all-ONEs (AIS) signal within 250 μs after AIS request generation (aAIS), and cease the insertion within 250 μs after the AIS request has cleared.

Defect Correlations: None.

Performance Monitoring: None.

8.6.5   P31s tandem connection non-intrusive trail termination sink function (P31sDm_TT_Sk)

Symbol:
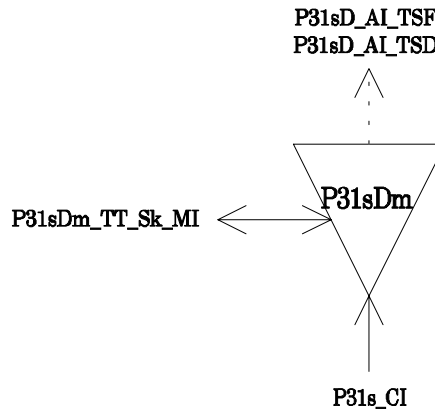
Figure 82: P31sDm_TT_Sk symbol

Interfaces:

Table 59: P31sDm_TT_Sk input and output signals

Input(s)	Output(s)
P31s_CI_D	P31sD_AI_TSF
P31s_CI_CK	P31sD_AI_TSD
P31s_CI_FS	P31sDm_TT_Sk_MI_cLTC
P31s_CI_SSF	P31sDm_TT_Sk_MI_cTIM
P31sDm_TT_Sk_MI_ExTI	P31sDm_TT_Sk_MI_cUNEQ
P31sDm_TT_Sk_MI_SSF_Reported	P31sDm_TT_Sk_MI_cDEG
P31sDm_TT_Sk_MI_RDI_Reported	P31sDm_TT_Sk_MI_cRDI
P31sDm_TT_Sk_MI_ODI_Reported	P31sDm_TT_Sk_MI_cSSF
P31sDm_TT_Sk_MI_TIMdis	P31sDm_TT_Sk_MI_cODI
P31sDm_TT_Sk_MI_DEGM	P31sDm_TT_Sk_MI_AcTI
P31sDm_TT_Sk_MI_DEGTHR	P31sDm_TT_Sk_MI_pN_EBC
P31sDm_TT_Sk_MI_1second	P31sDm_TT_Sk_MI_pF_EBC
	P31sDm_TT_Sk_MI_pN_DS
	P31sDm_TT_Sk_MI_pF_DS
	P31sDm_TT_Sk_MI_pOF_EBC
	P31sDm_TT_Sk_MI_pOF_DS

Processes:

This function can be used to perform the following:

1)   single ended maintenance of the TC by monitoring at an intermediate node, using remote information (RDI,REI);
2)   aid in fault localization within TC trail by monitoring near-end defects;
3)   monitoring of P31s performance at TC egressing point (except for connectivity defects before the TC) using remote outgoing information (ODI,OEI).

TC EDC violations: Even bit parity shall be computed for each bit n of every byte of the preceding P31s and compared with bit n of EM recovered from the current frame (n=1 to 8 inclusive). A difference between the computed and recovered EM values shall be taken as evidence of one or more errors in the computation block (nON_B). The magnitude (absolute value) of the difference between this calculated number of errors and the number of errors written into the IEC (see table 56) at the trail termination source shall be used to determine the error performance of the tandem connection for each transmitted P31s (figure 79). If this magnitude of the difference is one or more, an errored TC block is detected (nN_B). Refer to P31sD_TT_Sk.

NR[1-4]: The function shall extract the Incoming Error Code (IEC). It shall accept the received code without further processing.

NR[7-8][9-72]: The Received Trail Trace Identifier RxTI shall be recovered from the tandem connection trail trace identifier overhead and shall be made available as AcTI for network management purposes. The application and acceptance process shall be performed as specified in ETS 300 417-1-1 [8], subclauses 7.1, and 8.2.1.3. The mismatch detection process shall be as specified below.

The trace identifier process in this function is required to support "mode 1" (ETS 300 417-1-1 [8], subclause 7.1) operation only. "Old" tandem connection equipment does not exist.

NR[1-4]: The function shall extract the Incoming AIS code.

NR[5], NR[8][73]: The information carried in the REI, RDI bits in byte NR shall be extracted to enable single ended maintenance of a bi-directional tandem connection Trail. The REI (nF_B) shall be used to monitor the error performance of the other direction of transmission, and the RDI shall be used to provide information as to the status of the remote receiver. A "1" indicates a Remote Defect Indication state, while a "0" indicates the normal, working state. The application process shall be performed as specified in ETS 300 417-1-1 [8], subclauses 7.4.2 (REI), 7.4.11 and 8.2 (RDI).

NR[6], NR[7][74]: The information carried in the OEI, ODI bits in byte NR shall be extracted to enable single ended (intermediate) maintenance of a the P31s egressing the tandem connection Trail. The OEI (nOF_B) shall be used to monitor the error performance of the other direction of transmission, and the ODI shall be used to provide information as to the status of the remote receiver. A "1" indicates a Outgoing Defect Indication state, while a "0" indicates the normal, working state. The application process shall be performed equivalent to the remote maintenance case, as specified in ETS 300 417-1-1 [8], subclauses 7.4.2 (REI/OEI), 7.4.11 and 8.2 (RDI/ODI).

NR[7-8] - *Multiframe alignment:* The function shall perform a multiframe alignment on bits 7 and 8 of byte NR to recover the TTI, RDI, and ODI signals transported within the multiframed bits. The multiframe alignment shall be found by searching for the pattern "1111 1111 1111 1110" within the bits 7 and 8 of byte NR. The signal shall be continuously checked with the presumed multiframe start position for the alignment.

Frame alignment is deemed to have been lost (entering Out Of Multiframe (OOM) state) when two consecutive FAS are detected in error (i.e. $\geq$ 1 error in each FAS);

Frame alignment is deemed to have been recovered (entering In Multiframe (IM) state) when one non-errored FAS is found.

Defects:

TC Unequipped (dUNEQ):
The function shall detect for an unequipped Tandem Connection (UNEQ) condition by monitoring byte NR for code "00000000". The algorithm shall be according subclause 8.2.1.2 in ETS 300 417-1-1 [8], in which "accepted TSL" shall be read as "accepted NR byte".

TC Loss of Tandem Connection (dLTC):
The function shall detect for the presence/absence of the tandem connection overhead in the byte NR by evaluating the multiframe alignment signal in bits 7 and 8 of byte NR. The loss of tandem connection defect (dLTC) shall be detected if the multiframe alignment process is in the OOM state. The dLTC shall be cleared if the multiframe alignment process is in the IM state.

TC Connectivity (Trace Identifier) (dTIM):
The function shall detect for a TC mis-connection condition by monitoring the TC trace identifier. The Trace Identifier Mismatch defect (dTIM) shall be detected and cleared within a maximum period of 1 s in the absence of bit errors.

The defect detection process and its operation during the presence of bit errors is for further study.

The defect shall be suppressed during the receipt of SSF.

It shall be possible to disable the trace identifier mismatch defect detection (TIMdis).

TC Signal Degrade (dDEG):
The function shall detect for a TC signal degrade defect condition by monitoring for TC BIP-8 violations. The algorithm shall be according subclause 8.2.1.4 in ETS 300 417-1-1 [8].

TC Remote Defect (dRDI):
The function shall detect for a TC remote defect indication defect condition by monitoring the TC RDI signal. The algorithm shall be according subclause 8.2.1.5 in ETS 300 417-1-1 [8].

TC Remote Outgoing P31s Defect (dODI):
The function shall detect for a TC remote outgoing P31s defect indication defect condition by monitoring the TC ODI signal. The algorithm shall be according subclause 8.2.1.5 in ETS 300 417-1-1 [8].

Consequent Actions:

aTSF ← CI_SSF or dUNEQ or dTIM or dLTC

aTSD ← dDEG

Defect Correlations:

The function shall perform the following defect correlations (refer to subclause 8.2.3 in ETS 300 417-1-1 [8]):

cUNEQ ← MON and dUNEQ

cLTC ← MON and (not dUNEQ) and dLTC

cTIM ← MON and (not dUNEQ) and (not dLTC) and dTIM

cDEG ← MON and (not dTIM) and (not dLTC) and dDEG

cSSF ← MON and CI_SSF and SSF_reported

cRDI ← MON and (not dUNEQ) and (not dTIM) and (not dLTC) and dRDI and RDI_reported

cODI ← MON and (not dUNEQ) and (not dTIM) and (not dLTC) and dODI and ODI_Reported

It shall be an option to report SSF as a fault cause. This is controlled by means of the parameter SSF_Reported. The default shall be SSF_Reported = false.

It shall be an option to report RDI as a fault cause. This is controlled by means of the parameter RDI_Reported. The default shall be RDI_Reported = false.

It shall be an option to report ODI as a fault cause. This is controlled by means of the parameter ODI_Reported. The default shall be ODI_Reported = false.

Performance Monitoring:

The following TC error performance parameters shall be counted for each 1-second period (refer to subclauses 8.2.4 to 8.2.7 in ETS 300 417-1-1 [8]):

pN_DS ← aTSF or dEQ

pF_DS ← dRDI

pN_EBC ← ΣnN_B

pF_EBC ← ΣnF_B

pOF_DS ← dODI

pOF_EBC ← ΣnOF_B

9 P4s path layer functions

Figure 83: P4s path layer atomic functions

P4s layer CP

The Characteristic Information CI at this point is octet structured with an 125 µs frame (figure 84). Its format is characterized as P4s_AI plus the P4s trail termination overhead in the TR, EM, and MA locations as defined in ETS 300 337 [9]. For the case the signal has passed the tandem connection sublayer, P4s_CI has defined P4s tandem connection trail termination overhead in location NR.

> NOTE 1: NR will be undefined when the signal P4s_CI has not been processed in a tandem connection adaptation and trail termination function. NR definition is under study by ETSI TM3.

> NOTE 2: An unequipped P4s signal is for further study.

P4s layer AP

The Adaptation Information AI at this point is octet structured with an 125 µs frame (figure 84). It represents adapted client layer information comprising 2 160 bytes of client layer information, the signal label bits in byte MA, the multiframe indicator in byte MA, the timing marker bit in byte MA, and a 64 kbit/s general communication channel in byte GC. For the case the signal has passed the trail protection sublayer, P4s_AI has defined APS in bytes P1P2.

> NOTE 3: Bytes P1P2 will be undefined when the signal P4s_AI has not been processed in a trail protection connection function P4sP_C.

> NOTE 4: The structure of bytes P1P2 is not yet defined.

> NOTE 5: GC will be undefined when no GC byte adaptation source function is connected to the AP.

> NOTE 6: Bits 6,7 of byte MA will be undefined when the P31s transports an ATM signal.

The composition of the payload transported by an P4s will be determined by the client layer application. Typical compositions of the payload include:

- a TUG3 structured signal;
- a TUG2 structured signal;
- an ATM 138 240 kbit/s cell stream signal.
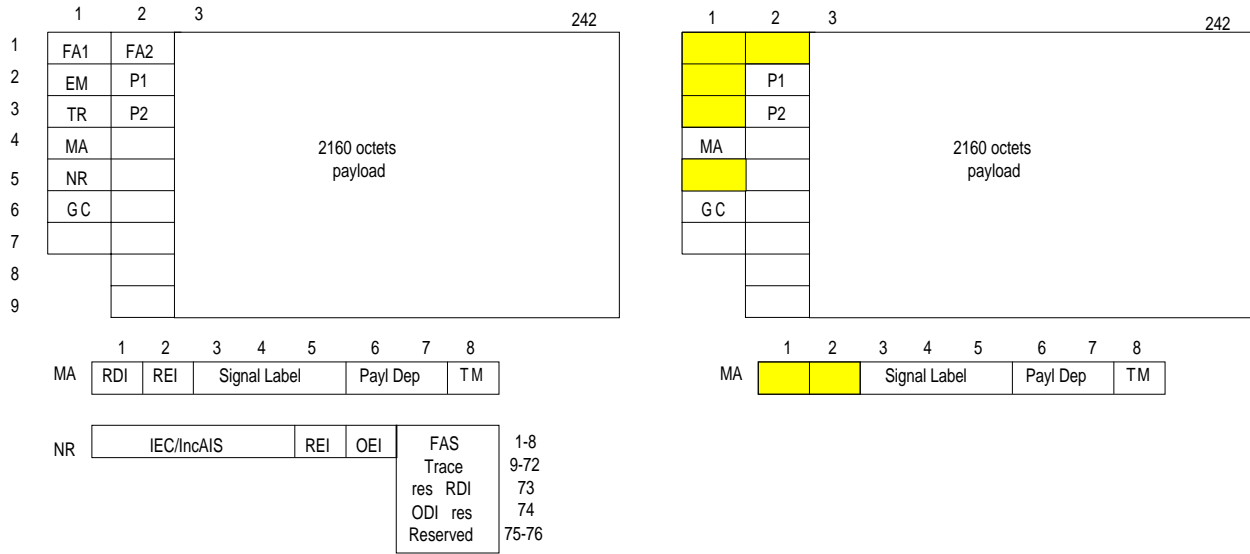
Figure 84: P4s_CI_D (left) and P4s_AI_D (right)

9.1 P4s connection functions

For further study.

9.2 P4s trail termination functions

9.2.1 P4s trail termination source P4s_TT_So

Symbol:
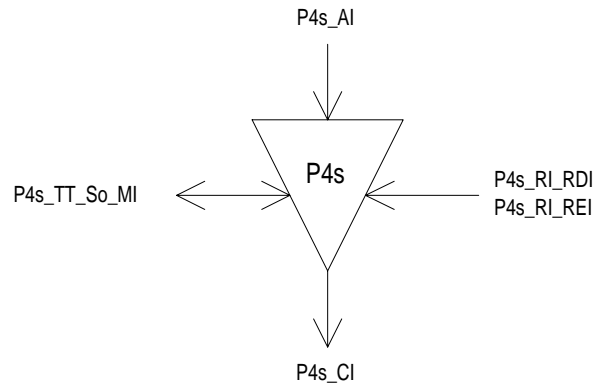
Figure 85: P4s_TT_So symbol

Interfaces:

Table 60: P4s_TT_So input and output signals

Input(s)	Output(s)
P4s_AI_D	P4s_CI_D
P4s_AI_CK	P4s_CI_CK
P4s_AI_FS	P4s_CI_FS
P4s_RI_RDI	
P4s_RI_REI	
P4s_TT_So_MI_TxTI	

Processes:

This function adds error monitoring, status overhead bytes, trace identifier and the frame alignment signal to the P4s_AI presented at its input, to form the P31s layer Characteristic Information. The processing of the trail termination overhead bytes is defined as follows:

TR: In this byte the function shall insert the Transmitted Trail Trace Identifier TxTI. Its format is described in ETS 300 417-1-1 [8], subclause 7.1.

MA[1]: Bit 1, a RDI indication, shall be set to "1" on activation of the RI_RDI within 250μs, determined by the associated P4s_TT_Sk function, and set to "0" within 250 μs on clearing of RI_RDI.

MA[2]: Bit 2, a REI (Remote Error Indication) indication, shall be set to "1" on declaration of RI_REI - determined by the associated P4s_TT_Sk function if one or more errors were detected by the BIP-8 process - and shall be otherwise set to zero.

EM: In this byte the function shall insert the BIP-8 EDC with even bit parity. Each bit n of current EM is computed to provide even parity over the nth bit of every byte in the previous frame of the Characteristic Information P4s_CI, i.e. EM is calculated over the entire previous P4s signal. Further reference is provided in ETS 300 417-1-1 [8], subclause 7.3 and ETS 300 337 [9].

FA1FA2 - *Frame Alignment Signal (FAS):* The function shall insert the 139 264 kbit/s 125 μs frame alignment signal FA1FA2 into the frame overhead as defined in ETS 300 337 [9] and depicted in figure 84.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

9.2.2 P4s trail termination sink P4s_TT_Sk

Symbol:
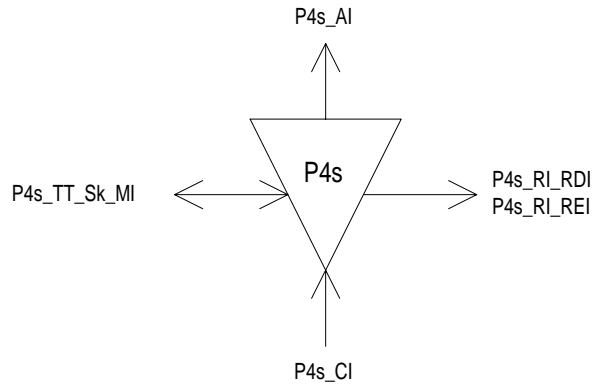
Figure 86: P4s_TT_Sk symbol

Interfaces:

Table 61: P4s_TT_Sk input and output signals

Input(s)	Output(s)
P4s_CI_D	P4s_AI_D
P4s_CI_CK	P4s_AI_CK
P4s_CI_FS	P4s_AI_FS
P4s_CI_SSF	P4s_AI_TSF
P4s_TT_Sk_MI_ExTI	P4s_AI_TSD
P4s_TT_Sk_MI_TPmode	P4s_RI_RDI
P4s_TT_Sk_MI_DEGTHR	P4s_RI_REI
P4s_TT_Sk_MI_DEGM	P4s_TT_Sk_MI_cUNEQ
P4s_TT_Sk_MI_1second	P4s_TT_Sk_MI_cTIM
P4s_TT_Sk_MI_SSF_Reported	P4s_TT_Sk_MI_cDEG
P4s_TT_Sk_MI_RDI_Reported	P4s_TT_Sk_MI_cRDI
P4s_TT_Sk_MI_TIMdis	P4s_TT_Sk_MI_cSSF
	P4s_TT_Sk_MI_pN_DS
	P4s_TT_Sk_MI_pF_DS
	P4s_TT_Sk_MI_pN_EBC
	P4s_TT_Sk_MI_pF_EBC
	P4s_TT_Sk_MI_AcTI

Processes:

This function monitors for 140 Mbit/s frame errors and recovers the trail termination status as defined in ETS 300 337 [9]. It extracts the payload independent overhead bytes EM, TR, MA bits 1, 2 from the P4s layer Characteristic information:

EM: Even bit parity (BIP-8) shall be computed for each bit n of every byte of the preceding frame and compared with bit n of EM recovered from the current frame (n=1 to 8 inclusive). A difference between the computed and recovered EM values shall be taken as evidence of one or more errors (nN_B) in the computation block.

TR: The 16 byte Trail Trace Identifier (TTI) is recovered from the TR byte and is made available for network management purposes. The application and the acceptance and mismatch detection process shall be performed as described in the ETS 300 417-1-1 [8], subclauses 7.1, and 8.2.1.3.

MA[1-2]: The relevant information carried in the MA byte (RDI in bit 1, REI in bit 2) shall be extracted to enable single ended maintenance of a bi-directional Trail. The REI (nF_B) shall be used to monitor the error performance of the reverse direction of transmission; the RDI provides information as to the status of

the remote receiver. A "1" indicates a RDI state, while a "0" indicates the normal working state. The application process shall be performed as specified in ETS 300 417-1-1 [8], subclauses 7.4. and 8.2.1.

MA[3-5]: The information in the signal label bits shall be extracted to allow unequipped P4s defect detection.

Defects:

The detection and removal conditions and processes for dUNEQ, dDEG, dRDI and dTIM are described in ETS 300 417-1-1 [8], subclause 8.2.1.

Consequent Actions:

aAIS   ←   dUNEQ or dTIM

aRDI   ←   CI_SSF or dUNEQ or dTIM

aTSF   ←   CI_SSF or dUNEQ or dTIM

aTSD   ←   dDEG

On declaration of an aAIS the function shall output an all ONEs signal within 250 μs; on clearing of aAIS the function shall output normal data within 250 μs.

Defect Correlations:

cUNEQ   ←   MON and dUNEQ

cTIM   ←   MON and dTIM (and not dUNEQ)

cDEG   ←   MON and dDEG and (not dUNEQ) and (not dTIM)

cRDI   ←   MON and dRDI and (not dTIM) and (not dUNEQ) and RDI_Reported

cSSF   ←   MON and CI_SSF and SSF_Reported

It shall be an option to report SSF as a fault cause. This is controlled by means of the parameter SSF_Reported. The default shall be SSF_Reported = false.

It shall be an option to report RDI as a fault cause. This is controlled by means of the parameter RDI_Reported. The default shall be RDI_Reported = false.

Performance Monitoring:

The performance monitoring process shall be performed as specified in ETS 300 417-1-1 [8], subclause 8.2.4 through 8.2.7.

pN_DS   ←   aTSF or dEQ

pF_DS   ←   dRDI

pN_EBC   ←   ΣnN_B

pF_EBC   ←   ΣnF_B

9.3 P4s adaptation functions

9.3.1 P4s layer to VC-3, VC-2, VC-12, and VC-11 layer compound adaptation source function P4s/SX-TUG3_A_So

Symbol:
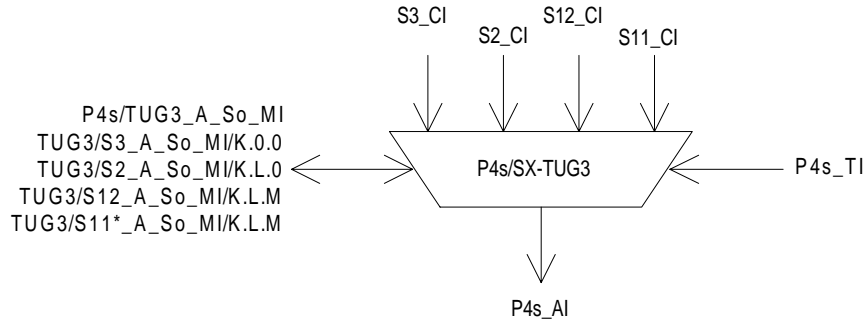
Figure 87: P4s/SX-TUG3_A_So symbol

Interfaces:

Table 62: P4s/SX-TUG3_A_So input and output signals

Input(s)	Output(s)
P4s/TUG3_A_So_MI P4s_TI maximum 2 inputs: S3_CI TUG3/S3_A_So_MI/K.0.0 maximum 19 inputs: S2_CI TUG3/S2_A_So_MI/K.L.0 maximum 57 inputs: S12_CI TUG3/S12_A_So_MI/K.L.M maximum 57 inputs: S11_CI TUG3/S11*_A_So_MI/K.L.M	P4s_AI

Processes:

The P4s/SX-TUG3_A_So compound function provides adaptation from the VC-3/2/12/11 layers to the P4s layer. This process is performed by a combination of several atomic functions as shown in figure 88. The P4s/TUG3_A_So function performs the P4s layer specific signal label and multiframe processing, while the TUG3/S3_A_So, TUG3/S2_A_So, TUG3/S12_A_So and TUG3/S11*_A_So functions perform the lower order VC specific frequency justification and bitrate adaptation. Each of these TUG3/Sm_A_So functions is characterized by the K.L.M parameters, which define the number of the TU within the P4s the function has access to (TU numbering scheme according to figure B-1). According to the TUG3 multiplex structures supported by the NE, a variety of possible combinations of these TUG3/Sm_A_So functions exists. Table 63 lists all possible TUG3/Sm_A_So functions within a P4s/SX-TUG3_A_So compound functions.
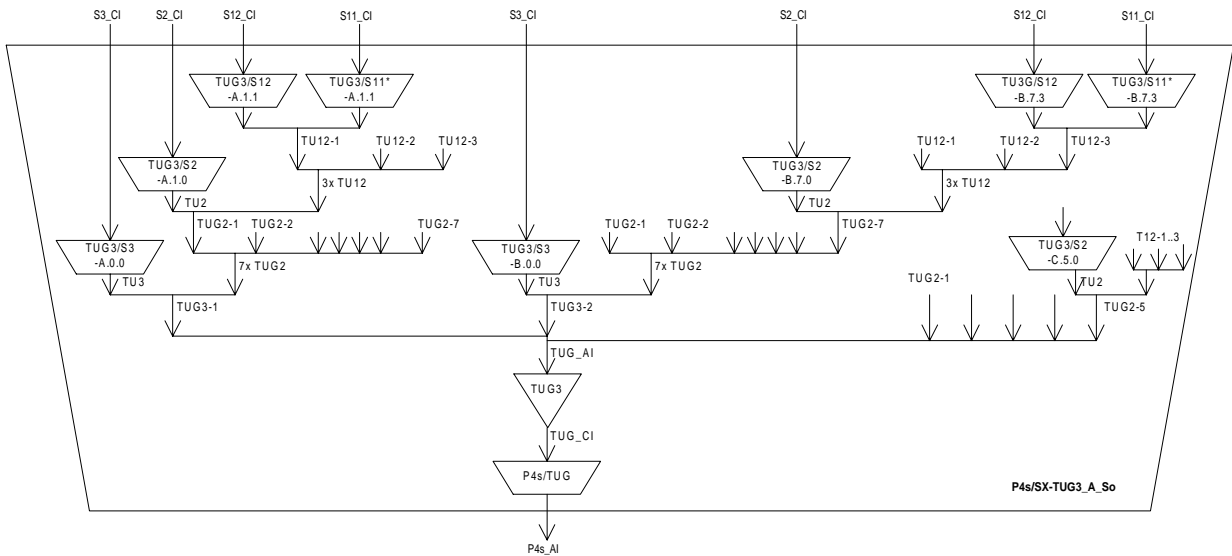
Figure 88: P4s/SX-TUG3_A_So compound function with set of TUG/Sm_A_So atomic functions

Table 63: Possible TUG3/Sm_A_So functions of a P4s/SX-TUG3_A_So compound function

Atomic function	TU-3/TUG-3 number K	TU-2/TUG-2 number L	TU-12 number M
TUG3/S3_A_Sk/K.0.0	A,B	0	0
TUG3/S2_A_Sk/K.L.0	A,B,C	1 to 7 (A,B) 1 to 5 (C)	0
TUG3/S12_A_Sk/K.L.M	A,B,C	1 to 7 (A,B) 1 to 5 (C)	1 to 3
TUG3/S11*_A_Sk/K.L.M	A,B,C	1 to 7 (A,B) 1 to 5 (C)	1 to 3

For specific implementations only a subset of these TUG3/Sm_A_So functions may be used (e.g. a terminal multiplexer with fixed 2 Mbit/s access has 57 TUG/S12_A_So functions). If a flexible TUG3 multiplex structure is supported, several TUG3/Sm_A_So functions may have access to the same TU timeslot. For such case, only one of these adaptation source functions is allowed to be activated. This is controlled by the equipment management function by activating/deactivating the functions according to the configured TUG3 multiplex structure.

NOTE 1: The P4s/TUG3_A_So, TUG3_T_So and TUG3/Sm_A_So (m = 3, 2, 12, 11*) defined in the following subclauses can only be used in a P4s/SX-TUG3_A_So compound function. These functions can not be used as stand alone functions.

NOTE 2: The TUG3 is a virtual sub-layer only applicable in a P4s/SX-TUG3_A compound function.

The number of TUG3/Sm_A (m=3,2,12,11*) functions that is active shall completely fill the P4s payload.

9.3.1.1 P4s layer to TUG3 adaptation source function P4s/TUG3_A_So

Symbol:
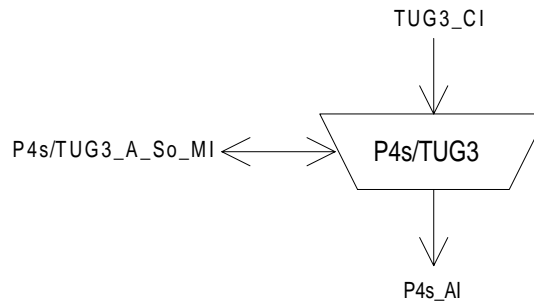
Figure 89: P4s/TUG3_A_So symbol

Interfaces:

Table 64: P4s/TUG3_A_So input and output signals

Input(s)	Output(s)
TUG3_CI_D	P4s_AI_D
TUG3_CI_CK	P4s_AI_CK
TUG3_CI_FS	P4s_AI_FS
TUG3_CI_MFS	
P4s/TUG3_A_So_MI_Active	
P4s/TUG3_A_So_MI_TU3_1	
P4s/TUG3_A_So_MI_TU3_2	

NOTE 1: The P4s/TUG3_A_So functions can only be used in a P4s/SX-TUG3_A_So compound function. It can not be used as a standalone function.

Processes:

The function adds two payload specific signals (bits MA[3-5] and MA[6-7]) to the P4s POH and fixed stuff (R0) bytes to the P4s payload (figure 91). The fixed stuff bytes R1 and R2 are added depending on the TUG3 multiplex structure.

NOTE 2: The fixed stuff bytes (R0, R1, R2) are undefined.

MA[3-5]: In this byte the function shall insert code "100" (SDH elements mapping II: $2 \times$ TUG-3 and $5 \times$ TUG-2 structure) as defined in ETS 300 337 [9].

MA[6-7]: The value of the multiframe indicator MA[6-7] shall be set as specified by ETS 300 337 [9], 500 µs TU multiframe sequence, and aligned with TUG3_CI_MFS.

					TU multiframe indicator		
1	2	3	4	5	6	7	8

Figure 90: TU multiframe indicator bits in byte MA
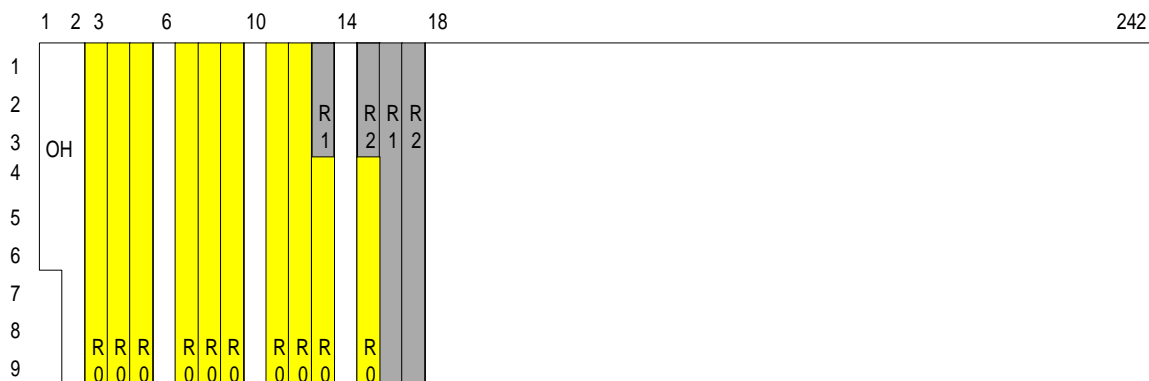
Figure 91: P4s payload (TUGs and fixed stuff "R" bytes)

Fixed Stuff bytes: The R0 bytes are always added. The R1 bytes are added if the TUG-3-A contains TUG-2s (MI_TU3_1 is false). The R2 bytes are added if the TUG-3-B contains TUG-2s (MI_TU3_2 is false).

Figure 83 shows that more than one adaptation source function exists in a P4s layer that can be connected to one P4s access point. For such case, only one of these adaptation source functions is allowed to be activated. Access to the access point by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

9.3.1.2   TUG3 trail termination source function TUG3_T_So

Symbol:
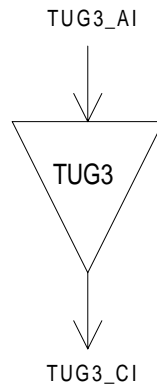
TUG3_AI

TUG3

TUG3_CI

Figure 92: TUG3_T_So symbol

Interfaces:

Table 65: TUG3_T_So input and output signals

Input(s)	Output(s)
TUG3_AI_D	TUG3_CI_D
TUG3_AI_CK	TUG3_CI_CK
TUG3_AI_FS	TUG3_CI_FS
TUG3_AI_MFS	TUG3_CI_MFS

NOTE: The TUG3_T_So functions can only be used in a P4s/SX-TUG3_A_So compound function. It can not be used as a standalone function.

Processes: None.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

9.3.1.3   TUG3 to VC-3 layer adaptation source function TUG3/S3_A_So/K.0.0

Symbol:
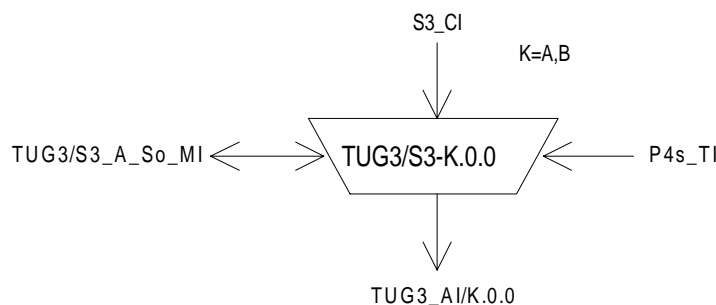
Figure 93: TUG3/S3_A_So symbol

Interfaces:

Table 66: TUG3/S3_A_So input and output signals

Input(s)	Output(s)
S3_CI_D	TUG3_AI_D
S3_CI_CK	TUG3_AI_CK
S3_CI_FS	TUG3_AI_FS
S3_CI_SSF	
P4s_TI_CK	
P4s_TI_FS	
TUG3/S3_A_So_MI_Active	

NOTE 1:   The TUG3/S3_A_So functions can only be used in a P4s/SX-TUG3_A_So compound
function. It can not be used as a standalone function.

	1			**13**	**15**	**16**			**19**	**- 21 - 24 - 27 - 29 - ......**	**240**		**242**
1				H1									
2				H2									
3				H3		H3+1							
4	MA												
5													
6													
7													
8													
9													

	indicates the 768 bytes belonging to the TU-3 (A0,0)

Figure 94: TUG3_AI_D/A.0.0 signal

Processes:

This function provides frequency justification and bitrate adaptation for a VC-3 signal, represented by a
nominally $(765 \times 64) = 48\ 960$ kbit/s information stream with a frequency accuracy within $\pm 4,6$ ppm and
the related frame phase, to be multiplexed into a P4s signal via a TU-3.

The frame phase of the VC-3 is coded in the related TU-3 pointer. Frequency justification, if required, is
performed by pointer adjustments. The accuracy of this coding process is specified below. Refer to annex
A of ETS 300 417-4-1 [10].

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (buffer) process. The data and frame start signals shall be written into the buffer under control of the associated input clock. The data and frame start signals shall be read out of the buffer under control of the P4s clock, frame position, and justification decision.

The justification decisions determine the phase error introduced by the TUG3/S3_A_So function. The amount of this phase error can be measured at the physical interfaces by monitoring the TU-3 pointer actions. An example is given in annex A.2 of ETS 300 417-4-1 [10].

Each justification decision results in a corresponding negative/positive justification action. Upon a positive justification action, the reading of 8 data bits shall be cancelled once and no data are written at the justification opportunity position H3+1. Upon a negative justification action, an extra 8 data bits shall be read out once into the justification opportunity position H3.

> NOTE 2: A requirement for maximum introduced phase error cannot be defined until a reference path is defined from which the requirements for network elements can be deduced. Such a requirement would also limit excessive phase error caused by pointer processors under fixed frequency offset conditions.

Buffer size: For further study.

The TU-3 pointer is carried in 2 bytes of payload specific OH in each container frame. The TU-3 pointer is aligned in the P4s payload in fixed position relative to the P4s frame. The TU-3 pointer points to the begin of the VC-3 frame within the P4s. The format of the TU-3 pointer and its location in the frame are defined in ETS 300 337 [9].

H1, H2 - *Pointer generation:* The function shall generate the TU-3 pointer as is described in ETS 300 417-1-1 [8], annex A: Pointer Generation. It shall insert the pointer in the appropriate H1, H2 positions with the SS field set to 10 to indicate TU-3.

TU-3 timeslot: The adaptation source function has access to a specific TU-3 of the TUG3 access point. The TU-3 is defined by the parameter K (K=A,B).

Figure 88 shows that more than one adaptation source function exists in the TUG3 virtual sub-layer that can be connected to one TUG3 access point. For such case, a subset of these adaptation source functions is allowed to be activated together, but only one adaptation source function may have access to a specific TU *timeslot*. Access to the same TU *timeslot* by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions:

aAIS ←   CI_SSF

On declaration of aAIS the function shall output an all-ONEs signal within 250 µs; on clearing of aAIS the function shall output normal data within 250 µs.

> NOTE 3: If CI_SSF is not connected (when connected to a S3_TT_So), CI_SSF is assumed to be false.

Performance Monitoring: None.

9.3.1.4   **TUG3 to VC-2 layer adaptation source function TUG3/S2_A_So/K.L.0**

Symbol:

```
                              S2_CI        K=A..C
                               │           L=1..7
                               │
                               ▼
                        ┌──────────────┐
TUG3/S2_A_So_MI  ◄────► │ TUG3/S2-K.L.0 │ ◄──── P4s_TI
                        └──────────────┘
                               │
                               ▼
                            TUG3_AI
```
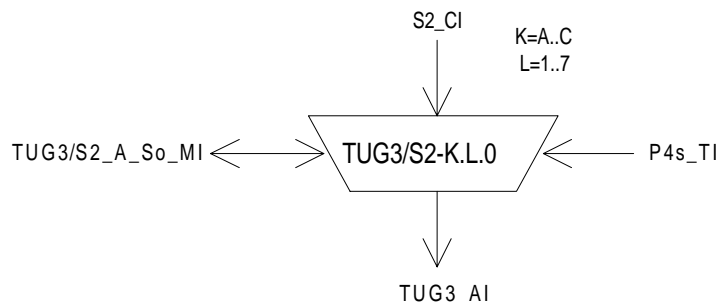
Figure 95: TUG3/S2_A_So symbol

Interfaces:

Table 67: TUG3/S2_A_So input and output signals

Input(s)	Output(s)
S2_CI_D	TUG3_AI _D
S2_CI_CK	TUG3_AI_CK
S2_CI_FS	TUG3_AI_FS
S2_CI_SSF	TUG3_AI_MFS
P4s_TI_CK	
P4s_TI_FS	
P4s_TI_MFS	
TUG3/S2_A_So_MI_Active	

NOTE 1:   The TUG3/S2_A_So functions can only be used in a P4s/SX-TUG3_A_So compound
            function. It can not be used as a standalone function.

Processes:

This function provides frequency justification and bitrate adaptation for a VC-2 signal, represented by a nominally $(428 \times 64/4) = 6\,848$ kbit/s information stream with a frequency accuracy within $\pm 4,6$ ppm and the related frame phase, to be multiplexed into a P4s signal via a TU-2.

The (500 µs) frame phase of the VC-2 is coded in the related TU-2 pointer. Frequency justification, if required, is performed by pointer adjustments. The accuracy of this coding process is specified below. Refer to annex A of ETS 300 417-4-1 [10].

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (buffer) process. The data and frame start signals shall be written into the buffer under control of the associated input clock. The data and frame start signals shall be read out of the buffer under control of the P4s clock, frame position, and justification decision.

The justification decisions determine the phase error introduced by the TUG3/S2_A_So function. The amount of this phase error can be measured at the physical interfaces by monitoring the TU-2 pointer actions. An example is given in annex A.2 of ETS 300 417-4-1 [10].

Each justification decision results in a corresponding negative/positive justification action. Upon a positive justification action, the reading of 8 data bits shall be cancelled once and no data are written at the justification opportunity position V3+1 (figure 96). Upon a negative justification action, an extra 8 data bits shall be read out once into the justification opportunity position V3.

NOTE 2: A requirement for maximum introduced phase error cannot be defined until a reference path is defined from which the requirements for network elements can be deduced. Such a requirement would also limit excessive phase error caused by pointer processors under fixed frequency offset conditions.

Buffer size: For further study.

	1	2									19	37	- 56 - 74 -	205		224	242
1											V1						
2																	
3																	
4	01*																
5																	
6																	
7																	
8																	
9																	
1											V2						
2																	
3																	
4	10*																
5																	
6																	
7																	
8																	
9																	
1											V3	V3+1					
2																	
3																	
4	11*																
5																	
6																	
7																	
8																	
9																	
1											V4						
2																	
3																	
4	00*																
5																	
6																	
7																	
8																	
9																	

	indicates the 432 bytes belonging to the TU-2 (A,1,0)
	01*, 10*, 11*, and 00* indicate code value in bits MA[6-7]

Figure 96: TUG_AI_D/A.1.0 signal

The TU-2 pointer is carried in bytes V1 and V2 of payload specific OH once per 500 µs multiframe (figure 96). The TU-2 pointer is aligned in the P4s payload in fixed positions relative to the P4s frame and multiframe. The format of the TU-2 pointer and its location in the frame/multiframe are defined in ETS 300 337 [9].

V1, V2 - *Pointer generation:* The function shall generate the TU-2 pointer as is described in ETS 300 417-1-1 [8], annex A: Pointer Generation. It shall insert the pointer in the appropriate V1, V2 positions with the SS field set to 00 to indicate TU-2.

> NOTE 3:   The byte V4 is undefined.

TU-2 timeslot: The adaptation source function has access to a specific TU-2 of the TUG3 access point. The TU-2 is defined by the parameters K and L (K=A,B, L=1 to 7 and K=C, L=1 to 5).

Figure 88 shows that more than one adaptation source function exists in the TUG3 virtual sub-layer that can be connected to one TUG3 access point. For such case, a subset of these adaptation source functions is allowed to be activated together, but only one adaptation source function may have access to a specific TU timeslot. Access to the same TU timeslot by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions:

aAIS ←   CI_SSF

On declaration of aAIS the function shall output an all ONEs signal within 1 ms; on clearing of aAIS the function shall output normal data within 1 ms.

> NOTE 4:   If CI_SSF is not connected (when connected to a S2_TT_So), CI_SSF is assumed to be false.

Defect Correlations: None.

Performance Monitoring: None.

9.3.1.5   TUG3 to VC-12 layer adaptation source function TUG3/S12_A_So/K.L.M

Symbol:

Figure 97: TUG3/S12_A_So symbol

Interfaces:

Table 68: TUG3/S12_A_So input and output signals

Input(s)	Output(s)
S12_CI_D	TUG3_AI_D
S12_CI_CK	TUG3_AI_CK
S12_CI_FS	TUG3_AI_FS
S12_CI_SSF	
P4s_TI_CK	
P4s_TI_FS	
P4s_TI_MFS	
TUG3/S12_A_So_MI_Active	

NOTE 1:   The TUG3/S12_A_So functions can only be used in a P4s/SX-TUG3_A_So compound function. It can not be used as a standalone function.

Processes:

This function provides frequency justification and bitrate adaptation for a VC-12 signal, represented by a nominally $(140 \times 64 / 4) = 2\ 240$ kbit/s information stream with a frequency accuracy within $\pm 4,6$ ppm and the related frame phase, to be multiplexed into a P4s signal via a TU-12.

The (500 µs) frame phase of the VC-12 is coded in the related TU-12 pointer. Frequency justification, if required, is performed by pointer adjustments. The accuracy of this coding process is specified below. Refer to annex A of ETS 300 417-4-1 [10].

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (buffer) process. The data and frame start signals shall be written into the buffer under control of the associated input clock. The data and frame start signals shall be read out of the buffer under control of the P4s clock, frame position, and justification decision.

The justification decisions determine the phase error introduced by the TUG/S12_A_So function. The amount of this phase error can be measured at the physical interfaces by monitoring the TU-12 pointer actions. An example is given in annex A.2 of ETS 300 417-4-1 [10].

Each justification decision results in a corresponding negative/positive justification action. Upon a positive justification action, the reading of 8 data bits shall be cancelled once and no data are written at the justification opportunity position V3+1 (figure 96). Upon a negative justification action, an extra 8 data bits shall be read out once into the justification opportunity position V3.

NOTE 2: A requirement for maximum introduced phase error cannot be defined until a reference path is defined from which the requirements for network elements can be deduced. Such a requirement would also limit excessive phase error caused by pointer processors under fixed frequency offset conditions.

Buffer size: For further study.

	1	2								21			77			133			189	242
1										V1										
2																				
3																				
4	01*																			
5																				
6																				
7																				
8																				
9																				
1										V2										
2																				
3																				
4	10*																			
5																				
6																				
7																				
8																				
9																				
1										V3			V3+1							
2																				
3																				
4	11*																			
5																				
6																				
7																				
8																				
9																				
1										V4										
2																				
3																				
4	00*																			
5																				
6																				
7																				
8																				
9																				

	indicates the 144 bytes belonging to the TU-12 (A,2,1)
01*, 10*, 11*, and 00* indicate code value in bits MA[6-7]	

Figure 98: TUG3_AI_D/A.2.1 signal

The TU-12 pointer is carried in bytes V1 and V2 of payload specific OH per 500 µs multiframe (figure 98). The TU-12 pointer is aligned in the P4s payload in fixed positions relative to the P4s frame and multiframe. The format of the TU-12 pointer and its location in the frame/multiframe are defined in ETS 300 337 [9].

V1, V2 - *Pointer generation:* The function shall generate the TU-12 pointer as is described in ETS 300 417-1-1 [8], annex A: Pointer Generation. It shall insert the pointer in the appropriate V1, V2 positions with the SS field set to 10 to indicate TU-12.

NOTE 3: The byte V4 is undefined.

TU-12 timeslot: The adaptation source function has access to a specific TU-12 of the TUG3 access point. The TU-12 is defined by the parameters K, L and M (K=A to C, L=1 to 7, M=1 to 3).

Figure 88 shows that more than one adaptation source function exists in the TUG3 layer that can be connected to one TUG access point. For such case, a subset of these adaptation source functions is

allowed to be activated together, but only one adaptation source function may have access to a specific TU timeslot. Access to the same TU timeslot by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions:

aAIS ←   CI_SSF

On declaration of aAIS the function shall output an all-ONEs signal within 1 ms; on clearing of aAIS the function shall output normal data within 1 ms.

> NOTE 4:   If CI_SSF is not connected (when connected to a S12_TT_So), CI_SSF is assumed to be false.

Defect Correlations: None.

Performance Monitoring: None.

9.3.1.6   TUG3 to VC-11 layer adaptation source function TUG3/S11*_A_So/K.L.M
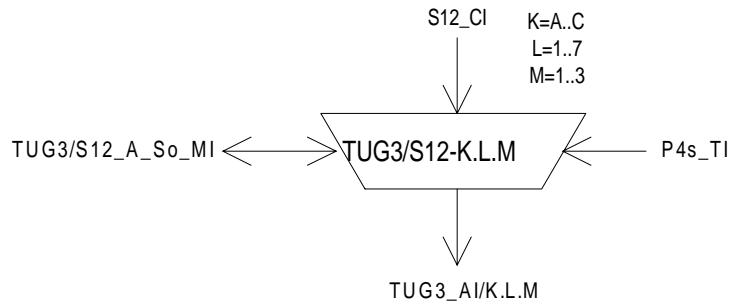
Symbol:

S11_CI   K=A..C
              L=1..7
              M=1..3

TUG3/S11*_A_So_MI ⟵⟶ TUG3/S11*-K.L.M ⟵ P4s_TI

TUG3_AI/K.L.M
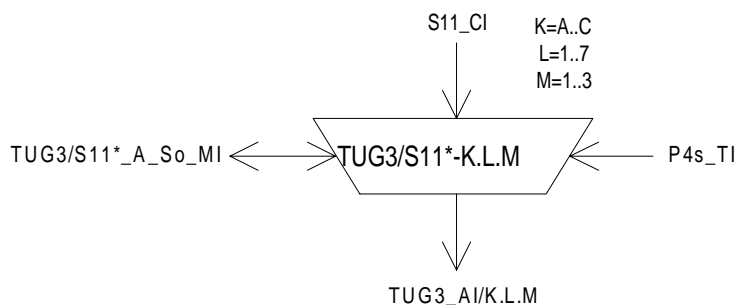
Figure 99: TUG3/S11*_A_So symbol

Interfaces:

Table 69: TUG3/S11*_A_So input and output signals

Input(s)	Output(s)
S11_CI_D	TUG3_AI_D
S11_CI_CK	TUG3_AI_CK
S11_CI_FS	TUG3_AI_FS
S11_CI_SSF	
P4s_TI_CK	
P4s_TI_FS	
P4s_TI_MFS	
TUG3/S11*_A_So_MI_Active	

NOTE 1:   The TUG3/S11*_A_So functions can only be used in a P4s/SX-TUG3_A_So compound function. It can not be used as a standalone function.

Processes:

This function provides frequency justification and bitrate adaptation for a VC-11 signal, represented by a nominally $(104 \times 64 / 4) = 1\ 664$ kbit/s information stream with a frequency accuracy within $\pm 4{,}6$ ppm and the related frame phase, to be multiplexed into a P4s signal. The VC-11 is transported within a TU-12; 9 bytes of fixed stuff (figure 100) are added per 125 µs to the VC-11 as specified by ETS 300 147 [1] to map the VC-11 into the TU-12 payload (see note 2).

NOTE 2:   Mapping a VC-11 into a TU-12 allows the VC-11 signal to be transported in a VC-12 based network (via S12_C and TUG/S12_A functions) and to non-intrusively monitor this VC-11 by means of a VC-12 non-intrusive monitor (S12m_TT_Sk). The TUG3/S11*_A function will be used at the junction of VC-11 and VC-12 networks.

The (500 µs) frame phase of the VC-11 is coded in the related TU-12 pointer. Frequency justification, if required, is performed by pointer adjustments. The accuracy of this coding process is specified below. Refer to annex A of ETS 300 417-4-1 [10].

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (buffer) process. The data and frame start signals shall be written into the buffer under control of the associated input clock. The data and frame start signals shall be read out of the buffer under control of the P4s clock, frame position, and justification decision.

The justification decisions determine the phase error introduced by the TUG3/S11*_A_So function. The amount of this phase error can be measured at the physical interfaces by monitoring the TU-12 pointer actions. An example is given in annex A.2 of ETS 300 417-4-1 [10].

Each justification decision results in a corresponding negative/positive justification action. Upon a positive justification action, the reading of 8 data bits shall be cancelled once and no data are written at the justification opportunity position V3+1 (figure 100). Upon a negative justification action, an extra 8 data bits shall be read out once into the justification opportunity position V3.

> NOTE 3: A requirement for maximum introduced phase error cannot be defined until a reference path is defined from which the requirements for network elements can be deduced. Such a requirement would also limit excessive phase error caused by pointer processors under fixed frequency offset conditions.

Buffer size: For further study.

	1	2	21	77	133	189	242
1			V1		R*		
2					R*		
3					R*		
4	01*				R*	V5	
5				R*			
6				R*			
7				R*			
8				R*			
9				R*			
1			V2		R*		
2					R*		
3					R*		
4	10*				R*	J2	
5				R*			
6				R*			
7				R*			
8				R*			
9				R*			
1			V3	V3+1	R*		
2					R*		
3					R*		
4	11*				R*	N2	
5				R*			
6				R*			
7				R*			
8				R*			
9				R*			
1			V4		R*		
2					R*		
3					R*		
4	00*				R*	K4	
5				R*			
6				R*			
7				R*			
8				R*			
9				R*			

indicates the 144 bytes belonging to the TU-12 (A,2,1)
01*, 10*, 11*, and 00* indicate code value in bits MA[6-7] R* indicates fixed stuff with even parity The positions of the V5, J2, N2, K4 and R* bytes is relative to the position of the VC-11 in the TU-12. The start of the VC-11 (V5 byte) is defined by the TU-12 pointer.

Figure 100: TUG3_AI_D/A.2.1 signal

The TU-12 pointer is carried in bytes V1 and V2 of payload specific OH per 500 µs multiframe (figure 100). The TU-12 pointer is aligned in the P4s payload in fixed positions relative to the P4s frame and multiframe. The format of the TU-12 pointer and its location in the frame/multiframe are defined in ETS 300 337 [9].

V1, V2 - *Pointer generation:* The function shall generate the TU-12 pointer as is described in ETS 300 417-1-1 [8], annex A: Pointer Generation. It shall insert the pointer in the appropriate V1, V2 positions with the SS field set to 10 to indicate TU-12.

NOTE 4: The byte V4 is undefined.

TU-12 timeslot: The adaptation source function has access to a specific TU-12 of the TUG access point. The TU-12 is defined by the parameters K, L and M (K=A to C, L=1 to 7, M=1 to 3).

Figure 88 shows that more than one adaptation source function exists in the TUG3 virtual sub-layer that can be connected to one TUG3 access point. For such case, a subset of these adaptation source functions is allowed to be activated together, but only one adaptation source function may have access to a specific TU timeslot. Access to the same TU timeslot by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions:

aAIS ←   CI_SSF

On declaration of aAIS the function shall output an all-ONEs signal within 1 ms; on clearing of aAIS the function shall output normal data within 1 ms.

Defect Correlations: None.

Performance Monitoring: None.

9.3.2 P4s layer to VC-3, VC-2, VC-12, and VC-11 layer compound adaptation sink function P4s/SX-TUG3_A_Sk

Symbol:
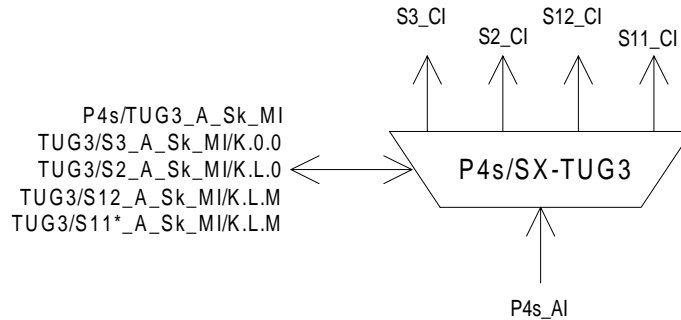
Figure 101: P4s/TUG3_A_Sk symbol

Interfaces:

Table 70: P4s/TUG3_A_Sk input and output signals

Input(s)	Output(s)
P4s_AI	P4s/TUG3_A_Sk_MI
P4s/TUG3_A_Sk_MI	
	maximum 2 outputs:
maximum 2 inputs:	S3_CI
TUG3/S3_A_Sk_MI/K.0.0	TUG3/S3_A_Sk_MI/K.0.0
maximum 19 inputs:	maximum 19 outputs:
TUG3/S2_A_Sk_MI/K.L.0	S2_CI
	TUG3/S2_A_Sk_MI/K.L.0
maximum 57 inputs:	
TUG3/S12_A_Sk_MI/K.L.M	maximum 57 outputs:
	S12_CI
maximum 57 inputs:	TUG3/S12_A_Sk_MI/K.L.M
TUG3/S11*_A_Sk_MI/K.L.M	
	maximum 57 outputs:
	S11_CI
	TUG3/S11*_A_Sk_MI/K.L.M

Processes:

The P4s/SX_A_Sk compound function provides adaptation from the P4s layer to the VC-3/2/12 layers. This process is performed by a combination of several atomic functions as shown in figure 102. The P4s/TUG3_A_Sk function performs the P4s layer specific signal label and multiframe processing, while the TUG3/S3_A_Sk, TUG3/S2_A_Sk, TUG3/S12_A_Sk and TUG3/S11*_A_Sk functions perform the lower order VC specific frequency justification and bitrate adaptation. Each of these TUG3/Sm_A_Sk functions is characterized by the K.L.M parameters, which define the number of the TU within the P4s the function has access to (TU numbering scheme according to figure B-1). According to the TUG3 multiplex structures supported by the NE, a variety of possible combinations of these TUG3/Sm_A_Sk functions exists. Table 71 lists all possible TUG3/Sm_A_Sk functions within a P4s/SX-TUG3_A_Sk compound functions.
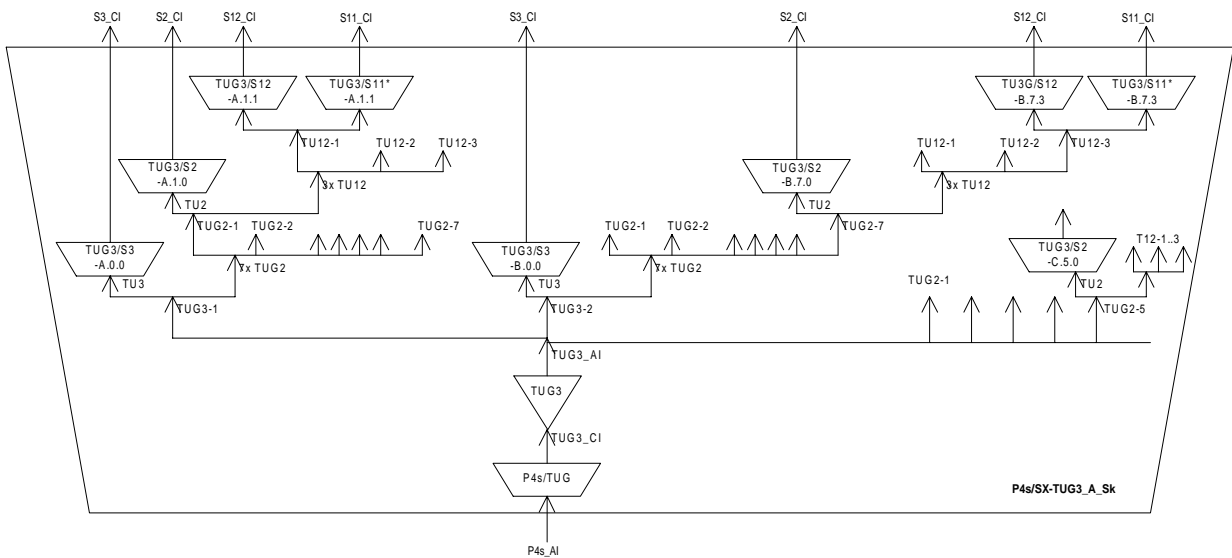
Figure 102: P4s/SX-TUG3_A_Sk compound function with set of TUG3/Sm_A_Sk atomic functions

Table 71: Possible TUG3/Sm_A_Sk functions of a P4s/SX-TUG3_A_Sk compound function

Atomic function	TU-3/TUG-3 number K	TU-2/TUG-2 number L	TU-12 number M
TUG3/S3_A_Sk/K.0.0	A,B	0	0
TUG3/S2_A_Sk/K.L.0	A,B,C	1 to 7 (A,B) 1 to 5 (C)	0
TUG3/S12_A_Sk/K.L.M	A,B,C	1 to 7 (A,B) 1 to 5 (C)	1 to 3
TUG3/S11*_A_Sk/K.L.M	A,B,C	1 to 7 (A,B) 1 to 5 (C)	1 to 3

For specific implementations only a subset of these TUG3/Sm_A_Sk functions may be used (e.g. a terminal multiplexer with fixed 2 Mbit/s access has 63 TUG3/S12_A_Sk functions). If a flexible TUG3 multiplex structure is supported, several TUG3/Sm_A_Sk functions may have access to the same TU timeslot. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults (e.g. cLOP) to be detected and reported. To prevent this an adaptation sink function can be deactivated. This is controlled by the equipment management function by activating/deactivating the functions according to the configured TUG3 multiplex structure.

NOTE 1: The P4s/TUG3_A_Sk, TUG3_T_Sk and TUG3/Sm_A_Sk (m = 3, 2, 12, 11*) defined in the following subclauses can only be used in a P4s/SX-TUG3_A_Sk compound function. These functions can not be used as stand alone functions.

NOTE 2: The TUG3 is a virtual sub-layer only applicable in a P4s/SX-TUG3_A compound function.

9.3.2.1 P4s layer to TUG3 adaptation sink function P4s/TUG3_A_Sk

Symbol:
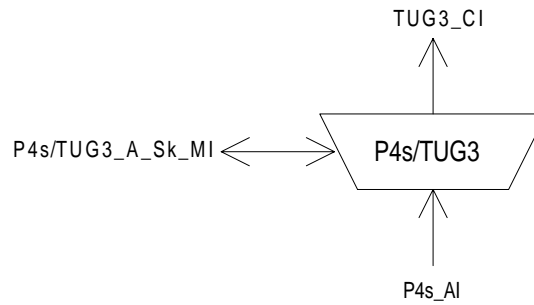
Figure 103: P4s/TUG3_A_Sk symbol

Interfaces:

Table 72: P4s/TUG3_A_Sk input and output signals

Input(s)	Output(s)
P4s_AI_D	TUG3_CI_D
P4s_AI_CK	TUG3_CI_CK
P4s_AI_FS	TUG3_CI_FS
P4s_AI_TSF	TUG3_CI_MFS
P4s/TUG3_A_Sk_MI_Active	TUG3_CI_SSF_TUG2
	TUG3_CI_SSF_TU3
	P4s/TUG3_A_Sk_MI_cPLM
	P4s/TUG3_A_Sk_MI_cLOM

NOTE 1: The P4s/TUG3_A_Sk function can only be used in a P4s/SX-TUG3_A_Sk compound function. It can not be used as a standalone function.

Processes:

The function monitors two payload specific signals (bits 3-5 and bits 6-7) of the P4s POH.

MA[3-5]: The function shall compare the content of the accepted bits 3 to 5 of byte MA with the expected value code "100" (SDH elements mapping II: $2 \times$ TUG-3 and $5 \times$ TUG-2 structure) as a check on consistency between the provisioning operation at each end. The application, acceptance and mismatch detection processes are described in ETS 300 417-1-1 [8], subclauses 7.2 and 8.1.2.

MA[6-7]: The function shall recover the 500 μs (multi)frame start phase performing multi-frame alignment on bits 6 and 7 of byte MA. Out-of-multiframe (OOM) shall be assumed once when an error is detected in the MA bit 6 and 7 sequence. Multiframe alignment shall be assumed to be recovered, and the inmultiframe (IM) state shall be entered, when in four consecutive P4s frames an error free MA bit 6,7 sequence is found.

Figure 83 shows that more than one adaptation sink function exists in this P4s layer that can be connected to one P4s access point. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults (e.g. cPLM) to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall activate the SSF signals at its output (CI_SSF_TU3 and CI_SSF_TUG2) and not report its status via the management point.

Defects:

The function shall detect for the dPLM defect according ETS 300 417-1-1 [8], subclause 8.2.1.

If the multiframe alignment process is in the OOM state and the MA multiframe is not recovered within X ms, a dLOM defect shall be declared. Once in a dLOM state, this state shall be exited when the multiframe is recovered (multiframe alignment process enter the IM state). X shall be a value in the range 1 to 5 (ms). X is not configurable.

Consequent Actions:

aSSF_TU3   ←   dPLM

aSSF_TUG2   ←   dPLM or dLOM

Defect Correlations:

cPLM ←   dPLM and (not AI_TSF)

cLOM ←   dLOM and (not AI_TSF) and (not dPLM)

Performance Monitoring: None.

9.3.2.2 **TUG3 trail termination sink function TUG3_T_Sk**

Symbol:

```
                          TUG3_AI
                             ↑
                            /|\
                           / | \
                          /  |  \
                         /   |   \
                        \ TUG3    /
                         \       /
                          \     /
                           \   /
                            \ /
                             ↑
                             |
                          TUG3_CI
```
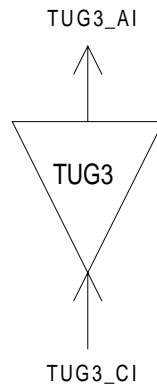
Figure 104: TUG3_T_Sk symbol

Interfaces:

Table 73: TUG3_T_Sk input and output signals

Input(s)	Output(s)
TUG3_CI_D	TUG3_AI_D
TUG3_CI_CK	TUG3_AI_CK
TUG3_CI_FS	TUG3_AI_FS
TUG3_CI_SSF_TUG2	TUG3_AI_TSF_TUG2
TUG3_CI_SSF_TU3	TUG3_AI_TSF_TU3

NOTE: The TUG3_T_Sk function can only be used in a P4s/SX-TUG3_A_Sk compound function. It can not be used as a standalone function.

Processes: None.

Defects: None.

Consequent Actions:

aTSF_TUG2 ← CI_SSF_TUG2

aTSF_TU3 ← CI_SSF_TU3

Defect Correlations: None.

Performance Monitoring: None.

9.3.2.3   TUG3 to VC-3 layer adaptation sink function TUG3/S3_A_Sk/K.0.0

Symbol:

S3_CI

K=A,B

TUG3/S3_A_Sk_MI ⟵⟶ TUG3/S3-K.0.0
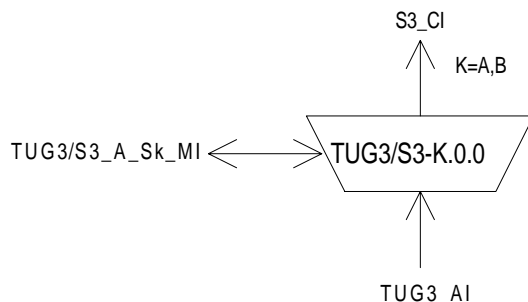
TUG3_AI

Figure 105: TUG3/S3_A_Sk symbol

Interfaces:

Table 74: TUG3/S3_A_Sk input and output signals

Input(s)	Output(s)
TUG3_AI_D	S3_CI_D
TUG3_AI_CK	S3_CI_CK
TUG3_AI_FS	S3_CI_FS
TUG3_AI_TSF_TU3	S3_CI_SSF
TUG3/S3_A_Sk_MI_AIS_Reported	TUG3/S3_A_Sk_MI_cLOP
TUG3/S3_A_Sk_MI_Active	TUG3/S3_A_Sk_MI_cAIS

NOTE: The TUG3/S3_A_Sk function can only be used in a P4s/SX-TUG3_A_Sk compound
function. It can not be used as a standalone function.

Processes:

This function recovers the VC-3 data with frame phase information from a TU-3.

H1, H2 - *TU-3 pointer interpretation:*   The function shall perform TU-3 pointer interpretation as specified
in annex B in ETS 300 417-1-1 [8] to recover the VC-3 frame phase within a TU-3 of a P4s.

TU-3 timeslot: The adaptation source function has access to a specific TU-3 of the TUG3 access point.
The TU-3 is defined by the parameter K (K=A,B).

Figure 102 shows that more than one adaptation sink function exists in this TUG3 virtual sub-layer that
can be connected to one TUG3 access point. In contradiction with the source direction, adaptation sink
functions may be activated all together. This will presumably cause faults (e.g. cLOP) to be detected and
reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is
true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D) and not report its status via its
management point.

Defects:

The function shall detect for dAIS and dLOP defects according the algorithm described under the pointer
interpreter process in ETS 300 417-1-1 [8], annex B, Pointer Interpretation.

Consequent Actions:

aAIS ←   dAIS or dLOP or AI_TSF_TU3

aSSF ←   dAIS or dLOP or AI_TSF_TU3

On declaration of aAIS the function shall output an all-ONEs (AIS) signal within 250 µs; on clearing of aAIS the function shall output the recovered data within 250 µs.

Defect Correlations:

cAIS ←   dAIS and (not AI_TSF_TU3) and AIS_Reported

cLOP ←   dLOP and (not AI_TSF_TU3)

It shall be an option to report AIS as a fault cause. This is controlled by means of the parameter AIS_Reported. The default shall be AIS_Reported = false.

Performance Monitoring: None**.**

9.3.2.4 TUG3 to VC-2 layer adaptation sink function TUG3/S2_A_Sk

Symbol:
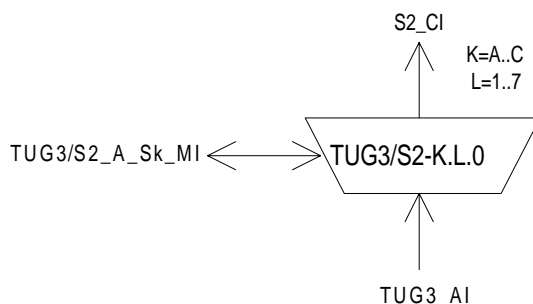
Figure 106: TUG3/S2_A_Sk symbol

Interfaces:

Table 75: TUG3/S2_A_Sk input and output signals

Input(s)	Output(s)
TUG3_AI_D	S2_CI_D
TUG3_AI_CK	S2_CI_CK
TUG3_AI_FS	S2_CI_FS
TUG3_AI_TSF_TUG2	S2_CI_SSF
TUG3/S2_A_Sk_MI_AIS_Reported	TUG3/S2_A_Sk_MI_cLOP
TUG3/S2_A_Sk_MI_Active	TUG3/S2_A_Sk_MI_cAIS

NOTE: The TUG3/S2_A_Sk function can only be used in a P4s/SX-TUG3_A_Sk compound function. It can not be used as a standalone function.

Processes:

This function recovers VC-2 data with frame phase information from a TU-2.

V1, V2 - *TU-2 pointer interpretation:* The function shall perform TU-2 pointer interpretation as specified in annex B in ETS 300 417-1-1 [8] to recover the VC-2 frame phase within a TU-2 of a P4s.

Defects:

The function shall detect for dAIS and dLOP defect according the algorithm described under the pointer interpreter process in ETS 300 417-1-1 [8], annex B, Pointer Interpretation.

TU-2 timeslot: The adaptation source function has access to a specific TU-2 of the TUG access point. The TU-2 is defined by the parameters K and L (K=A,B, L=1 to 7 and K=C, L=1 to 5).

Figure 102 shows that more than one adaptation sink function exists in this TUG3 virtual sub-layer that can be connected to one TUG access point. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults (e.g. cLOP) to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D) and not report its status via its management point.

Consequent Actions:

aAIS ← dAIS or dLOP or AI_TSF_TUG2

aSSF ← dAIS or dLOP or AI_TSF_TUG2

On declaration of aAIS the function shall output all-ONEs signal within 1 ms; on clearing of aAIS the function shall output the recovered data within 1 ms.

Defect Correlations:

cAIS ← dAIS and (not AI_TSF_TUG2) and AIS_Reported

cLOP ← dLOP and (not AI_TSF_TUG2)

It shall be an option to report AIS as a fault cause. This is controlled by means of the parameter AIS_Reported. The default shall be AIS_Reported = false.

Performance Monitoring: None**.**

9.3.2.5   TUG3 to VC-12 layer adaptation sink function TUG3/S12_A_Sk/K.L.M

Symbol:
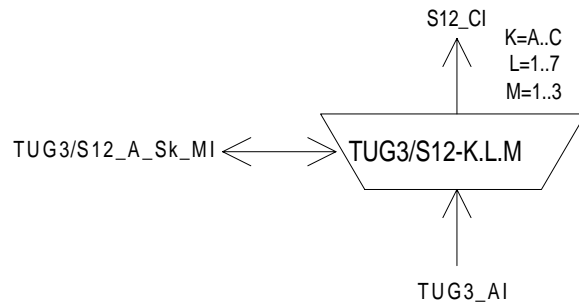
Figure 107: TUG3/S12_A_Sk symbol

Interfaces:

Table 76: TUG3/S12_A_Sk input and output signals

Input(s)	Output(s)
TUG3_AI_D	S12_CI_D
TUG3_AI_CK	S12_CI_CK
TUG3_AI_FS	S12_CI_FS
TUG3_AI_TSF_TUG2	S12_CI_SSF
TUG3/S12_A_Sk_MI_AIS_Reported	TUG3/S12_A_Sk_MI_cLOP
TUG3/S12_A_Sk_MI_Active	TUG3/S12_A_Sk_MI_cAIS

NOTE: The TUG3/S12_A_Sk functions can only be used in a P4s/SX-TUG3_A_Sk compound
                function. It can not be used as a standalone function.

Processes:

This function recovers VC-12 data with frame phase information from a TU-12.

V1, V2 - *TU-12 pointer interpretation:* The function shall perform TU-12 pointer interpretation as specified
in annex B in ETS 300 417-1-1 [8] to recover the VC-12 frame phase within a TU-12 of a P4s.

TU-12 timeslot: The adaptation source function has access to a specific TU-12 of the TUG3 access point.
The TU-12 is defined by the parameters K, L and M (K=A to C, L=1 to 7, M=1 to 3).

Figure 102 shows that more than one adaptation sink function exists in this TUG3 virtual sub-layer that
can be connected to one TUG3 access point. In contradiction with the source direction, adaptation sink
functions may be activated all together. This will presumably cause faults (e.g. cLOP) to be detected and
reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is
true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D) and not report its status via its
management point.

Defects:

The function shall detect for dAIS and dLOP defect according the algorithm described under the pointer
interpreter process in ETS 300 417-1-1 [8], annex B, Pointer Interpretation.

Consequent Actions:

aAIS ← dAIS or dLOP or AI_TSF_TUG2

aSSF ← dAIS or dLOP or AI_TSF_TUG2

On declaration of aAIS the function shall output all ONEs signal within 1 ms; on clearing of aAIS the function shall output the recovered data within 1 ms.

Defect Correlations:

cAIS ← dAIS and (not AI_TSF_TUG2) and AIS_Reported

cLOP ← dLOP and (not AI_TSF_TUG2)

It shall be an option to report AIS as a fault cause. This is controlled by means of the parameter AIS_Reported. The default shall be AIS_Reported = false.

Performance Monitoring: None**.**

**9.3.2.6   TUG3 to VC-11 layer adaptation sink function TUG3/S11*_A_Sk/K.L.M**

Symbol:
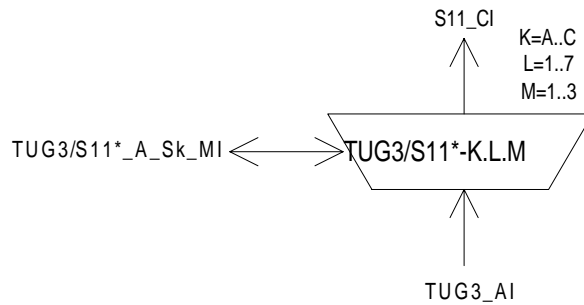
Figure 108: TUG3/S11*_A_Sk symbol

Interfaces:

Table 77: TUG3/S11*_A_Sk input and output signals

Input(s)	Output(s)
TUG3_AI_D	S11_CI_D
TUG3_AI_CK	S11_CI_CK
TUG3_AI_FS	S11_CI_FS
TUG3_AI_TSF_TUG2	S11_CI_SSF
TUG3/S11*_A_Sk_MI_AIS_Reported	TUG3/S11*_A_Sk_MI_cLOP
TUG3/S11*_A_Sk_MI_Active	TUG3/S11*_A_Sk_MI_cAIS

NOTE: The TUG3/S11*_A_Sk functions can only be used in a P4s/SX-TUG3_A_Sk compound function. It can not be used as a standalone function.

Processes:

This function recovers VC-11 data with frame phase information from a TU-12

V1, V2 - *TU-12 pointer interpretation:* The function shall perform TU-12 pointer interpretation as specified in annex B in ETS 300 417-1-1 [8] to recover the VC-11 frame phase within a TU-12 of a P4s.

TU-12 timeslot: The adaptation source function has access to a specific TU-12 of the TUG3 access point. The TU-12 is defined by the parameters K, L and M (K=A to C, L=1 to 7, M=1 to 3).

Figure 102 shows that more than one adaptation sink function exists in this TUG3 virtual sub-layer that can be connected to one TUG3 access point. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults (e.g. cLOP) to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D) and not report its status via its management point.

Defects:

The function shall detect for dAIS and dLOP defect according the algorithm described under the pointer interpreter process in ETS 300 417-1-1 [8], annex B, Pointer Interpretation.

Consequent Actions:

aAIS ← dAIS or dLOP or AI_TSF_TUG2

aSSF ← dAIS or dLOP or AI_TSF_TUG2

On declaration of aAIS the function shall output all ONEs signal within 1 ms; on clearing of aAIS the function shall output the recovered data within 1 ms.

Defect Correlations:

cAIS ← dAIS and (not AI_TSF_TUG2) and AIS_Reported

cLOP ← dLOP and (not AI_TSF_TUG2)

It shall be an option to report AIS as a fault cause. This is controlled by means of the parameter AIS_Reported. The default shall be AIS_Reported = false.

Performance Monitoring: None.

9.3.3 **P4s layer to VC-2, VC-12, and VC-11 layer compound adaptation source function P4s/SX-TUG2_A_So**

Symbol:

S2_CI   S12_CI   S11_CI

P4s/TUG2_A_So_MI
TUG2/S2_A_So_MI/L.0
TUG2/S12_A_So_MI/L.M
TUG2/S11*_A_So_MI/L.M

P4s/SX-TUG2

P4s_TI

P4s_AI
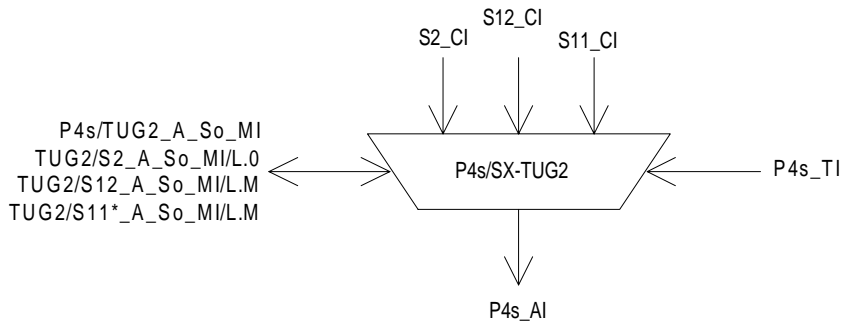
Figure 109: P4s/SX-TUG2_A_So symbol

Interfaces:

Table 78: P4s/SX-TUG2_A_So input and output signals

Input(s)	Output(s)
P4s/TUG_A_So_MI P4s_TI maximum 20 inputs: S2_CI TUG/S2_A_So_MI/L.0 maximum 60 inputs: S12_CI TUG/S12_A_So_MI/L.M maximum 60 inputs: S11_CI TUG/S11*_A_So_MI/L.M	P4s_AI

Processes:

The P4s/SX-TUG2_A_So compound function provides adaptation from the VC-/2/12/11 layers to the P4s layer. This process is performed by a combination of several atomic functions as shown in figure 110. The P4s/TUG_A_So function performs the P4s layer specific signal label and multiframe processing, while the TUG2/S2_A_So, TUG2/S12_A_So and TUG2/S11*_A_So functions perform the lower order VC specific frequency justification and bitrate adaptation. Each of these TUG2/Sm_A_So functions is characterized by the L.M parameters, which define the number of the TU within the P4s the function has access to (TU numbering scheme according to figure C-1). According to the TUG2 multiplex structures supported by the NE, a variety of possible combinations of these TUG2/Sm_A_So functions exists. Table 79 lists all possible TUG2/Sm_A_So functions within a P4s/SX-TUG2_A_So compound functions.
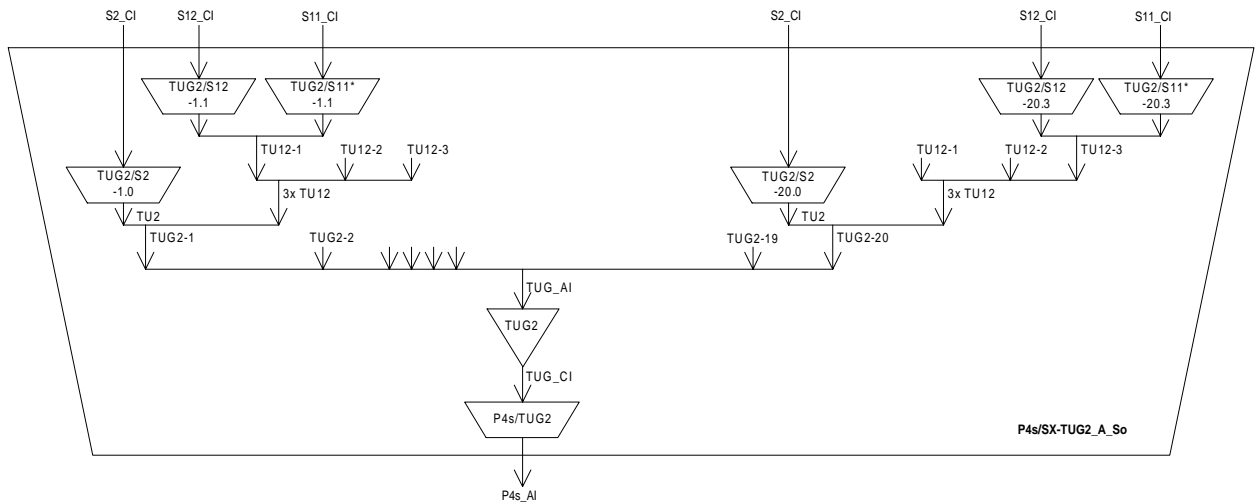
Figure 110: P4s/SX-TUG2_A_So compound function with set of TUG2/Sm_A_So atomic functions

Table 79: Possible TUG2/Sm_A_So functions of a P4s/SX-TUG2_A_So compound function

Atomic function	TU-2/TUG-2 number L	TU-12 number M
TUG2/S2_A_So/L.0	1 to 20	-
TUG2/S12_A_So/.L.M	1 to 20	1 to 3
TUG2/S11*_A_So/ L.M	1 to 20	1 to 3

For specific implementations only a subset of these TUG2/Sm_A_So functions may be used (e.g. a terminal multiplexer with fixed 2 Mbit/s access has 60 TUG2/S12_A_So functions). If a flexible TUG2 multiplex structure is supported, several TUG2/Sm_A_So functions may have access to the same TU timeslot. For such case, only one of these adaptation source functions is allowed to be activated. This is controlled by the equipment management function by activating/deactivating the functions according to the configured TUG2 multiplex structure.

NOTE 1:   The P4s/TUG2_A_So, TUG2_T_So and TUG2/Sm_A_So (m = 2, 12, 11*) defined in the following subclauses can only be used in a P4s/SX-TUG2_A_So compound function. These functions can not be used as stand alone functions.

NOTE 2:   The TUG2 is a virtual sub-layer only applicable in a P4s/SX-TUG2_A compound function.

The number of TUG2/Sm_A (m=2,12,11*) functions that is active shall completely fill the P4s payload.

9.3.3.1 P4s layer to TUG2 adaptation source function P4s/TUG2_A_So

Symbol:
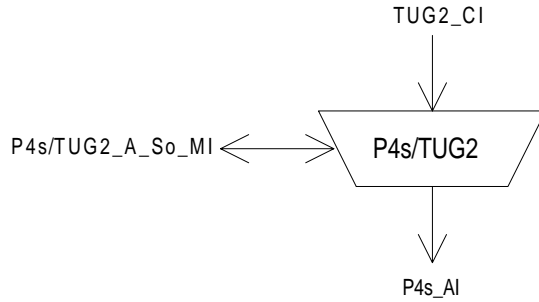
Figure 111: P4s/TUG2_A_So symbol

Interfaces:

Table 80: P4s/TUG2_A_So input and output signals

Input(s)	Output(s)
TUG2_CI_D	P4s_AI_D
TUG2_CI_CK	P4s_AI_CK
TUG2_CI_FS	P4s_AI_FS
TUG2_CI_MFS	
P4s/TUG2_A_So_MI_Active	

NOTE: The P4s/TUG2_A_So functions can only be used in a P4s/SX-TUG2_A_So compound function. It can not be used as a standalone function.

Processes:

The function adds two payload specific signals (bits MA[3-5] and MA[6-7]) to the P4s POH.

MA[3-5]: In this byte the function shall insert code "011" (SDH elements mapping I: $20 \times$ TUG-2 structure) as defined in ETS 300 337 [9].

MA[6-7]: The value of the multiframe indicator MA[6-7] shall be set as specified by ETS 300 337 [9], 500 µs TU multiframe sequence, and aligned with TUG2_CI_MFS.

					TU multiframe indicator		
1	2	3	4	5	6	7	8

Figure 112: TU multiframe indicator bits in byte MA

Figure 110 shows that more than one adaptation source function exists in a P4s layer that can be connected to one TUG2 access point. For such case, only one of these adaptation source functions is allowed to be activated. Access to the access point by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects:　　　　　　None.

Consequent Actions:　　None.

Defect Correlations:　　None.

Performance Monitoring:　None.

9.3.3.2   TUG2 trail termination source function TUG2_T_So

Symbol:
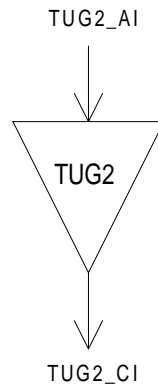
Figure 113: TUG2_T_So symbol

Interfaces:

Table 81: TUG2_T_So input and output signals

Input(s)	Output(s)
TUG2_AI_D	TUG2_CI_D
TUG2_AI_CK	TUG2_CI_CK
TUG2_AI_FS	TUG2_CI_FS
TUG2_AI_MFS	TUG2_CI_MFS

NOTE: The TUG2_T_So functions can only be used in a P4s/SX-TUG2_A_So compound function. It can not be used as a standalone function.

Processes:	None.
Defects:	None.
Consequent Actions:	None.
Defect Correlations:	None.
Performance Monitoring:	None.

9.3.3.3 TUG2 to VC-2 layer adaptation source function TUG2/S2_A_So/L.0

Symbol:
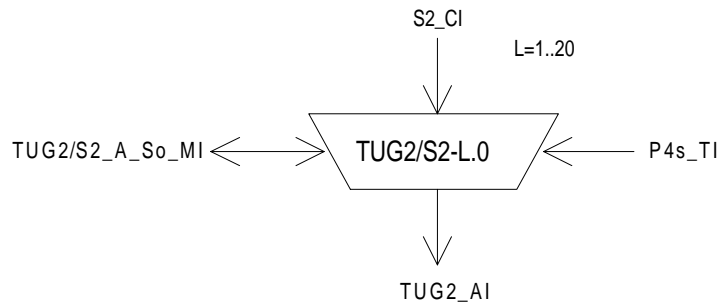
Figure 114: TUG2/S2_A_So symbol

Interfaces:

Table 82: TUG2/S2_A_So input and output signals

Input(s)	Output(s)
S2_CI_D	TUG2_AI _D
S2_CI_CK	TUG2_AI_CK
S2_CI_FS	TUG2_AI_FS
S2_CI_SSF	TUG2_AI_MFS
P4s_TI_CK	
P4s_TI_FS	
P4s_TI_MFS	
TUG2/S2_A_So_MI_Active	

NOTE 1: The TUG2/S2_A_So functions can only be used in a P4s/SX-TUG2_A_So compound function. It can not be used as a standalone function.

Processes:

This function provides frequency justification and bitrate adaptation for a VC-2 signal, represented by a nominally $(428 \times 64/4) = 6\,848$ kbit/s information stream with a frequency accuracy within $\pm$ 4,6 ppm and the related frame phase, to be multiplexed into a P4s signal via a TU-2.

The (500 µs) frame phase of the VC-2 is coded in the related TU-2 pointer. Frequency justification, if required, is performed by pointer adjustments. The accuracy of this coding process is specified below. Refer to annex A of ETS 300 417-4-1 [10].

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (buffer) process. The data and frame start signals shall be written into the buffer under control of the associated input clock. The data and frame start signals shall be read out of the buffer under control of the P4s clock, frame position, and justification decision.

The justification decisions determine the phase error introduced by the TUG2/S2_A_So function. The amount of this phase error can be measured at the physical interfaces by monitoring the TU-2 pointer actions. An example is given in annex A.2 of ETS 300 417-4-1 [10].

Each justification decision results in a corresponding negative/positive justification action. Upon a positive justification action, the reading of 8 data bits shall be cancelled once and no data are written at the justification opportunity position V3+1 (figure 115). Upon a negative justification action, an extra 8 data bits shall be read out once into the justification opportunity position V3.

NOTE 2: A requirement for maximum introduced phase error cannot be defined until a reference path is defined from which the requirements for network elements can be deduced. Such a requirement would also limit excessive phase error caused by pointer processors under fixed frequency offset conditions.

Buffer size: For further study.

	1	2							10		30	- 50 - 70 - 90 -	210		230	242
1									V1							
2																
3																
4	11*															
5																
6																
7																
8																
9																
1									V2							
2																
3																
4	00*															
5																
6																
7																
8																
9																
1									V3		V3+1					
2																
3																
4	01*															
5																
6																
7																
8																
9																
1									V4							
2																
3																
4	10*															
5																
6																
7																
8																
9																

	indicates the 432 bytes belonging to the TU-2 (8,0)
	01*, 10*, 11*, and 00* indicate code value in bits MA[6-7]

Figure 115: TUG2_AI_D/8.0 signal

The TU-2 pointer is carried in bytes V1 and V2 of payload specific OH once per 500 μs multiframe (figure 115). The TU-2 pointer is aligned in the P4s payload in fixed positions relative to the P4s frame and multiframe. The format of the TU-2 pointer and its location in the frame/multiframe are defined in ETS 300 337 [9].

V1, V2 - *Pointer generation:* The function shall generate the TU-2 pointer as is described in ETS 300 417-1-1 [8], annex A: Pointer Generation. It shall insert the pointer in the appropriate V1, V2 positions with the SS field set to 00 to indicate TU-2.

> NOTE 3: The byte V4 is undefined.

TU-2 timeslot: The adaptation source function has access to a specific TU-2 of the TUG access point. The TU-2 is defined by the parameter L (L=1 to 20).

Figure 110 shows that more than one adaptation source function exists in the TUG2 virtual sub-layer that can be connected to one TUG2 access point. For such case, a subset of these adaptation source functions is allowed to be activated together, but only one adaptation source function may have access to a specific TU timeslot. Access to the same TU timeslot by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions:

aAIS $\leftarrow$ CI_SSF

On declaration of aAIS the function shall output an all ONEs signal within 1 ms; on clearing of aAIS the function shall output normal data within 1 ms.

> NOTE 4: If CI_SSF is not connected (when connected to a S2_TT_So), CI_SSF is assumed to be false.

Defect Correlations: None.

Performance Monitoring: None.

**9.3.3.4   TUG2 to VC-12 layer adaptation source function TUG2/S12_A_So/L.M**

Symbol:
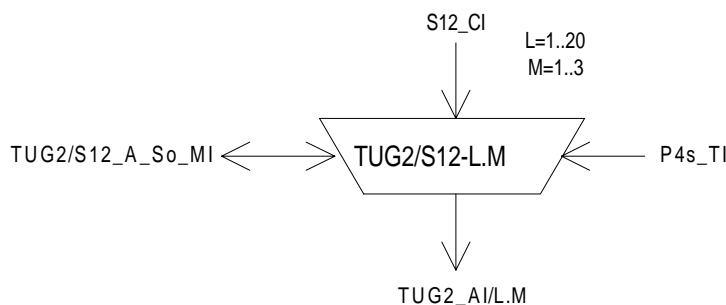
Figure 116: TUG2/S12_A_So symbol

Interfaces:

Table 83: TUG2/S12_A_So input and output signals

Input(s)	Output(s)
S12_CI_D	TUG2_AI_D
S12_CI_CK	TUG2_AI_CK
S12_CI_FS	TUG2_AI_FS
S12_CI_SSF	
P4s_TI_CK	
P4s_TI_FS	
P4s_TI_MFS	
TUG2/S12_A_So_MI_Active	

NOTE 1:   The TUG2/S12_A_So functions can only be used in a P4s/SX-TUG2_A_So compound
             function. It can not be used as a standalone function.

Processes:

This function provides frequency justification and bitrate adaptation for a VC-12 signal, represented by a nominally $(140 \times 64 / 4) = 2\,240$ kbit/s information stream with a frequency accuracy within $\pm 4{,}6$ ppm and the related frame phase, to be multiplexed into a P4s signal via a TU-12.

The (500 µs) frame phase of the VC-12 is coded in the related TU-12 pointer. Frequency justification, if required, is performed by pointer adjustments. The accuracy of this coding process is specified below. Refer to annex A of ETS 300 417-4-1 [10].

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (buffer) process. The data and frame start signals shall be written into the buffer under control of the associated input clock. The data and frame start signals shall be read out of the buffer under control of the P4s clock, frame position, and justification decision.

The justification decisions determine the phase error introduced by the TUG/S12_A_So function. The amount of this phase error can be measured at the physical interfaces by monitoring the TU-12 pointer actions. An example is given in annex A.2 of ETS 300 417-4-1 [10].

Each justification decision results in a corresponding negative/positive justification action. Upon a positive justification action, the reading of 8 data bits shall be cancelled once and no data are written at the justification opportunity position V3+1 (figure 117). Upon a negative justification action, an extra 8 data bits shall be read out once into the justification opportunity position V3.

NOTE 2: A requirement for maximum introduced phase error cannot be defined until a reference path is defined from which the requirements for network elements can be deduced. Such a requirement would also limit excessive phase error caused by pointer processors under fixed frequency offset conditions.

Buffer size: For further study.

	1	2									12			72			132			192	242
1											V1										
2																					
3																					
4	11*																				
5																					
6																					
7																					
8																					
9																					
1											V2										
2																					
3																					
4	00*																				
5																					
6																					
7																					
8																					
9																					
1											V3			V3+1							
2																					
3																					
4	01*																				
5																					
6																					
7																					
8																					
9																					
1											V4										
2																					
3																					
4	10*																				
5																					
6																					
7																					
8																					
9																					

	indicates the 144 bytes belonging to the TU-12 (10,1)
	01*, 10*, 11*, and 00* indicate code value in bits MA[6-7]

Figure 117: TUG2_AI_D/10.1 signal

The TU-12 pointer is carried in bytes V1 and V2 of payload specific OH per 500 μs multiframe (figure 117). The TU-12 pointer is aligned in the P4s payload in fixed positions relative to the P4s frame and multiframe. The format of the TU-12 pointer and its location in the frame/multiframe are defined in ETS 300 337 [9].

V1, V2 - *Pointer generation:* The function shall generate the TU-12 pointer as is described in ETS 300 417-1-1 [8], annex A: Pointer Generation. It shall insert the pointer in the appropriate V1, V2 positions with the SS field set to 10 to indicate TU-12.

NOTE 3: The byte V4 is undefined.

TU-12 timeslot: The adaptation source function has access to a specific TU-12 of the TUG2 access point. The TU-12 is defined by the parameters L and M (L=1 to 20, M=1 to 3).

Figure 110 shows that more than one adaptation source function exists in the TUG2 virtual sub-layer that can be connected to one TUG2 access point. For such case, a subset of these adaptation source functions is allowed to be activated together, but only one adaptation source function may have access to

a specific TU timeslot. Access to the same TU timeslot by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions:

aAIS ← CI_SSF

On declaration of aAIS the function shall output an all-ONEs signal within 1 ms; on clearing of aAIS the function shall output normal data within 1 ms.

> NOTE 4: If CI_SSF is not connected (when connected to a S12_TT_So), CI_SSF is assumed to be false.

Defect Correlations: None.

Performance Monitoring: None.

9.3.3.5 TUG2 to VC-11 layer adaptation source function TUG2/S11*_A_So/L.M

Symbol:
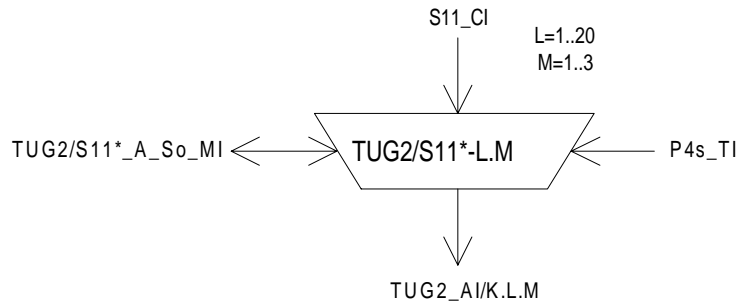
Figure 118: TUG2/S11*_A_So symbol

Interfaces:

Table 84: TUG2/S11*_A_So input and output signals

Input(s)	Output(s)
S11_CI_D	TUG2_AI_D
S11_CI_CK	TUG2_AI_CK
S11_CI_FS	TUG2_AI_FS
S11_CI_SSF	
P4s_TI_CK	
P4s_TI_FS	
P4s_TI_MFS	
TUG2/S11*_A_So_MI_Active	

NOTE 1: The TUG2/S11*_A_So functions can only be used in a P4s/SX-TUG2_A_So compound function. It can not be used as a standalone function.

Processes:

This function provides frequency justification and bitrate adaptation for a VC-11 signal, represented by a nominally $(104 \times 64 / 4) = 1\ 664$ kbit/s information stream with a frequency accuracy within $\pm 4,6$ ppm and the related frame phase, to be multiplexed into a P4s signal. The VC-11 is transported within a TU-12; 9 bytes of fixed stuff (figure 119) are added per 125 µs to the VC-11 as specified by ETS 300 147 [1] to map the VC-11 into the TU-12 payload (see note 2).

NOTE 2: Mapping a VC-11 into a TU-12 allows the VC-11 signal to be transported in a VC-12 based network (via S12_C and TUG/S12_A functions) and to non-intrusively monitor this VC-11 by means of a VC-12 non-intrusive monitor (S12m_TT_Sk). The TUG2/S11*_A function will be used at the junction of VC-11 and VC-12 networks.

The (500 µs) frame phase of the VC-11 is coded in the related TU-12 pointer. Frequency justification, if required, is performed by pointer adjustments. The accuracy of this coding process is specified below. Refer to annex A of ETS 300 417-4-1 [10].

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (buffer) process. The data and frame start signals shall be written into the buffer under control of the associated input clock. The data and frame start signals shall be read out of the buffer under control of the P4s clock, frame position, and justification decision.

The justification decisions determine the phase error introduced by the TUG2/S11*_A_So function. The amount of this phase error can be measured at the physical interfaces by monitoring the TU-12 pointer actions. An example is given in annex A.2 of ETS 300 417-4-1 [10].

Each justification decision results in a corresponding negative/positive justification action. Upon a positive justification action, the reading of 8 data bits shall be cancelled once and no data are written at the justification opportunity position V3+1 (figure 119). Upon a negative justification action, an extra 8 data bits shall be read out once into the justification opportunity position V3.

> NOTE 3: A requirement for maximum introduced phase error cannot be defined until a reference path is defined from which the requirements for network elements can be deduced. Such a requirement would also limit excessive phase error caused by pointer processors under fixed frequency offset conditions.

Buffer size: For further study.

	1	2		12		72		132		192	242
1				V1				R*			
2								R*			
3								R*			
4	11*							R*		V5	
5						R*					
6						R*					
7						R*					
8						R*					
9						R*					
1				V2				R*			
2								R*			
3								R*			
4	00*							R*		J2	
5						R*					
6						R*					
7						R*					
8						R*					
9						R*					
1				V3		V3+1		R*			
2								R*			
3								R*			
4	01*							R*		N2	
5						R*					
6						R*					
7						R*					
8						R*					
9						R*					
1				V4				R*			
2								R*			
3								R*			
4	10*							R*		K4	
5						R*					
6						R*					
7						R*					
8						R*					
9						R*					

	indicates the 144 bytes belonging to the TU-12 (10,1)
	01*, 10*, 11*, and 00* indicate code value in bits MA[6-7] R* indicates fixed stuff with even parity The positions of the V5, J2, N2, K4 and R^ bytes is relative to the position of the VC-11 in the TU-12. The start of the VC-11 (V5 byte) is defined by the TU-12 pointer.

Figure 119: TUG2_AI_D/10.1 signal

The TU-12 pointer is carried in bytes V1 and V2 of payload specific OH per 500 µs multiframe (figure 119). The TU-12 pointer is aligned in the P4s payload in fixed positions relative to the P4s frame and multiframe. The format of the TU-12 pointer and its location in the frame/multiframe are defined in ETS 300 337 [9].

V1, V2 - *Pointer generation:* The function shall generate the TU-12 pointer as is described in ETS 300 417-1-1 [8], annex A: Pointer Generation. It shall insert the pointer in the appropriate V1, V2 positions with the SS field set to 10 to indicate TU-12.

NOTE 4: The byte V4 is undefined.

TU-12 timeslot: The adaptation source function has access to a specific TU-12 of the TUG access point. The TU-12 is defined by the parameters L and M (L=1 to 20, M=1 to 3).

Figure 110 shows that more than one adaptation source function exists in the TUG virtual sub-layer that can be connected to one TUG access point. For such case, a subset of these adaptation source functions is allowed to be activated together, but only one adaptation source function may have access to a specific TU timeslot. Access to the same TU timeslot by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions:

aAIS ← CI_SSF

On declaration of aAIS the function shall output an all-ONEs signal within 1 ms; on clearing of aAIS the function shall output normal data within 1 ms.

Defect Correlations: None.

Performance Monitoring: None.

9.3.4 **P4s layer to VC-2, VC-12, and VC-11 layer compound adaptation sink function P4s/SX-TUG2_A_Sk**

Symbol:
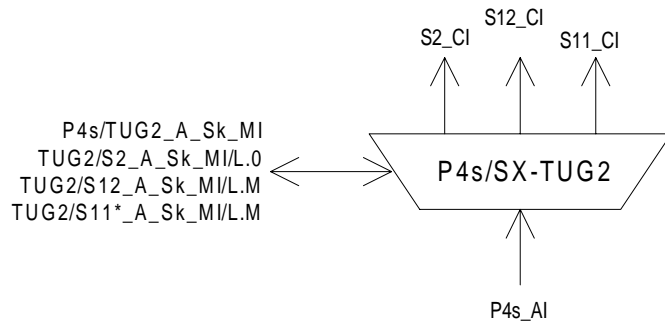
Figure 120: P4s/SX-TUG2_A_Sk symbol

Interfaces:

Table 85: P4s/SX-TUG2_A_Sk input and output signals

Input(s)	Output(s)
P4s_AI P4s/TUG2_A_Sk_MI maximum 20 inputs: TUG2/S2_A_Sk_MI/L.0 maximum 60 inputs: TUG2/S12_A_Sk_MI/L.M maximum 60 inputs: TUG2/S11*_A_Sk_MI/L.M	P4s/TUG2_A_Sk_MI maximum 20 outputs: S2_CI TUG2/S2_A_Sk_MI/L.0 maximum 60 outputs: S12_CI TUG2/S12_A_Sk_MI/L.M maximum 60 outputs: S11_CI TUG2/S11*_A_Sk_MI/L.M

Processes:

The P4s/SX-TUG2_A_Sk compound function provides adaptation from the P4s layer to the VC-2/12 layers. This process is performed by a combination of several atomic functions as shown in figure 121. The P4s/TUG2_A_Sk function performs the P4s layer specific signal label and multiframe processing, while the TUG2/S2_A_Sk, TUG2/S12_A_Sk and TUG2/S11*_A_Sk functions perform the lower order VC specific frequency justification and bitrate adaptation. Each of these TUG2/Sm_A_Sk functions is characterized by the K.L.M parameters, which define the number of the TU within the P4s the function has access to (TU numbering scheme according to figure C-1). According to the TUG multiplex structures supported by the NE, a variety of possible combinations of these TUG2/Sm_A_Sk functions exists. Table 86 lists all possible TUG2/Sm_A_Sk functions within a P4s/SX-TUG2_A_Sk compound functions.
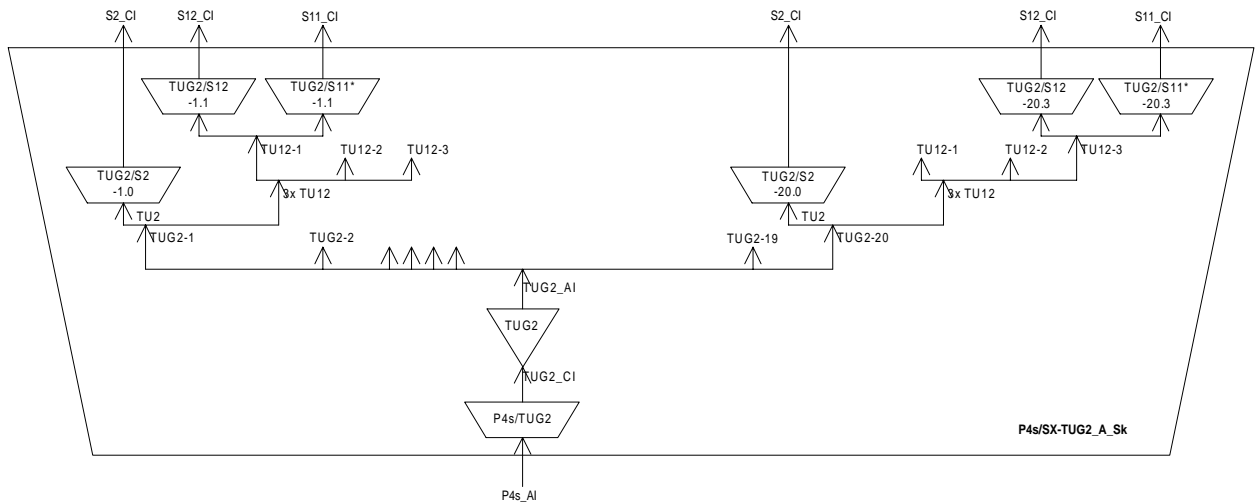
Figure 121: P4s/SX-TUG2_A_Sk compound function with set of TUG2/Sm_A_Sk atomic functions

Table 86: Possible TUG2/Sm_A_Sk functions of a P4s/SX-TUG2_A_Sk compound function

Atomic function	TU-2/TUG-2 number L	TU-12 number M
TUG2/S2_A_Sk/L.0	1 to 20	0
TUG2/S12_A_Sk/L.M	1 to 20	1 to 3
TUG2/S11*_A_Sk/L.M	1 to 20	1 to 3

For specific implementations only a subset of these TUG2/Sm_A_Sk functions may be used (e.g. a terminal multiplexer with fixed 2 Mbit/s access has 60 TUG2/S12_A_Sk functions). If a flexible TUG2 multiplex structure is supported, several TUG2/Sm_A_Sk functions may have access to the same TU timeslot. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults (e.g. cLOP) to be detected and reported. To prevent this an adaptation sink function can be deactivated. This is controlled by the equipment management function by activating/deactivating the functions according to the configured TUG multiplex structure.

NOTE 1: The P4s/TUG2_A_Sk, TUG2_T_Sk and TUG2/Sm_A_Sk (m = 2, 12, 11*) defined in the following subclauses can only be used in a P4s/SX-TUG2_A_Sk compound function. These functions can not be used as stand alone functions.

NOTE 2: The TUG2 is a virtual sub-layer only applicable in a P4s/SX-TUG2_A compound function.

9.3.4.1   P4s layer to TUG2 adaptation sink function P4s/TUG2_A_Sk

Symbol:

TUG2_CI

P4s/TUG2_A_Sk_MI ⟵⟶ P4s/TUG2
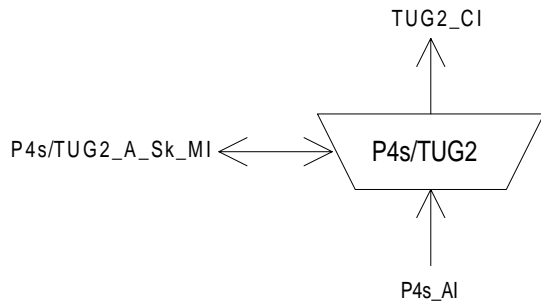
P4s_AI

Figure 122: P4s/TUG2_A_Sk symbol

Interfaces:

Table 87: P4s/TUG2_A_Sk input and output signals

Input(s)	Output(s)
P4s_AI_D	TUG2_CI_D
P4s_AI_CK	TUG2_CI_CK
P4s_AI_FS	TUG2_CI_FS
P4s_AI_TSF	TUG2_CI_MFS
P4s/TUG2_A_Sk_MI_Active	TUG2_CI_SSF_TUG2
	P4s/TUG2_A_Sk_MI_cPLM
	P4s/TUG2_A_Sk_MI_cLOM

NOTE: The P4s/TUG2_A_Sk functions can only be used in a P4s/SX-TUG2_A_Sk compound function. It can not be used as a standalone function.

Processes:

The function monitors two payload specific signals (bits 3-5 and bits 6-7) of the P4s POH.

MA[3-5]: The function shall compare the content of the accepted bits 3 to 5 of byte MA with the expected value code "011" (SDH elements mapping I: $20 \times$ TUG-2 structure) as a check on consistency between the provisioning operation at each end. The application, acceptance and mismatch detection processes are described in ETS 300 417-1-1 [8], subclauses 7.2 and 8.1.2.

MA[6-7]: The function shall recover the 500 µs (multi)frame start phase performing multi-frame alignment on bits 6 and 7 of byte MA. Out-of-multiframe (OOM) shall be assumed once when an error is detected in the MA bit 6 and 7 sequence. Multiframe alignment shall be assumed to be recovered, and the in-multiframe (IM) state shall be entered, when in four consecutive P4s frames an error free MA bit 6,7 sequence is found.

Figure 121 shows that more than one adaptation sink function exists in this P4s layer that can be connected to one P4s access point. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults (e.g. cPLM) to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall activate the SSF signals at its output (CI_SSF_TUG2) and not report its status via the management point.

Defects:

The function shall detect for the dPLM defect according ETS 300 417-1-1 [8], subclause 8.2.1.

If the multiframe alignment process is in the OOM state and the MA multiframe is not recovered within X ms, a dLOM defect shall be declared. Once in a dLOM state, this state shall be exited when the multiframe is recovered (multiframe alignment process enter the IM state). X shall be a value in the range 1 to 5 (ms). X is not configurable.

Consequent Actions:

aSSF_TUG2 $\leftarrow$ dPLM or dLOM

Defect Correlations:

cPLM $\leftarrow$ dPLM and (not AI_TSF)

cLOM $\leftarrow$ dLOM and (not AI_TSF) and (not dPLM)

Performance Monitoring: None.

9.3.4.2   **TUG2 trail termination sink function TUG2_T_Sk**

Symbol:
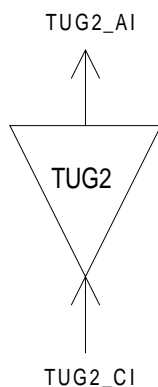
TUG2_AI

TUG2

TUG2_CI

Figure 123: TUG2_T_Sk symbol

Interfaces:

Table 88: TUG2_T_Sk input and output signals

Input(s)	Output(s)
TUG2_CI_D	TUG2_AI_D
TUG2_CI_CK	TUG2_AI_CK
TUG2_CI_FS	TUG2_AI_FS
TUG2_CI_SSF	TUG2_AI_TSF

NOTE: The TUG2_T_Sk function can only be used in a P4s/SX-TUG2_A_Sk compound function. It can not be used as a standalone function.

Processes: None.

Defects: None.

Consequent Actions:

aTSF ←   CI_SSF

Defect Correlations: None.

Performance Monitoring: None.

9.3.4.3 TUG2 to VC-2 layer adaptation sink function TUG2/S2_A_Sk/L.0

Symbol:

S2_CI

L=1..20

TUG2/S2_A_Sk_MI ⟷ TUG2/S2-L.0
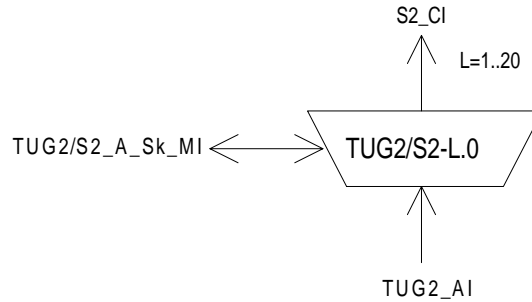
TUG2_AI

Figure 124: TUG2/S2_A_Sk symbol

Interfaces:

Table 89: TUG2/S2_A_Sk input and output signals

Input(s)	Output(s)
TUG2_AI_D	S2_CI_D
TUG2_AI_CK	S2_CI_CK
TUG2_AI_FS	S2_CI_FS
TUG2_AI_TSF_TG2	S2_CI_SSF
TUG2/S2_A_Sk_MI_AIS_Reported	TUG2/S2_A_Sk_MI_cLOP
TUG2/S2_A_Sk_MI_Active	TUG2/S2_A_Sk_MI_cAIS

NOTE: The TUG2/S2_A_Sk function can only be used in a P4s/SX-TUG2_A_Sk compound function. It can not be used as a standalone function.

Processes:

This function recovers VC-2 data with frame phase information from a TU-2.

V1, V2 - *TU-2 pointer interpretation:* The function shall perform TU-2 pointer interpretation as specified in annex B in ETS 300 417-1-1 [8] to recover the VC-2 frame phase within a TU-2 of a P4s.

Defects:

The function shall detect for dAIS and dLOP defect according the algorithm described under the pointer interpreter process in ETS 300 417-1-1 [8], annex B, Pointer Interpretation.

TU-2 timeslot: The adaptation source function has access to a specific TU-2 of the TUG access point. The TU-2 is defined by the parameter L (L=1 to 20).

Figure 121 shows that more than one adaptation sink function exists in this TUG2 virtual sub-layer that can be connected to one TUG2 access point. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults (e.g. cLOP) to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D) and not report its status via its management point.

Consequent Actions:

aAIS ← dAIS or dLOP or AI_TSF

aSSF ← dAIS or dLOP or AI_TSF

On declaration of aAIS the function shall output all-ONEs signal within 1 ms; on clearing of aAIS the function shall output the recovered data within 1 ms.

Defect Correlations:

cAIS ← dAIS and (not AI_TSF) and AIS_Reported

cLOP ← dLOP and (not AI_TSF)

It shall be an option to report AIS as a fault cause. This is controlled by means of the parameter AIS_Reported. The default shall be AIS_Reported = false.

Performance Monitoring: None.

9.3.4.4 TUG2 to VC-12 layer adaptation sink function TUG2/S12_A_Sk/L.M

Symbol:
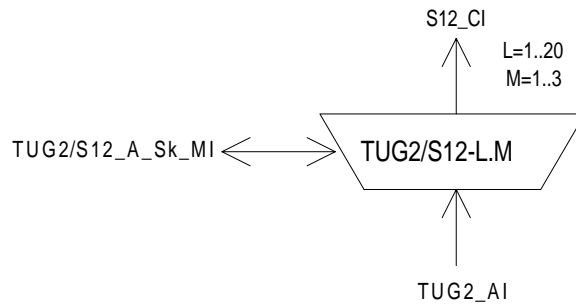
Figure 125: TUG2/S12_A_Sk symbol

Interfaces:

Table 90: TUG2/S12_A_Sk input and output signals

Input(s)	Output(s)
TUG2_AI_D	S12_CI_D
TUG2_AI_CK	S12_CI_CK
TUG2_AI_FS	S12_CI_FS
TUG2_AI_TSF	S12_CI_SSF
TUG2/S12_A_Sk_MI_AIS_Reported	TUG2/S12_A_Sk_MI_cLOP
TUG2/S12_A_Sk_MI_Active	TUG2/S12_A_Sk_MI_cAIS

> NOTE: The TUG2/S12_A_Sk functions can only be used in a P4s/SX-TUG2_A_Sk compound function. It can not be used as a standalone function.

Processes:

This function recovers VC-12 data with frame phase information from a TU-12.

V1, V2 - *TU-12 pointer interpretation:* The function shall perform TU-12 pointer interpretation as specified in annex B in ETS 300 417-1-1 [8] to recover the VC-12 frame phase within a TU-12 of a P4s.

TU-12 timeslot: The adaptation source function has access to a specific TU-12 of the TUG2 access point. The TU-12 is defined by the parameters L and M (L=1 to 20, M=1 to 3).

Figure 121 shows that more than one adaptation sink function exists in this TUG2 virtual sub-layer that can be connected to one TUG2 access point. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults (e.g. cLOP) to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D) and not report its status via its management point.

Defects:

The function shall detect for dAIS and dLOP defect according the algorithm described under the pointer interpreter process in ETS 300 417-1-1 [8], annex B, Pointer Interpretation.

Consequent Actions:

aAIS ←   dAIS or dLOP or AI_TSF

aSSF ←   dAIS or dLOP or AI_TSF

On declaration of aAIS the function shall output all ONEs signal within 1 ms; on clearing of aAIS the function shall output the recovered data within 1 ms.

Defect Correlations:

cAIS ←   dAIS and (not AI_TSF) and AIS_Reported

cLOP ←   dLOP and (not AI_TSF)

It shall be an option to report AIS as a fault cause. This is controlled by means of the parameter AIS_Reported. The default shall be AIS_Reported = false.

Performance Monitoring: None**.**

### 9.3.4.5 TUG2 to VC-11 layer adaptation sink function TUG2/S11*_A_Sk/L.M

Symbol:
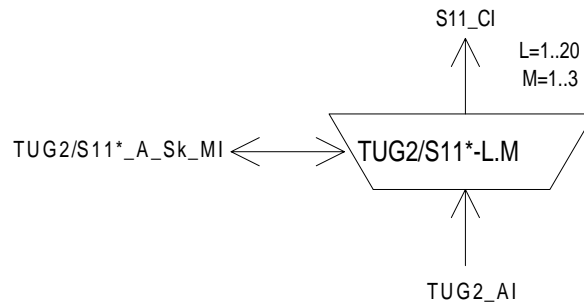
Figure 126: TUG2/S11*_A_Sk symbol

Interfaces:

Table 91: TUG2/S11*_A_Sk input and output signals

Input(s)	Output(s)
TUG2_AI_D	S11_CI_D
TUG2_AI_CK	S11_CI_CK
TUG2_AI_FS	S11_CI_FS
TUG2_AI_TSF	S11_CI_SSF
TUG2/S11*_A_Sk_MI_AIS_Reported	TUG2/S11*_A_Sk_MI_cLOP
TUG2/S11*_A_Sk_MI_Active	TUG2/S11*_A_Sk_MI_cAIS

NOTE: The TUG2/S11*_A_Sk functions can only be used in a P4s/SX-TUG2_A_Sk compound function. It can not be used as a standalone function.

Processes:

This function recovers VC-11 data with frame phase information from a TU-12:

V1, V2 - *TU-12 pointer interpretation:* The function shall perform TU-12 pointer interpretation as specified in annex B in ETS 300 417-1-1 [8] to recover the VC-11 frame phase within a TU-12 of a P4s.

TU-12 timeslot: The adaptation source function has access to a specific TU-12 of the TUG2 access point. The TU-12 is defined by the parameters L and M (L=1 to 20, M=1 to 3).

Figure 121 shows that more than one adaptation sink function exists in this TUG2 virtual sub-layer that can be connected to one TUG2 access point. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults (e.g. cLOP) to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D) and not report its status via its management point.

Defects:

The function shall detect for dAIS and dLOP defect according the algorithm described under the pointer interpreter process in ETS 300 417-1-1 [8], annex B, Pointer Interpretation.

Consequent Actions:

aAIS ← dAIS or dLOP or AI_TSF

aSSF ← dAIS or dLOP or AI_TSF

On declaration of aAIS the function shall output all ONEs signal within 1 ms; on clearing of aAIS the function shall output the recovered data within 1 ms.

Defect Correlations:

cAIS ← dAIS and (not AI_TSF_TUG2) and AIS_Reported

cLOP ← dLOP and (not AI_TSF_TUG2)

It shall be an option to report AIS as a fault cause. This is controlled by means of the parameter AIS_Reported. The default shall be AIS_Reported = false.

Performance Monitoring: None**.**

9.3.5 P4s layer to P0x layer adaptation source P4s/P0x_A_So

Symbol:
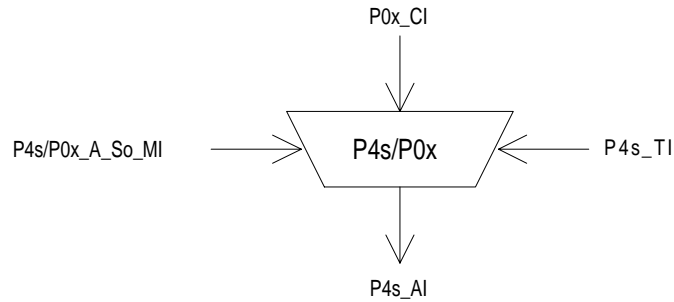
Figure 127: P4s/P0x_A_So symbol

Interfaces:

Table 92: P4s/P0x_A_So input and output signals

Input(s)	Output(s)
P0x_CI_D	P4s_AI_D
P0x_CI_CK	
P0x_CI_FS	
P4s_TI_CK	
P4s_TI_FS	
P4s/P0x_A_So_MI_Active	

Processes:

This function provides the multiplexing of a 64 kbit/s information stream into the P4s_AI using slip buffering. It takes P0x_CI, defined in ETS 300 166 [13] as an octet structured bit-stream with a rate of 64 kbit/s ± 100 ppm, present at its input and inserts it into the P4s POH byte GC as defined in ETS 300 337 [9] and depicted in figure 84.

Frequency justification and bitrate adaptation: The function shall provide for an elastic store (slip buffer) process. The data signal shall be written into the buffer under control of the associated input clock. The data shall be read out of the buffer under control of the P4s clock, frame position (P4s_TI), and justification decisions.

Each justification decision results in a corresponding negative/positive justification (slip) action. Upon a positive justification (slip) action, the reading of one 64 kbit/s octet (8 bits) shall be cancelled once. Upon a negative justification (slip) action, the same 64 kbit/s octet (8 bits) shall be read out a second time.

Buffer size: The elastic store (slip buffer) size shall be at least 2 octets.

Figure 83 shows that more than one adaptation source function exists in this P4s layer that can be connected to access point accessing the GC byte. For such case, one of these adaptation source functions is allowed to be activated. Access to the GC byte by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

9.3.6 P4s layer to P0x layer adaptation sink P4s/P0x_A_Sk

Symbol:
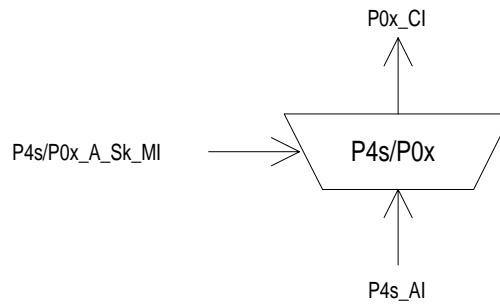
Figure 128: P4s/P0x_A_Sk symbol

Interfaces:

Table 93: P4s/P0x_A_Sk input and output signals

Input(s)	Output(s)
P4s_AI_D	P0x_CI_D
P4s_AI_CK	P0x_CI_CK
P4s_AI_FS	P0x_CI_FS
P4s_AI_TSF	
P4s/P0x_A_Sk_MI_Active	

Processes:

The function extracts the general communications channel byte GC from the P4s layer Characteristic Information. The recovered byte provides a 64 kbit/s channel for the client (user).

Smoothing and jitter limiting process: The function shall provide for a clock smoothing and elastic store (buffer) process. The data signal shall be written into the buffer under control of the associated (gapped) input clock. The data signal shall be read out of the buffer under control of a smoothed (equally spaced) 64 kHz clock (the rate is determined by the P4s signal generated at the remote node containing P4s/P0x_A_So). The residual jitter caused by pointer adjustments (measured at the 64 kbit/s interface) shall be within the limits specified in TBD.

Buffer size: In the presence of jitter as specified by TBD and a frequency within the range 64 kbit/s $\pm$ 4,6 ppm, this justification process shall not introduce any errors.

Following a step in frequency of the P0x signal transported by the P4s_AI (for example due to a frequency step of the server P4s signal, or removal of all-ONEs (AIS) signal with a frequency offset) there will be a maximum recovery time of X seconds after which this process shall not generate any bit errors.

The value of X is for further study; a value of 1 second has been proposed.

Figure 83 shows that more than one adaptation sink function exists in this P4s layer that can be connected to access point accessing the GC byte. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D).

Defects: None.

Consequent Actions:

aAIS ← AI_TSF

On declaration of aAIS the function shall output an all-ONEs (AIS) signal - complying to the frequency limits for this signal (a bit rate in range 64 kbit/s ± 100 ppm) - within 1 ms; on clearing of aAIS the function shall output normal data within 1 ms.

Defect Correlations: None.

Performance Monitoring: None.

9.3.7 P4s to V0x adaptation source P4s/V0x_A_So

Symbol:
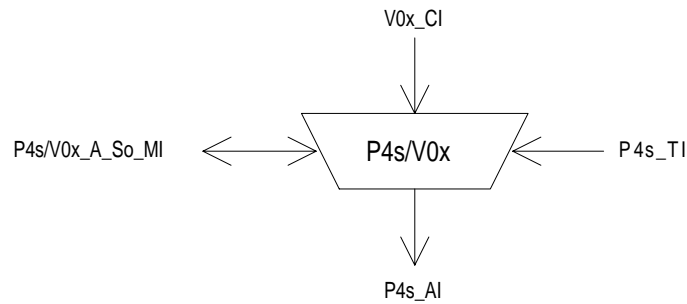
Figure 129: P4s/V0x_A_So symbol

Interfaces:

Table 94: P4s/V0x_A_So input and output signals

Input(s)	Output(s)
V0x_CI_D	P4s_AI_D
P4s_TI_CK	V0x_CI_CK
P4s_TI_FS	
P4s/V0x_A_So_MI_Active	

Processes:

This function multiplexes the V0x_CI data (64 kbit/s) into the byte location GC as defined in ETS 300 337 [9] and depicted in figure 84.

Figure 83 shows that more than one adaptation source function exists in this P4s layer that can be connected to access point accessing the GC byte. For such case, one of these adaptation source functions is allowed to be activated. Access to the GC byte by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

**9.3.8   P4s to V0x adaptation sink P4s/V0x_A_Sk**

Symbol:
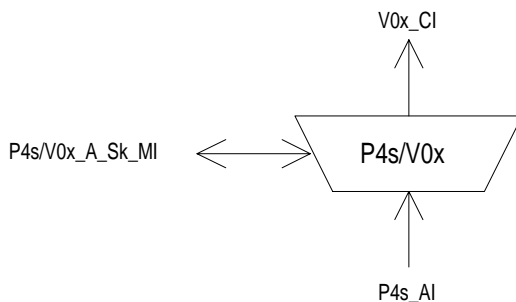
Figure 130: P4s/V0x_A_Sk symbol

Interfaces:

Table 95: P4s/V0x_A_Sk input and output signals

Input(s)	Output(s)
P4s_AI_D	V0x_CI_D
P4s_AI_CK	V0x_CI_CK
P4s_AI_FS	V0x_CI_SSF
P4s_AI_TSF	
P4s/V0x_A_Sk_MI_Active	

Processes:

This function separates user channel data from P4s Overhead (byte GC) as defined in ETS 300 337 [9] and depicted in figure 84.

Figure 83 shows that more than one adaptation sink function exists in this P4s layer that can be connected to access point accessing the GC byte. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D).

Defects: None.

Consequent Actions:

    aSSF ←   AI_TSF

On declaration of aAIS the function shall output an all-ONEs (AIS) signal - complying to the frequency limits for this signal (a bit rate in range 64 kbit/s ± TBD ppm) - within 1 ms; on clearing of aAIS the function shall output normal data within 1 ms.

Defect Correlations: None.

Performance Monitoring: None.

9.3.9 P4s to DCC adaptation source P4s/DCC_A_So

Symbol:
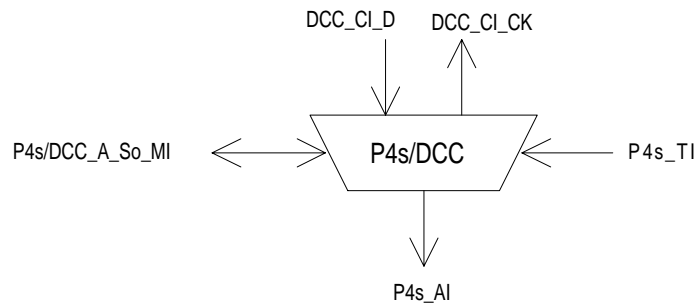
Figure 131: P4s/DCC_A_So symbol

Interfaces:

Table 96: P4s/DCC_A_Sk input and output signals

Input(s)	Output(s)
DCC_CI_D	P4s_AI_D
P4s_TI_CK	DCC_CI_CK
P4s_TI_FS	
P4s/DCC_A_So_MI_Active	

Processes:

The function multiplexes the DCC CI data (64 kbit/s) into the byte location GC as defined in ETS 300 337 [9] and depicted in figure 84 (see note 1).

> NOTE 1: DCC transmission can be "disabled" when the matrix connection in the connected DCC_C function is removed.

Figure 83 shows that more than one adaptation source function exists in this P4s layer that can be connected to access point accessing the GC byte. For such case, one of these adaptation source functions is allowed to be activated. Access to the GC byte by other adaptation source functions shall be denied.

Activation: The function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

9.3.10   P4s to DCC adaptation sink P4s/DCC_A_Sk

Symbol:
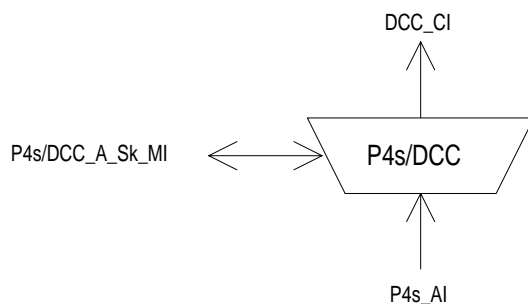
Figure 132: P4s/DCC_A_Sk symbol

Interfaces:

Table 97: P4s/DCC_A_Sk input and output signals

Input(s)	Output(s)
P4s_AI_D	DCC_CI_D
P4s_AI_CK	DCC_CI_CK
P4s_AI_FS	DCC_CI_SSF
P4s_AI_TSF	
P4s/DCC_A_Sk_MI_Active	

Processes:

The function separates DCC data from P4s Overhead (GC byte) as defined in ETS 300 337 [9] and depicted in figure 84 (see note 1).

NOTE 1:   DCC processing can be "disabled" when the matrix connection in the connected DCC_C function is removed.

Figure 83 shows that more than one adaptation sink function exists in this P4s layer that can be connected to access point accessing the GC byte. In contradiction with the source direction, adaptation sink functions may be activated all together. This will presumably cause faults to be detected and reported. To prevent this an adaptation sink function can be deactivated.

Activation: The function shall perform the operation specified above when it is activated (MI_Active is true). Otherwise, it shall transmit the all-ONEs signal at its output (CI_D).

Defects: None.

Consequent Actions:

aSSF ←   AI_TSF

Defect Correlations: None.

Performance Monitoring: None.

9.3.11 P4s to SD adaptation source P4s/SD_A_So

The specification of this function will be addressed in item ETS 300 417-6-1 [11].

9.3.12 P4s to SD adaptation sink P4s/SD_A_Sk

The specification of this function will be addressed in ETS 300 417-6-1 [11].

9.3.13 P4s to ATM VP compound adaptation source P4s/ATM_A_So

The specification of this function will be addressed under work item DEN/TM-01016 [12].

9.3.14 P4s to ATM VP compound adaptation sink P4s/ATM_A_Sk

The specification of this function will be addressed under work item DEN/TM-01016 [12].

9.4 P4s layer monitoring functions

9.4.1 P4s non-intrusive monitoring function P4sm_TT_Sk

Symbol:

P4s_AI_TSD
P4s_AI_TSF

P4sm_TT_Sk_MI

P4sm

P4s_CI
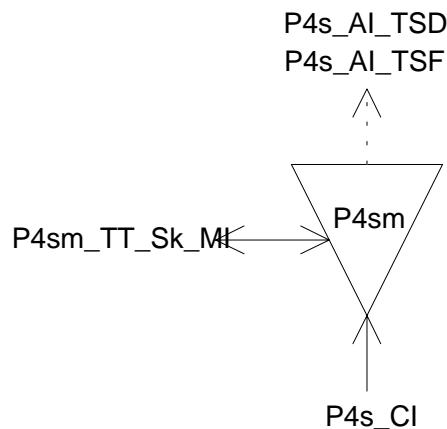
Figure 133: P4sm_TT_Sk symbol

Interfaces:

Table 98: P4sm_TT_Sk input and output signal

Input(s)	Output(s)
P4sm_CI_D	P4sm_AI_TSF
P4sm_CI_CK	P4sm_AI_TSD
P4sm_CI_FS	P4sm_TT_Sk_MI_cTIM
P4sm_CI_SSF	P4sm_TT_Sk_MI_cUNEQ
P4sm_TT_Sk_MI_TPmode	P4sm_TT_Sk_MI_cDEG
P4sm_TT_Sk_MI_SSF_Reported	P4sm_TT_Sk_MI_cRDI
P4sm_TT_Sk_MI_ExTI	P4sm_TT_Sk_MI_cSSF
P4sm_TT_Sk_MI_RDI_Reported	P4sm_TT_Sk_MI_AcTI
P4sm_TT_Sk_MI_DEGTHR	P4sm_TT_Sk_MI_pN_EBC
P4sm_TT_Sk_MI_DEGM	P4sm_TT_Sk_MI_pF_EBC
P4sm_TT_Sk_MI_1second	P4sm_TT_Sk_MI_pN_DS
P4sm_TT_Sk_MI_TIMdis	P4sm_TT_Sk_MI_pF_DS

NOTE 1: This non-intrusive monitor trail termination sink function has no associated source function.

Processes:

This function monitors for 34 Mbit/s frame errors and recovers the trail termination status as defined in ETS 300 337 [9]. It extracts the payload independent overhead bytes EM, TR, MA bits 1, 2 from the P4sm layer Characteristic information:

EM: Even bit parity (BIP-8) shall be computed for each bit n of every byte of the preceding frame and compared with bit n of EM recovered from the current frame (n=1 to 8 inclusive). A difference between the computed and recovered EM values shall be taken as evidence of one or more errors (nN_B) in the computation block.

TR: The 16 byte Trail Trace Identifier (TTI) shall be recovered from the TR byte and shall be made available for network management purposes. The application and the acceptance and mismatch detection process shall be performed as described in the ETS 300 417-1-1 [8], subclauses 7.1, and 8.2.1.3.

MA[1-2]: The relevant information carried in the MA byte (RDI in bit 1, REI in bit 2) shall be extracted to enable single ended maintenance of a bi-directional Trail. The REI (nF_B) shall be used to monitor the error performance of the reverse direction of transmission; the RDI provides information as to the status of the remote receiver. A "1" indicates a RDI state, while a "0" indicates the normal working state. The application process shall be performed as specified in ETS 300 417-1-1 [8], subclauses 7.4.2 (REI), 7.4.11 and 8.2 (RDI).

MA[3-5]: The information in the signal label bits shall be extracted to allow unequipped P4s and P4s-AIS defect detection.

Defects:

The detection and removal conditions and processes for dUNEQ, dDEG, dRDI and dTIM are described in ETS 300 417-1-1 [8], subclause 8.2.1 with the condition "aSSF" read as "aSSF or VC dAIS". To use the function within e.g. a tandem connection (see note 2), it shall be possible to disable the trace id mismatch detection (TIMdis).

> NOTE 2: Presumably, in such case the Trace Id. will be unknown to the tandem connection operator.

P4s AIS:
The function shall detect for an AIS condition by monitoring the P4s PSL for code "111". If 5 consecutive frames contain the "111" pattern in bits 3 to 5 of the MA byte a dAIS defect shall be detected. dAIS shall be cleared if in 5 consecutive frames any pattern other than the "111" is detected in bits 3 to 5 of the MA byte.

Consequent Actions:

aTSF   ← CI_SSF or dAIS or dUNEQ or dTIM

aTSD   ← dDEG

Defect Correlations:

cUNEQ   ← MON and dUNEQ

cTIM   ← MON and dTIM (and not dUNEQ)

cDEG   ← MON and dDEG and (not dUNEQ) and (not dTIM)

cRDI   ← MON and dRDI and (not dTIM) and (not dUNEQ) and RDI_Reported

cSSF   ← MON and (CI_SSF or dAIS) and SSF_Reported

It shall be an option to report SSF as a fault cause. This is controlled by means of the parameter SSF_Reported. The default shall be SSF_Reported = false.

It shall be an option to report RDI as a fault cause. This is controlled by means of the parameter RDI_Reported. The default shall be RDI_Reported = false.

Performance Monitoring:

The performance monitoring process shall be performed as specified in ETS 300 417-1-1 [8], subclause 8.2.4 through 8.2.7.

pN_DS   ←   aTSF or dEQ

pF_DS   ←   dRDI

pN_EBC   ←   ΣnN_B

pF_EBC   ←   ΣnF_B

> NOTE 3:   pF_DS/pF_EBC represent the performance of the total trail while pN_DS/pN_EBC represents only part of the trail up to the point of the non-intrusive monitor.

9.5 P4s layer trail protection functions

For further study.

9.6 P4s tandem connection sublayer functions

9.6.1 P4s tandem connection trail termination source function (P4sD_TT_So)

Symbol:
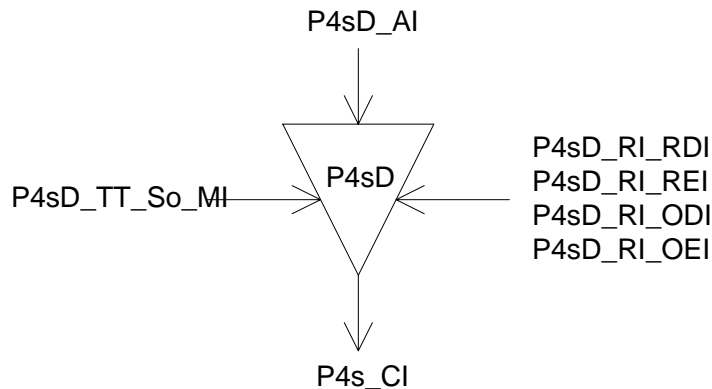
Figure 134: P4sD_TT_So symbol

Interfaces:

Table 99: P4sD_TT_So input and output signals

Input(s)	Output(s)
P4sD_AI_D	P4s_CI_D
P4sD_AI_CK	P4s_CI_CK
P4sD_AI_FS	P4s_CI_FS
P4sD_AI_SF	
P4sD_RI_RDI	
P4sD_RI_REI	
P4sD_RI_ODI	
P4sD_RI_OEI	
P4sD_TT_So_MI_TxTI	

Processes:

NR[8][73]: The function shall insert the TC RDI code within 1 multiframe (9,5 ms) after the RDI request generation (RI_RDI)) in the tandem connection trail termination sink function. It ceases TC RDI code insertion within 1 multiframe (9,5 ms) after the TC RDI request has cleared.

> NOTE: NR[x][y] refers to bit x (x = 7,8) of byte NR in frame y (y=1 to 76) of the 76 frame multiframe.

NR[5]: The function shall insert the RI_REI value in the REI bit in the following frame.

NR[7][74]: The function shall insert the ODI code within 1 multiframe (9,5 ms) after the ODI request generation (aODI)) in the tandem connection trail termination sink function. It ceases ODI code insertion at the first opportunity after the ODI request has cleared.

NR[6]: The function shall insert the RI_OEI value in the OEI bit in following frame.

NR[7-8]: The function shall insert in the multiframed NR[7-8] channel:

- the Frame Alignment Signal (FAS) "1111 1111 1111 1110" in FAS bits in frames 1 to 8;
- the TC trace identifier, received via MI_TxTI, in the TC-TI bits in frames 9 to 72;
- the TC RDI (NR[8][73]) and ODI (NR[7][74]) signals; and
- all-0s in the six reserved bits in frames 73 to 76.

NR[1-4]: Even BIP-8 shall be computed for each bit n of every byte of the preceding incoming P4s frame (P4s_AI) including EM byte and compared with byte EM recovered from the current frame. A difference between the computed and recovered BIP-8 values shall be taken as evidence of one or more errors in the computation block, and shall be inserted in bits 1 to 4 of byte NR (figure 76, table 54). If AI_SF is true, code "1110" shall be inserted in bits 1 to 4 of byte NR instead of the number of incoming BIP-8 violations.
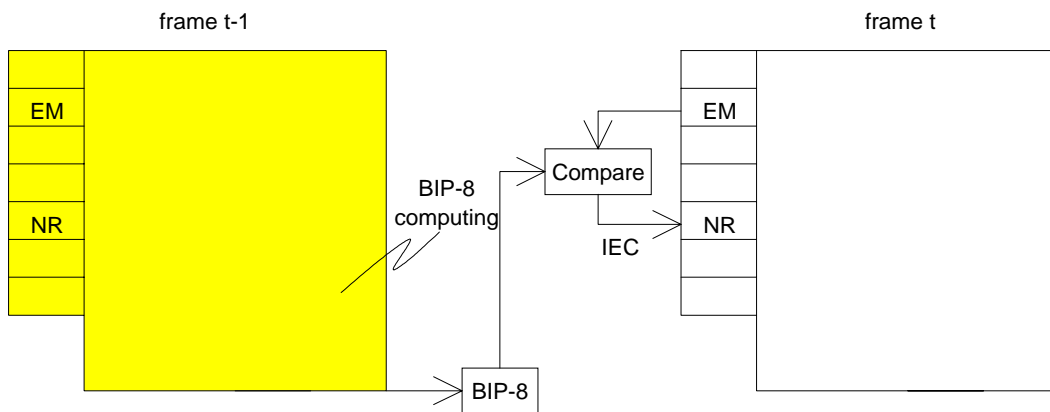
Figure 135: TC IEC computing and insertion

Table 100: IEC code generation

Number of BIP-8 violations	NR[1]	NR[2]	NR[3]	NR[4]
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
0	1	0	0	1

EM: The function shall compensate the P4s BIP8 (in EM) according the following rule:

Since the BIP-8 parity check is taken over the P4s (including NR), writing into NR at the P4sD_TT_So will affect the P4s path parity calculation. Unless this is compensated for, a device which monitors P4s path parity within the Tandem Connection (e.g., a non-intrusive monitor) may incorrectly count errors. The BIP-8 parity bits should always be consistent with the current state of the P4S. Therefore, whenever NR is written, BIP-8 shall be modified to compensate for the change in the NR value. Since the BIP-8 value in a given frame reflects a parity check over the previous frame (including the BIP-8 bits in that frame), the changes made to the BIP-8 bits in the previous frame shall also be considered in the compensation of BIP-8 for the current frame. Therefore, the following equation shall be used for BIP-8 compensation:

$$EM[i]'(t) = EM[i](t-1) \oplus EM[i]'(t-1) \oplus NR[i](t-1) \oplus NR[i]'(t-1) \oplus EM[i](t)$$

Where:

- EM[i] = the existing EM[i] value in the incoming signal;
- EM[i]' = the new (compensated) EM[i] value;
- NR[i] = the existing NR[i] value in the incoming signal;
- NR[i]' = the new value written into the NR[i] bit;
- $\oplus$ = exclusive OR operator;
- t = the time of the current frame;
- t-1 = the time of the previous frame.

Figure 136: EM[i], i=1 to 8 compensating process

Defects: None.

Consequent Actions: None.

Defect Correlations: None.

Performance Monitoring: None.

9.6.2 P4s tandem connection trail termination sink function (P4sD_TT_Sk)

Symbol:

P4sD_AI

P4sD_TT_Sk_MI

P4sD

P4sD_RI_RDI
P4sD_RI_REI
P4sD_RI_ODI
P4sD_RI_OEI
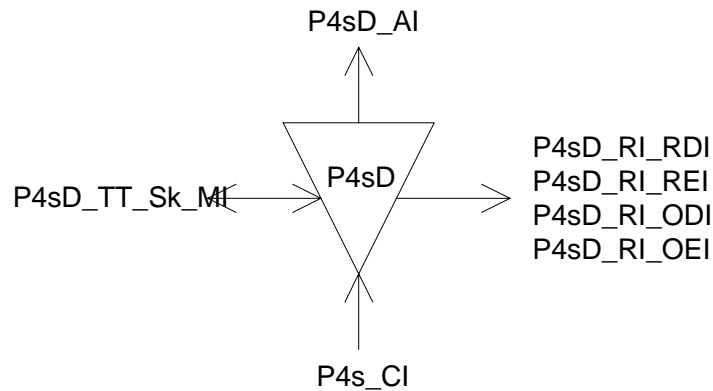
P4s_CI

Figure 137: P4sD_TT_Sk symbol

Interfaces:

Table 101: P4sD_TT_Sk input and output signals

Input(s)	Output(s)
P4s_CI_D	P4sD_AI_D
P4s_CI_CK	P4sD_AI_CK
P4s_CI_FS	P4sD_AI_FS
P4s_CI_SSF	P4sD_AI_TSF
P4sD_TT_Sk_MI_ExTI	P4sD_AI_TSD
P4sD_TT_Sk_MI_SSF_Reported	P4sD_AI_OSF
P4sD_TT_Sk_MI_RDI_Reported	P4sD_TT_Sk_MI_cLTC
P4sD_TT_Sk_MI_ODI_Reported	P4sD_TT_Sk_MI_cTIM
P4sD_TT_Sk_MI_TIMdis	P4sD_TT_Sk_MI_cUNEQ
P4sD_TT_Sk_MI_DEGM	P4sD_TT_Sk_MI_cDEG
P4sD_TT_Sk_MI_DEGTHR	P4sD_TT_Sk_MI_cRDI
P4sD_TT_Sk_MI_1second	P4sD_TT_Sk_MI_cSSF
	P4sD_TT_Sk_MI_cODI
	P4sD_TT_Sk_MI_AcTI
	P4sD_RI_RDI
	P4sD_RI_REI
	P4sD_RI_ODI
	P4sD_RI_OEI
	P4sD_TT_Sk_MI_pN_EBC
	P4sD_TT_Sk_MI_pF_EBC
	P4sD_TT_Sk_MI_pN_DS
	P4sD_TT_Sk_MI_pF_DS
	P4sD_TT_Sk_MI_pON_EBC
	P4sD_TT_Sk_MI_pOF_EBC
	P4sD_TT_Sk_MI_pON_DS
	P4sD_TT_Sk_MI_pOF_DS

Processes:

TC EDC violations: Even bit parity shall be computed for each bit n of every byte of the preceding P4s and compared with bit n of EM recovered from the current frame (n=1 to 8 inclusive). A difference between the computed and recovered EM values shall be taken as evidence of one or more errors in the computation block (nON_B). The magnitude (absolute value) of the difference between this calculated number of errors and the number of errors written into the IEC (see table 56) at the trail termination source shall be used to determine the error performance of the tandem connection for each transmitted P4s (figure 79). If this magnitude of the difference is one or more, an errored TC block is detected (nN_B).

NOTE 1: The EM data and the IEC read in the current frame both apply to the previous frame.

Table 102: IEC code interpretation

NR[1]	NR[2]	NR[3]	NR[4]	IEC code interpretation
0	0	0	0	0 errors
0	0	0	1	1 error
0	0	1	0	2 errors
0	0	1	1	3 errors
0	1	0	0	4 errors
0	1	0	1	5 errors
0	1	1	0	6 errors
0	1	1	1	7 errors
1	0	0	0	8 errors
1	0	0	1	0 errors
1	0	1	0	0 errors
1	0	1	1	0 errors
1	1	0	0	0 errors
1	1	0	1	0 errors
1	1	1	0	0 errors
1	1	1	1	0 errors

Figure 138: P4sD and P4s BIP-8 computing and comparison

NR[1-4]: The function shall extract the Incoming Error Code (IEC). It shall accept the received code without further processing.

NR[7-8][9-72]: The Received Trail Trace Identifier RxTI shall be recovered from the tandem connection trail trace identifier overhead and shall be made available as AcTI for network management purposes. The application and acceptance process shall be performed as specified in ETS 300 417-1-1 [8], subclauses 7.1, and 8.2.1.3. The mismatch detection process shall be as specified below.

The trace identifier process in this function is required to support "mode 1" (ETS 300 417-1-1 [8], subclause 7.1) operation only. "Old" tandem connection equipment does not exist.

NR[1-4]: The function shall extract the Incoming AIS code.

NR[5], NR[8][73]: The information carried in the REI, RDI bits in byte NR shall be extracted to enable single ended maintenance of a bi-directional tandem connection Trail. The REI (nF_B) shall be used to monitor the error performance of the other direction of transmission, and the RDI shall be used to provide information as to the status of the remote receiver. A "1" indicates a Remote Defect Indication state, while a "0" indicates the normal, working state. The application process shall be performed as specified in ETS 300 417-1-1 [8], subclauses 7.4.2 (REI), 7.4.11 and 8.2 (RDI).

NR[6], NR[7][74]: The information carried in the OEI, ODI bits in byte NR shall be extracted to enable single ended (intermediate) maintenance of a the P4s egressing the tandem connection Trail. The OEI (nOF_B) shall be used to monitor the error performance of the other direction of transmission, and the ODI shall be used to provide information as to the status of the remote receiver. A "1" indicates a Outgoing Defect Indication state, while a "0" indicates the normal, working state. The application process shall be performed equivalent to the remote maintenance case, as specified in ETS 300 417-1-1 [8], subclauses 7.4.2 (REI/OEI), 7.4.11 and 8.2 (RDI/ODI).

NR[7-8] - *Multiframe alignment:* The function shall perform a multiframe alignment on bits 7 and 8 of byte NR to recover the TTI, RDI, and ODI signals transported within the multiframed bits. The multiframe alignment shall be found by searching for the pattern "1111 1111 1111 1110" within the bits 7 and 8 of byte NR. The signal shall be continuously checked with the presumed multiframe start position for the alignment.

Frame alignment is deemed to have been lost (entering Out Of Multiframe (OOM) state) when two consecutive FAS are detected in error (i.e. ≥ 1 error in each FAS);

Frame alignment is deemed to have been recovered (entering In Multiframe (IM) state) when one non-errored FAS is found.

NR: The function shall terminate NR channel by inserting an all-ZEROs pattern.

EM: The function shall compensate the P4s BIP8 in byte EM according the algorithm defined in P4sD_TT_So.

Defects:

TC Unequipped (dUNEQ):
The function shall detect for an unequipped Tandem Connection (UNEQ) condition by monitoring byte NR for code "00000000". The algorithm shall be according subclause 8.2.1.2 in ETS 300 417-1-1 [8], in which "accepted TSL" shall be read as "accepted NR byte".

TC Loss of Tandem Connection (dLTC):
The function shall detect for the presence/absence of the tandem connection overhead in the byte NR by evaluating the multiframe alignment signal in bits 7 and 8 of byte NR. The loss of tandem connection defect (dLTC) shall be detected if the multiframe alignment process is in the OOM state. The dLTC shall be cleared if the multiframe alignment process is in the IM state.

TC Connectivity (Trace Identifier) (dTIM):
The function shall detect for a TC mis-connection condition by monitoring the TC trace identifier. The Trace Identifier Mismatch defect (dTIM) shall be detected and cleared within a maximum period of 1 s in the absence of bit errors.

The defect detection process and its operation during the presence of bit errors is for further study.

The defect shall be suppressed during the receipt of SSF.

It shall be possible to disable the trace identifier mismatch defect detection (TIMdis).

TC Signal Degrade (dDEG):
The function shall detect for a TC signal degrade defect condition by monitoring for TC BIP-8 violations. The algorithm shall be according subclause 8.2.1.4 in ETS 300 417-1-1 [8].

TC Remote Defect (dRDI):
The function shall detect for a TC remote defect indication defect condition by monitoring the TC RDI signal. The algorithm shall be according subclause 8.2.1.5 in ETS 300 417-1-1 [8].

TC Remote Outgoing P4S Defect (dODI):
The function shall detect for a TC remote outgoing P4S defect indication defect condition by monitoring the TC ODI signal. The algorithm shall be according subclause 8.2.1.5 in ETS 300 417-1-1 [8].

Incoming AIS (dIncAIS):
The function shall detect for a tandem connection incoming AIS condition by monitoring the IEC bits in byte NR for code "1110". If 5 consecutive frames contain the "1110" pattern in the IEC bits a dIncAIS defect shall be detected. dIncAIS shall be cleared if in 5 consecutive frames any pattern other than the "1110" is detected in the IEC bits.

> NOTE 2:   Bits 1 to 4 of byte NR support two applications: conveying the incoming error information (table 56) and conveying the incoming AIS information to the TC tail end. Codes 0000 to 1101, 1111 represent IncAIS is false, code 1110 represents IncAIS is true.

Consequent Actions:

The function shall perform the following consequent actions (refer to subclause 8.2.2 in ETS 300 417-1-1 [8]):

aAIS   ←   dUNEQ or dTIM or dLTC

aTSF   ←   CI_SSF or dUNEQ or dTIM or dLTC

aTSD   ←   dDEG

aRDI   ←   CI_SSF or dUNEQ or dTIM or dLTC

aREI   ←   nN_B

aODI   ←   CI_SSF or dUNEQ or dTIM or dIncAIS or dLTC

aOEI   ←   nON_B

aOSF   ←   CI_SSF or dUNEQ or dTIM or dLTC or dIncAIS

The function shall insert the all-ONEs (AIS) signal within 250 µs after AIS request generation (aAIS), and cease the insertion within 250 µs after the AIS request has cleared.

Defect Correlations:

The function shall perform the following defect correlations (refer to subclause 8.2.3 in ETS 300 417-1-1 [8]):

cUNEQ ←   MON and dUNEQ

cLTC   ←   MON and (not dUNEQ) and dLTC

cTIM   ←   MON and (not dUNEQ) and (not dLTC) and dTIM

cDEG   ←   MON and (not dTIM) and (not dLTC) and dDEG

cSSF   ←   MON and CI_SSF and SSF_reported

cRDI   ←   MON and (not dUNEQ) and (not dTIM) and (not dLTC) and dRDI and RDI_Reported

cODI   ←   MON and (not dUNEQ) and (not dTIM) and (not dLTC) and dODI and ODI_Reported

It shall be an option to report SSF as a fault cause. This is controlled by means of the parameter SSF_Reported. The default shall be SSF_Reported = false.

It shall be an option to report RDI as a fault cause. This is controlled by means of the parameter RDI_Reported. The default shall be RDI_Reported = false.

It shall be an option to report ODI as a fault cause. This is controlled by means of the parameter ODI_Reported. The default shall be ODI_Reported = false.

Performance Monitoring:

The following TC error performance parameters shall be counted for each 1-second period (refer to subclauses 8.2.4 to 8.2.7 in ETS 300 417-1-1 [8]):

pN_DS ← aTSF or dEQ

pF_DS ← dRDI

pN_EBC ← ΣnN_B

pF_EBC ← ΣnF_B

pON_DS ← aODI or dEQ

pOF_DS ← dODI

pON_EBC ← ΣnON_B

pOF_EBC ← ΣnOF_B

pN_EBC and pN_DS do not represent the actual performance monitoring support within an equipment. For that, these pN_DS/pN_EBC signals shall be connected to performance monitoring functions within the element management function. Similar for the far-end signals pF_EBC and pF_DS and for pON_EBC/pON_DS, pOF_EBC/pOF_DS.

9.6.3   P4s tandem connection to p4s adaptation source function (P4sD/P4s_A_So)

Symbol:

P4s_CI

P4sD/P4s   ← P4s_TI

P4sD_AI

Figure 139: P4sD/P4s_A_So symbol

Interfaces:

Table 103: P4sD/P4s_A_So input and output signals

Input(s)	Output(s)
P4s_CI_D	P4sD_AI_D
P4s_CI_CK	P4sD_AI_CK
P4s_CI_FS	P4sD_AI_FS
P4s_CI_SSF	P4sD_AI_SF
P4s_TI_CK	

Processes:

NOTE 1:   The function has no means to verify the existence of a tandem connection within the incoming signal. Nested tandem connections are not supported.

The function shall replace the incoming P4s signal (P4s_CI) by a local generated P4s frame with valid FA1 and FA2 bytes and all ONEs for all other bytes (i.e. enter "holdover") if an all-ONEs (AIS) P4S is received (i.e. if CI_SSF is TRUE).

NOTE 2:   The local frame start is generated with the P4s_TI timing.

Defects: None.

Consequent Actions:

AI_SF←   CI_SSF

Defect Correlations: None.

Performance Monitoring: None.

9.6.4   P4s tandem connection to p4s adaptation sink function (P4sD/P4s_A_Sk)

Symbol:

P4s_CI
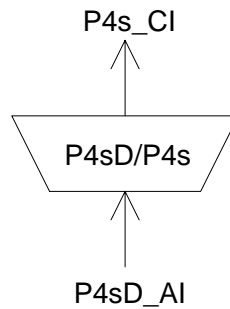
P4sD/P4s

P4sD_AI

Figure 140: P4sD/P4s_A_Sk symbol

Interfaces:

Table 104: P4sD/P4s_A_Sk input and output signals

Input(s)	Output(s)
P4sD_AI_D	P4s_CI_D
P4sD_AI_CK	P4s_CI_CK
P4sD_AI_FS	P4s_CI_FS
P4sD_AI_OSF	P4s_CI_SSF

Processes:

The function shall restore the invalid frame start condition (i.e. output aSSF = true) if that existed at the ingress of the tandem connection.

> NOTE 1:   In addition, the invalid frame start condition is activated on a tandem connection connectivity defect condition that causes all-ONEs (AIS) insertion in the P4sD_TT_Sk.

Defects: None.

Consequent Actions:

aAIS ←   AI_OSF

aSSF ←   AI_OSF

The function shall insert the all-ONEs (AIS) signal within 250 µs after AIS request generation (aAIS), and cease the insertion within 250 µs after the AIS request has cleared.

Defect Correlations: None.

Performance Monitoring: None.

9.6.5   P4s tandem connection non-intrusive trail termination sink function (P4sDm_TT_Sk)

Symbol:

P4sD_AI_TSF
P4sD_AI_TSD

P4sDm_TT_Sk_MI ⟶ | P4sDm |
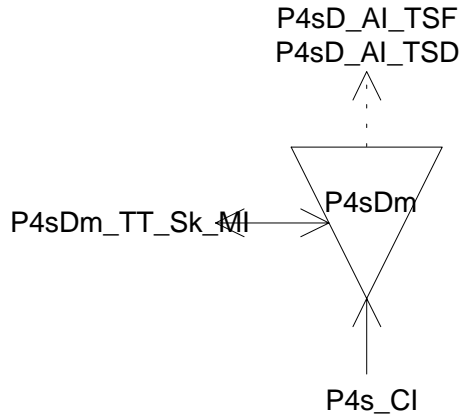
P4s_CI

Figure 141: P4sDm_TT_Sk symbol

Interfaces:

Table 105: P4sDm_TT_Sk input and output signals

Input(s)	Output(s)
P4s_CI_D	P4sD_AI_TSF
P4s_CI_CK	P4sD_AI_TSD
P4s_CI_FS	P4sDm_TT_Sk_MI_cLTC
P4s_CI_SSF	P4sDm_TT_Sk_MI_cTIM
P4sDm_TT_Sk_MI_ExTI	P4sDm_TT_Sk_MI_cUNEQ
P4sDm_TT_Sk_MI_SSF_Reported	P4sDm_TT_Sk_MI_cDEG
P4sDm_TT_Sk_MI_RDI_Reported	P4sDm_TT_Sk_MI_cRDI
P4sDm_TT_Sk_MI_ODI_Reported	P4sDm_TT_Sk_MI_cSSF
P4sDm_TT_Sk_MI_TIMdis	P4sDm_TT_Sk_MI_cODI
P4sDm_TT_Sk_MI_DEGM	P4sDm_TT_Sk_MI_AcTI
P4sDm_TT_Sk_MI_DEGTHR	P4sDm_TT_Sk_MI_pN_EBC
P4sDm_TT_Sk_MI_1second	P4sDm_TT_Sk_MI_pF_EBC
	P4sDm_TT_Sk_MI_pN_DS
	P4sDm_TT_Sk_MI_pF_DS
	P4sDm_TT_Sk_MI_pOF_EBC
	P4sDm_TT_Sk_MI_pOF_DS

Processes:

This function can be used to perform the following:

1)   single ended maintenance of the TC by monitoring at an intermediate node, using remote information (RDI,REI);
2)   aid in fault localization within TC trail by monitoring near-end defects;
3)   monitoring of P4S performance at TC egressing point (except for connectivity defects before the TC) using remote outgoing information (ODI,OEI),

TC EDC violations: Even bit parity shall be computed for each bit n of every byte of the preceding P4s and compared with bit n of EM recovered from the current frame (n=1 to 8 inclusive). A difference between the computed and recovered EM values shall be taken as evidence of one or more errors in the computation block (nON_B). The magnitude (absolute value) of the difference between this calculated number of errors and the number of errors written into the IEC (see table 56) at the trail termination source shall be used to determine the error performance of the tandem connection for each transmitted P4s (figure 79). If this magnitude of the difference is one or more, an errored TC block is detected (nN_B). Refer to P4sD_TT_Sk.

NR[1-4]: The function shall extract the Incoming Error Code (IEC). It shall accept the received code without further processing.

NR[7-8][9-72]: The Received Trail Trace Identifier RxTI shall be recovered from the tandem connection trail trace identifier overhead and shall be made available as AcTI for network management purposes. The application and acceptance process shall be performed as specified in ETS 300 417-1-1 [8], subclauses 7.1, and 8.2.1.3. The mismatch detection process shall be as specified below.

The trace identifier process in this function is required to support "mode 1" (ETS 300 417-1-1 [8], subclause 7.1) operation only. "Old" tandem connection equipment does not exist.

NR[1-4]: The function shall extract the Incoming AIS code.

NR[5], NR[8][73]: The information carried in the REI, RDI bits in byte NR shall be extracted to enable single ended maintenance of a bi-directional tandem connection Trail. The REI (nF_B) shall be used to monitor the error performance of the other direction of transmission, and the RDI shall be used to provide information as to the status of the remote receiver. A "1" indicates a Remote Defect Indication state, while a "0" indicates the normal, working state. The application process shall be performed as specified in ETS 300 417-1-1 [8], subclauses 7.4.2 (REI), 7.4.11 and 8.2 (RDI).

NR[6], NR[7][74]: The information carried in the OEI, ODI bits in byte NR shall be extracted to enable single ended (intermediate) maintenance of a the P4s egressing the tandem connection Trail. The OEI (nOF_B) shall be used to monitor the error performance of the other direction of transmission, and the ODI shall be used to provide information as to the status of the remote receiver. A "1" indicates a Outgoing Defect Indication state, while a "0" indicates the normal, working state. The application process shall be performed equivalent to the remote maintenance case, as specified in ETS 300 417-1-1 [8], subclauses 7.4.2 (REI/OEI), 7.4.11 and 8.2 (RDI/ODI).

NR[7-8] - *Multiframe alignment:* The function shall perform a multiframe alignment on bits 7 and 8 of byte NR to recover the TTI, RDI, and ODI signals transported within the multiframed bits. The multiframe alignment shall be found by searching for the pattern "1111 1111 1111 1110" within the bits 7 and 8 of byte NR. The signal shall be continuously checked with the presumed multiframe start position for the alignment.

Frame alignment is deemed to have been lost (entering Out Of Multiframe (OOM) state) when two consecutive FAS are detected in error (i.e. ≥ 1 error in each FAS);

Frame alignment is deemed to have been recovered (entering In Multiframe (IM) state) when one non-errored FAS is found.

Defects:

TC Unequipped (dUNEQ):
The function shall detect for an unequipped Tandem Connection (UNEQ) condition by monitoring byte NR for code "00000000". The algorithm shall be according subclause 8.2.1.2 in ETS 300 417-1-1 [8], in which "accepted TSL" shall be read as "accepted NR byte".

TC Loss of Tandem Connection (dLTC):
The function shall detect for the presence/absence of the tandem connection overhead in the byte NR by evaluating the multiframe alignment signal in bits 7 and 8 of byte NR. The loss of tandem connection defect (dLTC) shall be detected if the multiframe alignment process is in the OOM state. The dLTC shall be cleared if the multiframe alignment process is in the IM state.

TC Connectivity (Trace Identifier) (dTIM):
The function shall detect for a TC mis-connection condition by monitoring the TC trace identifier. The Trace Identifier Mismatch defect (dTIM) shall be detected and cleared within a maximum period of 1 s in the absence of bit errors.

The defect detection process and its operation during the presence of bit errors is for further study.

The defect shall be suppressed during the receipt of SSF.

It shall be possible to disable the trace identifier mismatch defect detection (TIMdis).

TC Signal Degrade (dDEG):
The function shall detect for a TC signal degrade defect condition by monitoring for TC BIP-8 violations. The algorithm shall be according subclause 8.2.1.4 in ETS 300 417-1-1 [8].

TC Remote Defect (dRDI):
The function shall detect for a TC remote defect indication defect condition by monitoring the TC RDI signal. The algorithm shall be according subclause 8.2.1.5 in ETS 300 417-1-1 [8].

TC Remote Outgoing P4S Defect (dODI):
The function shall detect for a TC remote outgoing P4S defect indication defect condition by monitoring the TC ODI signal. The algorithm shall be according subclause 8.2.1.5 in ETS 300 417-1-1 [8].

Consequent Actions:

aTSF   ←   CI_SSF or dUNEQ or dTIM or dLTC

aTSD   ←   dDEG

Defect Correlations:

The function shall perform the following defect correlations (refer to subclause 8.2.3 in ETS 300 417-1-1 [8]):

cUNEQ ←   MON and dUNEQ

cLTC   ←   MON and (not dUNEQ) and dLTC

cTIM   ←   MON and (not dUNEQ) and (not dLTC) and dTIM

cDEG   ←   MON and (not dTIM) and (not dLTC) and dDEG

cSSF   ←   MON and CI_SSF and SSF_reported

cRDI   ←   MON and (not dUNEQ) and (not dTIM) and (not dLTC) and dRDI and RDI_reported

cODI   ←   MON and (not dUNEQ) and (not dTIM) and (not dLTC) and dODI and ODI_Reported

It shall be an option to report SSF as a fault cause. This is controlled by means of the parameter SSF_Reported. The default shall be SSF_Reported = false.

It shall be an option to report RDI as a fault cause. This is controlled by means of the parameter RDI_Reported. The default shall be RDI_Reported = false.

It shall be an option to report ODI as a fault cause. This is controlled by means of the parameter ODI_Reported. The default shall be ODI_Reported = false.

Performance Monitoring:

The following TC error performance parameters shall be counted for each 1-second period (refer to subclauses 8.2.4 to 8.2.7 in ETS 300 417-1-1 [8]):

$pN\_DS \leftarrow aTSF$ or dEQ

$pF\_DS \leftarrow dRDI$

$pN\_EBC \leftarrow \Sigma nN\_B$

$pF\_EBC \leftarrow \Sigma nF\_B$

$pOF\_DS \leftarrow dODI$

$pOF\_EBC \leftarrow \Sigma nOF\_B$

10   P4x path layer functions

P4x layer CP

The Characteristic Information CI at this point is a 139 264 kbit/s bit stream of any content; e.g. P4s, P4e, or without standardized frame.

There are currently no P4x atomic functions defined. P4x_CP is defined only, supporting fixed interconnections.

11   P32x path layer functions

P32x layer CP

The Characteristic Information CI at this point is a 44 736 kbit/s bit stream of any content.

There are currently no P32x atomic functions defined. P32x_CP is defined only, supporting fixed interconnections.

12   P31x path layer functions

P31x layer CP

The Characteristic Information CI at this point is a 34 368 kbit/s bit stream of any content; e.g. P31s, P31e, or without standardized frame.

There are currently no P31x atomic functions defined. P31x_CP is defined only, supporting fixed interconnections.

13   P22x path layer functions

P22x layer CP

The Characteristic Information CI at this point is a 8 448 kbit/s bit stream of any content; e.g. P22e, or without standardized frame.

There are currently no P22x atomic functions defined. P22x_CP is defined only, supporting fixed interconnections.

14   P12x path layer functions

P12x layer CP

The Characteristic Information CI at this point is a 2 048 kbit/s bit stream of any content; e.g. P12s, ISDN PRA, or without standardized frame.

There are currently no P12x atomic functions defined. P12x_CP is defined only, supporting fixed interconnections.

15   P11x path layer functions

P11x layer CP

The Characteristic Information CI at this point is a 1 544 kbit/s bit stream of any content.

There are currently no P11x atomic functions defined. P11x_CP is defined only, supporting fixed interconnections.

16   P0x path layer functions

P0x layer CP

The Characteristic Information CI at this point is a 64 kbit/s bit stream of any content.

There are currently no P0x atomic functions defined. P0x_CP is defined only, supporting fixed interconnections.

Annex A (informative): Relationship between TU-2/12 address, and location of columns within a P4s TUG3 structured payload
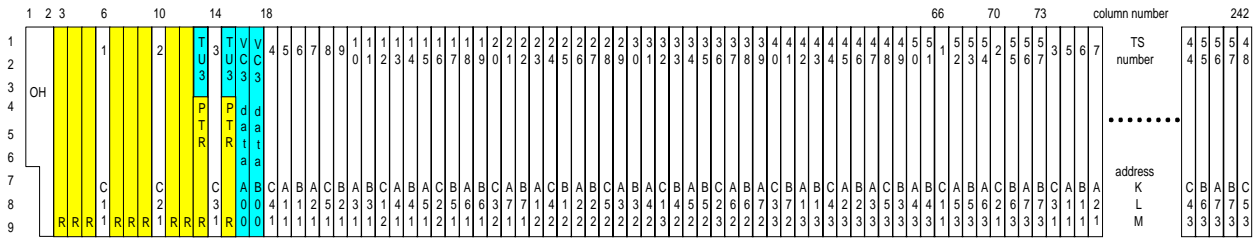
Figure A.1: P4s TUG3 payload (TUGs and fixed stuff "R" bytes)

Table A.1

TU-3 address			location of columns in a P4s-TUG3 occupied by TU-3 (K, L, M)											
K	L	M													
A	0	0	13	16	19	21	24	27	29	32	35	37	40	43
			45	48	51	53	56	59	61	64	67	69	72	75
			77	80	83	85	88	91	93	96	99	101	104	107
			109	112	115	117	120	123	125	128	131	133	136	139
			141	144	147	149	152	155	157	160	163	165	168	171
			173	176	179	181	184	187	189	192	195	197	200	203
			205	208	211	213	216	219	221	224	227	229	232	235
			237	240										
B	0	0	15	17	20	23	25	28	31	33	36	39	41	44
			47	49	52	55	57	60	63	65	68	71	73	76
			79	81	84	87	89	92	95	97	100	103	105	108
			111	113	116	119	121	124	127	129	132	135	137	140
			143	145	148	151	153	156	159	161	164	167	169	172
			175	177	180	183	185	188	191	193	196	199	201	204
			207	209	212	215	217	220	223	225	228	231	233	236
			239	241										

Table A.2

TU-2 address			location of columns in a P4s-TUG3 occupied by TU-2 (K, L, M)											
K	L	M	1	2	3	4	5	6	7	8	9	10	11	12
A	1	0	19	37	56	75	93	112	131	149	168	187	205	224
A	2	0	21	40	59	77	96	115	133	152	171	189	208	227
A	3	0	24	43	61	80	99	117	136	155	173	192	211	229
A	4	0	27	45	64	83	101	120	139	157	176	195	213	232
A	5	0	29	48	67	85	104	123	141	160	179	197	216	235
A	6	0	32	51	69	88	107	125	144	163	181	200	219	237
A	7	0	35	53	72	91	109	128	147	165	184	203	221	240
B	1	0	20	39	57	76	95	113	132	151	169	188	207	225
B	2	0	23	41	60	79	97	116	135	153	172	191	210	228
B	3	0	25	44	63	81	100	119	137	156	175	193	212	231
B	4	0	28	47	65	84	103	121	140	159	177	196	215	233
B	5	0	31	49	68	87	105	124	143	161	180	199	218	236
B	6	0	33	52	71	89	108	127	145	164	183	201	220	239
B	7	0	36	55	73	92	111	129	148	167	185	204	223	241
C	1	0	6	26	46	66	86	106	126	146	166	186	206	226
C	2	0	10	30	50	70	90	110	130	150	170	190	210	230
C	3	0	14	34	54	74	94	114	134	154	174	194	214	234
C	4	0	18	38	58	78	98	118	138	158	178	198	218	238
C	5	0	22	42	62	82	102	122	142	162	182	202	222	242

Table A.3: (every 56th column)

TU-12 address			location of columns in a P4sTUG3			
K	L	M	occupied by TU-12 (K, L, M)			
A	1	1	19	75	131	187
A	1	2	37	93	149	205
A	1	3	56	112	168	224
A	2	1	21	77	133	189
A	2	2	40	96	152	208
A	2	3	59	115	171	227
A	3	1	24	80	136	192
A	3	2	43	99	155	211
A	3	3	61	117	173	229
A	4	1	27	83	139	195
A	4	2	45	101	157	213
A	4	3	64	120	176	232
A	5	1	29	85	141	197
A	5	2	48	104	160	216
A	5	3	67	123	179	235
A	6	1	32	88	144	200
A	6	2	51	107	163	219
A	6	3	69	125	181	237
A	7	1	35	91	147	203
A	7	2	53	109	165	221
A	7	3	72	128	184	240

Table A.4: (every 56th column)

TU-12 address			location of columns in a P4sTUG3			
K	L	M	occupied by TU-12 (K, L, M)			
B	1	1	20	76	132	188
B	1	2	39	95	151	207
B	1	3	57	113	169	225
B	2	1	23	79	135	191
B	2	2	41	97	153	210
B	2	3	60	116	172	228
B	3	1	25	81	137	193
B	3	2	44	100	156	212
B	3	3	63	119	175	231
B	4	1	28	84	140	196
B	4	2	47	103	159	215
B	4	3	65	121	177	233
B	5	1	31	87	143	199
B	5	2	49	105	161	218
B	5	3	68	124	180	236
B	6	1	33	89	145	201
B	6	2	52	108	164	220
B	6	3	71	127	183	239
B	7	1	36	92	148	204
B	7	2	55	111	167	223
B	7	3	73	129	185	241

Table A.5: (every 60th column)

TU-12 address			location of columns in a P4sTUG3			
K	L	M	occupied by TU-12 (K, L, M)			
C	1	1	6	66	126	186
C	1	2	26	86	146	206
C	1	3	46	106	166	226
C	2	1	10	70	130	190
C	2	2	30	90	150	210
C	2	3	50	110	170	230
C	3	1	14	74	134	194
C	3	2	34	94	154	214
C	3	3	54	114	174	234
C	4	1	18	78	138	198
C	4	2	38	98	158	218
C	4	3	58	118	178	238
C	5	1	22	82	142	202
C	5	2	42	102	162	222
C	5	3	62	122	182	242

Annex B (informative): **Relationship between TU-2/12 address, and location of columns within a P4s TUG2 structured payload**

**Figure B.1: P4s TUG2 payload (20 x TUG2)**

Table B.1

TU-2 address		location of columns in a P4s-TUG2 occupied by TU-2 (K, L, M)											
L	M	1	2	3	4	5	6	7	8	9	10	11	12
1	0	3	23	43	63	83	103	123	143	163	183	203	223
2	0	4	24	44	64	84	104	124	144	164	184	204	224
3	0	5	25	45	65	85	105	125	145	165	185	205	225
4	0	6	26	46	66	86	106	126	146	166	186	206	226
5	0	7	27	47	67	87	107	127	147	167	187	207	227
6	0	8	28	48	68	88	108	128	148	168	188	208	228
7	0	9	29	49	69	89	109	129	149	169	189	209	229
8	0	10	30	50	70	90	110	130	150	170	190	210	230
9	0	11	31	51	71	91	111	131	151	171	191	211	231
10	0	12	32	52	72	92	112	132	152	172	192	212	232
11	0	13	33	53	73	93	113	133	153	173	193	213	233
12	0	14	34	54	74	94	114	134	154	174	194	214	234
13	0	15	35	55	75	95	115	135	155	175	195	215	235
14	0	16	36	56	76	96	116	136	156	176	196	216	236
15	0	17	37	57	77	97	117	137	157	177	197	217	237
16	0	18	38	58	78	98	118	138	158	178	198	218	238
17	0	19	39	59	79	99	119	139	159	179	199	219	239
18	0	20	40	60	80	100	120	140	160	180	200	220	240
19	0	21	41	61	81	101	121	141	161	181	201	221	241
20	0	22	42	62	82	102	122	142	162	182	202	222	242

Table B.2: (every 60th column)

TU-12 address		location of columns in a P4sTUG2			
L	M	occupied by TU-12 (L, M)			
1	1	3	63	123	183
1	2	23	83	143	203
1	3	43	103	163	223
2	1	4	64	124	184
2	2	24	84	144	204
2	3	44	104	164	224
3	1	5	65	125	185
3	2	25	85	145	205
3	3	45	105	165	225
4	1	6	66	126	186
4	2	26	86	146	206
4	3	46	106	166	226
5	1	7	67	127	187
5	2	27	87	147	207
5	3	47	107	167	227
6	1	8	68	128	188
6	2	28	88	148	208
6	3	48	108	168	228
7	1	9	69	129	189
7	2	29	89	149	209
7	3	49	109	169	229

Table B.3: (every 60th column)

TU-12 address		location of columns in a P4sTUG2			
L	M	occupied by TU-12 (L, M)			
8	1	10	70	130	190
8	2	30	90	150	210
8	3	50	110	170	230
9	1	11	71	131	191
9	2	31	91	151	211
9	3	51	111	171	231
10	1	12	72	132	192
10	2	32	92	152	212
10	3	52	112	172	232
11	1	13	73	133	193
11	2	33	93	153	213
11	3	53	113	173	233
12	1	14	74	134	194
12	2	34	94	154	214
12	3	54	114	174	234
13	1	15	75	135	195
13	2	35	95	155	215
13	3	55	115	175	235
14	1	16	76	136	196
14	2	36	96	156	216
14	3	56	116	176	236

Table B.4: (every 60th column)

TU-12 address		location of columns in a P4sTUG2			
L	M	occupied by TU-12 (L, M)			
15	1	17	77	137	197
15	2	37	97	157	217
15	3	57	117	177	237
16	1	18	78	138	198
16	2	38	98	158	218
16	3	58	118	178	238
17	1	19	79	139	199
17	2	39	99	159	219
17	3	59	119	179	239
18	1	20	80	140	200
18	2	40	100	160	220
18	3	60	120	180	240
19	1	21	81	141	201
19	2	41	101	161	221
19	3	61	121	181	241
20	1	22	82	142	202
20	2	42	102	162	222
20	3	62	122	182	242

Annex C (informative): Bibliography

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History

Document history		
February 1997	Public Enquiry	PE 9724: 1997-02-14 to 1997-06-13