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User Description, SDH/STM-1 AXE Exchange Terminal

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1 Introduction

The ET is the key product involved in connecting the AXE system to the surrounding world. All services provided by this product are gathered in one magazine. Exchange Terminals are found in all AXE exchanges regardless of AXE configuration or the type of network.

The ET155 ETSI is the interface unit between an SDH/STM-1 (G.707, 155 Mb/s, see reference on page 82) Synchronous Digital Path and the Group Switch in an exchange. The ET155 terminates STM-1 (i.e. 1953 time slots) PCM trunks.

The ET155 ETSI is implemented as a BYB 501 type product and is housed in a separate magazine together with the RP4-pair. One ET 155 magazine can house a maximum two ETC155s. ET 155s are connected to Group Switches via DL-3 interfaces.

The figure 1 illustrates the use of an ET155 in an application involving the combination of a Base Station Controller, a Mobile Switching Center, an International Exchange, a Transit Exchange and a Local Exchange.

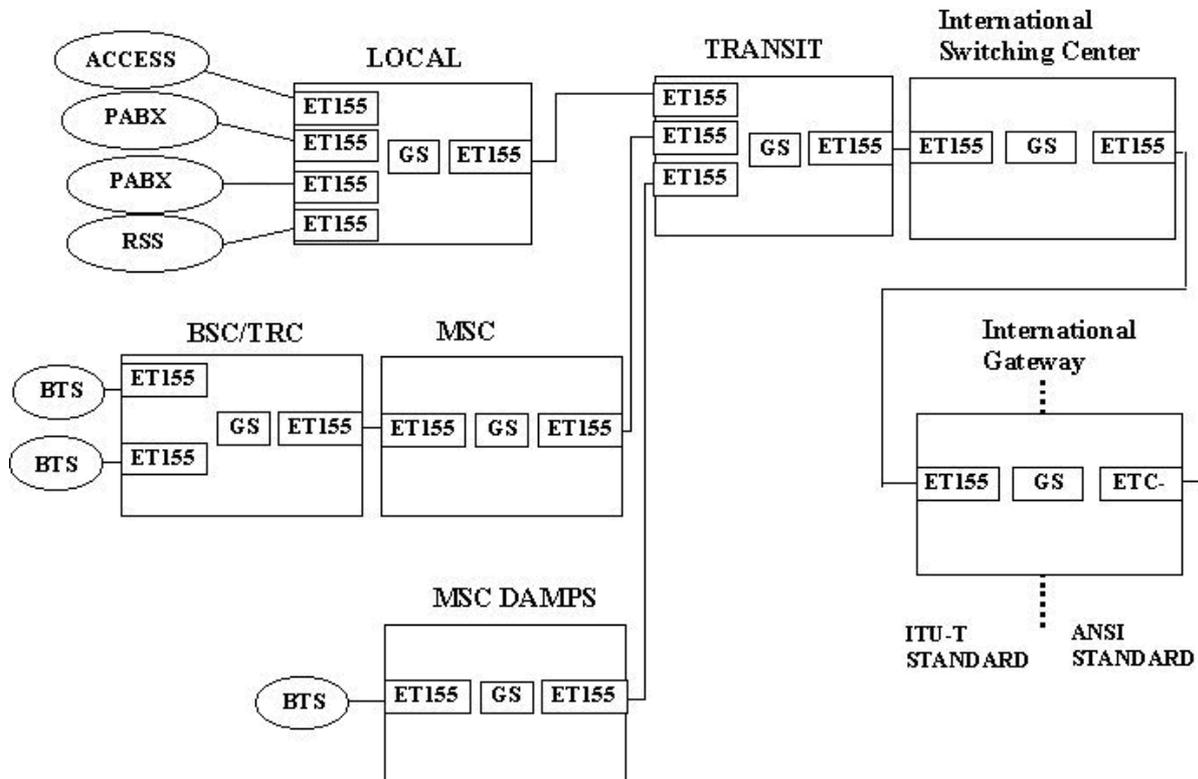


Figure 1 An example of the use of the ET 155

In BSS the use of ET 155 is illustrated in figure 2 where BSC and MSC with STM-1 interfaces are connected to the SDH Product Package, see user description, SDH Product Package on page 83.

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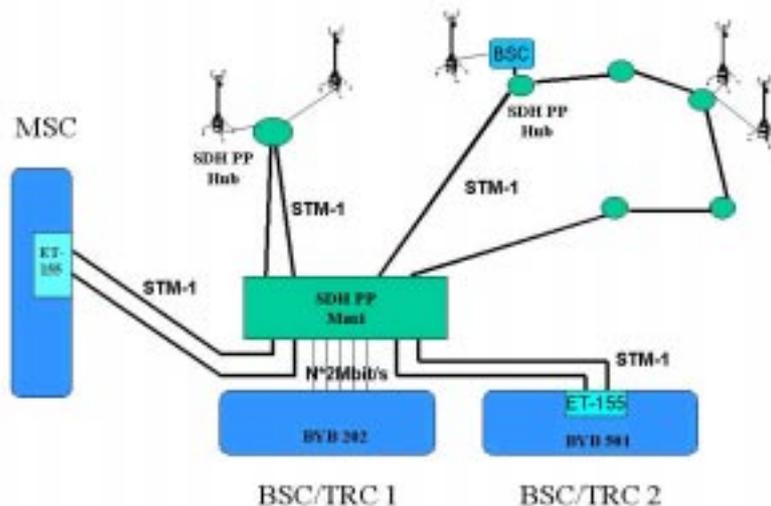


Figure 2 Network showing the use of ET 155 and the SDH Product Package in BSS.

2 Glossary

2.1 Abbreviations and acronyms

ADM	Add Drop Multiplexer
API	Access Point Identifier
APS	Automatic Protection Switching
ATM	Asynchronous Transfer Mode
AIS	Alarm Indication Signal
Anomaly	See M.20, section 3.2.1, see reference on page 82.
AU	Administrative Unit
AUG	Administrative Unit Group
BIP	Bit Interleaved Parity
BSC	Base Station Controller
BTS	Base Transceiver Station

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CAS	Channel Associated Signalling
CCS	Common Channel Signalling
CME20	Cellular Mobile Telephone System 20, GSM
CRC	Cyclic Redundancy Check
DCC	Digital Cross Connect
DB	Data Base
Defect	See M.20, section 3.2.2, see reference on page 82.
DEG	Degraded
DEGM	DEGraded defect Monitoring period
DEGTHR	DEGraded defect THReshold
DIP	Digital Path
DQDB	
DXX	Ericsson Cellular Transmission System
E1	2.048 Mbit/s interface
ERATE	Excessive bit error Rate
ES	Errored Seconds
ESL	Errored Seconds Limit
ET	Exchange Termination, Exchange Terminal. The Exchange Terminal consists of hardware and software.
ETC	Exchange Terminal Circuit. Exchange Terminal Circuit is the hardware part of the ET.
FAS	Frame Alignment Signal
FDDI	Fiber Distributed Data Interface
FS	Function Specification
GS	Group Switch
HP	Higher order Path
HPA	Higher order Path Adaptation

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HPC	Higher order Path Connection
HPOM	Higher order Path Overhead Monitor
HPT	Higher order Path Termination
HUG	Higher order path Unequipped Generator
ITU-T	International Telecommunication Union, Telecommunication Standardization Sector (formerly known as CCITT).
kbps	Kilobit/sec
LOF	Loss Of Frame alignment
LOM	Loss Of Multiframe
LOP	Loss Of Pointer
LOS	Loss Of Signal
LP	Lower order Path
LPA	Lower order Path Adaptation
LPC	Lower order Path Connection
LPOM	Lower order Path Overhead Monitor
LPT	Lower order Path Termination
LUG	Lower order Unequipped Generator
MAN	
Mbps	Megabit/sec
MFS	MultiFrame Structure
MS	Multiplex Section
MSP	Multiplex Section Protection
MSA	Multiplex Section Adaptation
MST	Multiplex Section Termination
OOF	Out Of Frame state
PC	Peg Counters
PCM	Pulse Code Modulation
PDH	Plesiochronous Digital Hierarchy

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PLM	PayLoad Mismatch
POH	Path Over Head
RBS	Radio Base Station
RDI	Remote Defect Indication (Previously called Remote Alarm Indication)
REFM	Remote End Fault indication, Multiframe structure(TS16 bit 6)
REI	Remote Error Indication
RFI	Remote Failure Indication
RR2-ES	Reset Report for Errored Seconds
RR2-SES	Reset Report for Severely Errored Seconds
RST	Regenerator Section Termination
RT1-ES	Reset Threshold for Errored Seconds
RT1-SES	Reset Threshold for Severely Errored Seconds
RTR1-ES	Reset Threshold Report for Errored Seconds
RTR1-SES	Reset Threshold Report for Severely Errored Seconds
SD	Signal Degrade
SDH	Synchronous Digital Hierarchy
SDIP	Synchronous Digital Path
SES	Severely Errored Seconds
SF	Slip Frequency or Signal Fail
SMF	Sub-Multi-Frame
SMI	Suspect Marked Interval
SNT	Switching Network Terminal. Switching Network Terminal is an equipment connected to the switch.
SOH	Section Overhead
ST	Status Counters
ST1-ES	Set Threshold for Errored Seconds
ST1-SES	Set Threshold for Severely Errored Seconds
ST2-ES	Set Threshold for Errored Seconds

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ST2-SES	Set Threshold for Severely Errored Seconds
SPI	SDH Physical Interface
STM-n	Synchronous Transport Module (-N)
TI	Time Interval (for SF supervision)
TIM	Trace Identifier Mismatch
TR1-ES	Threshold Report for Errored Seconds
TR1-SES	Threshold Report for Severely Errored Seconds
TR2-ES	Threshold Report for Errored Seconds
TR2-SES	Threshold Report for Severely Errored Seconds
TRC	Transcoder Controller
TS	Time Slot
TS0	Time Slot number 0
TS16	Time Slot number 16
TTI	Trail Trace Identifier
TU-n	Tributary Unit
TUG	Tributary Unit Group
UNEQ	Unequipped
VC-n	Virtual Container

3 Capabilities

3.1 General

The ET 155 ETSI is an Exchange Terminal that carries sixty-three 2 Mb/s signals mapped into SDH containers. Two different functional units (circuit boards) are used in the construction of an ET 155 - a Higher Order Termination Unit (HOT) and a Lower Order Termination Unit (LOT). The HOT board terminates the STM-1 Section Overhead (SOH) and the Higher Order Path (HP), whereas one LOT board terminates sixteen TU-12 signals (LP termination) and their corresponding 2 Mb/s signals. Four LOT boards are required to terminate sixty-three TU-12 signals.

One of the HOT boards operates in working mode, the other operates in standby mode, providing Multiplexor Section Protection (MSP 1+1) and HOT board Equipment Protection. One LOT board is used as a standby for the four working LOT boards.

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The ET 155 has an optical intra-office interface (S-1.1, wavelength 1310 nm).

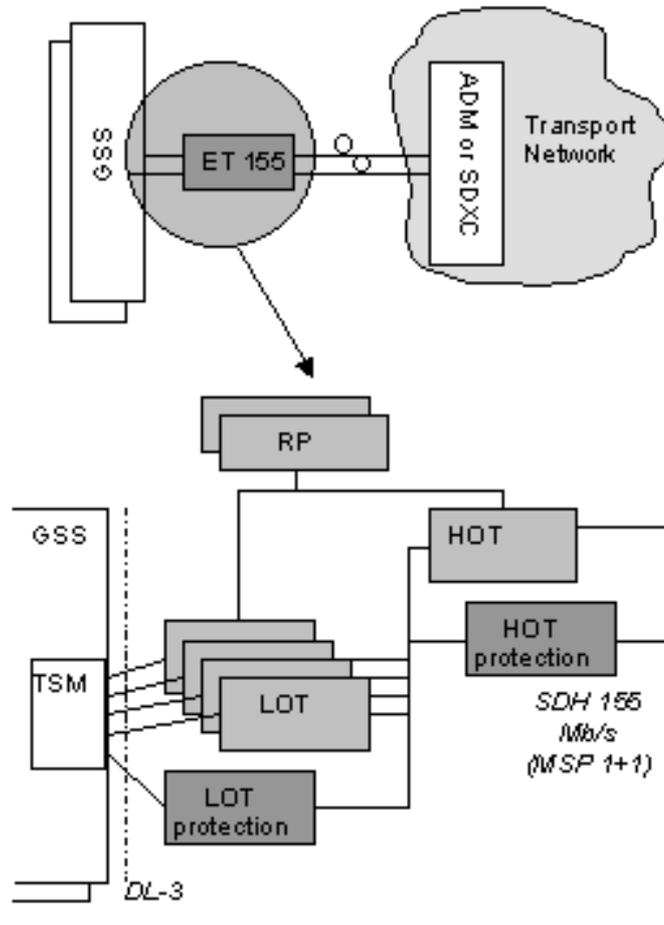


Figure 3 The ET 155 ETSI configuration

3.2 ET 155 features

Introduction

The ET155 is based on ITU-T recommendations, ETSI standards and stable drafts as of March 1998. The ET155 comprises the following functions/features:

- Optical Intra Office Interface S-1.1 1310 nm interface
- Asynchronous mapping/multiplexing of 2 Mbit/s signals in: VC-12->TU-12->TUG-2->TUG-3->VC-4->AU-4->AUG->STM-1.
- Termination and generation of Section Over Head (SOH), for Regenerator Section (RSOH) and Multiplex Section (MSOH)

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- Termination and generation of Path Over Head (POH), for VC-4 and VC-12 levels. Including 16 bytes Trail Trace Identifier (TTI) for both levels of transmission.
- Fault management/supervision on SDH level (MS, VC-4, VC-12) and on PDH level (for 2 Mbit/s PCM (E1 interfaces) included in STM-1/SDH).
- Alarm correlation between DIP/SDIP and the different layers within the SDH hierarchy.
- Performance monitoring/quality supervision on SDH level (MS, VC-4, VC-12) and on PDH level (for 2 Mbit/s PCM (E1 interfaces) included in STM-1/SDH).
- Equipment protection. Realized by redundant hardware connected to a special protection inlet in the group switch.
- Network protection: MSP 1+1, permanently bridged, non-revertive, combined with equipment protection. Realized by redundant HW and duplicated STM-1 interface.
- Partly equipped STM-1 frames can be supported (variable number of VC-12s).
- Individual supervision, test, fault localisation and restoration for each of the up-to seven boards included in an ET155 through a new concept of SUBSNTs within SNT.
- N User Parts can be supported. This means that the payload in STM-1 can consist of traffic from several signalling systems/ user parts. The user part devices are connected in groups of 32 channels (2 Mbit/s) to the ET155 SNTs. User parts for ISUP/TUP, old RSS (RT) and new RSS (RST, Access 910) can be connected to ET155 via ETDIF blocks.
- Tone sending in one or both directions on 64 Kbit/s level.
- Handling of frame slips on 2 Mbit/s level.
- 8 kHz signal can be derived from one or both STM-1 signals for synchronisation of the group switch, if protection is available.
- Possibility to assign a predefined fixed SSM pattern for the 2 Mbit/s level (one of four Sa-bits) and on the MS level.
- APZ supported tying and downloading of device processor (DP) SW.

The set of parts belongs to subsystem TSS and interworks with set of parts TUP and/or ISUP in TSS. For the Tone Sending function it can interwork with the user part via the RMP connection manager, or directly. It also interworks with the set of parts GSBASE and NETSYNCH in subsystem GSS, and with subsystems OMS and STS as well as system APZ. The set of parts may also interwork with user parts in other subsystems. For instance it can interwork with user parts RT and RST in SSS. When interworking with other subsystems, the ETDIF block is included in the relevant subsystem, whereas the blocks belonging to the CRT remains in TSS.

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The ET155 HW is realized as shown in figure 3. The exact amount of boards depends on configuration alternative chosen, e.g. protection (standby boards) may not be included. A fully equipped magazine is shown in figure 4.

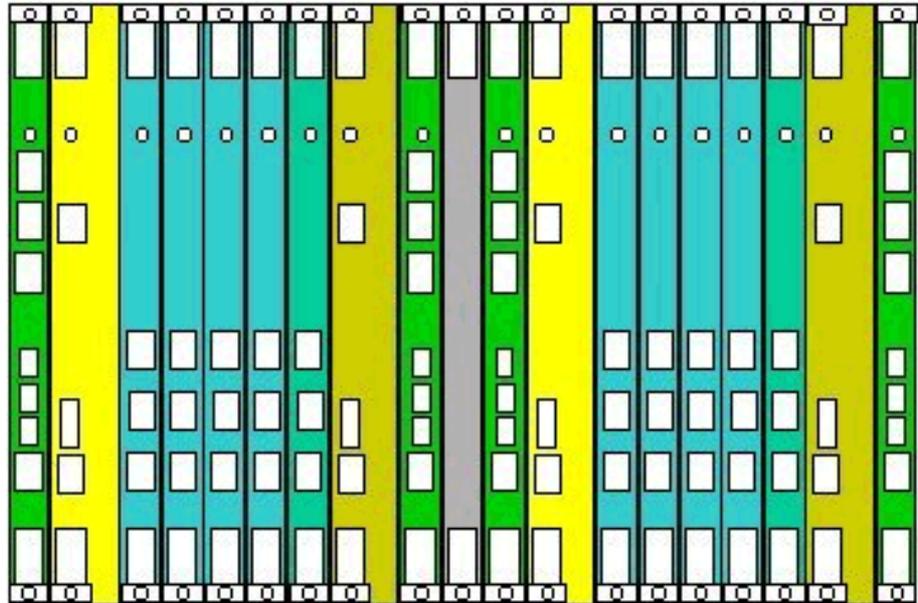


Figure 4 ET 155 magazine, fully equipped with an optical line interface and full protection.

3.3 Function Overview

Here follows a short description over the functions in ET155 and what is included in the more detailed descriptions in the later chapters.

3.3.1 2048 Kbit/s Digital Path Termination in STM-1, Administration and Maintenance.

A description of the administration and maintenance functions for 2048 Kbit/s digital path termination in a STM-1 system. Furthermore a description of the supervision functions used to locate faults in digital transmission systems and isolate such faults, the principles for quality supervision and how administration of the digital path is performed. Additional details in sub-chapters.

The function is mainly implemented in block DIPST, but with regional and device processor software belonging to block ET. A separate block DIPHID is used for storing performance/quality data for the digital path terminations.

3.3.1.1 Fault supervision

The purpose of Fault Supervision is to detect transmission faults, so that new calls are not set up on faulty transmission equipment. The basic principle is that when a defect occurs, it is first filtered for a while (normally 2.5 seconds) until it is regarded as a fault. Then the concerned transmission equipment is blocked for new traffic. An operator alarm is normally also given.

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If the defect then ceases, a new filtering period (normally 10 seconds) is started. After the completion of this period, the alarm to operator will be withdrawn and the concerned transmission equipment is put back in traffic.

3.3.1.2 Quality supervision

The transmission performance of the 2 Mbit/s digital path terminations (DIPs) in the SDH/STM-1 is supervised according to the ITU-T M.2100/M.2120 recommendations, see reference on page 82, which involves thresholding functions as well as rules for short-term storage of data. Basic performance parameters are errored, severely errored and unavailable seconds (ES, SES and UAS). An ES is a second with more than one bit error, an SES is a second with bit errors in at least 30% of all monitored blocks or a defect in the transmission. SES is a subset of ES. UAS are seconds excluded from the evaluation of performance due to transition into unavailable state. Unavailable state is declared after 10 consecutive SES and lasts until there has been 10 consecutive no-SES. During unavailable state no thresholding will occur, since in this state there is assumed to be an actual, permanent failure of the transmission and the performance of the link in this state is therefore not of any interest. ES, SES and UAS is counted for both directions of transmission.

3.3.1.2.1 Thresholding functions

There are two different monitoring periods, 15 minutes and 24 hours. The 15 minute monitoring period is used for thresholding against limits meant to signify unacceptable performance. Limits for unacceptable performance are set 10 to 100 times the reference performance objective as outlined by ITU-T for a given distance and transmission media. The 24 hours monitoring is used for thresholding against limits meant to signify degraded performance. Limits for degraded performance are set to approximately 75% of the reference performance objective outlined by ITU-T. The 15 minute intervals are locked to the system clock. The 24 hour intervals can be ordered to start at any given 15 minute interval, thus changeable to adjust to any thinkable time zone differences for comparable measurements on both sides of an international link. The start time for 24 hours time interval will be the same as for the SDIP carrying the concerned DIP.

Quality supervision is enabled per default, with default threshold limits as specified in the AI2 for block DIPST.

3.3.1.2.2 Historical storage functions

The performance monitoring function may provide direct access to performance data for the current and 16 recent 15 minute intervals, in addition to the current and recent 24 hours interval. These data are stored by the DIPHID block.

Collection and storing of performance data must be activated by command, i.e. this function is not activated per default as for the thresholding functions described in previous paragraph. Size alteration of DIPHID must be performed first, then activation for specified DIPs (one, several or all DIPs).

Performance data are also forwarded to STS subsystem, which can be used for regular outputs of data to file or printer. This functionality is activated per default.

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3.3.2 Administration and Maintenance Functions for SDH/STM-1 Exchange Termination

A description of the administration and maintenance functions for the SDH STM-1 termination. The supervision functions used to locate faults in synchronous digital transmission systems and isolate such faults are described and also a description on how the administration of the synchronous digital path is performed.

All individual transmission layers in the multiplexing structure is supervised (section overhead for regenerators not included). The basic principle for supervision is as described in previous sub-chapter (ch.2.1.1), but note that for the MS layer protection may be available, in that case subordinate layers are not affected.

One specific type of supervision can be enabled/disabled per STM-1 interface. That is the trail trace identifier (TTI) mismatch detection. The TTI is used to indicate trail set-up completion and to make sure that traffic is not delivered to the wrong destination. After trail set-up completion, TTI is used to detect any misconnections, in order to prevent delivery of traffic from the wrong source, and to allow for corrective action. The expected TTI value must also be defined in the system. If the supervision is activated, mismatch between expected and actually received TTI will be treated as any other defects in the transmission.

The function is mainly implemented in block SDIPST, but with regional and device processor software belonging to block ET.

3.3.3 SDH STM-1 QUALITY SUPERVISION

A description of the principles for quality supervision for the STM-1 termination. This includes the MS-, HP- and LP layer within the STM-1 termination.

The function is mainly implemented in block SDIPQ, but with regional and device processor software belonging to block ET. Block SDIPST is also involved in the function, as it transfers signals between ET and SDIPQ and between command block SDIPMC and SDIPQ. A separate block SDIPHID is used for storing performance/quality data for the synchronous digital path terminations.

The transmission performance of the 155 Mbit/s synchronous digital path terminations (SDIPs) is supervised according to the ITU-T M.2101/M.2120 recommendations, which involves thresholding functions as well as rules for short-term storage of data. Basic performance parameters are errored, severely errored and unavailable seconds (ES, SES and UAS). The definition of these is described in ITU M.2101. SES is a subset of ES. UAS are seconds excluded from the evaluation of performance due to transition into unavailable state. Unavailable state is declared after 10 consecutive SES. These 10 consecutive SES are part of unavailable state. Available state is declared again after 10 consecutive no-SES. These 10 consecutive no-SES are part of available state. During unavailable state no thresholding will occur, since in this state there is assumed to be an actual, permanent failure of the transmission and the performance of the link in this state is therefore not of any interest. ES, SES and UAS is counted for both directions of transmission separately.

3.3.3.1 Thresholding functions

There are two different monitoring periods, 15 minutes and 24 hours. The 15 minute monitoring period is used for thresholding against limits meant to signify unacceptable performance. The 24 hours monitoring is used for

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thresholding against limits meant to signify degraded performance. The 15 minute intervals are locked to the system clock. The 24 hour intervals can be ordered to start at any given 15 minute interval, thus changeable to adjust to any thinkable time zone differences for comparable measurements on both sides of an international link. The start time for 24 hours time interval will be the same for all levels within the SDIP and also for the DIPs related to this SDIP. Thresholding functions

Quality supervision is enabled per default, with default threshold limits as specified in the AI2 for block SDIPQ.

3.3.3.2 Historical storage functions

The performance monitoring function may provide direct access to performance data for the current and 16 recent 15 minute intervals, in addition to the current and recent 24 hours interval. These data are stored by the SDIPHID block.

Collection and storing of performance data must be activated by command, i.e. this function is not activated per default as for the thresholding functions described in previous paragraph. Size alteration of SDIPHID must be performed first, then activation for specified SDIPs (one, several or all SDIPs).

Performance data are also forwarded to STS subsystem, which can be used for regular outputs of data to file or printer. This functionality is activated per default.

3.3.4 Network Protection Function for SDH/STM-1 Exchange Termination

The Network Protection function provides protection against loss of traffic in case of transmission defects or anomalies in the Synchronous Transport Module level 1 (STM-1) link, connected to the 155 Mbit/s exchange terminal, and in case of hardware faults in the high order termination. The type of transmission protection supported is uni-directional, non-revertive, Multiplex Section Protection 1+1 (MSP 1+1). The network protection is combined with equipment protection, i.e. the duplicated STM-1 interface is terminated on two physical boards.

This is realized by adding a 2nd HOT board and utilising MSP1+1, permanently bridged, non-revertive switching as outlined by ITU-T G.783 Annex A. The STM-1 interface is thereby duplicated, with one active and one protecting STM-1 link. Permanently bridged means that the same traffic is transmitted on both STM-1 interfaces. This also means that there is no possibility to utilise the bandwidth of the protecting STM-1 link for additional traffic. The selection between active and protecting link is therefore only valid for the reception of traffic. Protection switching is triggered by transmission defect or degradation of the received STM-1 signal, or more precisely the multiplex section. Non-revertive switching means that there will be no switch-back if the defect/degradation of the STM-1 signal ceases. The active link will always be the one that were last switched to. Failures on a HOT board will also lead to a switch, but in that case the permanent bridging is no longer active. The protection function for the network interface also offers possibility for forced switch ordered by O-M command, i.e. locking the traffic reception to any of the two STM-1 links if that for some reason should be preferable, for instance at replacement of HOT boards or STM-1 interface.

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The function is mainly implemented in block SDIPST, but the equipment protection part is partly implemented in block ET. Regional and device processor software belongs to block ET.

NOTE: This function is optional.

3.3.5 Equipment Protection Function for SDH/STM-1 Exchange Termination

In digital transmission systems, faulty equipment can lead to degradation or loss of traffic channels and erroneous signalling. This document describes the equipment protection functions used to protect the traffic against equipment faults on the 155 Mbit/s Exchange Terminal, Synchronous Digital Hierarchy (SDH) system in the group switch interface.

This is realized by adding a 5th LOT board with an additional DL-3 interface that can be shared by up to 4 TSMs. At detection of faults in the LOT boards or lost or faulty signal in the DL-3 interface, the traffic will be redirected from the faulty DL-3 interface to the protecting DL-3 interface. Internally in the ET155 the HOT boards will start receiving traffic from protecting LOT. There is also a possibility for forced switch ordered by O-M command, meaning that the traffic from TSMs/DL-3 to/from one of the LOT boards will be routed through the protecting LOT board. This may be useful in case of replacement of LOT boards.

The function is implemented in block ET.

NOTE: This function is optional.

3.3.6 Counters in the Measurement Database for SDH/STM-1 Network Termination

A description of the counters that are provided to the function Statistic and Traffic measurement subsystem (STS) in the STM-1 network termination system. STS consists of functions for collection, storage, processing and presentation of statistical data.

The function is implemented in blocks DIPST and SDIPST.

4 Technical description

4.1 2048 kbps digital path termination

A description of the supervision functions used to locate faults in digital transmission systems and isolate such faults. It also describes the functions available for quality supervision of the digital paths. The latter supervision is used to alert staff, before the transmission quality is such that the digital path is considered faulty.

This paragraph also describes how administration of the digital path is performed.

The actions taken for each telephony device are not described here. However the time delay before action is taken is indicated.

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4.1.1 Allocation of a 2048kbit/s DIP into a VC12

The Digital Path termination is mapped into or "contained" in a Virtual Container 12. The DIPs and VC12s have a one-to-one relationship. The VC12 consists of the DIP and overhead information.

Table 1 VC12 frame structure.

V5	
R	
32 bytes	<- PDH Payload
R	
J2	
C1 C2 OOOORR	
32 bytes	<- PDH Payload
R	
N2	
C1 C2 OOOORR	
32 bytes	<- PDH Payload
R	
K4	
C1 C2 RRRR S1	
S2 DDDDDDD	
31 bytes	<- PDH Payload
R	

- C** Justification control bit
- D** Data bit
- J2** Connection verifier
- O** Overhead bit
- R** Fixed stuff bit
- S** Justification opportunity bit
- V5** Parity check
- K4** Automatic protection switching signalling at lower order path level.(not used)
- N2** Allocated for Tandem connection monitoring

Multiplexing structure of PDH DIP to STM-1

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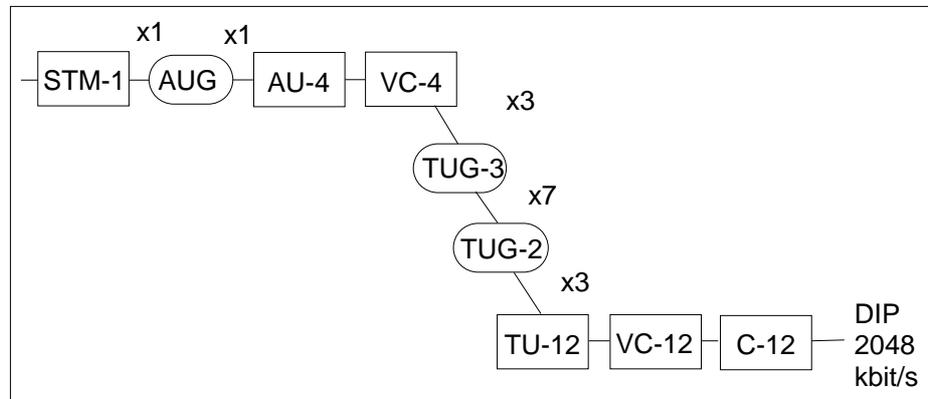


Figure 5 Multiplexing Levels

See G.707, chapter 10.1.4.1 for further details, reference on page 82.

4.1.2

Allocation of Bits in TS0 in normal frame structure

The allocation and notation of bits in time slot 0 is as follows (ITU-T G.704, reference on page 82):

Table 2 Allocation of Bits in TS0 in CRC-4 Inhibited Mode

Alternate Frames	Bit 1 to 8 in TS0							
	1	2	3	4	5	6	7	8
Frame containing the frame alignment signal	Si	0	0	1	1	0	1	1
	(1)	Frame alignment signal						
Frame not containing the frame alignment signal	Si	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
	(2)	(3)	(4)	(5)				

- (1) Si are bits reserved for international use. If not in use, these bits should be fixed at 1 on digital paths crossing an international border. However, they may be used nationally if the digital path does not cross a border.
- (2) Si are bits reserved for international use. If not in use, these bits should be fixed at 1 on digital paths crossing an international border. However, they may be used nationally if the digital path does not cross a border.
- (3) This bit is fixed to 1 to assist in avoiding simulations of the frame alignment signal.
- (4) Remote Defect Indication (RDI). Bit 3 of TS0 not containing the frame alignment word is set. State '0' = No alarm. State '1' = Alarm.
- (5) Sa4 to Sa8 are additional spare bits.

Note 1

Si are bits reserved for international use. If not in use, these bits should be fixed at 1 on digital paths crossing an international border. However, they may be used nationally if the digital path does not cross a border.

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- Note 2** This bit is fixed to 1 to assist in avoiding simulations of the frame alignment signal.
- Note 3** Remote Defect Indication (RDI). Bit 3 of TS0 not containing the frame alignment word is set. State '0' = No alarm. State '1' = Alarm.
- Note 4** Sa4 to Sa8 are additional spare bits.

4.1.3 Allocation of Bits in TS0 of CRC-4 MultiFrame Structure

The allocation and notation of bits in time slot 0 of the CRC-4 multiframe structure is defined by ITU-T G.704, reference on page 82, as follows:

Table 3 Allocation of Bits in TS0 of CRC-4 MultiFrame Structure

	Sub-multi frame	Frame	Bit 1 to 8 in TS0							
			1	2	3	4	5	6	7	8
MULTIFRAME	I	0	c1	0	0	1	1	0	1	1
		1	0	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
		2	c2	0	0	1	1	0	1	1
		3	0	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
		4	c3	0	0	1	1	0	1	1
		5	1	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
		6	c4	0	0	1	1	0	1	1
		7	0	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
	II	8	c1	0	0	1	1	0	1	1
		9	1	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
		10	c2	0	0	1	1	0	1	1
		11	1	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
		12	c3	0	0	1	1	0	1	1
		13	E	1	A	Sa4	Sa5	Sa6	Sa7	Sa8
		14	c4	0	0	1	1	0	1	1
15		E	1	A	Sa4	Sa5	Sa6	Sa7	Sa8	

Frame alignment signal is found in TS0 even frames.

- c1-c4** Cyclic Redundancy Check-4 (CRC-4) bits.
- E** Bits used to indicate received errored sub-multi-frames to the remote end.
- A** Remote Defect Indication (RDI).

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Bit 3 of outgoing TS0 not containing the frame alignment word is set. State '0' = No alarm. State '1' = Alarm.

Sa Sa4 to Sa8 are additional spare bits

The CRC-4 multiframe consists of 16 frames numbered 0-15 and it is divided into two 8-frame sub-multi-frames (SMF), designated SMF I and SMF II signifying their respective order of occurrence within the CRC-4 multiframe structure.

The SMF is the Cyclic Redundancy Check (CRC-4) block size (i.e. 2048 bits).

Every frame consists of $32 \times 8 = 256$ bits, which are divided into 32 time slots numbered 0-31.

The bits in each time slot are numbered 1-8.

In those frames containing the frame alignment signal, bit 1 contains CRC-4 bits. There are 4 CRC-4 bits in each SMF designated C1, C2, C3 and C4 forming the CRC-4 word. The CRC-4 word located in SMF number N, is calculated by means of multiplication/division process of a polynomial representation of SMF number N-1.

In those frames not containing the frame alignment signal, bit 1 contains the 6 bits CRC-4 multiframe alignment signal (form 001011) and two E bits.

The E bits are used to indicate received errored sub-multi-frames to the remote end by setting the binary state of one E bit from '1' to '0' for each received errored sub-multi-frame. If the E bits are not used, they are set to binary '1'.

4.1.4 Function Overview

4.1.4.1 Administration

The DIP Administration function handles

- connecting/disconnecting the DIP
- manual blocking/deblocking of the DIP
- change of DIP initial/configuration parameters

4.1.4.2 Maintenance

The maintenance functions for the 2048 kbit/s digital path termination are divided into two parts:

- Quality Supervision
- Fault Supervision

The aim of quality supervision is to supervise the quality of the service delivered by a DIP. That is in order to alert maintenance staff before the quality of the service is such that the DIP is considered faulty.

The quality supervision method sketched is in accordance with the ITU-T recommendations M.2100 and M.2120, references on page 82. In addition, supervision of slip frequency (SF) is available.

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Fault Supervision consists of detection of anomalies and defects on digital paths, to take appropriate automatic action and to alert the maintenance staff.

4.1.5 **Function:**

4.1.5.1 **Administration**

4.1.5.1.1 **Connecting and disconnecting the digital path**

The DIP can be connected and disconnected by command.

The DIP is given a unique name by command.

4.1.5.1.2 **Manual blocking and deblocking of the digital path**

The DIP can be blocked and deblocked by command.

At manual blocking the DIP supervision is stopped (The DIP is considered out of service). At manual deblocking the DIP supervision is started.

The state of the DIP can be printed by command. The DIP name, the blocking state and the fault situation on the DIP (if any) are given in the printout.

4.1.5.1.3 **Changing the initial data of the digital path**

Initial data can be changed by command (The term "initial data" is identical to "configuration data").

Initial data which can be changed are:

- Cyclic redundancy check mode.

(For each DIP, the CRC-4 procedure may be activated, deactivated or set to auto detect by command. When the CRC-4 mode is auto detect, the procedure is able to detect and adapt to the CRC-4 mode of the remote end, as proposed in ITU-T G.706, reference on page 82).
- Inhibit sending of AIS towards switch at excessive error rate or not.
- The value of the spare bits which are used to set bits in TSO (Sa4-Sa8).

The initial data can also be printed by command.

4.1.5.2 **Quality Supervision**

4.1.5.2.1 **Local end/remote end supervision**

Quality supervision is performed by measuring various parameters in the incoming transmission direction. The quality in the incoming transmission direction is also reported back through the outgoing transmission direction. Hence, by reading data coming in to a termination point, it is possible to obtain a picture of the quality perceived in the remote end termination point.

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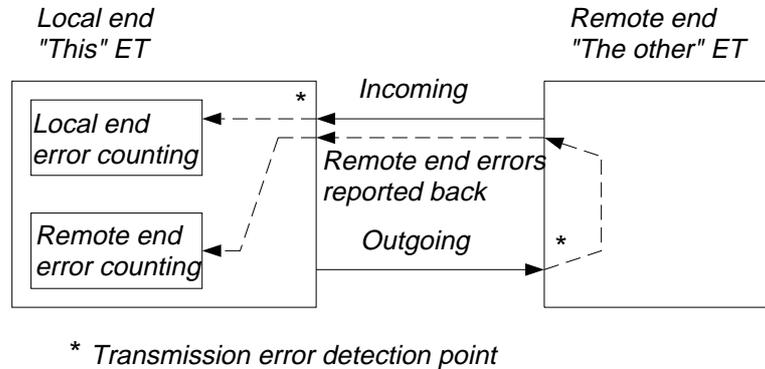


Figure 6 Counting of errors for local and remote end

4.1.5.2.2 Basic performance parameters

The quality of a DIP is monitored separately for incoming and outgoing direction. A certain set of anomalies and defects are defined (see chapter 4.1.5.4), which leads to registration of an event of impairment. The event is counted with a resolution of one second. I.e. if there is at least one error event within one second, the second is registered as an Errored Second (ES) or a Severely Errored Second (SES), depending upon the severity of the impairment. ES and SES are the basic performance parameters, upon which the quality supervision is based.

The evaluation of error performance and availability performance is based on the processing of the basic performance parameters.

ES and SES Evaluation Without CRC-4

The evaluation of these parameters is performed as given in table 4.

Table 4 ES and SES parameter evaluation criteria without CRC-4

Anomalies and defects in 1 second	Interpretation for receive direction	Interpretation for send direction	Notes	
>= 1 LOF	ES + SES	-	(1)	
>= 1 AIS	ES + SES	-		
>= 1 errored FAS	ES	-		
>= 28 errored FAS	ES + SES	-		
>= 1 slip	ES	-		(2)
>= 1 RDI	-	ES + SES		

- (1) ES can not be generated independently of SES in the send direction.
- (2) A controlled slip is classified as an anomaly and should be interpreted as causing an ES (but not a SES).

ES and SES Evaluation Including CRC-4

The evaluation of these parameters is performed as given in table 5

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Table 5 ES and SES parameter evaluation criteria for CRC-4

Anomalies and defects in 1 second	Interpretation for receive direction	Interpretation for send direction	Notes	
>= 1 LOF	ES + SES	-	(1)	
>= 1 AIS	ES + SES	-		
>= 1 CRC4 block errors	ES	-		
>= 805 CRC4 block error	ES + SES	-		
>= 1 slip	ES	-		(2)
>= 1 E-bit	-	ES		
>= 805 E-bits	-	ES + SES		
>= 1 RDI	-	ES + SES		

(1) Both send and receive ES and SES resolution possible in real-time from single end.

(2) A controlled slip is classified as an anomaly and should be interpreted as causing an ES (but not a SES).

4.1.5.2.3 Time Intervals

Both performance parameters are measured during two time intervals, which are rectangular fixed windows with length 15 minutes and 24 hours respectively. The start and end time for the 15 minute (T1) and 24 hour (T2) interval is the same for ES evaluation as for SES evaluation. Both the 15 minute and 24 hour intervals are synchronized to the exchange clock. In addition, the 15 minute interval is aligned with the 24 hour interval. I.e. the start of a 24 hour period is also the start of the first 15 minute period. The start time for degraded performance monitoring (24 hour) is set by a command in SDH quality supervision. The start time is valid for both PDH and SDH. The default value for the 24 hour period is 00:00.

4.1.5.2.4 Performance levels

Two performance levels, unacceptable or degraded performance level, are defined for both ES and SES supervision.

- Unacceptable Performance is monitored during fixed 15 minute time intervals (T1).
- Degraded Performance is monitored during fixed 24 hour time intervals (T2).

The actual performance level is derived through the monitoring and thresholding of the basic performance parameters (ES and SES).

4.1.5.2.5 Thresholding and reports

For both time intervals (15-minute and 24-hour), the basic performance parameters are counted in both transmission directions, in order to derive the actual performance level. Consequently, for each time interval (15-minute and 24-hour), there are 2 ES counters and 2 SES counters. I.e. there are 8 basic performance counters (counters for basic performance parameters) per DIP.

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A threshold report is issued when one of the performance levels (unacceptable or degraded) are entered. A performance level is entered if a threshold value is reached or crossed by the corresponding basic performance counter.

Even if a threshold report (alarm) has been issued, ES and SES are counted second by second to the end of the 15 minute interval, and then the counter is reset to 0 (zero).

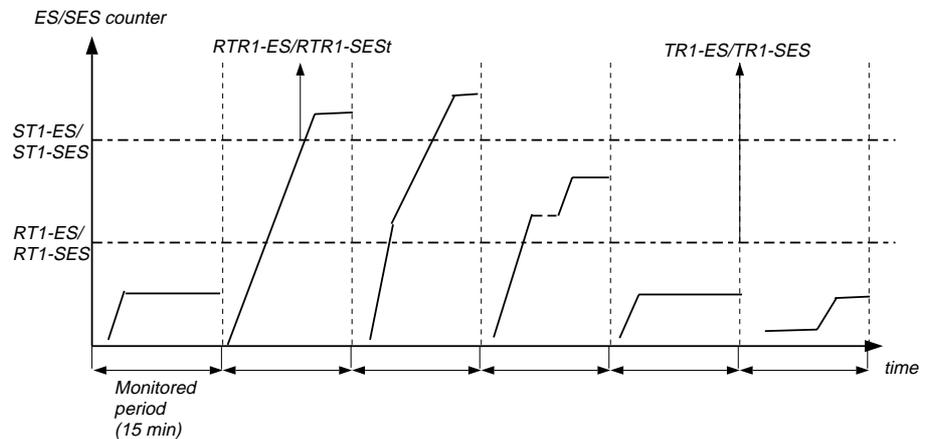
15-minute measurements

In both transmission directions, ES and SES are measured during 15-minute intervals to determine whether the performance level is unacceptable or not. If a threshold for unacceptable performance (ST1-ES or ST1-SES) is reached or crossed by the respective performance counter (incoming or outgoing ES or SES), a corresponding threshold report (TR1-ES or TR1-SES) is given.

The counters for ES and SES are compared to their respective set thresholds every second.

If the unacceptable performance level is reached in one 15-minute interval, the considered basic performance counter will be compared to a reset threshold at the end of subsequent 15-minute intervals. If the basic performance counter is below or equal to the reset threshold (RT1-ES or RT1-SES), a corresponding reset threshold report (RTR1-ES or RTR1-SES) is given.

The principles of thresholding in 15-minute intervals are illustrated in figure 7 below.



- ST1-ES Set Threshold for Errored Seconds
- TR1-ES Threshold Report for Errored Seconds
- RT1-ES Reset Threshold for Errored Seconds
- RTR1-ES Reset Threshold Report for Errored Seconds

- ST1-SES Set Threshold for Severely Errored Seconds
- TR1-SES Threshold Report for Severely Errored Seconds
- RT1-SES Reset Threshold for Severely Errored Seconds
- RTR1-SES Reset Threshold Report for Severely Errored Seconds

Figure 7 Principles of thresholding - unacceptable performance

24-hour measurements

In both transmission directions, ES and SES are measured during 24-hour intervals to determine whether the performance level is degraded or not. If

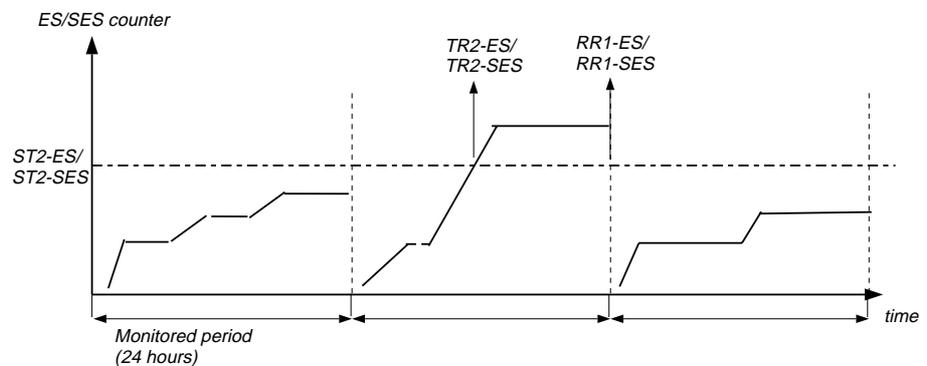
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a threshold for degraded performance (ST2-ES or ST2-SES) is reached or crossed by the respective performance counter (incoming or outgoing ES or SES), a corresponding threshold report (TR2-ES or TR2-SES) is given.

If the degraded performance level is reached in a 24-hour interval, a reset report (RR2-ES or RR2-SES) is given at the end of the interval.

The counters for ES and SES are compared to their respective thresholds every 15 minute.

The principles of thresholding in 24-hour intervals are illustrated in figure 8 below.



- ST2-ES Set Threshold for Errored Seconds
- TR2-ES Threshold Report for Errored Seconds
- RR2-ES Reset Report for Errored Seconds

- ST2-SES Set Threshold for Severely Errored Seconds
- TR2-SES Threshold Report for Severely Errored Seconds
- RR2-SES Reset Report for Severely Errored Seconds

Figure 8 Principles of thresholding - degraded performance

4.1.5.2.6 Transmission States

General

A digital path can be in one of two transmission states:

- Unavailable State
- Available State

Parameters ES and SES are not monitored during the unavailable state. The transmission state is determined from filtered SES/non-SES data.

Transmission State Evaluation

The unavailable state filter is a 10-second rectangular sliding window with 1-second granularity of slide. The Unavailable State is detected at the end of 10 consecutive SES events. These 10 seconds are considered to be part of the unavailable time. A DIP is in the unavailable state if one or both of the transmission directions are in the unavailable state.

The available state filter is a 10-second rectangular sliding window, with 1-second granularity of slide. The Available State is detected at the end of 10 consecutive non-SES events, subsequent to detection of unavailable state.

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These 10 seconds are considered to be part of the available time. A DIP is in the available state if both transmission directions are in the available state.

Unavailable time is measured per DIP. The unavailable time for a transmission direction is defined as the time during which the transmission direction is in the unavailable state. The unavailable time for the DIP is defined as the time during which the DIP is in the unavailable state (i.e. one or both of the transmission directions are in the unavailable state). During this time the ES and SES are not monitored in any transmission direction.

Upon detection of unavailable state for the DIP, an alarm is issued. A counter for the current unavailable time in seconds is started and the counter for the unavailable event is incremented by 1. Unavailable events are counted per DIP (i.e. there is only one unavailable event counter but three unavailable time counters).

Upon detection of unavailable state termination (i.e. re-entry to the available state), the unavailable state alarm is ceased and the counter for the current unavailable time is stopped. Unavailable state termination is detected at the end of 10 consecutive non-SES (in both transmission directions simultaneously).

Unavailable time and unavailable events are both counted during the 15-minute and 24-hour time intervals. Their respective counters are reset at the end of each interval.

Actions are taken to ensure that threshold reports (alarms) are correctly generated and ES/SES available state counters are correctly processed during changes in the transmission state. This implies that:

- All threshold reports (alarms) are delayed by 10 seconds
- At detection of unavailable state for the DIP, ES and SES counters in both transmission directions are decremented by the number accumulated during the last 10 seconds
- At detection of available state, the ES counters are incremented by the actual number of ES events during the last 10 seconds

At entry or termination of unavailable state, the alarm or alarm ceasing is time stamped. Time stamps are related to the first of the unavailable or available seconds respectively.

The figure 9 illustrates the rules for determining the unavailable second parameter for the DIP, and for inhibiting other parameter counts (ES and SES) during unavailable time.

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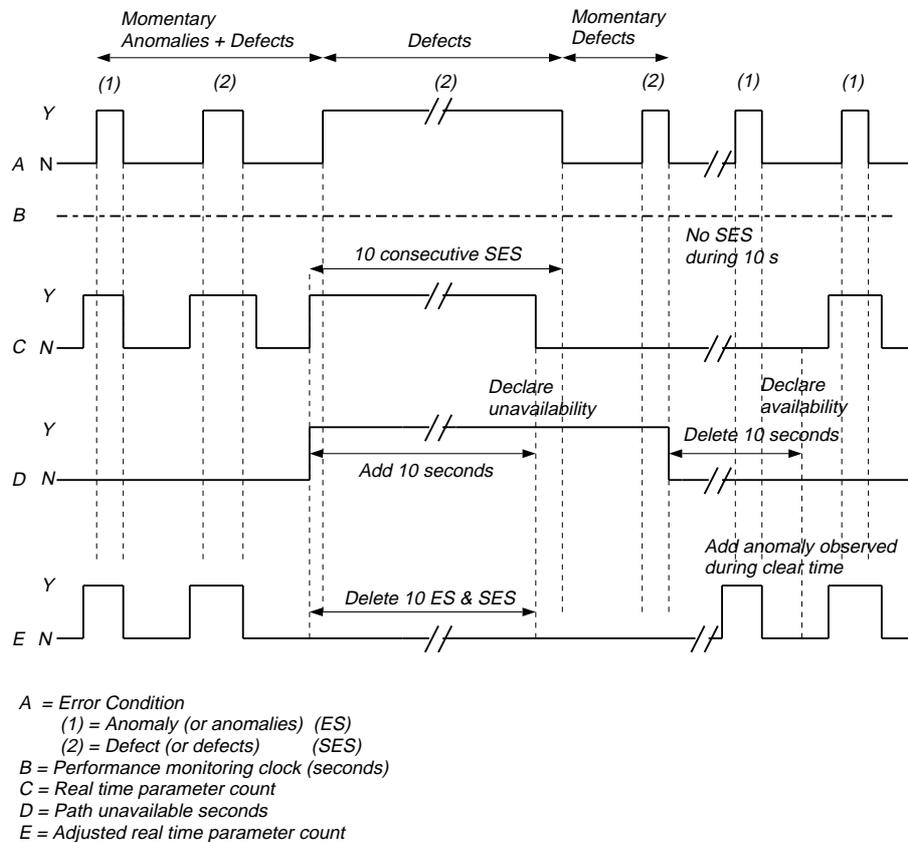


Figure 9 Illustration of performance monitoring inhibiting during unavailable time.

Note In the figure error conditions are considered in one transmission direction only.

4.1.5.2.7 Suspect intervals

Due to restart or blocking from superior individuals, some time intervals may not carry reliable information. Also, if the quality supervision functions are reset by command, the ES and SES counters may not be correct in the affected intervals. Such intervals are marked as suspected intervals.

Intervals are also suspect marked if there is a change in the system clock or a change in the start of the 24 hour time interval.

For a corrupted 15-minute interval, data is replaced by a flag which indicates a suspect interval. For a corrupted 24-hour interval, the collected data are printed with an indication that the interval is suspect marked. Note that quality data for suspected 15-minute intervals are accumulated to the 24-hour data.

4.1.5.2.8 Historical storage of quality data

Historical storage of quality data is done in accordance with M.2120, see reference on page 82. For each DIP it is possible to store and print the quality data ES, SES, UAS and UAV for

- 1 current 15-minute interval,
- n recent 15-minute intervals,

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- 1 current 24-hours interval,
- 1 recent 24-hours interval.

where n is set by an application parameter in the range 1 to 96 with 16 as default. ES and SES are counted in both transmission directions. UAS is counted in both transmission directions for the 15-minute interval, as well as bi-directionally for both intervals. UAV is registered bi-directionally. Hence, for the 15-minute intervals there are:

- 2 ES counters,
- 2 SES counters,
- 3 UAS counters,
- 1 UAV counter.

For the 24-hour intervals, there are:

- 2 ES counters,
- 2 SES counters,
- 1 UAS counter,
- 1 UAV counter,
- 1 SMI (Suspect Marked Interval) indication.

The recent register is used as a stack. At the end of a 15-minute period, the content of the current register is transferred to the first of the recent registers. When all of the recent registers are full, the oldest register values are discarded.

The storage function may be initiated and ended per DIP by command. The connection status may also be printed to display on which DIPs the function is active or passive.

The stored quality data may be printed by command.

4.1.5.3 Slip Frequency Supervision (SF)

A slip might occur due to imperfect network synchronization. A slip is defined as where one frame is either lost or duplicated. The supervision does not discriminate between these two events.

This supervision monitors the number of slips per time interval. SF supervision is performed in accordance with G.822, see reference on page 82, and works towards one limit value Z during a time interval TI. If the number of slips exceeds limit Z the alarm is initiated. Then as soon as the number of slips equals or falls below the limit, the alarm is ceased. The value that is compared with limit Z is the accumulated value during TI hours, the comparison towards limit is done every hour..

Time interval TI is handled as a "floating window" with 1 hour of granularity. The start time is the closest 15 minute boundary after bringing the digital path into service.

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4.1.5.3.1 Alarm correlation with other functions

Relationship between DIP quality supervision and STM-1 quality supervision

A quality supervision threshold crossing report issued from the quality supervision of MS, VC4 or VC12 within the STM-1 will inhibit threshold crossing reports from being issued from the corresponding 2048 Kbit/s digital path terminations in accordance with these principles:

- Unavailable State alarms on STM-1 will suppress all consequent Unavailable State alarms on DIP.
- Near-end ES alarms on STM-1 will suppress all consequent near-end ES alarms on DIP.
- Far-end ES alarms on STM-1 will suppress all consequent far-end ES alarms on DIP.
- Near-end SES alarms on STM-1 will suppress all consequent near-end ES/SES alarms on DIP.
- Far-end SES alarms on STM-1 will suppress all consequent far-end ES/SES alarms on DIP.

The suppression will be done independently for unacceptable and degraded performance for ES and SES alarms.

Relationship between DIP quality supervision and DIP fault supervision

Fault conditions on the 2048 Kbit/s digital path termination will suppress threshold crossing reports (alarms) from the quality supervision. Alarms already existing when a fault condition occurs will be ceased and no new threshold crossing reports will be issued as long as the fault condition exists.

Relationship between DIP quality supervision and STM-1 fault supervision

Fault conditions on the MS, VC-4 or VC-12 within the STM-1 will suppress threshold crossing reports (alarms) from the quality supervision. Alarms already existing when a fault condition occurs will be ceased and no new threshold crossing reports will be issued as long as the fault condition exists.

4.1.5.4 Fault Supervision

4.1.5.4.1 Relationship between SDIP fault supervision and DIP fault supervision

If an error occurs on the higher transmissions levels, MS, VC4 and VC12, then this error also must be present on the corresponding DIP, since the VC12 and VC4 are combinations of one or more DIPs. There is no need for alarms on DIP level if an alarm already has been issued on MS, VC4 or VC12. The DIP alarms will be suppressed as long as the alarm on MS, VC4 or VC12 persists.

4.1.5.4.2 2048 Kbit/s Alarm Indication Signal (AIS) Received

Incoming AIS is detected in accordance with ITU-T G.775, see reference on page 82. The equivalent binary contents of the AIS is a continuous stream of binary ones.

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The ET has the capability of detecting the presence of the AIS even in the presence of an error rate of $1E-3$. However, a signal with all bits except the frame alignment in the '1' state, shall not be mistaken as an AIS.

AIS is considered detected when both of the following conditions occur:

- loss of frame alignment
- reception of 512 bit periods containing less than 3 binary zeros.

4.1.5.4.3 Loss of Frame Alignment

Manual CRC mode off

Loss of frame alignment is detected in accordance with G.706, see reference on page 82, section 4.1.1.

Manual CRC mode on

Loss of frame alignment is detected in accordance with G.706, see reference on page 82, section 4.1.1 and 4.2.

In addition, the occurrence of more than 915 errored CRC-blocks per second is treated as a loss of frame alignment.

Automatic CRC mode

Loss of frame alignment is detected in accordance with G.706, see reference on page 82, Annex B.2.

4.1.5.4.4 Recovery of Frame Alignment

Manual CRC mode off

Frame alignment recovery is detected in accordance with G.706, see reference on page 82, section 4.1.2.

Manual CRC mode on

Frame alignment recovery is detected in accordance with G.706, see reference on page 82, section 4.1.2 and 4.2.

However, the recovery of frame alignment is not successful if more than 915 CRC blocks are received in error per second after a successful CRC multiframe alignment. In this situation, loss of frame alignment shall immediately be indicated.

Automatic CRC mode

Frame alignment recovery is detected in accordance with G.706, see reference on page 82, Annex B.2.

4.1.5.4.5 Excessive Bit Error Rate

The activation of ERATE is based on thresholding of FAS error frequency as proposed in ITU-T recommendation G.732, see reference on page 82. ERATE is activated and deactivated in accordance with G.732, see reference on

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page 82, section 4.1.6. The activating and the deactivating period specified as 'a few seconds'.

4.1.5.4.6 Remote Defect Indication Received

The defect indication from the remote end is a message sent up-streams. As a consequence the circuit is normally removed from service.

RDI is detected in accordance with ITU-T G.704, see reference on page 82. RDI is indicated when bit 3 of incoming time slot zero (TS0B3) is changed from state '0' to state '1' in those frames not containing the frame alignment signal.

In order to avoid spurious RDI detection, at least 3 consecutive TS0B3 which are set to '1', are required to give RDI.

4.1.5.4.7 Fault Filtering Times

There are two filtering times associated with the fault detection.

- A filtering time is used at detection of a fault to make sure that the fault remains.
- When the fault ceases, cease filtering time is used in order to make sure that the fault has disappeared.

The fault filtering times are both set by application parameters.

4.1.5.4.8 Alarm Filtering Times

The alarm fault filtering time is used for alarm initiation.

The alarm cease filtering time is used in order not to initiate alarm cease until it has been made sure that the fault no longer exists.

The alarm fault filtering time can be different from the alarm ceasing filtering time.

The filtering times for alarm initiation and alarm cease are set by application parameters.

4.1.5.4.9 Actions at Fault Conditions

The maintenance actions specified in table 6 are taken as consequence of the faults detected.

Service alarm is generated to indicate that the service provided by the PDH digital path is no longer available (Channels are blocked).

Prompt Maintenance alarm is generated to signify that maintenance is required locally. Note that for a given fault condition it is possible to set if the prompt maintenance alarm should be generated or not.

RDI is generated by operating bit 3, time slot 0 of an outgoing channel not containing the frame alignment word. RDI is generated in order to notify the remote end about erroneous transmission towards the local end.

AIS generated towards the switching stage indicates that a failure has been identified in the circuit and that the other maintenance consequences to this failure should be inhibited.

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Table 6 Actions within the exchange

Anomalies and defects detected	Consequent actions				
	Alarm indication signal (AIS)	1	2a	3	4
Loss of frame alignment (LOF)	1	2a	3	4	
Excessive bit error rate (ERATE)	1	2a	3	4a	
Remote Defect Indication (RDI)	1	2a			
Loss of clock from GS	1	2			5

- 1 =** Service alarm indication generated. For the ET this implies informing the device owner about the alarm condition.
- 2 =** Prompt maintenance alarm indication generated. This is an alarm that is printed on the operator's console.
- 3 =** RDI to the remote end generated.
- 4 =** AIS towards the switching stages generated.
- 5 =** 2048 kbit/s AIS towards digital path.
- a =** It shall be set-able from the operator whether this alarm indication should be generated or not.

4.1.5.4.10 Detailed Description of Actions at Fault Conditions

In the following table 7 to table 14, the consequent actions that are taken are presented and the time delays before the actions are taken. If two or more faults/fault indications are detected at the same time, the detailed set of consequent actions will be taken for the faults/fault indication with the highest priority (only one set of consequent actions is taken).

The order of priority is:

- 1** Alarm Indication Signal
- 2** Loss of Frame Alignment
- 3** Excessive Error Rate
- 4** Remote Defect Indication

where 1. represents the highest priority and 4. represents the lowest priority.

Following terms are used in the tables.

- P** The possible range value.
- R** The recommended value (always true when P is missing).
- U** The uncertainty of the value, given as "=X ms".

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In the worst possible case, the time to carry out the consequent action will be $R + X$ ms.

:= means "is set to"

i.e. "TS0B3 := 1" means "TS0B3 is set to 1" (done by the ET, towards the DIP).

In the first column, the "name" of the event is stated.

In the second column, the values of P, R, and U are given.

In the third column, the consequent actions to the event and comments are stated.

The alarm can be activated/deactivated by a command for each fault type.

The following notes are referred to in the table 7 to table 14.

Note 1 The fault filtering is used for alarm initiation. This filtering time will be common to all alarms (initiation), but can be different from the alarm ceasing filtering time.

Note 2 The cease filtering is used for alarm cease.

Note 3 If CRC-4 is used and frame synchronization is found, but less than two CRC-4 multiframes are found within 8-10 ms a re-framing attempt is made. Then if CRC-4 multiframe is found, but there are >915 erroneous CRC-4 blocks in a second, a re-framing attempt is made again.

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Table 7 AIS Commences

Alarm indication	Delay of action event	Consequent actions and comments
Alarm Indication Signal (AIS)	R = 0 U = 0 - 1 ms	AIS is sent towards the switch stage.
	R = 0 U = 0 - 1 ms	Remote Defect Indication transmitted, TS0B3 := 1 .
	P = 50 ms - 10 min R = 2500 ms U = 0 - 13 ms	Treatment of telephony devices is started. (P is an application parameter.)
	P = 0 - 300 ms R = 0 U = 2 s See Note 1	Alarm and Printout is initiated. (P is an application parameter. This time is started when the previous time (50 ms - 10 min) has elapsed.)

Table 8 AIS Ceases

Alarm indication	Delay of action event	Consequent actions and comments
Alarm Indication Signal (AIS) ceases	R = 0 U = 0 - 1 ms	AIS towards the switching stage ceases.
	R = 0 U = 0 - 1 ms	Defect indication to Remote End is ceased, TS0B3 := 0 .
	P = 50 ms - 10 min R = 10000 ms U = 0 - 13 ms	Treatment of telephony devices is started. (P is an application parameter.)
	P = 0 - 300 ms R = 0 U = 2 s See Note 2	Alarm ceases and printout is initiated. (P is an application parameter. This time is started when the previous time (50 ms - 10 min) has elapsed.)

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Table 9 LOF Commences

Alarm indication	Delay of action event	Consequent actions and comments
Loss of Frame Alignment	R = 0 U = 0 - 1 ms	AIS is sent towards the switching stage.
	R = 0 U = 0 - 1 ms	Remote Defect Indication transmitted, TS0B3 := 1 .
	P = 50 ms - 10 min R = 2500 ms U = 0 - 13 ms	Treatment of telephony devices is started. (P is an application parameter.)
	P = 0 - 300 ms R = 0 U = 2 s See Note 1	Alarm and Printout is initiated. (P is an application parameter. This time is started when the previous time (50 ms - 10 min) has elapsed.)

Table 10 LOF Recovery

Alarm indication	Delay of action event	Consequent actions and comments
Recovery of Frame Alignment Signal	R = 0 U = 0 - 1 ms	AIS towards the switching stage ceases.
See Note 3	R = 0 U = 0 - 1 ms	Defect indication to Remote End is ceased, TS0B3 := 0 .
	P = 50 ms - 10 min R = 10000 ms U = 0 - 13 ms	Treatment of telephony devices is started. (P is an application parameter.)
	P = 0 - 300 ms R = 0 U = 2 s See Note 2	Alarm ceases and printout is initiated. (P is an application parameter. This time is started when the previous time (50 ms - 10 min) has elapsed.)

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 Table 11 *ERATE Commences*

Alarm indication	Delay of action event	Consequent actions and comments
Excessive Error Rate	R = 0 U = 0 - 1 ms	Defect indication to Remote End is transmitted, TS0B3 := 1 .
	R = 0 U = 0 - 1 ms	AIS is sent towards the switching stage. (Market dependent)
	P = 50 ms - 10 min R = 2500 ms U = 0 - 3 ms	Treatment of telephony devices is started.
	P = 0 - 300 ms R = 0 U = 2 s See Note 1	Alarm and Printout is initiated. (P is an application parameter. This time is started when the previous time (50 ms - 10 min) has elapsed.)

 Table 12 *ERATE Ceases*

Alarm indication	Delay of action event	Consequent actions and comments
Excessive Error Rate Ceases	R = 0 U = 0 - 1 ms	Defect indication to Remote End is ceased, TS0B3 := 0 .
	R = 0 ms U = 0 - 1 ms	AIS towards the switching stage ceases. (Market dependent)
	P = 50 ms - 10 min R = 10000 ms U = 0 - 13 ms	Treatment of telephony devices is started. (P is an application parameter.)
	P = 0 - 300 ms R = 0 U = 2 s See Note 2	Alarm ceases and printout is initiated. (P is an application parameter. This time is started when the previous time (50 ms - 10 min) has elapsed.)

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Table 13 RDI Commences

Alarm indication	Delay of action event	Consequent actions and comments
Defect Indication recieved from the remote end	P = 50 ms - 10 min R = 2500 ms U = 0 - 13 ms	Treatment of telephony devices is started.
	P = 0 - 300 ms R = 0 U = 2 s See Note 1	Alarm and Printout is initiated. (P is an application parameter. This time is started when the previous time (50 ms - 10 min) has elapsed.)

Table 14 RDI Ceases

Alarm indication	Delay of action event	Consequent actions and comments
Defect Indication from the remote end ceases	P = 50 ms - 10 min R = 10000 ms U = 0 - 13 ms	Treatment of telephony devices is started. (P is an application parameter.)
	P = 0 - 300 ms R = 0 U = 2 s See Note 2	Alarm ceases and printout is initiated. (P is an application parameter. This time is started when the previous time (50 ms - 10 min) has elapsed.)

4.1.5.4.11 Actions at Faults in own Exchange

Loss of clocking signal

If the clock signal from the Group Switch is lost, alarm indication signal (AIS) to the remote end is sent.

Further actions are part of the SNT maintenance function and not within the scope of this UD.

4.2 Administration and Maintenance functions

A description of the administration and maintenance functions for the SDH STM-1 termination.

The supervision functions used to locate faults in synchronous digital transmission systems and isolate such faults are described and also a description on how the administration of the synchronous digital path is performed.

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4.2.1 Multiplexing Structure

The method for multiplexing a 2048 kbit/s signal into the required SDH order is shown in figure 10. The figure also shows that it is possible to have up to $3 \times 7 \times 3 = 63$ VC-12s in one STM-1 signal.

Note Ref. G707 ch. 6.1, see reference on page 82

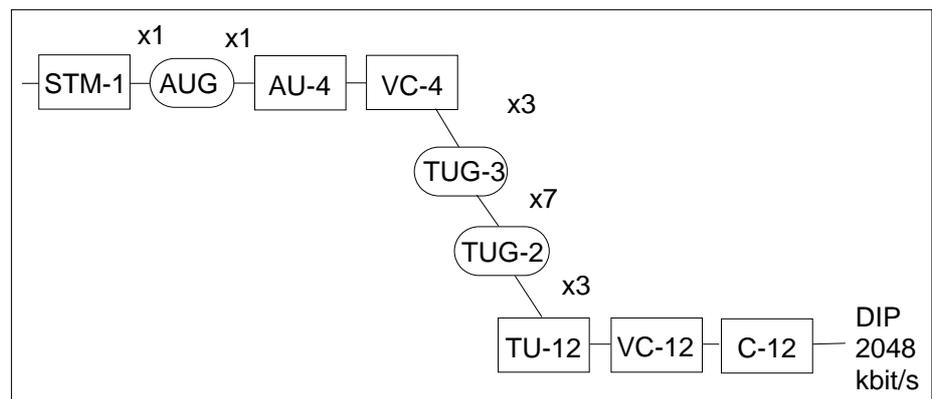


Figure 10 Multiplexing Levels

4.2.2 Basic STM-1 Frame Structure

In figure 11 a STM-1 signal is illustrated as a frame with 9 rows and 270 bytes in each row. The sending of the frame starts with 9 bytes from the RSOH section and continues with 261 byte of STM-1 payload, then there will be a new row starting with the next 9 byte from RSOH and new payload. This continues for total of 9 rows and form the STM-1 frame structure.

The first 9 byte in each row are for information and used by the SDH system itself. This area is divided into 3 parts:

- Regenerator section overhead
- Space allocated to administrative unit pointer
- Multiplex section overhead

The regenerator section overhead and the multiplex section overhead together form the STM-1 section overhead. The remaining 261 bytes per row provide the STM-1 payload.

Note Ref. G707 ch. 6.2, see reference on page 82

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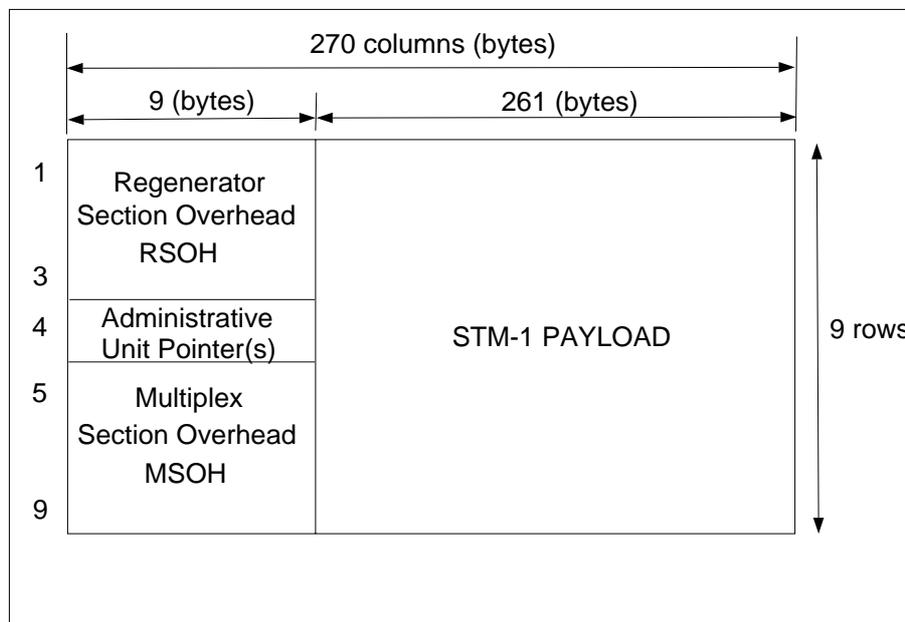


Figure 11 STM-1 Frame Structure

The STM-1 section overhead and the administrative unit pointer are shown in detail in table 15.

Note Ref. G707 ch. 9.2, see reference on page 82

Table 15 STM-1 Section Overhead (RSOH, AU-pointers and MSOH)

A1	A1	A1	A2	A2	A2	J0		
B1			E1			F1		
D1			D2			D3		
H1			H2			H3	H3	H3
B2	B2	B2	K1			K2		
D4			D5			D6		
D7			D8			D9		
D10			D11			D12		
S1					M1	E2		

A1 and A2 Frame alignment word

B1 This byte is used for regenerator section error monitoring function.

B2 These bytes are used for a MS error monitoring function (MS-DEG).

D1 - D3 192 kbit/s regenerator section data communication channel ((Tx=H'00, Rx ignored).

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- D4 - D12** 576 kbit/s MS data communication channel (Tx=H'00, Rx ignored).
- E1 and E2** Orderwire channels for voice communication (Tx=H'00, Rx ignored).
- F1** User channel (Tx=00, Rx ignored).
- H1 and H2** Administrative unit pointers
- H3** These bytes are used at negative AU-pointer justification.
- J0** Regenerator section trace (Tx=H'01, Rx ignored).
- K1 and K2 (b1-b4)** Automatic protection switching channel.
- K2 (b5-b8)** Bit 5 indicates protection algorithm used (MSP 1+1). Bit 6-8 is used for transmitting MS-RDI and MS-AIS
- M1** Used as a MS remote error indication. Conveys the count of interleaved bit blocks that have been detected in error by the BIP-24 (B2).
- S1** Allocated for synchronization messages (fixed predefined pattern).

4.2.3 VC-4 Frame Structure

In figure 12 the STM-1 payload is shown in form of a VC-4 frame. The first byte in each row combine to make the VC-4 path section overhead.

Note Ref. G707 ch. 7.1, see reference on page 82

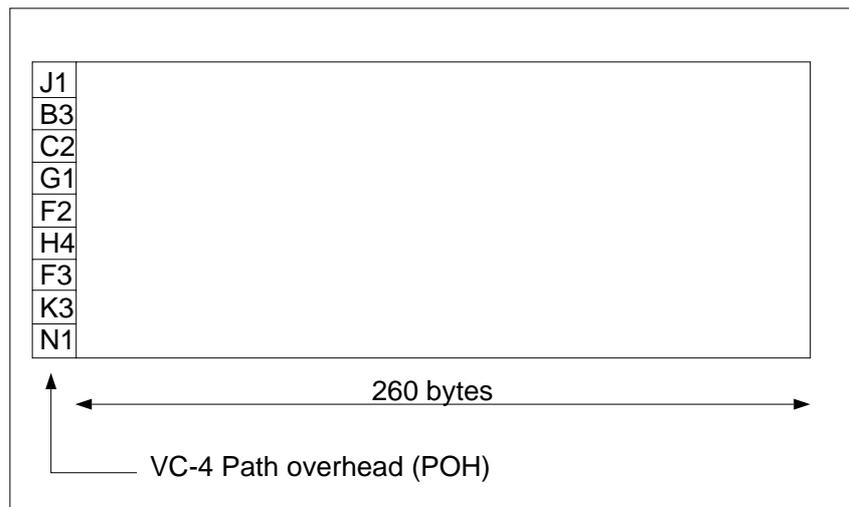


Figure 12 VC-4 Frame

- J1** This byte is used to transmit repetitively a Trail Trace Identifier (TTI) so that a path receiving terminal can verify its continued

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connection to the intended transmitter. The TTI consist of a CRC-7 checksum (C1-C7,C1=MSB), a flagpattern (B7 in all bytes) and an access point identifier (API, 7 bits of byte 1 to 15).

B3 One byte is allocated for path error monitoring function (BIP-8 code) (HP-DEG).

C2 One byte is allocated to indicate the composition or the maintenance status of the VC-4.

Possible values for C2 (C2 = 02 - TUG2 structure, is used in this ET155 product):

- 00 - Unequipped or supervisory unequipped
- 01 - Equipped - non specific
- 02 - TUG structure
- 03 - Locked TU-n
- 04 - Asynchronous mapping of 34368 Kbit/s or 44736 Kbit/s into the container-4
- 12 - Asynchronous mapping of 139262 Kbit/s into the container-4
- 13 - ATM mapping
- 14 - MAN (DQDB) mapping
- 15 - FDDI mapping
- FE - Test signal
- FF - Undefined

G1 One byte is allocated to convey the path status and performance back to a VC-4 trail termination source as detected by a trail termination sink.

F2 This byte is allocated for user communication purposes between path elements (Tx=H'00, Rx ignored).

H4 This byte provides a generalized position indicator for payloads.

F3 This byte is allocated for user communication purposes between path elements (Tx=H'00, Rx ignored).

K3 This byte is used for APS signalling for Trail protection at the VC-4 path level (Tx=H'00, Rx ignored).

N1 This byte is used to provide a Tandem Connection Monitoring function (Tx=H'00, Rx ignored).

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4.2.4 VC-12 Mapping in TU-12 Multiframe

In figure 13 it is shown that a VC-12 together with V1-V4 forms a TU-12 multiframe. V1 and V2, form the tributary unit pointer, which points to the start of the VC-12 frame. One TU-12 multiframe is transmitted in four STM-1 frames.

Note Ref. G707 ch. 8.3, see reference on page 82

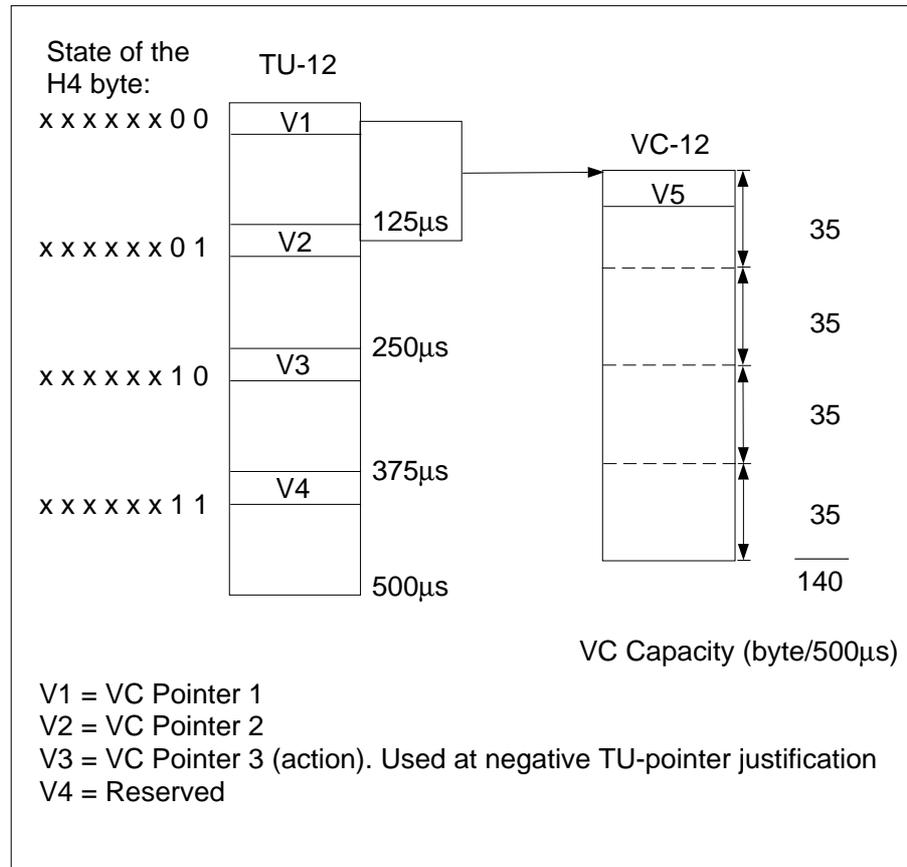


Figure 13 VC-12 Mapping in Multiframe TU-12

4.2.5 VC-12 Frame Structure

One 2048 kbit/s signal can be mapped into a VC-12 frame.

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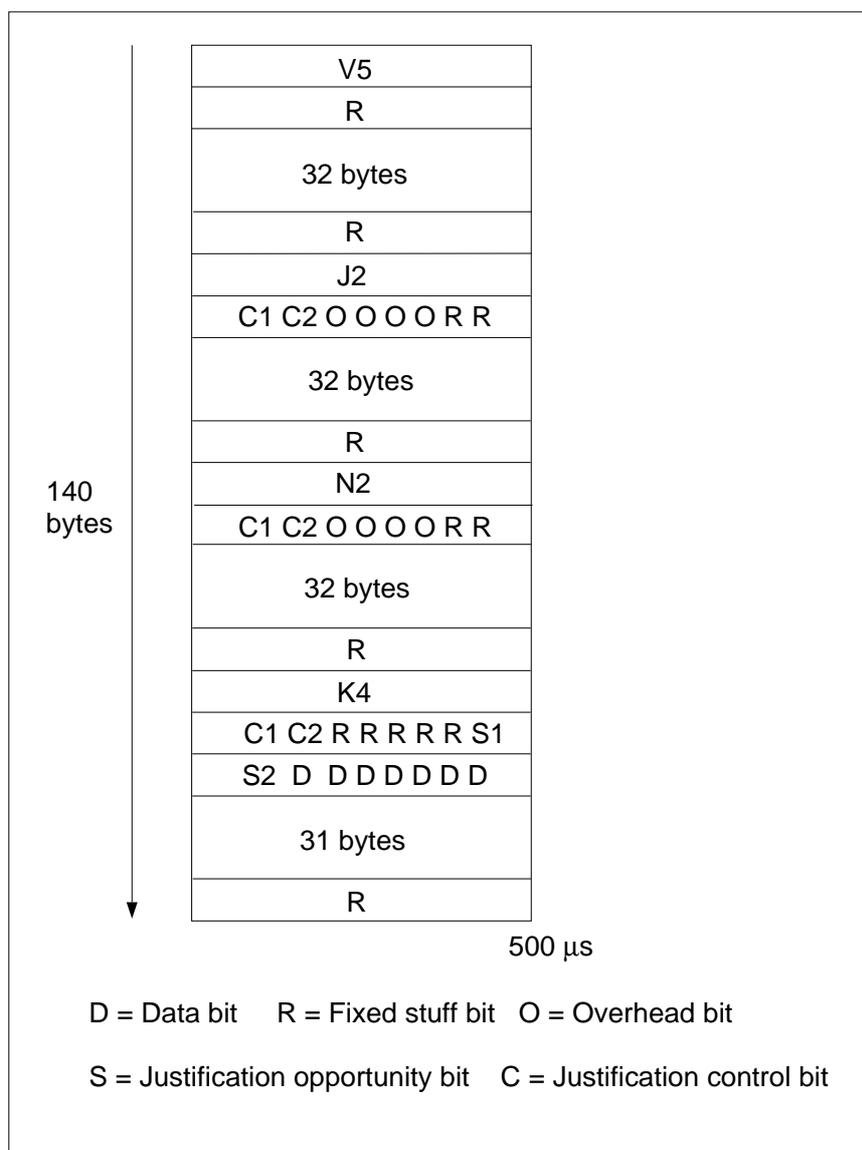


Figure 14 Asynchronous Mapping of 2048 kbit/s. The figure shows a 2048 kbit/s signal mapped into a VC-12 frame.

- J2** This byte is used to transmit repetitively a Low Order Trail Trace Identifier (TTI) so that a path receiving terminal can verify its continued connection to the intended transmitter.
- V5** Described in figure 15
- K4** Automatic protection switching signalling at lower order path level.
- N2** Allocated for Tandem connection monitoring.

4.2.6 V5 Byte Coding

In figure 15 the V5 Byte contains is shown in details.

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Note Ref. G707 ch.9.3.2, see reference on page 82

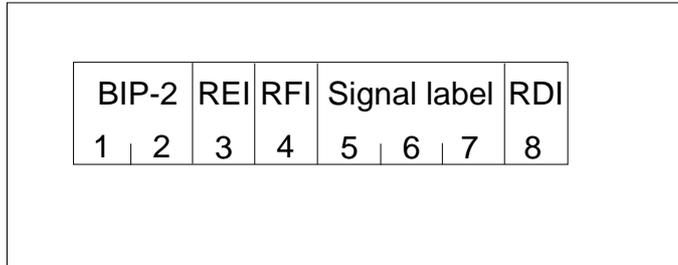


Figure 15 V5 Byte

- BIP-2** Bit Interleaved Parity is used for error performance monitoring.
- REI** Remote Error Indication bit is set to '1' if one or more error where detected by the BIP-2 monitoring.
- RFI** Remote Failure Indication bit is set to '1' if a defect persist beyond the maximum time allocated to the transmission system protection mechanisms.
- RDI** Remote Defect Indication bit is set to '1' if AIS or LOS i detected.
- Signal Label** – 000 - Unequipped or supervisory unequipped
- 001 - Equipped - non specific
- 010 - Asynchronous
- 011 - Bit synchronous
- 100 - Byte synchronous
- 101 - Undefined
- 110 - Test signal
- 111 - Undefined

Signal label = 010 - Asynchronous, is used in this ET 155 product.

4.2.7 SDIP Layers

The different layers within an Synchronous Digital Path (SDIP) and the relationship between them are shown in figure 16. It is possible to equip the SDIP with two MSs, where one MS is used for protection. The SDIP can also be equipped with one MS only, the SDIP is then working without protection. The SDIP also contains one HP and up to 63 LPs.

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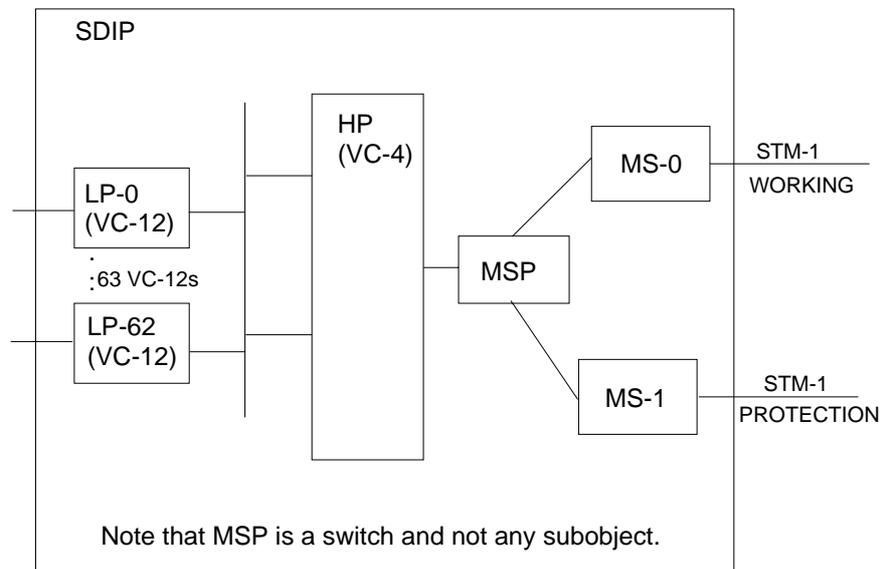


Figure 16 Relationship Between Layers and Subobjects in SDIP

4.2.8 Function

4.2.8.1 Function Overview

4.2.8.1.1 Administration

The SDIP Administration function handles

- Connecting and disconnecting of the SDIP
- Manual blocking or deblocking of the SDIP
- Change and print of SDIP initial or configuration parameters
- Handling the Trail Trace Identifier (TTI)

4.2.8.1.2 Maintenance

The fault supervision function shall detect anomalies and defects within all layers of SDH (STM-1), to take appropriate automatic action and to alert the maintenance staff.

4.2.8.2 Administration

4.2.8.2.1 Connecting the SDIP

The SDIP can be connected by command in two ways:

- The SDIP is given a unique name by command and the system automatically indexes the MS(s), the VC-4 and the VC-12s according to the connected hardware.
- If an arbitrary number of VC-12s is to be connected, the SDIP is given a unique name and the VC-12s are specified by command. The MSs and the VC-4 are indexed automatically.

4.2.8.2.2 Disconnecting the SDIP

The SDIP can be disconnected by command.

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4.2.8.2.3 Changing the SDIP Configuration

SDIP configuration data can be changed, MSs or VC-12s are increased or decreased by command. Configuration data which can be changed is:

- The number of MSs connected to each SDIP. This specifies if one or two MSs are connected to the SDIP.
- Number of VC-12 terminations for each given SDIP.

4.2.8.2.4 Printing the SDIP Configuration

Configuration data for the SDIP, including all MSs and VC-12s connected, can be printed by command.

4.2.8.2.5 Changing SDIP Initial Data

Initial data can be changed by command.

Initial data that can be changed is:

- The degraded defect threshold (DEGTHR). The value range is from 1 to 100% and the default value is 30%.
- The sliding monitoring period of degraded defect (DEGM). The value range is from 2 to 10s and the default value is 3s.
- MS-REI mode. Specifies whether MS-REI shall be used for performance monitoring or not. The default value is: MS-REI detection supported.

It is possible to set separate DEGTHR and DEGM values for each of the levels MS, VC-4 and VC-12. All VC-12s within the same VC-4 will have the same value.

4.2.8.2.6 Printing SDIP Initial Data

The initial data can also be printed by command.

4.2.8.2.7 Manual Blocking and Deblocking of SDIP

It is possible to block and unblock the whole SDIP by one command. When the whole SDIP is blocked all layers (MSs, HP and LPs) within the actual SDIP are blocked.

The SDIP internal levels, VC-12s, VC-4 and the MSs can be blocked and unblocked by command. It is possible to block or unblock each subobject within the SDIP separately.

At manual blocking of an SDIP subobject, the fault supervision is stopped for that object. At unblocking the fault supervision is started again.

4.2.8.2.8 Printing SDIP state

The state of the SDIP including all current fault information can be printed by command.

4.2.8.2.9 Trail Trace Identifier

The Trail trace identifier is a character string which is continuously sent in the layer overhead of VC-4 and VC-12 as an identification of the transmitting termination point.

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If no value is specified for the TTI to transmit then the value binary zero is transmitted. If no value is specified for the TTI to be expected from the far end, the received TTI is ignored and TIM is not generated.

The Trace Identifier Mismatch (TIM) defect detection can be enabled and disabled by command. The HP-TIM defect detection is possible to set per VC-4, while the LP-TIM defect detection is possible to set for each VC-12.

4.2.8.2.10 Changing the TTI

The transmitted and expected TTI for VC-4 and VC-12 can be changed by command.

The TTI can be printed by command. In the printout the expected, transmitted and received TTI for VC-4 and VC-12 are given. The printout also show if TIM is enabled or disabled for the actual layers.

4.2.8.3 Fault Supervision

The purpose of Fault Supervision function is to detect transmission faults, take appropriate automatic actions to avoid traffic being set up on faulty equipment, and initiate alarm printouts.

The defects LOS, LOF, MS-AIS and MS-DEG initiates the network protection function, see figure 17.

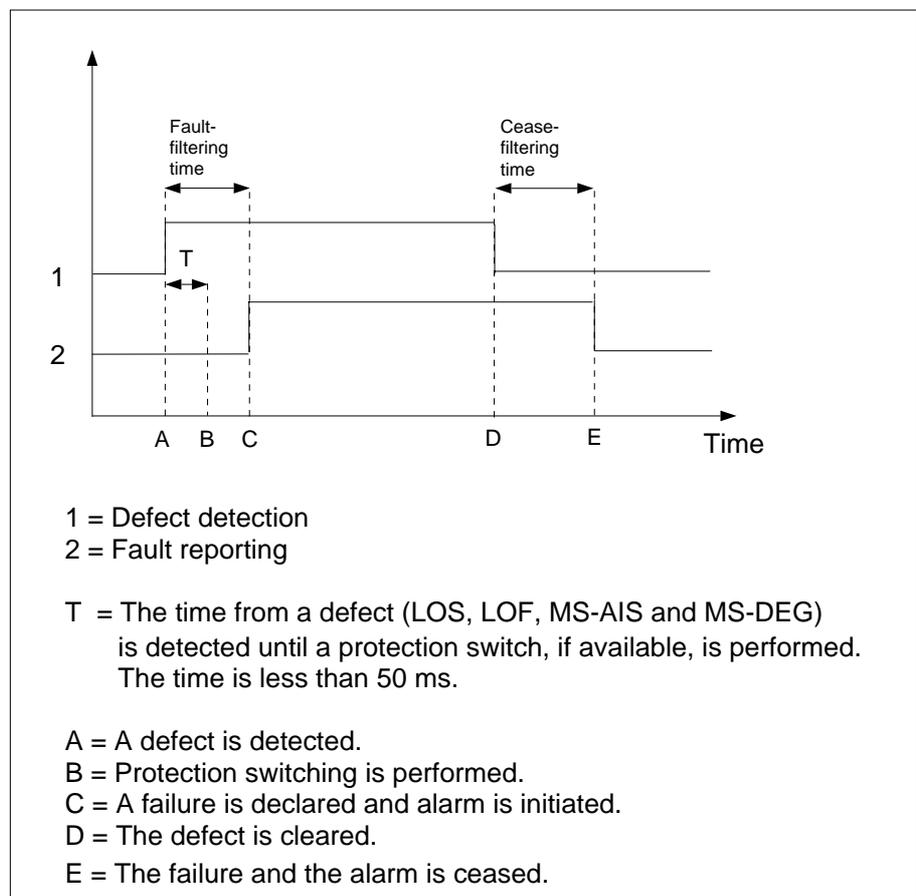


Figure 17 Defect Filtering Times and Network Protection Switching

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In figure 17 a summary of the Fault Supervision function is shown.

A defect is detected at point A. If this defect leads to sending of RDI and AIS (see table 17), sending is generated at this point.

The defects LOS, LOF, MS-AIS and MS-DEG will initiate the Network Protection function. If network protection is available, the Network Protection function switches the traffic to the standby MS. This network protection switch is done at point B.

When the defect has lasted longer than the fault filtering time, a failure is declared and an alarm is given to the operator, point C. The operator can set the fault filtering time, see chapter 4.2.8.3.26.

At point D, the defect is cleared and sending of RDI and AIS is stopped.

When the defect has been cleared longer than the cease filtering time, the failure and the alarm is ceased, point E. The operator can set the cease filtering time, see chapter 4.2.8.3.26.

4.2.8.3.1 Start Fault Supervision

Fault supervision is started for a specified subobject in the SDIP when that subobject is deblocked manually or automatically from a superior function.

4.2.8.3.2 Stop Fault Supervision

The fault supervision is stopped on a specified subobject within the SDIP if the specified subobject is blocked manually or automatically from a superior function.

4.2.8.3.3 Loss of Incoming Signal (LOS)

LOS defect is detected for both electrical and optical interfaces. The LOS defect ceases at frame alignment recovery.

4.2.8.3.4 Loss of Frame Alignment (LOF)

If the Frame alignment word, bytes A1 and A2, see table 15, has not been received for 4 consecutive frames then OOF state is entered. If the OOF state persists for 3 ms +/- 0.25 ms, then LOF is detected.

When two consecutive Frame alignment words have been received the in frame state is entered. The LOF defect is cleared when the "in frame state" has persisted continuously for 3 ms +/- 0.25 ms.

4.2.8.3.5 Multiplex section - alarm indication signal (MS-AIS)

If at least five consecutive frames contains the 111 pattern in bits 6, 7 and 8 of the K2 byte, see table 15, the MS-AIS defect is detected. The MS-AIS defect is cleared if five consecutive frames contains any other pattern than 111 in bits 6, 7 and 8 of the K2 byte.

4.2.8.3.6 Multiplex section - degraded (MS-DEG)

The B2 bytes, see table 15, are allocated for the multiplex error monitoring function. Once every second, the number of errored blocks during the second is compared with the DEGTHR. If the number of errored blocks is equal or greater than DEGTHR, the one second is declared bad, otherwise it is declared good. The degraded defect is detected if DEGM consecutive bad seconds have occurred and cleared if DEGM consecutive good seconds have occurred. (The default value for DEGM are 3s and the default value for

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DEGTHR is 30%, these values can be changed by command, see Section 2.2).

4.2.8.3.7 **Multiplex section - remote defect indication (MS-RDI)**

If at least five consecutive frames contain the 110 pattern in bits 6, 7 and 8 of the K2 byte, see table 15, the MS-RDI defect is detected. The MS-RDI defect is cleared if five consecutive frames contain a cleared RDI signal.

4.2.8.3.8 **Administrative unit - loss of pointer (AU-LOP)**

The H1 and H2 bytes, see table 15, contain the AU pointer. The AU-LOP defect is detected if the pointer interpreter is in the LOP state, see ref. [1] Annex B. The AU-LOP defect is cleared if the pointer interpreter is not in the LOP state.

4.2.8.3.9 **Administrative unit - alarm indication signal (AU-AIS)**

The H1 and H2 bytes, see table 15, contain the AU pointer. The AU-AIS defect is detected if the pointer interpreter is in the AIS state, see ref. [1] Annex B. The AU-LOP defect is cleared if the pointer interpreter is not in the AIS state.

4.2.8.3.10 **Higher order path - unequipped VC indication (HP-UNEQ)**

The HP-UNEQ defect is detected if five consecutive frames contains the pattern H'00h in the C2 byte, see figure 12. The HP-UNEQ defect is cleared if the C2 byte contains a value greater than 0 in five consecutive frames.

4.2.8.3.11 **Higher order path - trace identifier mismatch (HP-TIM)**

The received TTI in the J1 byte, see figure 12, is compared to the expected TTI. If a mismatch occurs, the HP-TIM defect is detected. The HP-TIM defect is cleared when the received TTI and the expected TTI are identical again. HP-TIM can be turned on/off by command TPTII/TPTIE.

4.2.8.3.12 **Higher order path - remote defect indication (HP-RDI)**

If bit 5 of the received G1 byte, see figure 12 is set in five consecutive frames the HP-RDI defect is detected. The HP-RDI defect is cleared if bit 5 in the received G1 byte is cleared in five consecutive frames.

4.2.8.3.13 **Higher order path - degraded (HP-DEG)**

The B3 byte, see figure 12, are allocated for the Path Error Monitoring function. Once every second, the number of errored blocks during the second is compared with the degraded defect threshold (DEGTHR). If the number of errored blocks is equal or greater than DEGTHR the one second is declared bad, otherwise it is declared good. The degraded defect is detected if DEGM consecutive bad seconds have occurred. The degraded defect is cleared if DEGM consecutive good seconds have occurred. (The default value for DEGM are 3s and the default value for DEGTHR is 30%, these values can be changed by command, see chapter 4.2.8.2.

4.2.8.3.14 **Higher order path - payload mismatch (HP-PLM)**

The received C2 byte, see figure 12, is compared with the expected C2 byte. If a mismatch occurs then the HP-PLM defect is detected. The HP-PLM defect is cleared when the received C2 byte and the expected C2 byte are identical. However value "01- Equipped - non specific", and "02 -TUG" will always be accepted when received.

4.2.8.3.15 **Tributary unit - loss of multiframe (TU-LOM)**

The TU-LOM defect is detected if two or more consecutive H4 bytes are mismatched for two consecutive multiframes. TU-LOM defect can be declared within 6 frames. When the alarm occurs, the internal H4 multiframe detector

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starts a search for a multiframe pattern immediately. Recovery occurs when four consecutive H4 byte values are detected.

4.2.8.3.16 Tributary unit - loss of pointer (TU-LOP)

The V1 and V2 bytes, see figure 13, contain the TU pointer. The TU-LOP defect is detected if the pointer interpreter is in the LOP state, see ETS 300 417-1-1 Annex B on page 82. The TU-LOP defect is cleared if the pointer interpreter is not in the LOP state.

4.2.8.3.17 Tributary unit - alarm indication signal (TU-AIS)

The V1 and V2 bytes, see figure 13, contain the TU pointer. The TU-AIS defect is detected if the pointer interpreter is in the AIS state, see ETS 300 417-1-1 Annex B on page 82. The TU-AIS defect is cleared if the pointer interpreter is not in the AIS state.

4.2.8.3.18 Lower order path - unequipped VC indication (LP-UNEQ)

The LP-UNEQ defect is detected if five consecutive frames contains the pattern 000 in the signal label in the V5 byte, see figure 14 and figure 15. The LP-UNEQ defect is cleared if the signal label contains a value greater than 0 in five consecutive frames.

4.2.8.3.19 Lower order path - trace identifier mismatch (LP-TIM)

The received trail trace identifier in the J2 byte, see figure 14, is compared with the expected trail trace identifier. If a mismatch occurs, the LP-TIM defect is detected. The LP-TIM defect is cleared when the received TTI and the expected TTI is identical again. LP-TIM can be turned on/off by command TPTIT/TPTIE.

4.2.8.3.20 Lower order path - remote defect indication (LP-RDI)

If bit 8 of the received V5 byte, see figure 14 and figure 15, is set in five consecutive frames the LP-RDI defect is detected. The LP-RDI defect is cleared if bit 8 in the received V5 byte is cleared in five consecutive frames.

4.2.8.3.21 Lower order path - degraded (LP-DEG)

The BIP-2 in the V5 byte, see figure 14 and figure 15, are allocated for the error performance monitoring function. Once every second, the number of errored blocks during the second is compared with the degraded defect threshold (DEGTHR). If the number of errored blocks is equal or greater than DEGTHR the one second is declared bad, otherwise it is declared good. The degraded defect is detected if DEGM consecutive bad seconds have occurred. The degraded defect is cleared if DEGM consecutive good seconds have occurred. (The default value for DEGM are 3s and the default value for DEGTHR is 30%, these values can be changed by command, see chapter 4.2.8.2.

4.2.8.3.22 Lower order path - payload mismatch (LP-PLM)

The received signal label in the V5 byte, see figure 14 and figure 15, is compared with the expected signal label. If a mismatch occur then the LP-PLM defect is detected. The LP-PLM defect is cleared when the received C2 byte and the expected C2 byte are identical. However value "001- Equipped - non specific", and "010-Asynchronous" will always be accepted when received.

4.2.8.3.23 Prompt Maintenance Alarm

For each failure condition the operator can specify by command the alarm class, A1, A2 or A3, and whether the prompt maintenance alarm indication shall be generated or not. The operator may also by command print the status for the SDIP and the subobjects within the SDIP (MS, VC-4 and VC-12s).

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4.2.8.3.24 Alarm Printing

The alarms to the operator includes the following information:

- Identification of the affected SDIP, MS, VC-4 and/or VC-12
- State information for the whole SDIP
- The fault situation causing the alarm
- The alarm class
- Date and time stamp information

In addition, for defects HP-TIM and LP-TIM, the received and expected TTI values are included in the alarm report information. For defects HP-PLM and LP-PLM, the received and expected values are also included in the alarm report information.

4.2.8.3.25 Fault Filtering Times

There are two filtering times associated with the fault detection.

- A defect is filtered specified period before a failure is declared. This fault filtering time can be set in the range 100 ms to 10 minutes in steps of 100 ms. Default value is 2.5 s.
- When the fault ceases, a cease filtering time is used in order to ensure that the fault has disappeared. This cease filtering time can be set in the range 100 ms to 10 minutes in steps of 100 ms. Default value is 10 s.

The fault filtering time and cease filtering time are both set by application parameters.

4.2.8.3.26 Alarm Filtering

Failures at the SDIP have the following priority, see table 16. The order of priority is based on ETSI/ITU Standards/recommendations.

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Table 16 LOS has highest priority and LP-PLM has lowest. Defect in the column “Suppressing Failures” suppresses defect in the same column with lower priority.

	Suppressing Failures	No-suppressing Failures	Priority
MS	LOS		High
	LOF		
	AIS		
		DEG	
	RDI	RDI *)	
VC-4 (HP)	LOP/AIS *)		
	UNEQ		
	TIM		
		DEG	
	RDI		
	PLM		
	TU-LOM		
VC-12 (LP)	LOP/AIS *)		
	UNEQ		
	TIM		
		DEG	
	RDI		
	PLM		

*) LOP and AIS do not appear at the same time, they are mutually exclusive. RDI can be no-suppressing when network protection is available

LOS has highest priority and LP-PLM has lowest priority. Only defects in column “Suppressing Failures” will suppress defects of lower priority. If several “Suppressing Failures” are detected simultaneously, only the failure with highest priority is reported. Defects in the column “No-suppressing Failures” do not suppress any other defects. It is possible to have two active alarms at the same time, one alarm for “Suppressing Failures” and one alarm for “No-suppressing Failures”. This means that for instance an MS-RDI and an MS-DEG alarm may be present at the same time for a given MS-object.

4.2.8.3.27 Actions at Fault Conditions

The maintenance actions specified in table 17 are taken as consequence of the detected faults.

A service alarm indication is generated to signify that the service is no longer available.

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The prompt maintenance alarm indication is generated to signify that performance is below acceptable standards and that immediate maintenance attention is required locally. For a given fault condition, it is possible specify whether the prompt maintenance alarm is generated or not.

RDI is generated to notify the remote end about erroneous transmission towards the local end.

Table 17 Fault Conditions and Alarms Detected by SDH Fault Supervision

Anomalies and defects detected	Consequent actions			
Loss Of incoming Signal (LOS)	1f	2a	3b Note	4 g Note
Loss Of Frame (LOF)	1f	2a	3b	4g
MS-AIS	1f	2a	3b	4g
MS-DEG	-	2a	-	-
MS-RDI	1f	2a	-	-
AU-LOP	1	2a	3c	4
AU-AIS	1	2a	3c	4
HP-UNEQ VC indication	1	2a	3c	4
HP-TIM	1	2a	3c	4
HP-DEG	-	2a	-	-
HP-RDI	1	2a	-	-
HP-PLM	1	2a	3c	4
TU-LOM	1	2a	3c	4
TU-LOP	1	2a	3d	4
TU-AIS	1	2a	3d	4
LP UNEQ VC indication	1	2a	3d	4
LP-TIM	1	2a	3d	4
LP-DEG	-	2a	-	-
LP-RDI	1	2a	-	-
LP-PLM	1	2a	3e	4

- 1 =** Service alarm indication generated.
- 2 =** Prompt maintenance alarm indication generated.
- 3 =** RDI to remote end generated (see also b-e below)
- 4 =** AIS towards the switching stages generated.
- a =** The operator is able to set whether this alarm indication should be generated or not.

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b = Remote defect indications generated to remote end for affected levels. If network protection switching is possible only MS-RDI is generated to remote end.

If MS-RDI is reported for an MS that is unprotected, the MS-RDI is treated as a suppressing defect. However, if MS-RDI is reported for an MS that is protected, the MS-RDI is treated as a no-suppressing defect. This is in order to be consistent with actions at remote end (which probably has detected LOS/LOF and therefore has terminated traffic on its side).

- MS-RDI
- HP-RDI
- LP-RDI
- PDH-RDI

c = Remote defect indications generated to remote end for affected levels

- HP-RDI
- LP-RDI
- PDH-RDI

d = Remote defect indications generated to remote end for affected levels

- LP-RDI
- PDH-RDI

e = Remote defect indications generated to remote end for affected levels

- PDH-RDI

f = Service alarm indication is only generated if network protection switching was not possible.

g = AIS is only generated if network protection switching was not possible.

Note = LOS does not generate AIS or RDI. LOS suppresses LOF and all following defects. It is the LOF that follow upon the LOS that generates AIS and RDI.

For each layer of STM-1 (physical-, regenerator-, multiplex-, higher order path-, lower order path- sections) maintenance signals are detected or generated. An alarm indication signal (AIS) is a signal sent against the switch as an indication that a defect or failure has been detected. A remote defect indication (RDI) is a signal to be returned to the remote end to inform that the near end has detected an incoming failure or is receiving AIS. The figure 18 shows the standardized maintenance signal interaction hierarchy for STM-1 without the network protection function.

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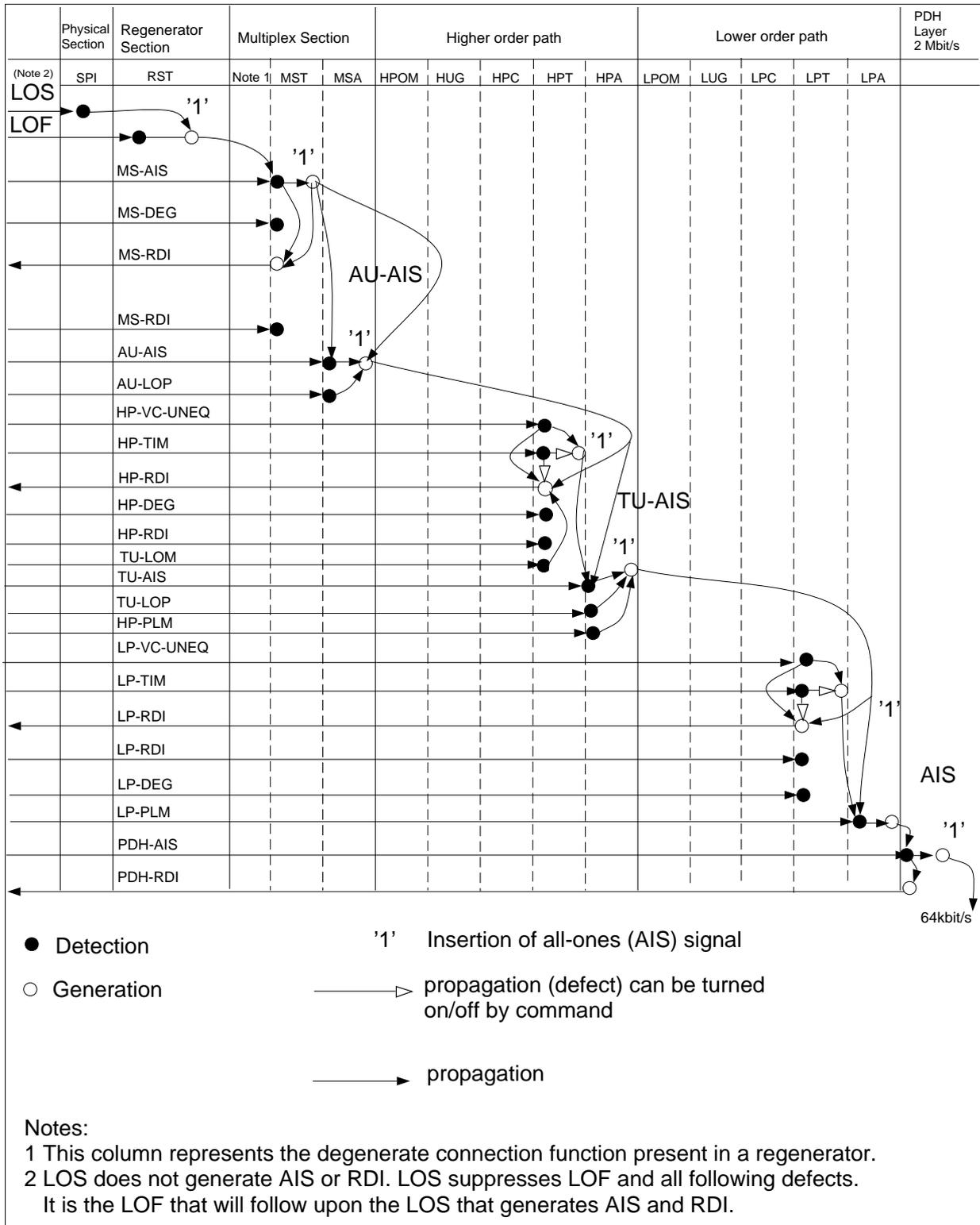


Figure 18 STM-1 maintenance signal interaction described without the network protection function. The open arrows are defect detections that can be turned on/off by operator command. In addition, the interaction between SDH and PDH is included.

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4.3 Quality Supervision

A description of the quality supervision function for 155 Mbit/s synchronous digital path termination. That is the quality supervision, also known as performance monitoring of the multiplex sections, higher order path and lower order paths within the synchronous digital paths. The function is used to alert maintenance staff, before the transmission quality is such that concerned multiplex section, higher order path or lower order path is considered faulty.

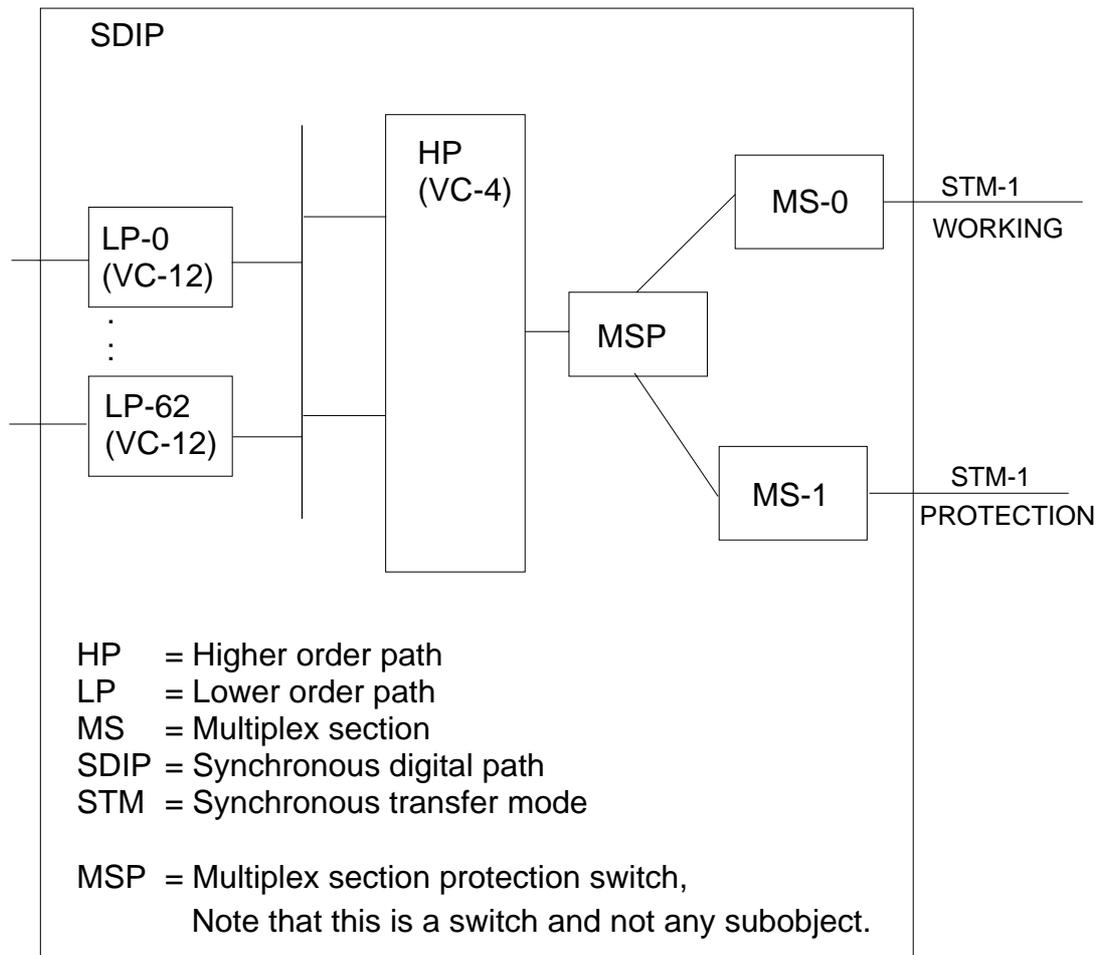


Figure 19 Relationship Between Layers and Subobjects in SDIP

4.3.1 Function

4.3.1.1 Overview

The aim of quality supervision is to supervise the quality of the SDIP. That is in order to alert maintenance staff before the quality of the service is such that whole or part of the SDIP is considered faulty. Historical storage of quality data is included in the function.

4.3.1.2 Monitored Objects

Performance is monitored in the termination points of the multiplex section, higher order path, and lower order path of the SDH system. This means that

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performance is monitored for each subobject, that is the MS, HP and LP subobjects, within an SDIP.

4.3.1.3 Basic Performance Parameters

The performance of MS, HP and LP subobjects within an SDIP is monitored separately for incoming and outgoing direction. For each layer a certain set of anomalies and defects are defined, which leads to registration of an event of impairment. The event is registered as an Errored Second (ES) or a Severely Errored Second (SES), depending upon the severity of the impairment. ES and SES are the basic performance parameters, upon which the quality supervision is based.

The evaluation of error performance and availability performance is based on the processing of the basic performance parameters.

4.3.1.3.1 Near End or Far End Monitoring

Error performance is monitored by measuring various parameters in the incoming transmission direction. Incoming errors and defects are reported to the remote end by use of remote error indication, REI, and remote defect indication, RDI. Hence, by reading REI and RDI coming in to a termination point, it is possible to obtain a picture of the quality perceived in the remote end termination point.

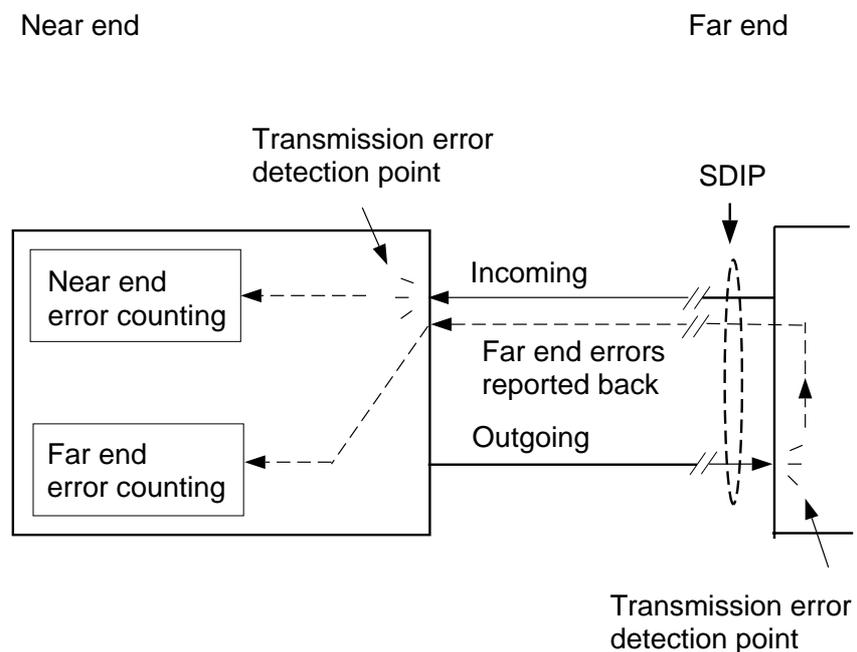


Figure 20 Counting of Errors for Near End and Far End

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4.3.1.3.2 ES and SES Parameter Evaluation Criteria for the Multiplex Section Layer

Table 18

Anomalies and defects in one second	Interpretation for receive direction	Interpretation for send direction	Notes
>= 1 LOS	ES+SES	-	
>= 1 LOF	ES+SES	-	
>= 1 MS-AIS	ES+SES	-	
>= 1 MS-BIP-1 errors	ES	-	
>= 28800 MS-BIP-1 errors	ES+SES	-	
>= 1 MS-REI	-	ES	Note 1
>= 28800 MS-REI	-	ES+SES	Note 1
>= 1 MS-RDI	-	ES+SES	

Note 1: In order to be compatible with equipment not supporting MS-REI at remote end, MS-REI detection may be turned on/off by command. MS-REI detection is supported by default.

4.3.1.3.3 ES and SES Parameter Evaluation Criteria for the Higher Order Path Layer

Table 19

Anomalies and defects in one second	Interpretation for receive direction	Interpretation for send direction	Notes
>= 1 AU-AIS	ES+SES	-	
>= 1 AU-LOP	ES+SES	-	
>= 1 HP-TIM	ES+SES	-	
>= 1 HP-UNEQ	ES+SES	-	
>= 1 HP-BIP-8 errors	ES	-	
>= 2400 HP-BIP-8 errors	ES+SES	-	
>= 1 HP-REI	-	ES	
>= 2400 HP-REI	-	ES+SES	
>= 1 HP-RDI	-	ES+SES	

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4.3.1.3.4 ES and SES Parameter Evaluation Criteria for the Lower Order Path Layer

Table 20

Anomalies and defects in one second	Interpretation for receive direction	Interpretation for send direction	Notes
>= 1 TU-LOM	ES+SES	-	
>= 1 TU-AIS	ES+SES	-	
>= 1 TU-LOP	ES+SES	-	
>= 1 LP-TIM	ES+SES	-	
>= 1 LP-UNEQ	ES+SES	-	
>= 1 LP-BIP-2 errors	ES	-	
>= 600 LP-BIP-2 errors	ES+SES	-	
>= 1 LP-REI	-	ES	
>= 600 LP-REI	-	ES+SES	
>= 1 LP-RDI	-	ES+SES	

4.3.1.4 Time Intervals

Both performance parameters, ES and SES, are counted during two time intervals, which are rectangular fixed windows with length 15 minutes and 24 hours respectively. The start and end time for the 15-minute (T1) and 24-hour (T2) intervals are the same for ES evaluation as for SES evaluation. Both the 15-minute and 24-hour intervals are synchronized to the exchange clock. In addition, the 15-minute interval is aligned with the 24-hour interval. That is the start of a 24-hour period is also the start of a 15-minute period.

The start and end time for the 15-minute period are the same from both ES and SES and must fall on the hour and at 15, 30 and 45 minutes after the hour.

The 15-minute measurement starts immediately when the supervised object, MS, HP or LP, is taken into service. Hence it may happen that the first interval will not be fully 15-minutes. If the first interval not is fully 15-minutes, it will be suspect marked.

The start and end time for the 24-hour period are the same from both ES and SES and must fall on a 15-minute window boundary. The start time of the 24-hour interval can be set by command in steps of 15-minutes. The default start time is 00.00.

4.3.1.5 Performance Levels

Three performance levels, acceptable, degraded and unacceptable performance level, are defined for ES and SES supervision.

Unacceptable or degraded performance level is entered when significant or gradual degradation in quality has been declared respectively.

- Unacceptable Performance Level is evaluated during fixed 15-minute time intervals (T1).

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- Degraded Performance Level is evaluated during fixed 24-hour time intervals (T2).

The actual performance level is derived through the monitoring and thresholding of the basic performance parameters (ES and SES).

4.3.1.6 Thresholding and Reports

For both time intervals (15-minute and 24-hour), the basic performance parameters are counted in both transmission directions, in order to derive the actual performance level. Consequently, for each time interval (15-minute and 24-hour), there are two ES counters and two SES counters per MS, VC-4 and VC-12.

A threshold report is issued when either unacceptable or degraded performance level is entered. A performance level is entered if a threshold value is reached or crossed by the corresponding basic performance counter.

However, a fault alarm for an SDIP subobject will suppress threshold reports (both for unacceptable and degraded performance) for concerned SDIP subobject, corresponding subordinate SDIP subobjects on lower level SDH layers and for corresponding DIPs on PDH layer.

ES and SES are counted second by second to the end of the 15-minute interval independently on if a threshold report (alarm) has been issued or not. Then the counters are stored and reset to 0 (zero).

4.3.1.7 15-minute Measurements

In both transmission directions, ES and SES are measured during 15-minute intervals to determine whether the performance level is unacceptable or not. If a threshold for unacceptable performance is reached or crossed by the respective performance counter (incoming or outgoing ES or SES), a corresponding threshold report is given.

The default threshold values and the threshold value ranges are listed below. The values are the same for both transmission directions.

Table 21

Layer	Threshold	Default value	Value range
MS	ST1-ES	50 ES	0-900 ES
MS	ST1-SES	10 SES	0-900 SES
HP	ST1-ES	180 ES	0-900 ES
HP	ST1-SES	15 SES	0-900 SES
LP	ST1-ES	120 ES	0-900 ES
LP	ST1-SES	15 SES	0-900 SES

If the unacceptable performance level is reached in one 15-minute interval, the considered basic performance counter will be compared to a reset threshold at the end of subsequent 15-minute intervals. If the basic performance counter is below or equal to the reset threshold, a corresponding reset threshold report is given.

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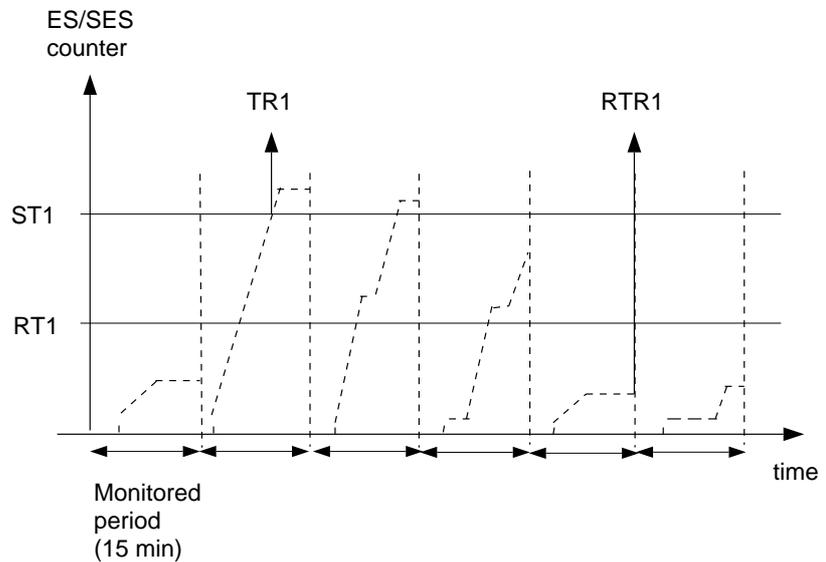
The default reset threshold values and the value ranges are listed below. The values are the same for both transmission directions.

Table 22

Layer	Threshold	Default value	Value range
MS	RT1-ES	0 ES	0-900 ES
MS	RT1-SES	0 SES	0-900 SES
HP	RT1-ES	0 ES	0-900 ES
HP	RT1-SES	0 SES	0-900 SES
LP	RT1-ES	0 ES	0-900 ES
LP	RT1-SES	0 SES	0-900 SES

The counters for ES and SES are compared to their respective set thresholds every second and to their respective reset thresholds at the end of each 15-minute interval.

The principles of thresholding in 15-minute intervals are illustrated in figure 21 below.



- ST1 Set Threshold
- TR1 Threshold Report
- RT1 Reset Threshold
- RTR1 Reset Threshold Report

Figure 21 Principles of Thresholding - Unacceptable Performance

4.3.1.8 24-hour Measurements

In both transmission directions, ES and SES are counted during 24-hour intervals to determine whether the performance level is degraded or not. If a threshold for degraded performance is reached or crossed by the respective

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performance counter (incoming or outgoing ES or SES), a corresponding threshold report is given.

The default threshold values and the threshold value ranges are listed below. The values are the same for both transmission directions.

Table 23

Layer	Threshold	Default value	Value range
MS	ST2-ES	7 ES	0-86400 ES
MS	ST2-SES	1 SES	0-86400 SES
HP	ST2-ES	223 ES	0-86400 ES
HP	ST2-SES	3 SES	0-86400 SES
LP	ST2-ES	56 ES	0-86400 ES
LP	ST2-SES	3 SES	0-86400 SES

The default threshold values for the different degraded performance limits are calculated according to formulas given by ITU-T M.2101, see reference on page 82. Degraded performance limits will have to be calculated for each configuration. The calculation of the default threshold values described in table 23 will now be shown. Parameters like distance of path (sum of all PCE = Path Core Elements) and allocation Performance Objectives (PO) to each PCE considered.

Note These calculations are only in order to illustrate an example. In reality this must be calculated for each network configuration depending on the physical media used.

MS

===

From table 3/M.2101:

$PO.ES = 8\%$ $PO.SES = 0.1\%$

Estimated length: $d = 1$ km

From table 2B/M.2101:

Allocation: 0.2% (terrestrial)

Allocated Performance Objective (APO.ES) = $0.2\% \times 8\% \times 86400 = 14$

$APO.SES = 0.2\% \times 0.1\% \times 86400 = 1$ (rounded off)

Degraded Performance Limit (DPL.ES) = $0.5 \times APO.ES = 7$

$DPL.SES = 0.5 \times APO.SES = 1$ (rounded off)

VC4

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====

From table 3/M.2101:

PO.ES = 8%

PO.SES= 0.1%

Estimated length: d = 500 km

From table 2A/M2101:

Allocations:

Terminating end: 2%

Terrestrial: 0.3%

Terminating far end: 2%

Sum Allocations% (A%) = 4.3%

APO.ES= 4.3% x 8% x 86400 = 297

APO.SES= 4.3% x 0.1% x 86400 = 4

DPL.ES = 0.75 x 297 = 223

DPL.SES = 0.75.4 = 3

VC12

=====

From table 3/M.2101:

PO.ES= 2%

PO.SES= 0.1 %

Estimated length: d = 500 km

Allocations:

Terminating end: 2%

Terrestrial: 0.3%

Terminating far end: 2%

Sum A% = 4.3%

APO.ES= 4.3% x 2% x 86400 = 74

APO.SES= 4.3% x 0.1% x 86400 = 4

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$$DPL.ES = 0.75 \times 74 = 56$$

$$DPL.SES = 0.75 \times 4 = 3$$

If the degraded performance level is reached in a 24-hour interval, a reset report is given at the end of the interval.

The counters for ES, and SES are compared to their respective thresholds every 15 minutes.

The principles of thresholding in 24-hour intervals are illustrated in figure 22 below.

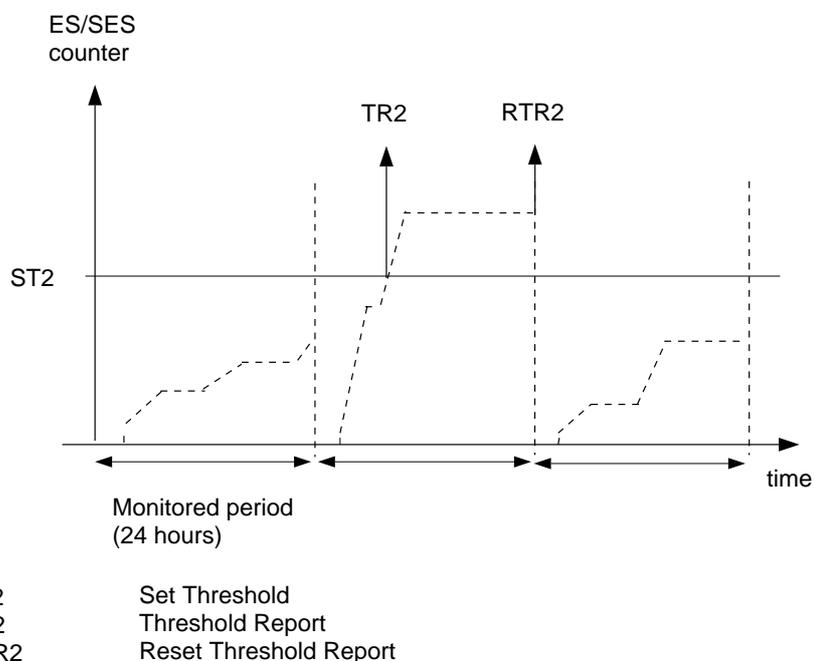


Figure 22 Principles of Thresholding - Degraded Performance

4.3.1.9 Transmission States

4.3.1.9.1 General

A synchronous digital path subobject (MS, HP or LP) can be in one of two transmission states:

- Unavailable State
- Available State

The transmission state is determined from filtered SES/non-SES data.

4.3.1.9.2 Transmission State Evaluation

The unavailable state filter is a 10-second rectangular sliding window with 1-second granularity of slide. The Unavailable State is declared at the end of 10 consecutive SES events. These 10 seconds are considered to be part of the unavailable time (UAS).

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The available state filter is a 10-second rectangular sliding window, with 1-second granularity of slide. The Available State is detected at the end of 10 consecutive non-SES events, subsequent to detection of unavailable state. These 10 seconds are considered to be part of the available time.

The unavailable time for the SDIP subobject is defined as the time during which the SDIP subobject is in the unavailable state. During this time the ES and SES are not counted.

Upon detection of unavailable state for the SDIP subobject, an alarm is issued and the counter for the unavailable event (UAV) is incremented by 1. The unavailable time is counted in seconds. At entry and termination of unavailable state, the alarm and alarm ceasing are time stamped. The time stamps are related to the first of the unavailable or available seconds respectively. A counter for the current unavailable time in seconds is started.

Unavailable state alarm on lower level is suppressed by higher level alarms, hence an alarm on MS level will suppress alarms on corresponding VC-4, VC-12 and PDH level. Unavailable state alarm is also suppressed if a failure exists simultaneously on the same level or a higher level.

Unavailable time and unavailable events are counted in both incoming and outgoing direction (see figure 20) during the 15-minute and 24-hour time intervals. Their respective counters are reset at the end of each interval.

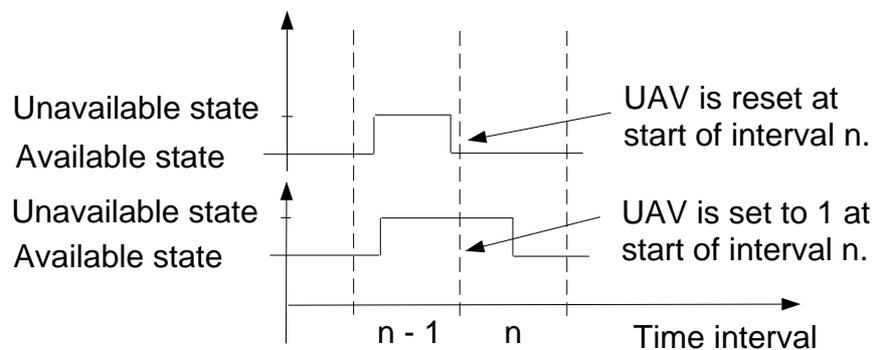


Figure 23 Illustration of Resetting and Setting of UAV Counter at Start of Each Interval

Actions are taken to ensure that threshold reports (alarms) are correctly generated and ES/SES available state counters are correctly processed during changes in the transmission state. This implies that:

- All threshold reports (alarms) are delayed by 10 seconds.
- At detection of unavailable state for the SDIP subobject, ES and SES counters are decremented by the number accumulated during the last 10 seconds.
- At detection of available state, the ES counters are incremented by the actual number of ES events during the last 10 seconds.

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The rules for determining the unavailable second parameter for the SDIP subobject and for inhibiting other parameter counts during unavailable time is illustrated in figure 24.

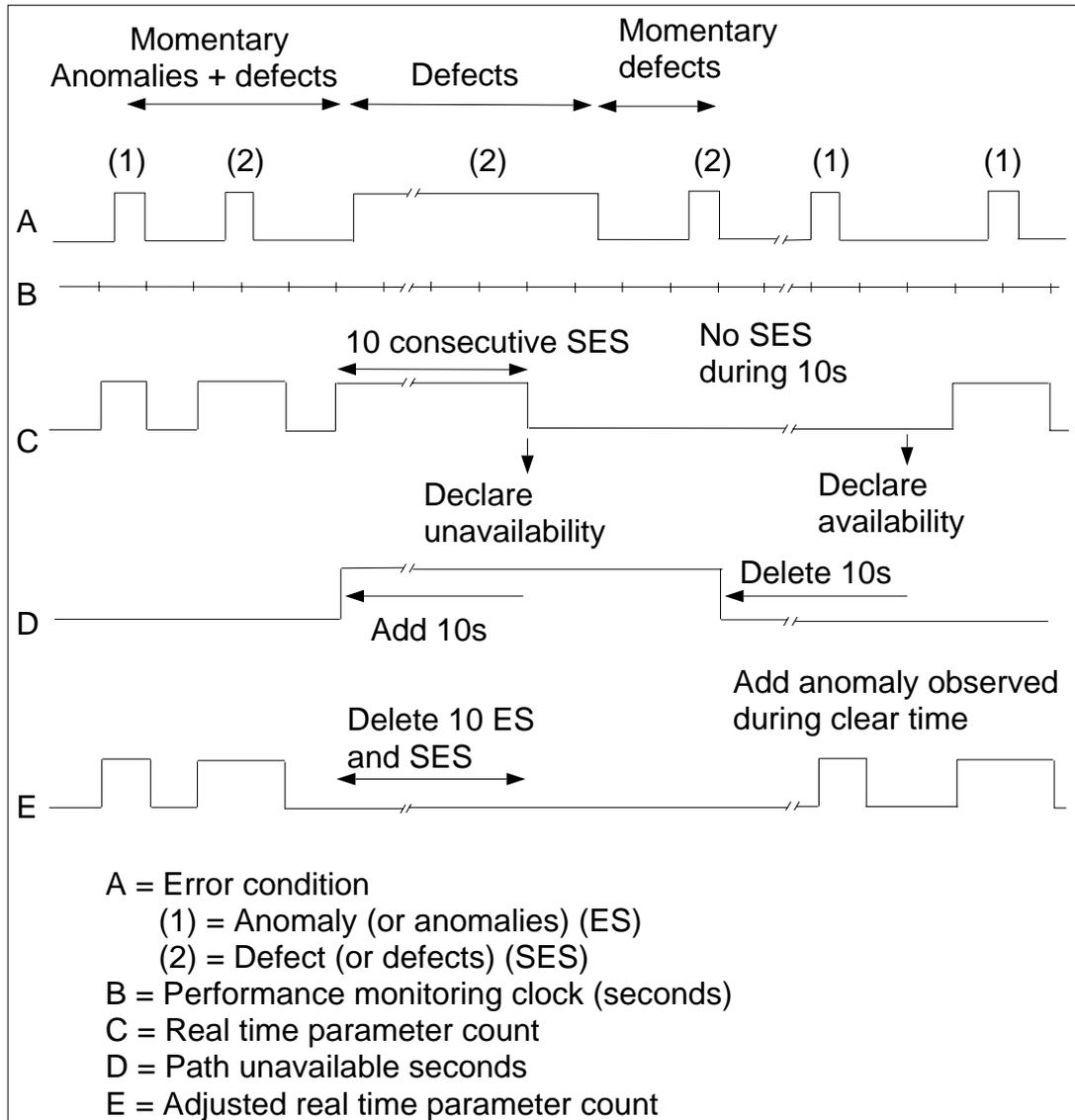


Figure 24 Illustration of Performance Monitoring Inhibiting During Unavailable Time

Note In the figure error conditions are considered in one transmission direction only.

4.3.1.10 Suspect Intervals

In case an interval does not contain correct data for some reason, the interval is suspect marked. The reason that an interval does not contain correct data can be due to a restart or a blocking from superior individuals. Also, if the quality supervision functions are reset by command and the system clock is changed, the ES and SES counters may not be correct in the affected intervals.

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For a suspect 15-minute interval, historical data are replaced by a “S” which indicates a suspect interval. Printing of current data will show the actual counter values. The data in the suspected 15-minute intervals are accumulated to the 24-hour data. For a suspect 24-hour interval a flag is set to indicate one or more corrupted 15-minute intervals within the 24-hour interval.

4.3.1.11 Historical Storage of Quality Data

For each subobject it is possible to store and print the quality data: ES, SES, UAS and UAV.

These quality data can be stored and printed for :

- 1 current 15-minute interval
- n recent 15-minute intervals
- 1 current 24-hours interval
- 1 recent 24-hours interval

where n is set by an application parameter in the range of 1 to 96 with 16 as guiding value. ES, SES, UAS and UAV is counted separately for both incoming and outgoing transmission direction (see figure 20). Hence, for both 15-minute and 24-hour intervals there are:

- 1 Near end ES counter for each subobject
- 1 Far end ES counter for each subobject
- 1 Near end SES counter for each subobject
- 1 Far end SES counter for each subobject
- 1 Near end UAS counter for each subobject
- 1 Far end UAS counter for each subobject
- 1 Near end UAV counter for each subobject
- 1 Far end UAV counter for each subobject

In addition to the counters there is a flag used to tell whether the 24 hour interval has been suspectmarked or not.

The recent register is used as a stack. At the end of a 15-minute period, the content of the current register is transferred to the first of the recent registers. When all of the recent registers are full, the oldest register values are discarded.

The storage function may be initiated and ended per SDIP by command. The connection status may also be printed to display on which SDIPs the function is active or passive.

The stored quality data may be printed by command..

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4.4 Network protection

The Network Protection function provides protection against loss of traffic in case of transmission defects or anomalies in the Synchronous Transport Module level 1 (STM-1) link, connected to the 155 Mbit/s exchange terminal, and in case of hardware faults in the high order termination, equipment protection.

The type of transmission protection supported is uni-directional, non-revertive, Multiplex Section Protection 1+1 (MSP 1+1) according to referenced standards.

4.4.1 Function

4.4.1.1 Network Protection Function Overview

The Network Protection function uses a 1+1 MSP architecture which mean that the STM-1 signal is transmitted simultaneously on both multiplex sections, see figure 25, that means that the STM-1 signal is permanently connected (bridged) to the working and protecting MSs at the transmitting end. The MSP at the receiving end monitors the condition of the two received STM-1 signals and selects the appropriate signal. In uni-directional switching only the receiving end performs a switch in case of a detected transmission fault on the received signal. As the function operates in non-revertive mode, the switch is maintained even after recovery from failure.

The protection configuration (channel 1, MSP 1+1) is transmitted in the K2 byte of the MSOH. The K1 byte transmits "No request, channel 1".

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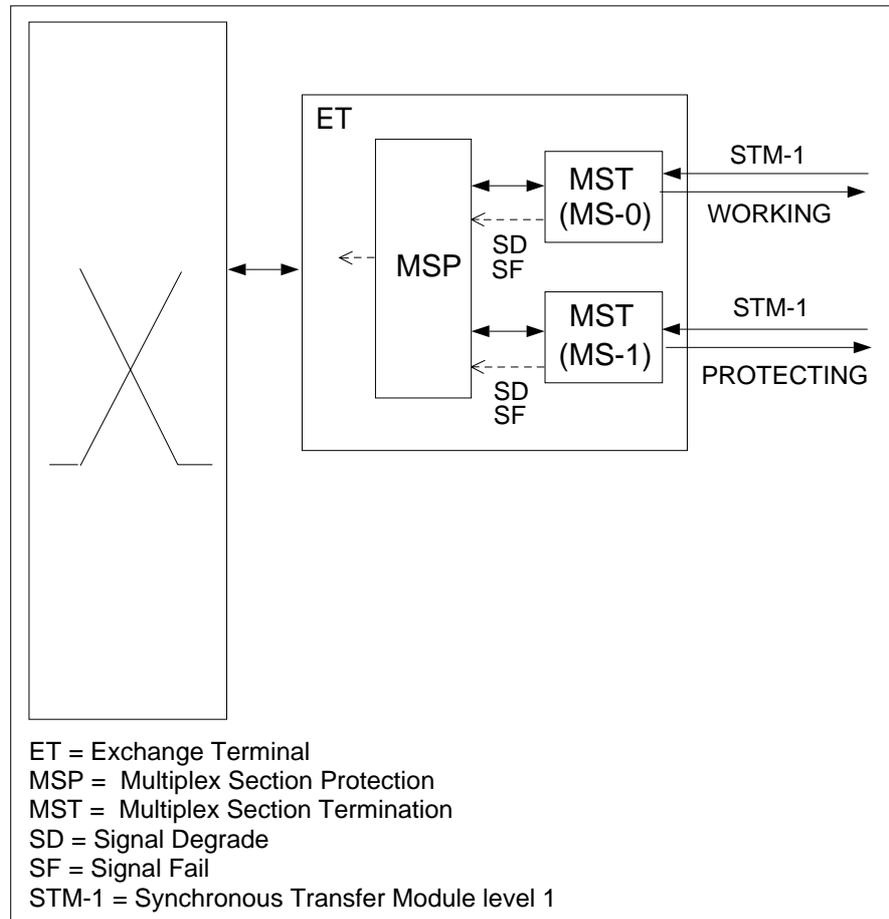


Figure 25 Model Of The Network Protection Switching Function

Automatic Network Protection

This function takes appropriate automatic switching actions in case of a signal fail or signal degrade condition of the received signal, or in case of a hardware fault in one of the two MS terminations.

Manually Initiated Network Protection Switch

This function handles three commands:

- Forced Switch
- Clear Forced Switch
- Manual Switch

4.4.1.2 Automatic Network Protection

If a defect is detected in the working MS, the traffic selection is automatically switched over to the protecting MS, provided that network protection is permitted. A fault on the hardware terminating the working MS or the higher order path also results in an automatic switch.

Network protection switching is initiated in case of an:

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- SD (Signal Degrade)
- SF (Signal Fail)
- hardware fault

Note that SD has lower priority than SF and hardware fault.

SF and hardware fault is treated equally.

After completion of an automatic network protection switch,

- Protection Switching Event (PSE) is reported.

A network protection switch is not performed if:

- the traffic selection is locked to the working MS
- a defect or fault, with equal or higher priority, exists in the protecting MS

When a network protection switch is not performed:

- a “Network Protection Switching Reject” notification is given.

4.4.1.3 Manually Initiated Network Protection Switch

The traffic selection can be locked to a specified MS with the “Forced Switch” command. The command initiates a switch from the working MS to the protecting MS, if the specified MS is the protecting one.

After completion of a “Forced Switch”:

- an “Unprotected Mode” alarm informs that the MS is running in an unprotected mode.

The lock can be cleared with the “Clear Forced Switch” command. The command does not result in a network protection switch, unless the lock has been to a faulty MS.

After completion of a “Clear Forced Switch”:

- the “Unprotected Mode” alarm is ceased.

The “Manual Switch” command initiates a network protection switch without locking the traffic selection to the specified MS. The command initiates a switch from the working MS to the protecting MS.

The status of the Network Protection function can be checked with the command “Print Network Protection Status”.

- The network protection status is printed.

4.5 Equipment protection

In digital transmission systems, faulty equipment can lead to degradation or loss of traffic channels and erroneous signalling.

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This paragraph describes the equipment protection functions used to protect the traffic against equipment faults on the 155 Mbit/s Exchange Terminal, Synchronous Digital Hierarchy (SDH) system.

4.5.1 Function

4.5.1.1 Equipment Protection Function Overview

Equipment protection provides protection against hardware failures by using standby equipment.

An SDH/STM-1 ET is connected to the GS by 5 Digital Links, where 4 of these links carry 512 traffic channel each, and the 5th link is used for protection purposes, hence achieving 1:n protection where $n \leq 4$. The 5th digital link is dedicated for equipment protection purposes, that is, protection against disturbances on the digital link itself or failures on the equipment terminating the digital link.

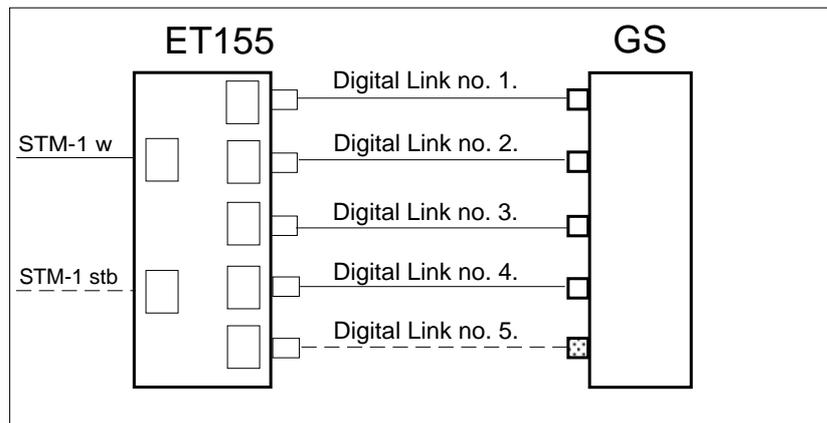


Figure 26 Equipment Protection Architecture.

The request to perform equipment protection switching can be initiated either externally or automatically. External requests are entered using commands. Automatic requests are based on hardware faults detected or faults in interface between ET and GS.

4.5.1.2 Equipment Protection

Request for Switching

If a fault occurs on a board, the traffic is switched automatically to the standby board.

Equipment protection switching is initiated for the following conditions:

- Hardware failures in the working unit
- Faults in the interface between ET and GS

The following will occur when the equipment protection switching has been initiated:

- An alarm is given for the faulty board. The alarm also notifies that an equipment protection switch has been performed

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Equipment protection is not performed if the standby (protecting) unit is not available, if it is out of service or already occupied, and:

- An alarm is given for the faulty board, including the information that it is not possible to perform equipment protection switching, that is in this case, the traffic is lost because the standby board is not available

Return to Original State

When a fault disappears, for example, owing to successful restoration or manual repair, the previously working board returns to its original state and the standby unit is released, that is, a switch of traffic from the standby board back to the original working board is performed.

A release of the standby unit will not be performed if the traffic is locked to the standby board.

4.5.1.3 Lock Traffic to Standby Board

It is possible to lock the traffic from one of the four working boards to the standby board by command, for example, in order to replace one of the boards.

After completion an alarm stating that the ET is in unprotected mode is activated.

An attempt to lock traffic to the standby board is not accepted if the standby board is out of service.

4.5.1.4 Clear Locking Traffic to Standby Board

The locking of traffic to the standby board can be cleared by command.

After completion the Equipment Protection Function Unprotected Mode alarm is ceased.

The attempt to clear the lock is accepted only if the board from where the traffic was transferred has returned to its original working state.

4.5.1.5 Print Equipment Protection Status

The status of the equipment protection function can be printed by command.

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4.6 Counters in the measurement database

4.6.1 STS

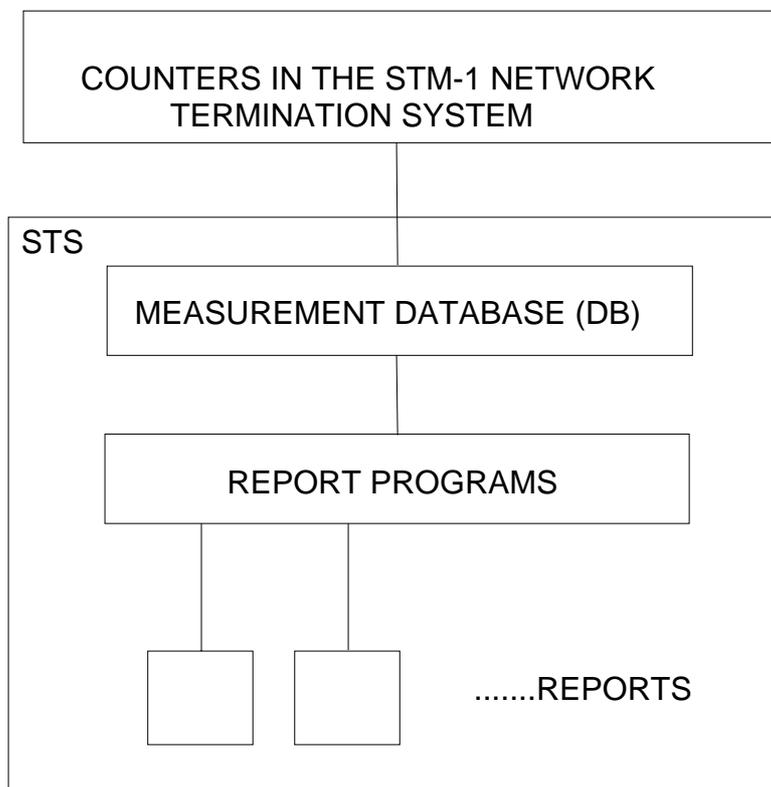


Figure 27

The counter values, collected from the STM-1 network termination system, are normally read at specific intervals for all object types.

The collected counter values are stored in the measurement database.

The report program is a program that generates one or several reports according to a given specification. By using the report time table it is possible to order regular output of reports. It is also possible to order a report by command.

4.6.2 SDIP Structure

The different layers within an SDIP (synchronous digital path) and the relationship between them are shown in figure 28. Normally consists the SDIP of two multiplex sections (MSs), where one of the MSs is used for protection. The SDIP can also consist of only one MS, the SDIP is then working without protection. In addition the SDIP contains one HP (Higher order path) and up to 63 LPs (lower order path).

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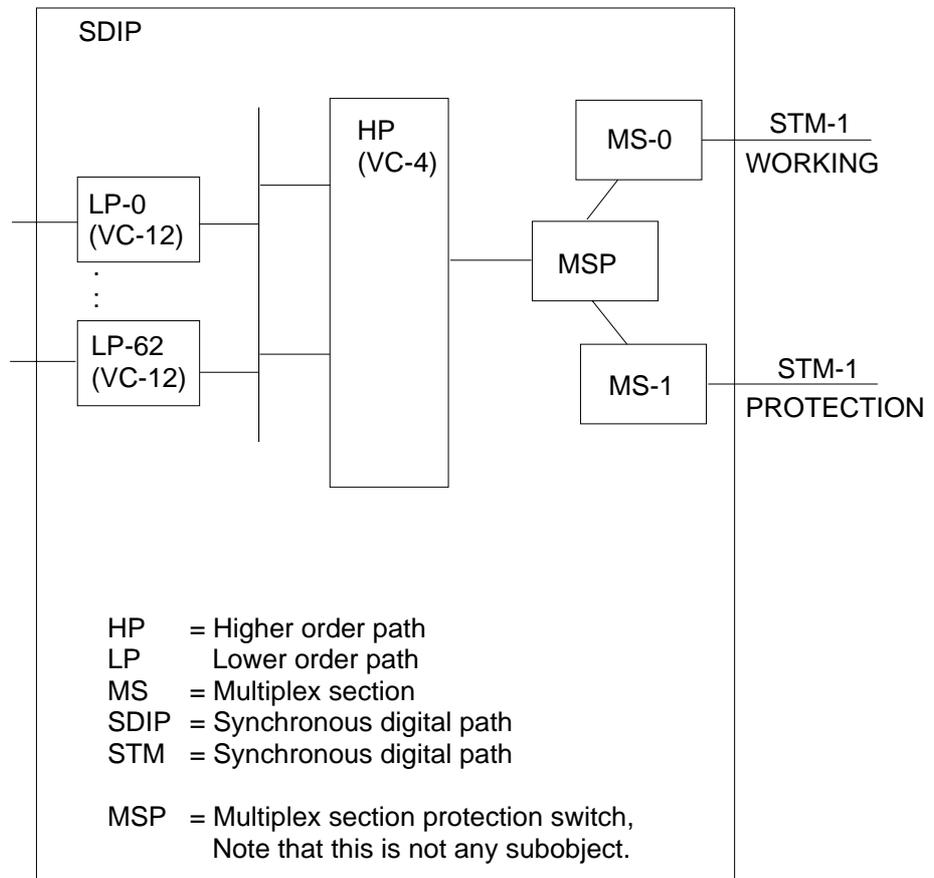


Figure 28 Relationship Between Layers and Subobjects in SDIP

4.6.3 Function

4.6.3.1 Digital Path and Synchronous Digital Path Supervision Counters

Performance measurement for digital paths and synchronous digital paths (blocking supervision, disturbance supervision etc.) require counters for digital path and synchronous digital path.

Number of Connected Digital Paths (DIPs)

The counter for number of connected digital paths shows the number of connected DIPs. It is increased when digital paths are connected to the switch or decreased when the connections are removed.

Number of Blockings made by the Digital Path Supervision

When a DIP-fault is detected and the DIP is blocked because of this fault the counter "number of blockings made by the Digital Path supervision" is increased by one.

Number of Connected Synchronous Digital Paths (SDIPs)

The counter for number of connected synchronous digital paths shows the number of connected SDIPs for each SDIP type (each SDIPST block). It is increased when synchronous digital paths are connected to the switch or decreased when the connections are removed.

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Number of Connected Multiplex Sections.

The counter for number of connected multiplex sections shows the number of connected MSs for each SDIP type (each SDIPST block). It is increased when multiplex sections are connected to the switch or decreased when the connections are removed.

Number of Connected Higher Order Path Objects (VC-4).

The counter for number of connected higher order path objects shows the number of connected HPs for each SDIP type (each SDIPST block). It is increased when higher order path objects are connected to the switch or decreased when the connections are removed.

Number of Connected Lower Order Path Objects (VC-12).

The counter for number of connected lower order path objects shows the number of connected LPs for each SDIP type (each SDIPST block). It is increased when lower order path objects are connected to the switch or decreased when the connections are removed.

Number of Blockings Made by the Synchronous Digital Path Supervision.

When the whole SDIP (all MSs, HP and all LPs) is blocked because of a detected fault, the counter "number of blockings made by the Synchronous Digital Path supervision" is increased by one.

Number of Blockings Made by the Multiplex Section Supervision.

When a MS-fault is detected and the MS is blocked because of this fault, the counter "number of blockings made by the Multiplex Section supervision" is increased by one.

Number of Blockings Made by the Higher Order Path Supervision.

When a HP-fault is detected and the HP-layer is blocked because of this fault, the counter "number of blockings made by the Higher Order Path supervision" is increased by one.

Number of Blockings Made by the Lower Order Path Supervision.

When a LP-fault is detected and the LP-layer is blocked because of this fault, the counter "number of blockings made by the Lower Order Path supervision" is increased by one.

Number of Network Protection Switching Events Multiplex Section.

If a network protection switching at the near end is caused by a defect at the MS layer or initiated by command, the counter "Number of network protection switching events multiplex section" is increased by one.

4.6.3.2 Digital Path Quality Counters

It is necessary to have counters for all the quality supervision parameters.

Number of Errored Seconds at local end

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The counter for number of errored seconds that have appeared at the incoming direction of a DIP. This counter is updated with a frequency of 15 minutes.

Number of Severely Errored Seconds at local end

The counter for number of severely errored seconds that have appeared at the incoming direction of a DIP. This counter is updated with a frequency of 15 minutes.

Number of Unavailable Seconds at local end

The counter for number of unavailable seconds that have appeared at the incoming direction of a DIP. This counter is updated with a frequency of 15 minutes.

Number of Errored Seconds from Remote End

The counter for number of errored seconds that have appeared at the outgoing direction of a DIP. This counter is updated with a frequency of 15 minutes.

Number of Severely Errored Seconds from Remote End

The counter for number of severely errored seconds that have appeared at the outgoing direction of a DIP. This counter is updated with a frequency of 15 minutes.

Number of Unavailable Seconds from Remote End

The counter for number of unavailable seconds that have appeared at the outgoing direction of a DIP. This counter is updated with a frequency of 15 minutes.

Number of Unavailable State Events

The counter for number of times the DIP has entered the unavailable state in either incoming, outgoing or both directions of a DIP. This counter is updated at each entry into the unavailable state.

Number of Unavailable Seconds, Bidirectional

The counter for number of unavailable seconds that have appeared at both incoming and outgoing directions of a DIP. This counter is updated with a frequency of 15 minutes.

Number of Slips

The counter for number of slips that have appeared at the incoming direction of a DIP. This counter is updated once every hour.

4.6.3.3 Synchronous Digital Path Higher Order Path Quality Counters

Number of Errored Seconds Higher Order Path Near End

The counter for number of errored seconds that have appeared at the incoming direction of the higher order path, during available time. This counter is updated with a frequency of 15 minutes.

Number of Errored Seconds Higher Order Path Far End

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The counter for number of errored seconds that have appeared at the outgoing direction of the higher order path, during available time. This counter is updated with a frequency of 15 minutes.

Number of Severely Errored Seconds Higher Order Path Near End

The counter for number of severely errored seconds that have appeared at the incoming direction of the higher order path, during available time. This counter is updated with a frequency of 15 minutes.

Number of Severely Errored Seconds Higher Order Path Far End

The counter for number of severely errored seconds that have appeared at the outgoing direction of the higher order path, during available time. This counter is updated with a frequency of 15 minutes.

Number of Unavailable Seconds Higher Order Path Near End

The counter for number of unavailable seconds that have appeared at the incoming direction of the higher order path. This counter is updated with a frequency of 15 minutes.

Number of Unavailable Seconds Higher Order Path Far End

The counter for number of unavailable seconds that have appeared at the outgoing direction of the higher order path. This counter is updated with a frequency of 15 minutes.

Number of Unavailable Events Higher Order Path Near End

The counter for number of times the SDIP has entered the unavailable state at the incoming direction of the higher order path. This counter is updated with a frequency of 15 minutes.

Number of Unavailable Events Higher Order Path Far End

The counter for number of times the SDIP has entered the unavailable state at the outgoing direction of the higher order path. This counter is updated with a frequency of 15 minutes.

4.6.3.4 Synchronous Digital Path Lower Order Path Quality Counters

Number of Errored Seconds Lower Order Path Near End

The counter for number of errored seconds that have appeared at the incoming direction of the lower order path, during available time. This counter is updated with a frequency of 15 minutes.

Number of Errored Seconds Lower Order Path Far End

The counter for number of errored seconds that have appeared at the outgoing direction of the lower order path, during available time. This counter is updated with a frequency of 15 minutes.

Number of Severely Errored Seconds Lower Order Path Near End

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The counter for number of severely errored seconds that have appeared at the incoming direction of the lower order path, during available time. This counter is updated with a frequency of 15 minutes.

Number of Severely Errored Seconds Lower Order Path Far End

The counter for number of severely errored seconds that have appeared at the outgoing direction of the lower order path, during available time. This counter is updated with a frequency of 15 minutes.

Number of Unavailable Seconds Lower Order Path Near End

The counter for number of unavailable seconds that have appeared at the incoming direction of the lower order path. This counter is updated with a frequency of 15 minutes.

Number of Unavailable Seconds Lower Order Path Far End

The counter for number of unavailable seconds that have appeared at the outgoing direction of the lower order path. This counter is updated with a frequency of 15 minutes.

Number of Unavailable Events Lower Order Path Near End

The counter for number of times the SDIP has entered the unavailable state at the incoming direction of the lower order path. This counter is updated with a frequency of 15 minutes.

Number of Unavailable Events Lower Order Path Far End

The counter for number of times the SDIP has entered the unavailable state at the outgoing direction of the lower order path. This counter is updated with a frequency of 15 minutes.

4.6.3.5 Synchronous Digital Path Multiplex Section Quality Counters

Number of Errored Seconds Multiplex Section Near End

The counter for number of errored seconds that have appeared at the incoming direction of the multiplex section, during available time. This counter is updated with a frequency of 15 minutes.

Number of Errored Seconds Multiplex Section Far End

The counter for number of errored seconds that have appeared at the outgoing direction of the multiplex section, during available time. This counter is updated with a frequency of 15 minutes.

Number of Severely Errored Seconds Multiplex Section Near End

The counter for number of severely errored seconds that have appeared at the incoming direction of the multiplex section, during available time. This counter is updated with a frequency of 15 minutes.

Number of Severely Errored Seconds Multiplex Section Far End

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The counter for number of severely errored seconds that have appeared at the outgoing direction of the multiplex section, during available time. This counter is updated with a frequency of 15 minutes.

Number of Unavailable Seconds Multiplex Section Near End

The counter for number of unavailable seconds that have appeared at the incoming direction of the multiplex section. This counter is updated with a frequency of 15 minutes.

Number of Unavailable Seconds Multiplex Section Far End

The counter for number of unavailable seconds that have appeared at the outgoing direction of the multiplex section. This counter is updated with a frequency of 15 minutes.

Number of Unavailable Events Multiplex Section Near End

The counter for number of times the SDIP has entered the unavailable state at the incoming direction of the multiplex section. This counter is updated with a frequency of 15 minutes.

Number of Unavailable Events Multiplex Section Far End

The counter for number of times the SDIP has entered the unavailable state at the outgoing direction of the multiplex section. This counter is updated with a frequency of 15 minutes.

4.6.3.6 Interface to STS

The DB contains an internal job table that arranges for the different counters to be copied at the correct time. An object type is a set of objects of the same type and with an identical set of counters.

Example:

Object type: DIGPATH

Objects: The individual digital paths

Counters: Number of connected digital paths, etc...

The counters are listed per object type. Every type of equipment or concept is grouped into an object type. The counters are identified by the object type and the name of the counter. There are two types of counters relevant to this function:

- Event counters (Peg Counters=PC). Always stepped up.
- Level counters (Status counters=ST). Stepped up/down.

The object types are as follows:

- DIGPATH
- DIP

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- SDIPLP
- SDIPHP
- SDIPMS

4.6.3.7 Counter per Object Type

4.6.3.7.1 Object Type = DIGPATH (Digital Path)

Digital Path counters and Synchronous Digital Path counters.

One record per type of DIP/SDIP.

Every type of DIP (every DIPST block) is identified by the block name.

Every type of SDIP (every SDIPST block) is identified by the block name.

Table 24

Type	Counter-name	Description
ST	NDIPST	Number of connected digital paths.
PC	NBLOC	Number of blockings made by digital path supervision function.
ST	NCONSDIP	Number of connected synchronous digital paths.
ST	NCONMS	Number of connected multiplex sections.
ST	NCONHP	Number of connected higher order path objects. (VC-4)
ST	NCONLP	Number of connected lower order path objects. (VC-12)
PC	NBLOSDIP	Number of blockings made by the synchronous digital path supervision.
PC	NBLOMS	Number of blockings made by the multiplex section supervision.
PC	NBLOHP	Number of blockings made by the higher order path supervision.
PC	NBLOLP	Number of blockings made by the lower order path supervision.
PC	NPC	Network protection switching counter, indicates number of performed network protection switching events.

4.6.3.7.2 Object Type = DIP (Digital Path)

Digital Path Quality Counters.

One record per DIP.

Every DIP is identified by a DIP name.

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Table 25

Type	Counter-name	Description
PC	ES	Number of errored seconds at local end.
PC	SES	Number of severely errored seconds at local end.
PC	UAS	Number of unavailable seconds at local end.
PC	ESR	Number of errored seconds from remote end.
PC	SESR	Number of severely errored seconds from remote end.
PC	UASR	Number of unavailable seconds from remote end.
PC	UAV	Number of times the DIP has entered the unavailable state.
PC	UASB	Number of unavailable seconds at both local and remote end.
PC	SF	Number of slips.

4.6.3.7.3 Object Type = SDIPHP (Synchronous Digital Path Higher Order Path)

Quality Counters for the synchronous digital path higher order path.

One record per HP object.

Every HP object is identified by the SDIP name and the HP name with an index number.

Table 26

Type	Counter-name	Description
PC	HPNES	Number of errored seconds higher order path near end
PC	HPFES	Number of errored seconds higher order path far end
PC	HPNSES	Number of severely errored seconds higher order path near end
PC	HPFSES	Number of severely errored seconds higher order path far end
PC	HPNUAS	Number of unavailable seconds higher order path near end
PC	HPFUAS	Number of unavailable seconds higher order path far end

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Type	Counter-name	Description
PC	HPNUAV	Number of unavailable events higher order path near end
PC	HPFUAV	Number of unavailable events higher order path far end

4.6.3.7.4 Object Type = SDIPLP (Synchronous Digital Path Lower Order Path)

Quality counters for the Synchronous digital path lower order path.

One record per LP object.

Every LP object is identified by the SDIP name and the LP name with an index number.

Table 27

Type	Counter-name	Description
PC	LPNES	Number of errored seconds lower order path near end
PC	LPFES	Number of errored seconds lower order path far end
PC	LPNSES	Number of severely errored seconds lower order path near end
PC	LPFSES	Number of severely errored seconds lower order path far end
PC	LPNUAS	Number of unavailable seconds lower order path near end
PC	LPFUAS	Number of unavailable seconds lower order path far end
PC	LPNUAV	Number of unavailable events lower order path near end
PC	LPFUAV	Number of unavailable events lower order path far end

4.6.3.7.5 Object Type = SDIPMS (Synchronous Digital Path Multiplex Section)

Quality counters for the Synchronous digital path multiplex section.

One record per STM-1 interface/MS object (i.e. an SDIP may contain one or more Multiplex Sections, dependent on protection. See figure 19. One Multiplex Section corresponds to an STM-1 interface).

Every MS object is identified by the SDIP name and the MS name with an index number.

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Table 28

Type	Counter-name	Description
PC	MSNES	Number of errored seconds multiplex section near end
PC	MSFES	Number of errored seconds multiplex section far end
PC	MSNSES	Number of severely errored seconds multiplex section near end
PC	MSFSES	Number of severely errored seconds multiplex section far end
PC	MSNUAS	Number of unavailable seconds multiplex section near end
PC	MSFUAS	Number of unavailable seconds multiplex section far end
PC	MSNUAV	Number of unavailable events multiplex section near end
PC	MSFUAV	Number of unavailable events multiplex section far end

4.6.3.8 Translation Function

Table 29

Object Type	Object Identifier
DIGPATH	Block Name. Digital Path counters and Synchronous Digital Path counters. Every type of DIP (every DIPST block) is identified by the block name. Every type of SDIP (every SDIPST block) is identified by the block name
DIP	DIP Name. Digital Path Quality Counters. Every DIP is identified by a DIP name.
SDIPLP	SDIP Name VC12- Low Order Path index Number. Quality Counters for the synchronous digital path order path. Every LP object is identified by the SDIP name and the LP name with an index number.
SDIPHP	SDIP Name VC4- High Order Path index Number. Quality Counters for the synchronous digital path higher order path. Every HP object is identified by the SDIP name and the HP name with an index number.
SDIPMS	SDIP Name MS- Multiplex Section index Number. Quality counters for the synchronous digital path multiplex section. Every MS object is identified by the SDIP name and the MS name with an index number.

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5 Engineering Guidelines

6 Parameters

6.1 Parameters for special adjustments

7 References

- 1 ITU-T Recommendation G.703(1991), Physical/Electrical Characteristics of Hierarchical Digital Interfaces.
- 2 ITU-T Recommendation G.704 (07/95), Synchronous Frame Structures used at 1544, 6312, 2048, 8488 and 44763 kbit/s Hierarchical Levels.
- 3 ITU-T Recommendation G.706 (1991), Frame Alignment and Cyclic Redundancy Check (CRC) Procedures Relating to Basic Frame Structures Defined in Recommendation G.704.
- 4 ITU-T Recommendation G.707 (03/96) "Network Node Interface for the Synchronous Digital Hierarchy (SDH)"
- 5 ITU-T Recommendation G.708 (06/99), Sub STM-0 network node interface for the synchronous digital hierarchy (SDH)
- 6 ITU-T Recommendation G.732 (1988), Characteristics of Primary PCM Multiplex Equipment Operating at 2048 kbit/s.
- 7 ITU-T Recommendation G.775 (11/94), Loss Of Signal (LOS) and Alarm Indication Signal (AIS) Defect Detection and Clearance Criteria.
- 8 ITU-T Recommendation G.782,
- 9 ITU-T Recommendation G.783 (04/97) "Characteristics of Synchronous Digital Hierarchy (SDH) Equipment Functional Blocks"
- 10 ITU-T Recommendation Q.822 (04/94) "Stage 1, Stage 2 and Stage 3 description for the Q3 interface - Performance management"
- 11 ITU-T Recommendation G.826 (08/96) "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate"
- 12 ITU-T Recommendation G.957 (06/99), Optical interfaces for equipments and systems relating to the synchronous digital hierarchy.,
- 13 ITU-T Recommendation M.20 (10/92), Maintenance philosophy for telecommunication networks.

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- 14** ITU-T Recommendation M.2100 (07/95), Performance Limits for Bringing-Into-Service and Maintenance of International Digital Paths, Sections and Transmission Systems.
- 15** ITU-T Recommendation M.2101.1 (04/97) "Performance limits for bringing-into-service and maintenance of international SDH paths and multiplex sections"
- 16** ITU-T Recommendation M.2120 (04/97) "PDH Path, Section and Transmission System and SDH Path and Multiplex Section Fault Detection and Localisation Procedures"
- 17** ETSI Specification ETS 300 417-1-1 "Transmission and Multiplexing (TM); Generic functional requirements for Synchronous Digital Hierarchy (SDH) equipment. Part 1-1: Generic processes and performance".
- 18** ETSI Specification ETS 300 417-2-1 "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 2-1: Synchronous Digital Hierarchy (SDH) and Plesiochronous Digital Hierarchy (PDH) physical section layer functions".
- 19** ETSI Draft Specification ETS 300 417-3-1 "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 3-1: Synchronous Transport Module-N (STM-N) regenerator and multiplex section layer functions".
- 20** ETSI Draft Specification ETS 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".
- 21** User Description, SDH Product Package
- 22** User Description, Transmission E1

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