INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

M.2101

(06/2003)

SERIES M: TMN AND NETWORK MAINTENANCE: INTERNATIONAL TRANSMISSION SYSTEMS, TELEPHONE CIRCUITS, TELEGRAPHY, FACSIMILE AND LEASED CIRCUITS

International transport network

Performance limits for bringing-into-service and maintenance of international multi-operator SDH paths and multiplex sections

ITU-T Recommendation M.2101

ITU-T M-SERIES RECOMMENDATIONS

TMN AND NETWORK MAINTENANCE: INTERNATIONAL TRANSMISSION SYSTEMS, TELEPHONE CIRCUITS, TELEGRAPHY, FACSIMILE AND LEASED CIRCUITS

Introduction and general principles of maintenance and maintenance organization	M.10–M.299
International transmission systems	M.300–M.559
International telephone circuits	M.560–M.759
Common channel signalling systems	M.760–M.799
International telegraph systems and phototelegraph transmission	M.800–M.899
International leased group and supergroup links	M.900–M.999
International leased circuits	M.1000–M.1099
Mobile telecommunication systems and services	M.1100–M.1199
International public telephone network	M.1200–M.1299
International data transmission systems	M.1300–M.1399
Designations and information exchange	M.1400–M.1999
International transport network	**M.2000–M.2999**
Telecommunications management network	M.3000–M.3599
Integrated services digital networks	M.3600–M.3999
Common channel signalling systems	M.4000–M.4999

For further details, please refer to the list of ITU-T Recommendations.

ITU-T Recommendation M.2101

Performance limits for bringing-into-service and maintenance of international multi-operator SDH paths and multiplex sections

Summary

This Recommendation provides limits for Bringing-Into-Service (BIS) and maintenance for international multi-operator SDH paths, including tandem connections, and international multi-operator SDH multiplex sections using equipment designed according to ITU-T Recs G.826, G.828 and G.829. Error, timing and availability performance are considered. This Recommendation also deals with all levels of PDH signals transported within SDH containers. Regenerator sections are not covered by this Recommendation. BIS limits and maintenance procedures for radio regenerator sections are described in the relevant ITU-R Recommendations.

Maintenance of systems designed to ITU-T Recs G.826, G.828 and G.829 should use the limits given in this Recommendation.

This revised Recommendation includes all applicable material from ITU-T Rec. M.2101.1 and is therefore the only Recommendation to be used for SDH technology.

Source

ITU-T Recommendation M.2101 was approved by ITU-T Study Group 4 (2001-2004) under the ITU-T Recommendation A.8 procedure on 13 June 2003.

Keywords

Allocated Performance Objective (APO), Background Block Error (BBE), Bringing-Into-Service (BIS), Bringing-Into-Service Performance Objective (BISPO), Degraded Performance Level (DPL), Errored Second (ES), Limits, Maintenance, Performance Objectives, Severely Errored Second (SES), Severely Errored Period (SEP), Tandem Connection Monitoring (TCM), Unacceptable Performance Level (UPL).

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g. interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Introduction

This Recommendation provides limits for bringing-into-service and maintenance of international multi-operator SDH paths and multiplex sections in order to achieve the performance objectives given for a multi-service environment. These objectives include error performance (ITU-T Recs G.826 and G.828), timing performance (ITU-T Rec. G.822) and availability (ITU-T Rec. G.827). This Recommendation defines the parameters and their associated objectives in order to respect the principles given in ITU-T Recs M.20, M.32 and M.34.

"International multi-operator" in this Recommendation refers to SDH paths and multiplex sections which cross international boundaries with a change in jurisdictional responsibility.

The SDH signal format and structure are described in ITU-T Rec. G.707. The long-term error performance objectives for SDH paths are given in ITU-T Recs G.826 and G.828. For availability performance, ITU-T Rec. G.827 provides the long-term requirements. Availability performance requirements from a short-term maintenance perspective are under study.

ITU-T Rec. G.803 provides a modelling method for describing the functions which exist or are required to make up a telecommunications network. This modelling method has been used where appropriate within this Recommendation.

The methods and procedures for applying these limits are described in ITU-T Rec. M.2110 for bringing-into-service tests and procedures and in ITU-T Rec. M.2120 for the maintenance procedures.

This Recommendation uses certain principles that form the basis of the maintenance of a digital network:

– It is desirable to do in-service, continuous measurements. In some cases, out-of-service measurements may be necessary.
– A single set of parameters must be used for maintenance of the SDH hierarchy (see ITU-T Rec. G.702), however, the actual limits are bit rate dependent.
– Error performance limits of international SDH paths and multiplex sections are dependent on the medium used.

The reasons for revising this Recommendation include the addition of Tandem Connection Monitoring (TCM), Background Block Error (BBE)[1] measurements and the Severely Errored Period (SEP) event in accordance with ITU-T Rec. G.828.

This revised Recommendation includes all applicable material from ITU-T Rec. M.2101.1 and is therefore the only Recommendation to be used for SDH technology.

The use of the SEP event and limits for maintenance are under study.

[1] BBE measures will not be required for installed equipment designed according to ITU-T Rec. G.826.

ITU-T Recommendation M.2101

Performance limits for bringing-into-service and maintenance of international multi-operator SDH paths and multiplex sections

1 Scope

This Recommendation defines the performance objectives and limits for bringing-into-service and maintenance of international multi-operator SDH paths and multiplex sections and also SDH signals transported over PDH networks. For the case of PDH signals transported over SDH networks, ITU-T Rec. M.2100 applies to the PDH path. For the case of mixed PDH/SDH terminated paths, ITU-T Rec. M.2100 applies (at the PDH bit rate). Further guidance is given in the main body of this Recommendation on how ITU-T Recs M.2100 and M.2101 relate. "International" in this Recommendation refers to SDH paths and multiplex sections which cross international boundaries with a change in jurisdictional responsibility. SDH regenerator sections are not covered by this Recommendation. By bilateral agreement, ITU-R Rec. F.1330-1 may be used in conjunction with this Recommendation for radio-relay systems where applicable. Maintenance of SDH systems designed to ITU-T Recs G.826, G.828 and G.829 should use the limits given in the relevant parts of this Recommendation.

The use of the SEP event and limits for maintenance are under study[2].

This Recommendation does not consider commissioning of SDH equipment into the network. The SDH VC-11 bit rate is the lowest considered by this Recommendation. It does not, therefore, consider 64 kbit/s circuits or sub-64 kbit/s, which are dealt with by ITU-T Recs M.2100 and M.1340.

Limits for BIS and maintenance are given for Virtual Containers (VC) and Synchronous Transport Module-N (STM-N). Limits are also given for triggering maintenance activity (e.g., repair, fault localization, etc.).

Methods of deriving performance information from Bit Interleaved Parity-Ns (BIP-N) and other path overhead information are given. Tandem connection monitoring is considered in this Recommendation. The guidance given in this Recommendation in terms of performance limits for maintenance purposes, and that given in the companion ITU-T Recs M.2110 and M.2120 provide a consistent platform from which the requirements for a maintenance management system can be derived.

This revised Recommendation includes all applicable material from ITU-T Rec. M.2101.1 and is therefore the only Recommendation to be used for SDH technology.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the

[2] As provided in section 8.5.4 of Resolution 1 of the 1996 WTSC, the United States of America registers a degree of reservation against the use of the objectives in Tables 3a/M.2101 and D.1 to D.4/M.2101, and intends to treat the values of these tables as though their entries were designated "FFS", i.e., for further study. As the text of ITU-T Rec. G.828, approved in Kyoto in March 2000, places no numeric end-to-end performance objectives on the SEPI parameter, the use of numeric maintenance objectives in ITU-T Rec. M.2101 is unjustified.

most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

– ITU-R Recommendation F.1330-1 (1999), *Performance limits for bringing-into-service of the parts of international plesiochronous digital hierarchy and synchronous digital hierarchy paths and sections implemented by digital radio-relay systems*.
– ITU-T Recommendation G.702 (1988), *Digital hierarchy bit rates*.
– ITU-T Recommendation G.707/Y.1322 (2000), *Network node interface for the synchronous digital hierarchy (SDH)*.
– ITU-T Recommendation G.784 (1999), *Synchronous digital hierarchy (SDH) management*.
– ITU-T Recommendation G.803 (2000), *Architectures of transport networks based on the synchronous digital hierarchy (SDH)*.
– ITU-T Recommendation G.822 (1988), *Controlled slip rate objectives on an international digital connection*.
– ITU-T Recommendation G.825 (2000), *The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)*.
– ITU-T Recommendation G.826 (2002), *End-to-end error performance parameters and objectives for international, constant bit-rate digital paths and connections*.
– ITU-T Recommendation G.827 (2000), *Availability parameters and objectives for path elements of international constant bit-rate digital paths at or above the primary rate*.
– ITU-T Recommendation G.828 (2000), *Error performance parameters and objectives for international, constant bit-rate synchronous digital paths*.
– ITU-T Recommendation G.829 (2002), *Error performance events for SDH multiplex and regenerator sections*.
– ITU-T Recommendation M.20 (1992), *Maintenance philosophy for telecommunications networks*.
– ITU-T Recommendation M.32 (1988), *Principles for using alarm information for maintenance of international transmission systems and equipment*.
– ITU-T Recommendation M.34 (1988), *Performance monitoring on international transmission systems and equipment*.
– ITU-T Recommendation M.60 (1993), *Maintenance terminology and definitions*.
– ITU-T Recommendation M.1340 (2000), *Performance objectives, allocations and limits for international PDH leased circuits and supporting data transmission links and systems*.
– ITU-T Recommendation M.2100 (2003), *Performance limits for bringing-into-service and maintenance of international multi-operator PDH paths and connections*.
– ITU-T Recommendation M.2110 (2002), *Bringing-into-service of international multi-operator paths, sections and transmission systems*.
– ITU-T Recommendation M.2120 (2002), *International multi-operator paths, sections and transmission systems fault detection and localization procedures*.
– ITU-T Recommendation O.181 (2002), *Equipment to assess error performance on STM-N interfaces*.

3 Terms and definitions

General terms and definitions related to this Recommendation are provided in ITU-T Rec. M.60. This Recommendation defines the following terms:

3.1 usage of the terms "path" and "multiplex section" in this Recommendation: The terms "path" and "multiplex section" describe unidirectional transport entities. For a bidirectional path or multiplex section, all objectives, limits, etc. should be applied to each direction of the trail independently from the other direction. This means that for maintenance purposes, performance shall be evaluated per direction, i.e., events occurring on the A-Z direction shall not have any impact on the evaluation of performance events occurring on the Z-A direction, and vice versa.

3.2 performance objective (PO): Performance objective for the international portion of the hypothetical reference path (see Figures 3/G.826 and 3/G.828) or multiplex section.

3.3 allocated performance objective (APO): Performance objective for a real path calculated according to the allocation rules.

3.4 bringing-into-service performance objective (BISPO): Bringing-into-service performance objective for a real path or multiplex section calculated from its APO.

3.5 international portion: An international digital path can be subdivided into two national portions and one international portion. The boundary between these portions is defined to be an International Gateway.

The national portion is outside the scope of this Recommendation.

3.6 international gateway (IG): International VC-*n* Sink/Source equipment.

3.7 path core elements (PCE): An international digital path has been partitioned in geographical terms for the purpose of allocating the Performance Objectives (POs). These portions have been titled Path Core Elements (PCEs).

Two types of international PCE are used:

– an International Path Core Element (IPCE) is between an IG and a Frontier Station (FS) in a terminating country, or between FSs in a transit country (see definition of IG in 3.6);

– an Inter-Country Path Core Element (ICPCE) is between the agreed frontier stations of the two countries involved. The ICPCE corresponds to the highest-order digital trail carried on a digital transmission system linking the two countries. An ICPCE may be transported on a terrestrial, satellite or undersea cable transmission system.

There are two cases where a country may not contain an IPCE:

– depending on the geographical situation and network topology, the IG may coincide with the FS in a terminating country;

– the path uses only one FS in a transit country.

3.8 the international boundary and border crossing points: The International Boundary, the point at which control transfers from one international operator to the next international operator, normally exists within the ICPCE. Generally, this would be half-way along a submarine cable or terrestrial border crossing ICPCE. The Border Crossing Point may coincide with the International Boundary (for example, for a terrestrial border crossing ICPCE) or, in the case of a submarine cable (for example), there would be two border crossings, corresponding to the coastline of the operator's country, which would not coincide with the International Boundary.

3.9 international paths operating in tandem: International paths may operate in tandem where network topology requires links between certain terminating countries to be established. The restriction is that the allocation must not exceed 63%.

NOTE – ITU-T Recs G.826 and G.828 allocate a block allowance of 17.5% of the overall performance objectives to one national portion of a path. In addition, a length-dependent allowance of 0.2% per 100 km is allocated to this portion. Considering that a path comprises two national portions, and assuming a minimum length of 2 × 500 km, the total allocation assigned to the national portion is:

$$2 \times 17.5\% + 2 \times 1.0\% = 37.0\%$$

Because this Recommendation only deals with the **international portion**, only:

$$100\% – 37\% = 63\%$$

can be assigned to the **international** portion.

3.10 in-service measurement points: The full definitions of sections and paths are given in ITU-T Rec. G.803. The following definitions are for use with this Recommendation, and are for guidance only. See also ITU-T Rec. G.803 for an illustration of these objects.

3.11 STM-N section network connection: The link between STM-N Section Network Connection termination points. Examples include point-to-point submarine cables and border crossings. This is the highest bit-rate part of the SDH transmission network. It would not normally be possible to make any measurements of this.

3.12 STM-N section trail: The STM-N Section Network Connection and its termination points. Since this includes termination points, measurements can be made.

This Recommendation gives performance limits for international STM-N multiplex section trails, which will be the case for some submarine cables, satellite links or terrestrial border crossings. Where STM-N section trails are operating in tandem across a given operator's territory to make up its Path Core Element, it is the responsibility of the operator to ensure that the performance of the Section Trails operating in tandem meets the requirements for its Path Core Element, as given in this Recommendation.

3.13 STM-N termination point: Terminates the STM-N Section Network Connection, and interfaces with the adaptation function. At this point, the STM-N Section Overhead is removed.

3.14 STM-N adaptation function: Multiplexes between the Higher-Order Path Layer and the STM-N Section layer. It interfaces the STM-N Termination point with either the Higher-Order Path Trail termination point or a Higher-Order Path Subnetwork Connection.

3.15 higher-order path subnetwork connection: Provides connectivity between STM-N/HOPL adaptation functions, permitting higher-order VCs (VC-3[3], VC-4) to be connected between STM-N Section Trails. Add-drop multiplexers or cross-connects would normally provide this type of connection.

3.16 higher-order path trail: Exists between and includes the Higher-Order Path Termination Points. Since it is terminated, measurements can be made over this trail. It is made up of one or more STM-N Section Trails operating in tandem, and therefore also includes one or more Higher-Order Path Subnetwork Connections.

Performance limits for Higher-Order path trails (VC-3s and VC-4s) will only be given by this Recommendation when the VC-3 or VC-4 is the end-to-end path solely under consideration, or when the Higher-Order Path Trail corresponds directly to a Path Core Element. In the case where one operator's Path Core Element is made up of a number of Higher-Order path trails operating in tandem, it is the responsibility of that operator to ensure that the performance of those trails operating in tandem meets the performance limit for its PCE.

---

[3] Note that the Virtual Container 3 (VC-3) can be considered to be either a lower-order or a higher-order VC.

3.17 higher-order adaptation function: Multiplexes between the higher-order path layer (a given higher-order path trail) and the lower-order path layer, interfacing to the higher-order trail termination points, and either the lower-order trail termination point or to a Lower-Order Path Subnetwork Connection.

3.18 lower-order path subnetwork connection: Provides a link between higher-order to lower-order path layer adaptation functions. This link would normally exist inside equipment such as an add-drop multiplexer or cross-connect. It allows higher-order path trails to operate in tandem in order to make up a Lower-Order path trail.

3.19 lower-order path trail: Exists between and includes the Lower-Order Path Trail Termination Points, where the VC-1, -2 or -3 overhead is removed. Measurements can therefore be made of this object. Performance limits are given in this Recommendation for Lower-Order Path Trails.

4 Abbreviations

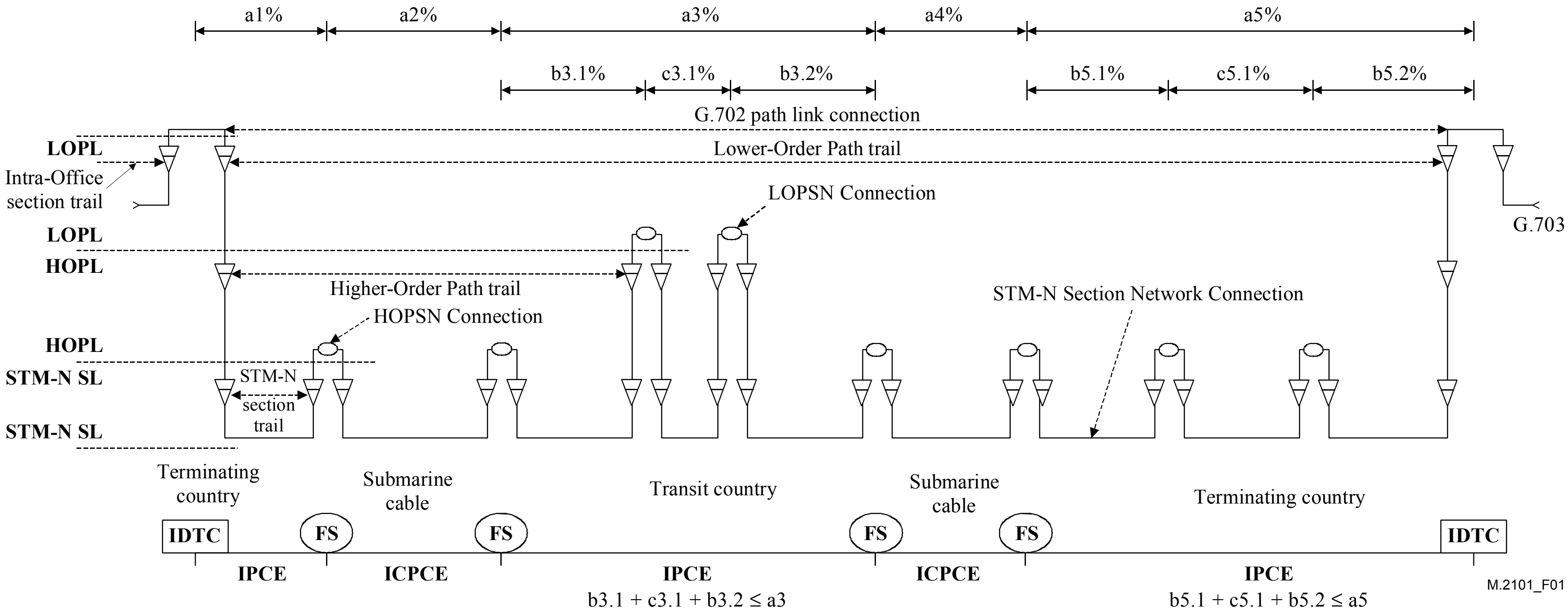
This Recommendation uses the following abbreviations:

AIS	Alarm Indication Signal
APO	Allocated Performance Objective
AU	Administrative Unit
BBE	Background Block Error
BBER	Background Block Error Ratio
BER	Bit Error Ratio
BIP	Bit Interleaved Parity
BIS	Bringing-Into-Service
BISPO	BIS Performance Objective
DPL	Degraded Performance Level
EDC	Error Detection Code
ES	Errored Second
ESR	Errored Second Ratio
FAS	Frame Alignment Signal
FS	Frontier Station
HO	Higher Order
HOPL	Higher-Order Path Layer
HP	Higher order Path
HPTC	Higher-Order Path Tandem Connection
IB	International Border
ICPCE	Inter-Country Path Core Element
IDTC	International Digital Transmission Centre
IG	International Gateway
IPCE	International Path Core Element
IS	In-Service

ISM	In Service Monitoring
LO	Lower Order
LOM	Loss Of Multiframe
LOP	Loss of Pointer
LOPL	Lower-Order Path Layer
LP	Lower order Path
LPTC	Lower-Order Path Tandem Connection
LTC	Loss of Tandem Connection
MS	Multiplex Section
NNI	Network Node Interface
OOS	Out-of-Service
PCE	Path Core Element
PDH	Plesiochronous Digital Hierarchy
PEP	Path End Point
PO	Performance Objective
PRBS	Pseudo-Random Binary Sequence
RDI	Remote Defect Indication
REI	Remote Error Indication
rf	routing factor
SDH	Synchronous Digital Hierarchy
SEP	Severely Errored Period
SEPI	Severely Errored Period Intensity
SES	Severely Errored Second
SESR	Severely Errored Second Ratio
STM	Synchronous Transport Module
TC	Tandem Connection
TCM	Tandem Connection Monitoring
TIM	Trail Identifier Mismatch
TMN	Telecommunication Management Network
TP	Test Period
TU	Tributary Unit
UPL	Unacceptable Performance Level
VC	Virtual Container

5 Hypothetical reference model

For performance of international path and multiplex section layers, the physical relationship between the international LOPL, HOPL and STM-N Section Layers is illustrated in Figure 1.



FS Frontier Station

IDTC International Digital Transmission Centre

HOPL	Higher-Order Path Layer
HOPSN	Higher-Order Path Subnetwork Connection
ICPCE	Inter-Country Path Core Element
IPCE	International Path Core Element
LOPL	Lower-Order Path Layer
LOPSN	Lower-Order Path Subnetwork Connection
STM-N SL	STM-N Section Layer

NOTE 1 – According to ITU-T Recs G.826 and G.828, the Allocated Performance Objective of the international portion must not exceed 63% of the Performance Objective.

NOTE 2 – A common international portion consists of two terminating countries (IPCEs), and one submarine cable, satellite system or terrestrial border crossing (ICPCE). The physical endpoints of the international portion exist within IDTCs; the IDTC corresponds to one of the IGs (International Gateways) as given in ITU-T Recs G.826 and G.828.

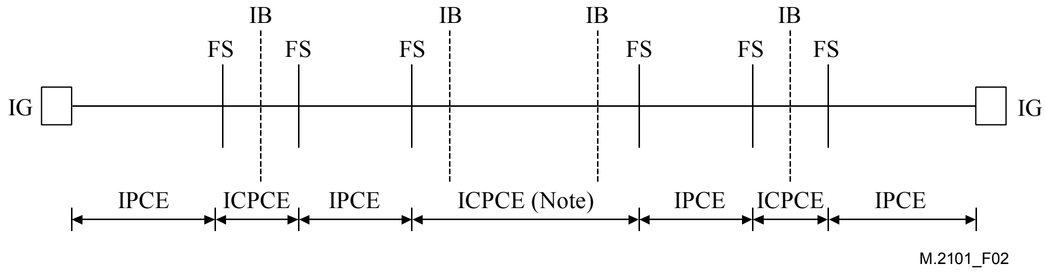
NOTE 3 – More complex path structures may include transit countries, which would exist between the two terminating countries linked by IPCE (terrestrial border crossings, submarine cables or satellite links). ICPCEs operating in tandem are acceptable (e.g. submarine cables operating in tandem).

NOTE 4 – This international path allocation shows the relationship between Path Core Elements and ITU-T Rec G.803 network modelling. Please see Figure 4-1/G.803 for a precise network model.

Figure 1/M.2101 – Example of apportionment for an international path

6 Allocation principles for end-to-end VC connections

This clause specifies the allocation of error performance objectives for the international portion of international digital paths, in terms of PCEs as shown in Figure 2.



IB International Border
IG International Gateway
FS Frontier Station

NOTE – This ICPCE crosses two intenational borders and is typically on a satellite or undersea cable transmission system.

Figure 2/M.2101 – Example of the components of a path to show PCEs

It is the responsibility of each operator to design its network in a way that is consistent with the PCE country allocation for the international path. The allocation of each portion of the international path can be determined from the values given in Table 2a; the allocation for multiplex sections is given in Table 2b. These allocations are a percentage of the end-to-end PO. Distances referred to in Tables 2a and 2b are actual distances, or great circle (also called air-route or air-mile) distances multiplied by the routing factor (rf), whichever is less. See Table 1.

Table 1/M.2101 – PCE great circle length vs. routing factor

PCE great circle length	Routing Factor (rf)	Calculated PCE length
d < 1000 km	1.5	1.5 × d km
1000 km ≤ d < 1200 km	1500/d	1500 km
d ≥ 1200 km	1.25	1.25 × d km

As shown in Figure 1, it is possible that access to the bit stream for a given path may not coincide with the end of a PCE. In this case, or if a transit country has other access points within its network, it may be necessary to make a suballocation for maintenance purposes, e.g., fault localization as described in ITU-T Rec. M.2120. Such suballocations will be the responsibility of the network operator(s) of the country involved, with the following constraints:

– the sum of suballocations may not exceed the allocation of Table 2a for the PCE in question;

– the values of the suballocations must be communicated to all maintenance centres involved before bringing the path into service and after any rearrangement which changes the values.

Table 2a/M.2101 – Maximum allocation of PO to path core elements

PCE classification	Allocation (% of end-to-end PO)
IPCE	
Terminating/Transit national network:	
d ≤ 100 km	1.2
100 km < d ≤ 200 km	1.4
200 km < d ≤ 300 km	1.6
300 km < d ≤ 400 km	1.8
400 km < d ≤ 500 km	2
500 km < d ≤ 1000 km	3
1000 km < d ≤ 2500 km	4
2500 km < d ≤ 5000 km	6
5000 km < d ≤ 7500 km	8
d > 7500 km	10
ICPCE (Note)	
Optical undersea cable:	
d ≤ 500 km	1
d > 500 km	2.5
Satellite:	
Normal operation	35
Wideband cable restoration mode	35
Terrestrial:	
d < 300 km	0.3
NOTE – ICPCE allocations must be met regardless of how many MS make up the ICPCE.	

Table 2b/M.2101 – Maximum allocation of PO to international multiplex sections

Facility type	Allocation (% of end-to-end PO)
Terrestrial	0.2
Satellite	35
Optical undersea cable	
d < 500 km	0.2
d > 500 km	0.5

VC connections using rings: For the purpose of calculating error performance limits for paths transported by SDH rings, the Path End Points should first be identified, and then the performance allocated in the normal way, using the air-route distance multiplied by the routing factor. This will result in only one set of error performance limits independently of the direction around the ring (the clockwise direction, or the anti-clockwise direction).

7 Performance objectives

In this Recommendation, ES, SES, BBE and SEP events are dealt with. Of these, ES, SES and BBE are considered essential for BIS and maintenance purposes. The ESR, SESR and BBER values given in Table 3a are 50% of the G.826 and G.828 values for paths in order to provide some margin for maintenance purposes.

Table 3a/M.2101 – Performance objectives for end-to-end international paths

Rate (kbit/s) Parameter	1664 (VC-11)	2240 (VC-12)	6848 (VC-2)	48 960 (VC-3)	150 336 (VC-4)	601 344 (VC-4-4c)	2 405 376 (VC-4-16c)	9 621 504 (VC-4-64c)
Blocks/second	2000	2000	2000	8000	8000	8000	8000	8000
ESR (according to ITU-T Rec. G.826, see Note 1)	0.02	0.02	0.025	0.0375	0.08	NA	NA	NA
ESR (according to ITU-T Rec. G.828, see Note 2)	0.005	0.005	0.005	0.01	0.02	NA	NA	NA
SESR % of time	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
SEPI events/s (Note 3)	1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}	1×10^{-4}
BBER (according to ITU-T Rec. G.826, see Note 1)	NA	NA	NA	NA	NA	NA	NA	NA
BBER (according to ITU-T Rec. G.828, see Note 2)	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}

NA Not applicable for this Recommendation

NOTE 1 – These ESR and BBER values are applicable to paths designed according to ITU-T Rec. G.826.

NOTE 2 – These ESR and BBER values are applicable to paths designed according to ITU-T Rec. G.828.

NOTE 3 – The use of SEPI and limits for maintenance are under study.

NOTE 4 – For VC-4-4/16c, each VC-4 is transmitted 8000 times per second. Because each VC-4 is not evaluated separately, the total number of monitored blocks is still 8000.

Table 3b/M.2101 – Performance objectives for end-to-end international multiplex sections

Rate (kbit/s)	STM-0	STM-1	STM-4	STM-16	STM-64
Blocks/second	64 000	192 000	768 000	3 072 000	12 288 000
ESR (according to ITU-T Rec. G.826, see Note 1)	0.0375	0.08	NA	NA	NA
ESR (according to ITU-T Rec. G.828, see Note 2)	0.01	0.02	NA	NA	NA
SESR	0.001	0.001	0.001	0.001	0.001
BBER (according to ITU-T Rec. G.826, see Note 1)	NA	NA	NA	NA	NA
BBER (according to ITU-T Rec. G.828, see Note 2)	2.5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}	5×10^{-5}

Table 3b/M.2101 – Performance objectives for end-to-end international multiplex sections

NA Not applicable for this Recommendation
NOTE 1 – These ESR and BBER values are applicable to sections forming parts of paths designed according to ITU-T Rec. G.826.
NOTE 2 – These EST and BBER values are applicable to sections forming parts of paths designed according to ITU-T Rec. G.828.

For this Recommendation, SDH signals are evaluated end-to-end such that the ES, BBE and SES event definitions are in accordance with ITU-T Recs G.826 and G.828 for paths. Each Virtual Container (VC) termination point will calculate the ES, BBE and SES counts for the end-to-end VC. For multiplex sections, ES, BBE and SES event definitions are in accordance with ITU-T Rec. G.829.

End-to-end performance over any trail or connection can only be calculated from whatever signal (e.g., VC or STM) whose source and sink points coincide with the ends chosen for the measurement. Aggregation of performance measurements of trails operating in tandem should only be used where there is no VC or STM source to sink measurement possible. This situation may occur, for example, where VC-1s operating in tandem have been used to make up the full end-to-end path transporting $N \times 64$ kbit/s or primary rate PDH signals. In this case, the PDH Path Overhead evaluated results will provide a better guide to the end-to-end error performance of the path.

A PDH signal transported by an SDH container is evaluated end-to-end according to ITU-T Rec. M.2100. The SDH transport portion is evaluated according to this Recommendation. For the case of mixed PDH/SDH Terminated paths, ITU-T Rec. M.2100 applies (at the PDH bit rate).

In the case where SDH containers are mapped into PDH frames, then this Recommendation should be applied. Note that in this case, PDH subnetworks may have difficulty meeting the more stringent requirements that this Recommendation's SDH path performance limits may impose. Careful maintenance of PDH subnetworks is required to ensure that the SDH container objectives are met.

See Figure 3 for more information.

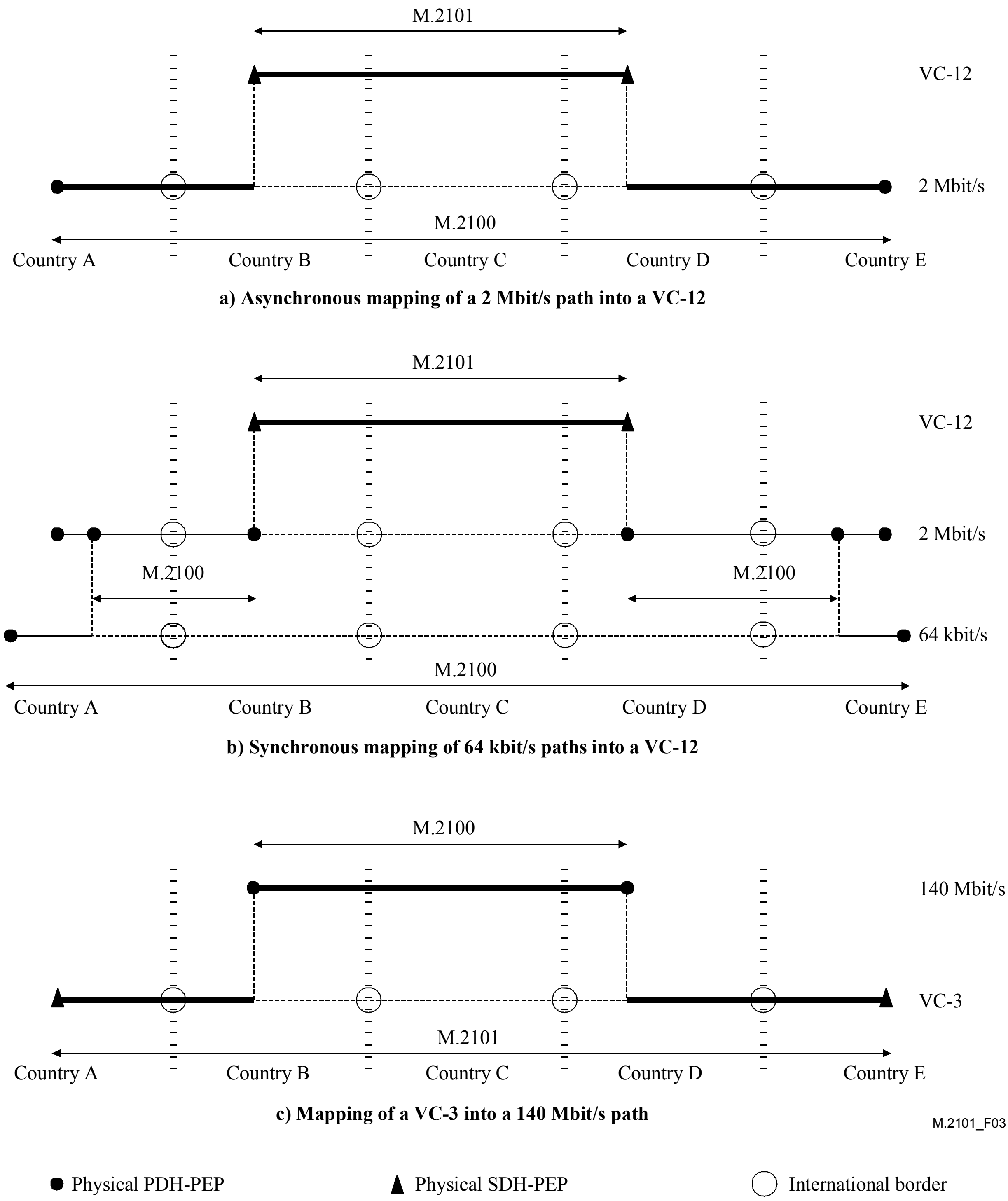


Figure 3/M.2101 – Applications of ITU-T Recs M.2100 and M.2101 for mixed SDH and PDH transmission

8 Evaluation of error performance events

This clause addresses the evaluation of the error performance events defined in ITU-T Recs G.826, G.828 and G.829, using anomalies and defects (see definition in ITU-T Rec. M.20).

In-service evaluation is considered in 8.1 and out-of-service evaluation is considered in 8.2.

NOTE – Only standardized path signals are considered under in-service evaluation; transmission systems with proprietary overhead are not covered. However, both paths and systems can be evaluated using out-of-service measurements.

The treatment of the BBE, ES and SES counts during the unavailable state is explained in clause 14.

8.1 Evaluation of ES/BBE/SES events from in-service measurements

8.1.1 Local anomaly and defect indication

The ES, BBE and SES events are evaluated from in-service anomalies and in-service defects relevant to the section and path terminating equipment at the network level of interest over a one-second integration period. See Annexes C/G.826 and B/G.828 for the list of performance-related in-service anomalies dealing with paths. For multiplex sections, see ITU-T Rec. G.829.

8.1.2 Remote anomaly and defect indication

Anomalies and defects detected by section and path terminating equipment are reported to the far-end terminating equipment every frame (125 µsec.) using a byte reserved for this purpose in the section and path overhead. Therefore, the in-service anomalies and defects described in ITU-T Recs G.826, G.828 and G.829 are available at the terminating equipment for the transmitted direction as well as the received direction.

Anomaly and defect event indicators may be processed into ES, BBE and SES events. Tables have been prepared in Annex B for HO and LO Path Layer and the multiplex section layer. Each table in Annex B provides guidance for ES/BBE/SES evaluation criteria as follows:

– Table B.1 for LO Path Layer;

– Table B.2 for HO Path Layer;

– Table B.3 for multiplex section Layer.

Where applicable, return in-service anomaly or defect information from a remote path terminating equipment is included in the tables. This allows, when required, a single-ended bidirectional monitoring capability.

8.2 Out-of-Service (OOS) measurements

In general, OOS measurements are more accurate than in service measurements since they are performed using a deterministic test signal applied to the NNI. This test signal includes payload and framing overhead information which can then be monitored downstream and errors detected. It may be necessary to stress-test the digital path using test signals with a defined range of variable parameters e.g., frequency offset, pulse density, jitter, wander, etc.

ITU-T Rec. O.181 specifies measuring equipment to assess the error performance of SDH digital paths at NNIs and includes both a transmitter and a receiver for testing. If only PDH tributary testing is required, then O.15.x-series Recommendations compliant measuring equipment may be used, but the evaluation criteria for ES and SES from anomalies and defects are given in ITU-T Rec. M.2100. In some network equipment, an internal pattern generator and/or error detector may be available which can be connected to the PDH adaptation function or used to stimulate and measure an SDH VC-n container. Assessment of error performance using existing ISM PDH and/or SDH capabilities can also be used whether or not the path payload is stimulated.

Each of the above methods can be used per-direction of a path or with a distant loopback applied to make a loop-around test.

9 Performance limits – general considerations

Performance limits relative to Allocated Performance Objective from a long-term perspective are given in Table 4.

9.1 Relationship between performance limits and objectives

The limits in this Recommendation are to be used to indicate the need for actions during maintenance and bringing-into-service. A network maintained to these limits should meet the performance objectives specified in ITU-T Recs G.826 and G.828.

The particular parameters measured, the measurement duration, and the limits used for the procedure need not be identical to those used for specifying the performance objectives as long as they result in network performance which meets these objectives. For example, the error performance objectives refer to long periods, such as one month. However, practical considerations demand that maintenance and BIS limits be based on shorter measurement intervals.

Statistical fluctuations in the occurrence of anomalies and defects mean that one cannot be certain that the long-term objectives are met. The limits on the numbers of events and the duration of measurements attempt to ensure that multiplex sections or paths exhibiting unacceptable or degraded performance can be detected. The only way to ensure that a multiplex section or path meets network performance objectives is to evaluate continuous measurement over a long period (i.e., months).

9.2 Types of limits

Limits are needed for several maintenance functions as defined in ITU-T Rec. M.20. This Recommendation provides path and multiplex section limits for three of these functions:

– bringing-into-service;
– keeping the network operational (maintenance);
– system restoration.

System restoration limits are equal to BIS limits.

Limits for commissioning (installation and acceptance) of multiplex sections are not provided in ITU-T Recommendations.

9.2.1 BIS tests/limits

BIS tests are done by measurements using a PRBS between digital terminating points. When a particular path/section is brought into service, the collection of anomalies and defects for the BIS tests shall be done at the actual termination points of this path/section. See ITU-T Rec. M.2110 for further information. These should be long-term measurements for routes with new equipment and long-term (e.g., 24 hour) BIS tests should be used. However, for practical reasons (a new path on a route with many paths already in-service, rearrangements of the network, etc.) the measurements between PEPs may be reduced to a quick measurement and the assessment completed with performance monitoring equipment.

Tests results should be compared to the BIS limits given in this Recommendation.

9.2.2 Maintenance limits

Once entities have been placed into service, supervision of the network requires additional limits, as described in ITU-T Rec. M.20. This supervision is done by in-service performance monitoring. The supervision process involves analyzing anomalies and defects detected by maintenance entities to determine if the performance level is normal, degraded, or unacceptable. Thus, degraded and unacceptable performance limits are required.

9.2.3 System restoration limit

A limit on performance after intervention (repair) is required and is equal to the BIS limit.

10 Performance limits for bringing-into-service

The BIS testing procedures, including how to deal with any period of unavailability during the test, is defined in ITU-T Rec. M.2110. This clause defines the methodology for calculation of BIS performance limits for international paths. The derivation of the limits is a function of a given allocation and the measurement duration, and is based on a pragmatic rule. These limits, which depend on parameters and objectives from ITU-T Recs G.826, G.828 and G.829, are derived from the values shown in Tables 2 and 3. The Bringing-into-service Performance Objective (BISPO) is derived from the APO.

The ratio between the APO and the BISPO is called the ageing factor. This factor should be as large as possible to minimize maintenance interventions. The ageing factor for paths is 0.5. For sections, the ageing factor is 0.1, except for SES where it is 0.5.

One limit, S, is derived from the BISPO for use in BIS testing.

If the test result is less than or equal to the S limit, the entity can be brought into service with some confidence. Corrective action is required if the performance is worse than the limit S.

Continuous in-service monitoring is required to provide sufficient confidence in the long-term performance.

10.1 Calculation of path performance objectives and limits

NOTE 1 – For paths designed in accordance with ITU-T Rec. G.826, BBE is not applicable.

NOTE 2 – The use of SEP is for further study.

The following steps shall be followed to obtain path performance limits:

Step a : *Identification of PO*

1) Identify the bit rate of the path.

2) Read the PO for the appropriate bit rate from Table 3a for ES, BBE, SES and SEP:
PO_{es} = x (ratio);

PO_{ses} = y (ratio);

PO_{bbe} = z (ratio);

PO_{sep} = n (counts/s).

Step b : *Calculation of allocation*

3) Identify all PCEs for the entire path, and set N = the total number of PCEs.

4) Label the PCEs as PCE_1 to PCE_N as shown in Figure 1.

5) Identify the length, *d*, of each PCE_n. The length, *d*, is either the actual path length or can be estimated by the great circle length between its endpoints multiplied by the appropriate routing factor from Table 1.

6) Read the allocation, a_n%, (as a percentage of end-to-end PO) for PCE_n from Table 2a. Note that the allocations in Table 2a are maximum values; more stringent values can be used by bilateral or multilateral agreement.

7) Calculate A%, the path allocation, where:

$$A\% = \sum a_n\%; \text{i.e.,} \, a_1\% + a_2\% + ... + a_N\%$$

Step c : *Calculation of APO*

8) Determine the required Test Period, (TP) where TP = 15 min., 2 hours, or 24 hours. Express TP in seconds, e.g., TP = 900 seconds for a 15-minute test.

9) Calculate the Allocated Performance Objective (APO) counts for ES and SES require from the information already obtained:

$APO_{es} = A \times PO_{es} \times TP \div 100$ (convert A% to ratio);

$APO_{ses} = A \times PO_{ses} \times TP \div 100$ (convert A% to ratio).

10) Calculate the APO counts for BBE required from the information already obtained plus the block size from Table 3:

$APO_{bbe} = A \times PO_{bbe} \times TP \times 2000 \div 100$ (convert A% to ratio – VC-1 and 2);

$APO_{bbe} = A \times PO_{bbe} \times TP \times 8000 \div 100$ (convert A% to ratio – VC-3 and 4 and VC-4-Xc).

Step d : *Calculation of BISPO and S values*

11) Calculate the BISPOs for the path:

$$BISPO_{es} = \frac{APO_{es}}{2} \quad BISPO_{ses} = \frac{APO_{ses}}{2} \quad BISPO_{bbe} = \frac{APO_{bbe}}{2}$$

12) Calculate S values:

$D_{es} = 2\sqrt{BISPO_{es}}$

$S_{es} = BISPO_{es} - D_{es}$

$D_{ses} = 2\sqrt{BISPO_{ses}}$

$S_{ses} = BISPO_{ses} - D_{ses}$

$D_{bbe} = 2\sqrt{BISPO_{bbe}}$

$S_{bbe} = BISPO_{bbe} - D_{bbe}$

Round all S values to the nearest integer value ≥ 0.

Note that in some cases, the BBE S limits are non-zero while the ES limits are zero or invalid (i.e., do not provide 95% confidence that the BISPO will be met long term). It is generally suggested that a longer test be used where the ES limits are invalid. In either case, the BBE test cannot be accepted if there is more than 1 ES.

10.2 BIS limit values for paths

By application of the methodology of 10.1, the performance limits for BIS of paths are calculated according to the allocation and the testing duration. BIS tests described in ITU-T Rec. M.2110 are:

– 15-minute test;

– 2-hour test;

– 24-hour test.

According to those durations, S values are defined as S_{15}, S_2 and S_{24}. These S values can be read from the tables given in Annexes C (based on ITU-T Rec. G.826) and D (based on ITU-T Rec. G.828).

10.3 Calculation of multiplex sections performance objectives and limits

The following steps shall be followed to obtain multiplex sections performance limits:

Step a : *Identification of PO*

1) Identify the bit rate of the multiplex section.

2) Read the PO for the appropriate bit rate from Table 3b for both ES and SES:

PO_{es} = x (ratio);

PO_{ses} = y (ratio);

PO_{bbe} = z (ratio).

Step b : *Calculation of allocation*

3) Identify the length, *d*, of the multiplex section. The length, *d*, is either the actual multiplex section length or can be estimated by the great circle length between its endpoints multiplied by the appropriate routing factor from Table 1.

4) Read the allocation, A%, (as a percentage of end-to-end PO) from Table 2b.

Step c : *Calculation of APO*

5) Determine the required Test Period, (TP) where TP = 24 hours.

6) Express TP in seconds, e.g., TP = 86 400 seconds.

7) Calculate the Allocated Performance Objectives (APOs) required from the information already obtained:

$APO_{es} = A \times PO_{es} \times TP \div 100$ (convert A% to ratio);

$APO_{ses} = A \times PO_{ses} \times TP \div 100$ (convert A% to ratio).

8) Calculate the APO counts for BBE required from the information already obtained plus the block size from Table 3:

$APO_{bbe} = A \times PO_{bbe} \times TP \times 64\,000 \div 100$ (convert A% to ratio – STM-0);

$APO_{bbe} = A \times PO_{bbe} \times TP \times 192\,000 \div 100$ (convert A% to ratio – STM-1);

$APO_{bbe} = A \times PO_{bbe} \times TP \times 768\,000 \div 100$ (convert A% to ratio – STM-4);

$APO_{bbe} = A \times PO_{bbe} \times TP \times 3\,072\,000 \div 100$ (convert A% to ratio – STM-16);

$APO_{bbe} = A \times PO_{bbe} \times TP \times 12\,288\,000 \div 100$ (convert A% to ratio – STM-64).

Step d : *Calculation of BISPO and S values*

9) Calculate the BISPOs for the multiplex section:

$$BISPO_{es} = \frac{APO_{es}}{10}$$

$$BISPO_{ses} = \frac{APO_{ses}}{2}$$

$$BISPO_{bbe} = \frac{APO_{bbe}}{10}$$

10) Calculate S values:

$D_{es} = 2\surd\ BISPO_{es}$

$S_{es} = BISPO_{es} - D_{es}$

$D_{ses} = 2\surd\ BISPO_{ses}$

$S_{ses} = BISPO_{ses} - D_{ses}$

$D_{bbe} = 2\surd\ BISPO_{bbe}$

$S_{bbe} = BISPO_{es} - D_{bbe}$

Round all S values to the nearest integer value.

10.4 BIS limit values for multiplex sections

By application of the methodology of 10.3, the performance limits for BIS of multiplex sections are calculated according to the allocation and the testing duration. BIS tests described in ITU-T Rec. M.2110 are 24-hour tests.

According to this duration, S values are defined as S_{24}. These S_{24} values can be read from the tables given in Annexes C (based on ITU-T Rec. G.826) and D (based on ITU-T Rec. G.828).

11 Performance limits for maintenance

Once entities have been placed into service, the supervision of the network requires additional limits, as described in ITU-T Rec. M.20. The supervision process involves analyzing anomalies and defects detected by maintenance entities to determine the performance level. The maintenance procedures are defined in ITU-T Rec. M.2120.

11.1 Performance levels and limits

With regard to the performance limits for maintenance, the general conditions on performance limits apply. See 9.2.2.

According to ITU-T Rec. M.20, an entity can be in a limited number of predefined conditions depending on its performance. These conditions are called performance levels, and are the Unacceptable Performance Level (UPL), the Degraded Performance Level (DPL) and the Acceptable Performance Level.

Unacceptable performance level

An unacceptable performance level is defined in ITU-T Rec. M.20. The unacceptable performance limit for a given entity is derived from an objective of at least 10 times the APO during a 15-minute period.

Degraded performance level

A degraded performance level is defined in ITU-T Rec. M.20. The degraded performance limit for a given entity is derived from an objective on the order of 0.5 times the APO for sections and 0.75 times the APO for paths. The monitoring duration is a fixed duration of 24 hours.

Performance limit after intervention (repair)

This performance limit is the same as the BIS limit for paths and sections (see ITU-T Rec. M.2110).

The boundaries between the performance levels are called performance limits. The performance limits are a function of the APO as follows:

– UP Limit $\geq$ 10 × APO where TP = 900 seconds;

– DP Limit = 0.75 × APO (path) where TP = 86 400 seconds;

– DP Limit = 0.50 × APO (multiplex section) where TP = 86 400 seconds.

In the case of testing performance after repair, a special threshold, "Performance After Repair", is used (see ITU-T Recs M.34 and M.2110) where:

– Performance After Repair = 0.1 × APO (multiplex section) for ES and BBE;

– Performance After Repair = 0.5 × APO (multiplex section) for SES and SEP;

– Performance After Repair = 0.5 × APO (path).

Performance levels are bounded by UPL and DPL Limits. The "Performance After Repair" and BIS thresholds are included in the ACCEPTABLE range but are not boundaries between performance levels. The PO is contained within the DEGRADED range but is also not a boundary. These principles are illustrated in Table 4.

Table 4/M.2101 – Performance levels and limits (ES, BBE, SES and SEP) relative to long-term APO (> 1 month) performance ranges

Multiplex sections		Paths	
Limit (Relative to APO)	**Performance level range**	**Limit (Relative to APO)**	**Performance level range**
BIS/Performance after repair (ES and BBE) 0.10	ACCEPTABLE (< 0.5 APO)	BIS/Performance after repair 0.50	ACCEPTABLE (< 0.75 APO)
BIS/Performance after repair (SES) (Note) 0.5	ACCEPTABLE (< 0.5 APO)		
Performance objective 1.00	DEGRADED (≥ 0.50 to < 10 APO)	Performance objective 1.00	DEGRADED (≥ 0.75 to < 10 APO)
	UNACCEPTABLE (≥ 10 APO)		UNACCEPTABLE (≥ 10 APO)
NOTE – The use of SEP and limits for maintenance are under study.			

11.2 Performance limit thresholds

When a limit is given to a specific value in terms of ES, BBE and/or SES, the ES, BBE and/or SES value is called a threshold. Each threshold will have an associated measurement duration.

11.2.1 Use of thresholds

The general strategy for the use of performance monitoring information and thresholds is described in ITU-T Recs M.20 and M.34. These thresholds and monitoring information will be reported to operations systems via the TMN for both real time and longer term analysis. When thresholds of unacceptable or degraded performance levels are reached, maintenance action should be initiated independently of the performance measurement. Other thresholds may be used for maintenance and longer term quality analysis. The operations systems will use real time processing to assign maintenance priorities to these threshold crossings and information, using the performance supervision process described in ITU-T Rec. M.20.

11.2.2 Types of thresholds

There are two types of thresholds according to the monitoring duration T1 or T2.

Thresholds associated with a T1 evaluation period

The monitoring duration T1 is fixed to a 15-minute value and ES, BBE and SES are counted over this period. The T1 period is to assist in detection of transition to or from the unacceptable performance level.

A threshold report occurs when an ES, BBE or SES threshold is met or exceeded. The reset threshold report, which is an optional feature, occurs when the number of ES, BBE and SES is lower than or equal to the reset threshold. Those principles are explained in ITU-T Rec. M.2120.

Thresholds associated with a T2 evaluation period

The monitoring duration T2 is fixed to a 24-hour value. The T2 period is to assist in detection of transition to the degraded performance level.

A threshold report occurs when an ES, BBE or SES threshold is met or exceeded over the period of time T2 as explained in ITU-T Rec. M.2120.

11.2.3 Threshold values

ES, BBE and SES thresholds should be programmable to suit specific operating requirements. In particular, the need for iterative adjustment (with operational experience) of the threshold is seen as a likely requirement.

The default unacceptable performance thresholds for the 15-minute evaluation periods are given in E.1 for VC-1, 2, 3, 4 and STM-0, 1 and 4.

The degraded performance thresholds for the 24-hour evaluation period are the responsibility of each network operator. 0.75 × APO values are suggested for paths. 0.5 × APO values are suggested for multiplex sections.

12 Long-term quality monitoring/measurement

Performance monitoring history should be kept for at least one year (suggested) by the management system.

13 Effects of timing impairments on error performance

Jitter and wander are timing impairments related to the fluctuations in the timing signal. Limits for jitter and wander are defined in ITU-T Rec. G.825. Those limits are fixed in such a way that a given level of jitter could be applied to the input of network equipment without producing errors or excessive jitter at its output.

Therefore, for maintenance purposes, the error performance requirements are sufficient to deal with those timing impairments.

14 Availability and unavailability

14.1 Criteria for entry/exit to/from the unavailable state

According to clauses 4.7/G.826 and 3.6/G.828, the error performance of a path shall only be evaluated whilst the path is in the available state. The reason is that error performance is a parameter which characterizes the service provided by the path. When the service is not available, this characteristic is irrelevant.

In line with this general principle, the evaluation of the error performance shall be based on the numbers of events which happened during available time.

Annex A of ITU-T Recs G.826 and 828 further stipulates that a bidirectional service between A and B is only available if both of the two constituent unidirectional services (A to B, and B to A) are available. The reason is that a client is not very much interested in the detailed performance of one direction if the other direction is completely broken.

This Recommendation has a different approach because it is dealing with BIS and maintenance. Maintenance consists of identifying, localizing and correcting failures which affect the performance of a path. In order to be able to carry out these tasks efficiently, the view of an operator working on failures affecting one direction of a bidirectional path should not be obscured by possible unavailability of the other direction.

For this reason, this Recommendation uses only the criteria for a single direction, and not the criterion for a bidirectional path.

The criteria for a single direction are: "A period of unavailable time begins at the onset of ten consecutive SES events. These ten seconds are considered to be part of unavailable time. A new period of available time begins at the onset of ten consecutive non-SES events. These ten seconds are considered to be part of available time."

Hence, in order to evaluate the error performance of a transport entity against the objectives put forward in clause 10, each direction shall be evaluated while disregarding the behaviour of the other direction, and the counting of events for a direction shall only be inhibited when that direction is unavailable.

To determine the entry/exit to/from unavailability, the collection of SES is necessary. See ITU-T Rec. G.784 for implementation of SES collection.

14.2 Consequences for error performance measurements

To determine the entry into and exit from unavailability, it is necessary to collect SES and to determine unavailability for each direction of a two-way path or connection independently. It should be noted that when only one direction is in the unavailable state, measurements made on the opposite direction should not be included in the performance assessment of the bidirectional path or connection.

14.3 Inhibiting performance monitoring during unavailable time

During unavailable time, the count of performance events is inhibited. When only one direction of a bidirectional path is unavailable, the count of performance events is inhibited for this direction and continues for the other direction.

Figure 4 illustrates the rules for determining the unavailable second parameter and for inhibiting other parameter counts. Reading down and left to right, the first row represents the error condition and shows momentary and persistent conditions. It indicates if an error condition exists (Y) or not (N). Error conditions include anomalies and defects as shown. Proceeding in a similar manner, the latter three rows show the procedures for calculating path unavailable seconds, real-time and adjusted real-time parameter counts.

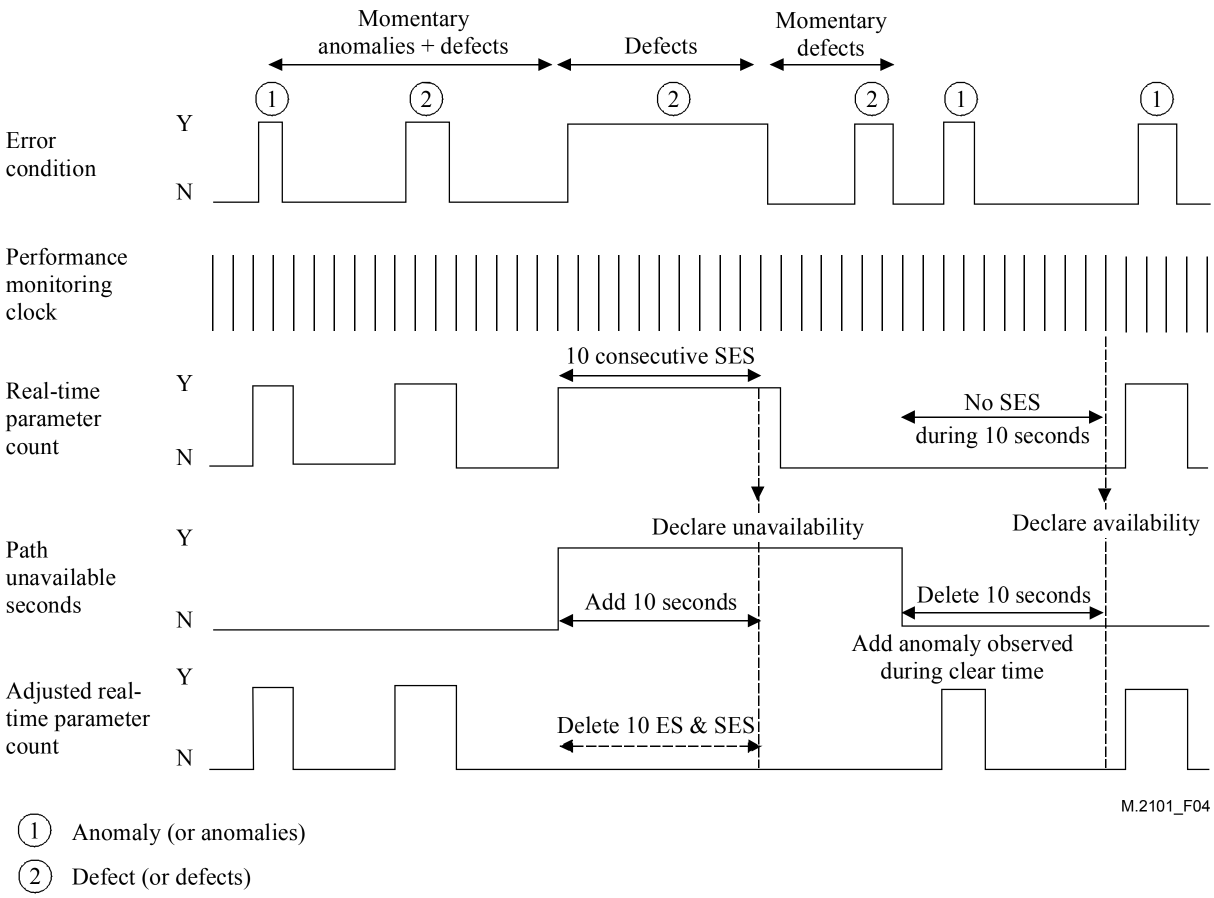


Figure 4/M.2101 – Illustration of performance monitoring inhibiting during unavailable time

Figure 4 shows the correction to the unavailable counter, and the rules for deleting and adding increments in time in the unavailable second counter. It also shows the count of anomalies during the clearing time interval.

Note that the signal condition transition, or declaration instant of a defect or anomaly condition is independent of the performance monitoring clock one-second boundaries.

14.4 Unavailability limits

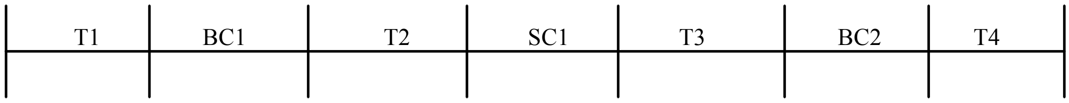
Unavailability limits for maintenance are under study. In general, any transition to the unavailable state should be unacceptable for BIS. For radio and satellite systems however, unavailable periods due to natural phenomena (e.g., rain fade) may be acceptable.

Annex A

Example applications of path allocation from Table 2a

This annex provides an example showing the application of path allocation (A%) as described in clause 6.

Example: An SDH path



T	Terminating or transit IPCE	
BC	Border crossing ICPCE	1000 km – 2500 km 2 × 4.0% = 8.0%
SC	Submarine cable ICPCE	500 km – 1000 km 1 × 3.0% = 3.0 %
T1, T4	IPCE (Terminating)	400 km – 500 km 1 × 2.0% = 2.0%
T2	IPCE (Transit)	1 × 2.5% = 2.5%
T3	IPCE (Transit)	2 × 0.3% = 0.6%
SC1	ICPCE (Optical undersea cable)	
BC1, BC2	ICPCE (Terrestial)	Total SDH path allocation = 16.1%

Annex B

In-service ES, BBE and SES event evaluation criteria

In addition to path performance monitoring, this annex covers Tandem Connection Monitoring (TCM) as shown in Tables B.1 and B.2. VC-n and TC-n trails are equivalent from a performance perspective. The established rules for VC-n apply also to TC-n. Further details are given in ITU-T Recs G.707 and G.803.

Table B.3 gives the criteria for Multiplex Sections.

Table B.1/M.2101 – In-service ES, BBE and SES event evaluation criteria for the LO path layer

Virtual container type	Path/TC overhead available to derive anomaly and defect information		ES/SES event evaluation criteria (Anomalies and defects in 1 second)			Remarks
			Thresholds and mapping for anomalies and defects in 1 second	Interpretation for Receive direction	Interpretation for Send direction	
	Path	TC				
VC-11,	H4	H4	1 HP-LOM	ES + SES		
VC-12,	V1, V2	V1, V2	1 TU-AIS	ES + SES		
VC-2,	V1, V2	V1, V2	1 TU-LOP	ES + SES		
	J2	N2	1 LP/LPTC-TIM	ES + SES		
	V5	N2	1 LP/LPTC-UNEQ	ES + SES		
	NA	N2	1 LPTC-LTC	ES + SES		
	V5	N2	1 BIP-2 error	ES		
	V5	N2	600 "BIP-2" errors	ES + SES		"BIP-2" error
	V5	N2	# of "BIP-2" errors	# of BBE		≡"BIP-2"≠0
	V5	N2	1 LP/LPTC-REI		ES	
	V5	N2	600 "LP/LPTC REI>0"		ES + SES	
	V5	N2	# of "LP/LPTC REI>0"		# of BBE	
	V5	N2	1 LP/LPTC-RDI		ES + SES	

Table B.1/M.2101 – In-service ES, BBE and SES event evaluation criteria for the LO path layer

Virtual container type	Path/TC overhead available to derive anomaly and defect information		ES/SES event evaluation criteria (Anomalies and defects in 1 second)			Remarks
			Thresholds and mapping for anomalies and defects in 1 second	Interpretation for Receive direction	Interpretation for Send direction	
VC-3	H1, H2	H1, H2	1 TU-AIS	ES + SES		
	H1, H2	H1, H2	1 TU-LOP	ES + SES		
	J1	N1	1 LP/LPTC-TIM	ES + SES		
	C2	N1	1 LP/LPTC-UNEQ	ES + SES		
	NA	N1	1 LPTC-LTC	ES + SES		
	B3	N1/B3	1 BIP-8 error	ES		"BIP-8" error
	B3	N1/B3	2 400 "BIP-8" errors	ES + SES		≡"BIP-8"≠0
	G1	N1	1 LP/LPTC-REI		ES	
	G1	N1	2 400 "LP/LPTC REI>0"		ES + SES	
	G1	N1	1 LP/LPTC RDI		ES + SES	
	B3	N1/B3	# of "BIP-8" errors	# of BBE		(Note)
	G1	N1	# of "LP/LPTC REI>0"		# of BBE	(Note)

NA Not applicable

NOTE – BBE not counted during a second which is declared to be an SES.

Table B.2/M.2101 – In-service ES, SES and BBE event evaluation criteria for the HO path layer

Virtual container type	Path overhead available to derive anomaly and defect information		ES/SES event evaluation criteria (Anomalies and defects in 1 second)			Remarks
			Thresholds and mapping for anomalies and defects in 1 second	Interpretation for Receive direction	Interpretation for Send direction	
	Path	TC				
VC-3,	H1, H2	H1, H2	1 AU-AIS	ES + SES		
VC-4 and	H1, H2	H1, H2	1 AU-LOP	ES + SES		
VC-4-4C	J1	N1	1 HP/HPTC-TIM	ES + SES		
and	C2	N1	1 HP/HPTC-UNEQ	ES + SES		
VC-4-16c	NA	N1	1 HPTC-LTC	ES + SES		
and	B3	N1/B3	1 "BIP-8" error	ES		"BIP-8" error
VC-4-64c	B3	N1/B3	2 400 "BIP-8" errors	ES + SES		≡"BIP-8"≠0
	B3	N1/B3	# of "BIP-8" errors	# of BBE		(Note)
	G1	N1	1 "HP/HPTC-REI>0"		ES	
	G1	N1	2 400 "HP/HPTC REI>0"		ES + SES	
	G1	N1	1 HP/HPTC-RDI		ES + SES	
	G1	N1	# of "HP/HPTC REI>0"		# of BBE	(Note)

NA Not applicable

NOTE – BBE not counted during a second which is declared to be an SES.

Table B.3/M.2101 – In-service ES, SES and BBE event evaluation criteria for the multiplex section layer

Section type and STM level	Section overhead available to derive anomaly and defect information	ES/SES event evaluation criteria (Anomalies and defects in 1 second)			Remarks
		Thresholds and mapping for anomalies and defects in 1 second	Interpretation for Receive direction	Interpretation for Send direction	
MS-STM-0,	B2 B2 M1 M1 M1 M1	1 BIP-1 error # of BIP-1 errors 1 MS-AIS 1 MS-REI > 0 ∑MS-REI count 1 MS-RDI	ES # of BBE ES + SES	 ES # of BBE ES + SES	MS-REI contains FE BIP-1 count/frame
MS-STM-1, MS-STM-4, and MS-STM-16 MS-STM-64	B2 B2 K1, K2 M1 M1 K2	1 BIP-1 error # of BIP-1 errors 1 MS-AIS 1 MS-REI > 0 ∑MS-REI count 1 MS-RDI	ES # of BBE ES + SES	 ES # of BBE ES + SES	MS-REI contains FE BIP-1 count/frame
MS-STM-0	B2 M1	a BIP-1 a MS-REI	ES + SES	 ES + SES	SES BBE thresholds for STM-0 are under study
MS-STM-1	B2 M1	28 800 BIP-1 28 800 ∑MS-REI	ES + SES	 ES + SES	
MS-STM-4	B2 M1	192 000 BIP-1 192 000 ∑MS-REI	ES + SES	 ES + SES	
MS-STM-16 MS-STM-64	B2 M1	b BIP-1 b ∑MS-REI	ES + SES	 ES + SES	SES and BBE thresholds are under study
NOTE – BBE not counted during a second which is declared to be an SES.					

Annex C

Values for bringing-into-service limits for international digital paths and multiplex sections, based on ITU-T Rec. G.826

Tables have been prepared for each path level from VC-1 to VC-4 and for each section level from STM-0 to STM-64. These table are based on ITU-T Rec. G.826.

– Table C.1: VC-1;
– Table C.2: VC-2;
– Table C.3: VC-3;
– Table C.4: VC-4;
– Table C.5: STM-0;
– Table C.6: STM-1;
– Table C.7: STM-4, 16 and 64.

Table C.1/M.2101 – BIS performance limits for VC-1 based on ITU-T Rec. G.826

	15 min		2 hours		24 hours	
	ES	SES	ES	SES	ES	SES
Path Alloc.	S15	S15	S2	S2	S24	S24
0.2%	0	0	0	0	0	0
0.5%	0	0	0	0	0	0
1.0%	0	0	0	0	3	0
1.5%	0	0	0	0	6	0
2.0%	0	0	0	0	9	0
2.5%	0	0	0	0	12	0
3.0%	0	0	0	0	16	0
3.5%	0	0	0	0	19	0
4.0%	0	0	0	0	23	0
4.5%	0	0	0	0	26	0
5.0%	0	0	0	0	30	0
5.5%	0	0	0	0	34	0
6.0%	0	0	0	0	37	0
6.5%	0	0	0	0	41	0
7.0%	0	0	1	0	45	0
7.5%	0	0	1	0	49	0
8.0%	0	0	1	0	52	0
8.5%	0	0	1	0	56	0
9.0%	0	0	1	0	60	0
9.5%	0	0	2	0	64	0
10.0%	0	0	2	0	68	0
10.5%	0	0	2	0	72	0
11.0%	0	0	2	0	76	0
11.5%	0	0	3	0	79	1
12.0%	0	0	3	0	83	1
12.5%	0	0	3	0	87	1
13.0%	0	0	3	0	91	1
13.5%	0	0	3	0	95	1
14.0%	0	0	4	0	99	1
14.5%	0	0	4	0	103	1
15.0%	0	0	4	0	107	1
15.5%	0	0	4	0	111	2
16.0%	0	0	5	0	115	2
16.5%	0	0	5	0	119	2
17.0%	0	0	5	0	123	2
17.5%	0	0	6	0	127	2
18.0%	0	0	6	0	131	2
18.5%	0	0	6	0	135	2
19.0%	0	0	6	0	139	2

	15 min		2 hours		24 hours	
	ES	SES	ES	SES	ES	SES
Path Alloc.	S15	S15	S2	S2	S24	S24
19.5%	0	0	7	0	143	3
20.0%	0	0	7	0	147	3
20.5%	0	0	7	0	151	3
21.0%	0	0	7	0	155	3
21.5%	0	0	8	0	159	3
22.0%	0	0	8	0	163	3
22.5%	0	0	8	0	167	3
23.0%	0	0	8	0	171	4
23.5%	0	0	9	0	175	4
24.0%	0	0	9	0	179	4
24.5%	0	0	9	0	183	4
25.0%	0	0	10	0	187	4
25.5%	0	0	10	0	191	4
26.0%	0	0	10	0	195	5
26.5%	0	0	10	0	199	5
27.0%	0	0	11	0	203	5
27.5%	0	0	11	0	207	5
28.0%	0	0	11	0	211	5
28.5%	0	0	11	0	215	5
29.0%	0	0	12	0	219	5
29.5%	0	0	12	0	223	6
30.0%	0	0	12	0	227	6
30.5%	0	0	13	0	231	6
31.0%	0	0	13	0	235	6
31.5%	0	0	13	0	239	6
32.0%	0	0	13	0	243	6
32.5%	0	0	14	0	247	7
33.0%	0	0	14	0	251	7
33.5%	0	0	14	0	255	7
34.0%	0	0	15	0	259	7
34.5%	0	0	15	0	264	7
35.0%	0	0	15	0	268	7
35.5%	0	0	15	0	272	8
36.0%	0	0	16	0	276	8
36.5%	0	0	16	0	280	8
37.0%	0	0	16	0	284	8
37.5%	0	0	17	0	288	8
38.0%	0	0	17	0	292	8
38.5%	0	0	17	0	296	8

Table C.1/M.2101 – BIS performance limits for VC-1 based on ITU-T Rec. G.826

	15 min		2 hours		24 hours	
	ES	SES	ES	SES	ES	SES
Path Alloc.	S15	S15	S2	S2	S24	S24
39.0%	0	0	17	0	300	9
39.5%	0	0	18	0	304	9
40.0%	0	0	18	0	308	9
40.5%	0	0	18	0	313	9
41.0%	0	0	19	0	317	9
41.5%	0	0	19	0	321	9
42.0%	0	0	19	0	325	10
42.5%	0	0	20	0	329	10
43.0%	0	0	20	0	333	10
43.5%	0	0	20	0	337	10
44.0%	0	0	20	0	341	10
44.5%	0	0	21	0	345	10
45.0%	0	0	21	0	349	11
45.5%	0	0	21	0	353	11
46.0%	0	0	22	0	358	11
46.5%	0	0	22	0	362	11
47.0%	0	0	22	0	366	11
47.5%	0	0	23	0	370	11
48.0%	0	0	23	0	374	12
48.5%	0	0	23	0	378	12
49.0%	0	0	23	0	382	12
49.5%	0	0	24	0	386	12
50.0%	0	0	24	0	390	12
50.5%	0	0	24	0	395	12
51.0%	0	0	25	0	399	13
51.5%	0	0	25	0	403	13
52.0%	0	0	25	0	407	13
52.5%	0	0	26	0	411	13
53.0%	0	0	26	0	415	13
53.5%	0	0	26	0	419	13
54.0%	0	0	26	0	423	14
54.5%	0	0	27	0	427	14
55.0%	0	0	27	0	432	14
55.5%	0	0	27	0	436	14
56.0%	0	0	28	0	440	14
56.5%	0	0	28	0	444	15
57.0%	0	0	28	0	448	15
57.5%	0	0	29	0	452	15
58.0%	0	0	29	0	456	15
58.5%	0	0	29	0	460	15
59.0%	0	0	29	0	465	15
59.5%	0	0	30	0	469	16
60.0%	0	0	30	0	473	16
60.5%	0	0	30	0	477	16
61.0%	0	0	31	0	481	16
61.5%	0	0	31	0	485	16
62.0%	0	0	31	0	489	16
62.5%	0	0	32	0	494	17
63.0%	0	0	32	0	498	17

Table C.2/M.2101 – BIS performance limits for VC-2 based on ITU-T Rec. G.826

	15 min		2 hours		24 hours			15 min		2 hours		24 hours	
	ES	SES	ES	SES	ES	SES		ES	SES	ES	SES	ES	SES
Path Alloc.	S15	S15	S2	S2	S24	S24	Path Alloc.	S15	S15	S2	S2	S24	S24
0.2%	0	0	0	0	0	0	19.5%	0	0	9	0	182	3
0.5%	0	0	0	0	1	0	20.0%	0	0	10	0	187	3
1.0%	0	0	0	0	4	0	20.5%	0	0	10	0	192	3
1.5%	0	0	0	0	8	0	21.0%	0	0	10	0	197	3
2.0%	0	0	0	0	12	0	21.5%	0	0	11	0	202	3
2.5%	0	0	0	0	17	0	22.0%	0	0	11	0	207	3
3.0%	0	0	0	0	21	0	22.5%	0	0	11	0	212	3
3.5%	0	0	0	0	26	0	23.0%	0	0	12	0	217	4
4.0%	0	0	0	0	30	0	23.5%	0	0	12	0	222	4
4.5%	0	0	0	0	35	0	24.0%	0	0	12	0	227	4
5.0%	0	0	0	0	39	0	24.5%	0	0	13	0	232	4
5.5%	0	0	1	0	44	0	25.0%	0	0	13	0	237	4
6.0%	0	0	1	0	49	0	25.5%	0	0	13	0	242	4
6.5%	0	0	1	0	53	0	26.0%	0	0	14	0	247	5
7.0%	0	0	1	0	58	0	26.5%	0	0	14	0	252	5
7.5%	0	0	2	0	63	0	27.0%	0	0	14	0	257	5
8.0%	0	0	2	0	68	0	27.5%	0	0	15	0	263	5
8.5%	0	0	2	0	73	0	28.0%	0	0	15	0	268	5
9.0%	0	0	2	0	77	0	28.5%	0	0	16	0	273	5
9.5%	0	0	3	0	82	0	29.0%	0	0	16	0	278	5
10.0%	0	0	3	0	87	0	29.5%	0	0	16	0	283	6
10.5%	0	0	3	0	92	0	30.0%	0	0	17	0	288	6
11.0%	0	0	4	0	97	0	30.5%	0	0	17	0	293	6
11.5%	0	0	4	0	102	1	31.0%	0	0	17	0	298	6
12.0%	0	0	4	0	107	1	31.5%	0	0	18	0	303	6
12.5%	0	0	5	0	112	1	32.0%	0	0	18	0	308	6
13.0%	0	0	5	0	117	1	32.5%	0	0	18	0	314	7
13.5%	0	0	5	0	122	1	33.0%	0	0	19	0	319	7
14.0%	0	0	6	0	127	1	33.5%	0	0	19	0	324	7
14.5%	0	0	6	0	132	1	34.0%	0	0	20	0	329	7
15.0%	0	0	6	0	137	1	34.5%	0	0	20	0	334	7
15.5%	0	0	6	0	142	2	35.0%	0	0	20	0	339	7
16.0%	0	0	7	0	147	2	35.5%	0	0	21	0	344	8
16.5%	0	0	7	0	152	2	36.0%	0	0	21	0	349	8
17.0%	0	0	7	0	157	2	36.5%	0	0	21	0	354	8
17.5%	0	0	8	0	162	2	37.0%	0	0	22	0	360	8
18.0%	0	0	8	0	167	2	37.5%	0	0	22	0	365	8
18.5%	0	0	8	0	172	2	38.0%	0	0	23	0	370	8
19.0%	0	0	9	0	177	2	38.5%	0	0	23	0	375	8

Table C.2/M.2101 – BIS performance limits for VC-2 based on ITU-T Rec. G.826

	15 min		2 hours		24 hours	
	ES	SES	ES	SES	ES	SES
Path Alloc.	S15	S15	S2	S2	S24	S24
39.0%	0	0	23	0	380	9
39.5%	0	0	24	0	385	9
40.0%	0	0	24	0	390	9
40.5%	0	0	24	0	396	9
41.0%	0	0	25	0	401	9
41.5%	0	0	25	0	406	9
42.0%	0	0	26	0	411	10
42.5%	0	0	26	0	416	10
43.0%	0	0	26	0	421	10
43.5%	0	0	27	0	426	10
44.0%	0	0	27	0	432	10
44.5%	0	0	27	0	437	10
45.0%	0	0	28	0	442	11
45.5%	0	0	28	0	447	11
46.0%	0	0	29	0	452	11
46.5%	0	0	29	0	457	11
47.0%	0	0	29	0	463	11
47.5%	0	0	30	0	468	11
48.0%	0	0	30	0	473	12
48.5%	0	0	30	0	478	12
49.0%	0	0	31	0	483	12
49.5%	0	0	31	0	488	12
50.0%	0	0	32	0	494	12
50.5%	0	0	32	0	499	12
51.0%	0	0	32	0	504	13
51.5%	0	0	33	0	509	13
52.0%	0	0	33	0	514	13
52.5%	0	0	34	0	519	13
53.0%	0	0	34	0	525	13
53.5%	0	0	34	0	530	13
54.0%	0	0	35	0	535	14
54.5%	0	0	35	0	540	14
55.0%	0	0	35	0	545	14
55.5%	0	0	36	0	550	14
56.0%	0	0	36	0	556	14
56.5%	0	0	37	0	561	15
57.0%	0	0	37	0	566	15
57.5%	0	0	37	0	571	15
58.0%	0	0	38	0	576	15
58.5%	0	0	38	0	582	15
59.0%	0	0	39	0	587	15
59.5%	0	0	39	0	592	16
60.0%	0	0	39	0	597	16
60.5%	0	0	40	0	602	16
61.0%	0	0	40	0	607	16
61.5%	0	0	40	0	613	16
62.0%	0	0	41	0	618	16
62.5%	0	0	41	0	623	17
63.0%	0	0	42	0	628	17

Table C.3/M.2101 – BIS performance limits for VC-3 based on ITU-T Rec. G.826

	15 min		2 hours		24 hours	
	ES	SES	ES	SES	ES	SES
Path Alloc.	S15	S15	S2	S2	S24	S24
0.2%	0	0	0	0	0	0
0.5%	0	0	0	0	2	0
1.0%	0	0	0	0	8	0
1.5%	0	0	0	0	14	0
2.0%	0	0	0	0	21	0
2.5%	0	0	0	0	28	0
3.0%	0	0	0	0	35	0
3.5%	0	0	0	0	42	0
4.0%	0	0	1	0	49	0
4.5%	0	0	1	0	56	0
5.0%	0	0	2	0	63	0
5.5%	0	0	2	0	70	0
6.0%	0	0	2	0	77	0
6.5%	0	0	3	0	85	0
7.0%	0	0	3	0	92	0
7.5%	0	0	4	0	99	0
8.0%	0	0	4	0	107	0
8.5%	0	0	5	0	114	0
9.0%	0	0	5	0	122	0
9.5%	0	0	6	0	129	0
10.0%	0	0	6	0	137	0
10.5%	0	0	7	0	144	0
11.0%	0	0	7	0	152	0
11.5%	0	0	8	0	159	1
12.0%	0	0	8	0	167	1
12.5%	0	0	9	0	174	1
13.0%	0	0	9	0	182	1
13.5%	0	0	10	0	189	1
14.0%	0	0	10	0	197	1
14.5%	0	0	11	0	204	1
15.0%	0	0	11	0	212	1
15.5%	0	0	12	0	219	2
16.0%	0	0	12	0	227	2
16.5%	0	0	13	0	235	2
17.0%	0	0	13	0	242	2
17.5%	0	0	14	0	250	2
18.0%	0	0	14	0	257	2
18.5%	0	0	15	0	265	2
19.0%	0	0	16	0	273	2

	15 min		2 hours		24 hours	
	ES	SES	ES	SES	ES	SES
Path Alloc.	S15	S15	S2	S2	S24	S24
19.5%	0	0	16	0	280	3
20.0%	0	0	17	0	288	3
20.5%	0	0	17	0	296	3
21.0%	0	0	18	0	303	3
21.5%	0	0	18	0	311	3
22.0%	0	0	19	0	319	3
22.5%	0	0	19	0	326	3
23.0%	0	0	20	0	334	4
23.5%	0	0	20	0	342	4
24.0%	0	0	21	0	349	4
24.5%	0	0	22	0	357	4
25.0%	0	0	22	0	365	4
25.5%	0	0	23	0	372	4
26.0%	0	0	23	0	380	5
26.5%	0	0	24	0	388	5
27.0%	0	0	24	0	396	5
27.5%	0	0	25	0	403	5
28.0%	0	0	26	0	411	5
28.5%	0	0	26	0	419	5
29.0%	0	0	27	0	426	5
29.5%	1	0	27	0	434	6
30.0%	1	0	28	0	442	6
30.5%	1	0	28	0	450	6
31.0%	1	0	29	0	457	6
31.5%	1	0	29	0	465	6
32.0%	1	0	30	0	473	6
32.5%	1	0	31	0	481	7
33.0%	1	0	31	0	488	7
33.5%	1	0	32	0	496	7
34.0%	1	0	32	0	504	7
34.5%	1	0	33	0	512	7
35.0%	1	0	34	0	519	7
35.5%	1	0	34	0	527	8
36.0%	1	0	35	0	535	8
36.5%	1	0	35	0	543	8
37.0%	1	0	36	0	550	8
37.5%	1	0	36	0	558	8
38.0%	1	0	37	0	566	8
38.5%	1	0	38	0	574	8

Table C.3/M.2101 – BIS performance limits for VC-3 based on ITU-T Rec. G.826

	15 min		2 hours		24 hours	
	ES	SES	ES	SES	ES	SES
Path Alloc.	**S15**	**S15**	**S2**	**S2**	**S24**	**S24**
39.0%	1	0	38	0	582	9
39.5%	2	0	39	0	589	9
40.0%	2	0	39	0	597	9
40.5%	2	0	40	0	605	9
41.0%	2	0	40	0	613	9
41.5%	2	0	41	0	620	9
42.0%	2	0	42	0	628	10
42.5%	2	0	42	0	636	10
43.0%	2	0	43	0	644	10
43.5%	2	0	43	0	652	10
44.0%	2	0	44	0	659	10
44.5%	2	0	45	0	667	10
45.0%	2	0	45	0	675	11
45.5%	2	0	46	0	683	11
46.0%	2	0	46	0	691	11
46.5%	2	0	47	0	698	11
47.0%	2	0	48	0	706	11
47.5%	2	0	48	0	714	11
48.0%	2	0	49	0	722	12
48.5%	2	0	49	0	730	12
49.0%	3	0	50	0	737	12
49.5%	3	0	50	0	745	12
50.0%	3	0	51	0	753	12
50.5%	3	0	52	0	761	12
51.0%	3	0	52	0	769	13

	15 min		2 hours		24 hours	
	ES	SES	ES	SES	ES	SES
Path Alloc.	**S15**	**S15**	**S2**	**S2**	**S24**	**S24**
51.5%	3	0	53	0	777	13
52.0%	3	0	53	0	784	13
52.5%	3	0	54	0	792	13
53.0%	3	0	55	0	800	13
53.5%	3	0	55	0	808	13
54.0%	3	0	56	0	816	14
54.5%	3	0	56	0	823	14
55.0%	3	0	57	0	831	14
55.5%	3	0	58	0	839	14
56.0%	3	0	58	0	847	14
56.5%	3	0	59	0	855	15
57.0%	3	0	59	0	863	15
57.5%	3	0	60	0	870	15
58.0%	4	0	61	0	878	15
58.5%	4	0	61	0	886	15
59.0%	4	0	62	0	894	15
59.5%	4	0	62	0	902	16
60.0%	4	0	63	0	910	16
60.5%	4	0	64	0	917	16
61.0%	4	0	64	0	925	16
61.5%	4	0	65	0	933	16
62.0%	4	0	65	0	941	16
62.5%	4	0	66	0	949	17
63.0%	4	0	67	0	957	17

Table C.4/M.2101 – BIS performance limits for VC-4 based on ITU-T Rec. G.826

	15 min		2 hours		24 hours	
	ES	SES	ES	SES	ES	SES
Path Alloc.	S15	S15	S2	S2	S24	S24
0.2%	0	0	0	0	2	0
0.5%	0	0	0	0	9	0
1.0%	0	0	0	0	23	0
1.5%	0	0	0	0	37	0
2.0%	0	0	1	0	52	0
2.5%	0	0	2	0	68	0
3.0%	0	0	3	0	83	0
3.5%	0	0	4	0	99	0
4.0%	0	0	5	0	115	0
4.5%	0	0	6	0	131	0
5.0%	0	0	7	0	147	0
5.5%	0	0	8	0	163	0
6.0%	0	0	9	0	179	0
6.5%	0	0	10	0	195	0
7.0%	0	0	11	0	211	0
7.5%	0	0	12	0	227	0
8.0%	0	0	13	0	243	0
8.5%	0	0	15	0	259	0
9.0%	0	0	16	0	276	0
9.5%	0	0	17	0	292	0
10.0%	0	0	18	0	308	0
10.5%	0	0	19	0	325	0
11.0%	0	0	20	0	341	0
11.5%	0	0	22	0	358	1
12.0%	0	0	23	0	374	1
12.5%	0	0	24	0	390	1
13.0%	0	0	25	0	407	1
13.5%	0	0	26	0	423	1
14.0%	1	0	28	0	440	1
14.5%	1	0	29	0	456	1
15.0%	1	0	30	0	473	1
15.5%	1	0	31	0	489	2
16.0%	1	0	33	0	506	2
16.5%	1	0	34	0	522	2
17.0%	1	0	35	0	539	2
17.5%	1	0	36	0	556	2
18.0%	1	0	37	0	572	2
18.5%	1	0	39	0	589	2
19.0%	2	0	40	0	605	2

	15 min		2 hours		24 hours	
	ES	SES	ES	SES	ES	SES
Path Alloc.	S15	S15	S2	S2	S24	S24
19.5%	2	0	41	0	622	3
20.0%	2	0	42	0	639	3
20.5%	2	0	44	0	655	3
21.0%	2	0	45	0	672	3
21.5%	2	0	46	0	689	3
22.0%	2	0	47	0	705	3
22.5%	2	0	49	0	722	3
23.0%	3	0	50	0	738	4
23.5%	3	0	51	0	755	4
24.0%	3	0	52	0	772	4
24.5%	3	0	54	0	789	4
25.0%	3	0	55	0	805	4
25.5%	3	0	56	0	822	4
26.0%	3	0	58	0	839	5
26.5%	3	0	59	0	855	5
27.0%	3	0	60	0	872	5
27.5%	4	0	61	0	889	5
28.0%	4	0	63	0	905	5
28.5%	4	0	64	0	922	5
29.0%	4	0	65	0	939	5
29.5%	4	0	67	0	956	6
30.0%	4	0	68	0	972	6
30.5%	4	0	69	0	989	6
31.0%	4	0	70	0	1006	6
31.5%	5	0	72	0	1023	6
32.0%	5	0	73	0	1039	6
32.5%	5	0	74	0	1056	7
33.0%	5	0	76	0	1073	7
33.5%	5	0	77	0	1090	7
34.0%	5	0	78	0	1106	7
34.5%	5	0	79	0	1123	7
35.0%	6	0	81	0	1140	7
35.5%	6	0	82	0	1157	8
36.0%	6	0	83	0	1174	8
36.5%	6	0	85	0	1190	8
37.0%	6	0	86	0	1207	8
37.5%	6	0	87	0	1224	8
38.0%	6	0	89	0	1241	8
38.5%	6	0	90	0	1258	8

Table C.4/M.2101 – BIS performance limits for VC-4 based on ITU-T Rec. G.826

	15 min		2 hours		24 hours	
	ES	SES	ES	SES	ES	SES
Path Alloc.	**S15**	**S15**	**S2**	**S2**	**S24**	**S24**
39.0%	7	0	91	0	1274	9
39.5%	7	0	92	0	1291	9
40.0%	7	0	94	0	1308	9
40.5%	7	0	95	0	1325	9
41.0%	7	0	96	0	1342	9
41.5%	7	0	98	0	1358	10
42.0%	7	0	99	0	1375	10
42.5%	7	0	100	0	1392	10
43.0%	8	0	102	0	1409	10
43.5%	8	0	103	0	1426	10
44.0%	8	0	104	0	1443	10
44.5%	8	0	106	0	1459	11
45.0%	8	0	107	0	1476	11
45.5%	8	0	108	0	1493	11
46.0%	8	0	109	0	1510	11
46.5%	9	0	111	0	1527	11
47.0%	9	0	112	0	1544	11
47.5%	9	0	113	0	1561	12
48.0%	9	0	115	0	1577	12
48.5%	9	0	116	0	1594	12
49.0%	9	0	117	0	1611	12
49.5%	9	0	119	0	1628	12
50.0%	10	0	120	0	1645	12
50.5%	10	0	121	0	1662	12
51.0%	10	0	123	0	1679	13

	15 min		2 hours		24 hours	
	ES	SES	ES	SES	ES	SES
Path Alloc.	**S15**	**S15**	**S2**	**S2**	**S24**	**S24**
51.5%	10	0	124	0	1695	13
52.0%	10	0	125	0	1712	13
52.5%	10	0	127	0	1729	13
53.0%	10	0	128	0	1746	13
53.5%	10	0	129	0	1763	13
54.0%	11	0	131	0	1780	14
54.5%	11	0	132	0	1797	14
55.0%	11	0	133	0	1814	14
55.5%	11	0	135	0	1830	14
56.0%	11	0	136	0	1847	14
56.5%	11	0	137	0	1864	15
57.0%	11	0	139	0	1881	15
57.5%	12	0	140	0	1898	15
58.0%	12	0	141	0	1915	15
58.5%	12	0	143	0	1932	15
59.0%	12	0	144	0	1949	15
59.5%	12	0	145	0	1966	16
60.0%	12	0	147	0	1983	16
60.5%	12	0	148	0	1999	16
61.0%	13	0	149	0	2016	16
61.5%	13	0	151	0	2033	16
62.0%	13	0	152	0	2050	16
62.5%	13	0	153	0	2067	17
63.0%	13	0	155	0	2084	17

Table C.5/M.2101 – BIS performance limits for STM-0 based on ITU-T Rec. G.826

Path Alloc.	24 hours	
	ES	SES
	S24	S24
0.2%	0	0
0.5%	0	0
35.0%	92	0

Table C.6/M.2101 – BIS performance limits for STM-1 based on ITU-T Rec. G.826

Path Alloc.	24 hours	
	ES	SES
	S24	S24
0.2%	0	0
0.5%	0	0
35.0%	211	0

Table C.7/M.2101 – BIS performance limits for STM-4, 16 and 64 based on ITU-T Rec. G.826

Path Alloc.	24 hours	
	ES	SES
	S24	S24
0.2%	NA	0
0.5%	NA	0
35.0%	NA	0

Annex D

Values for bringing-into-service limits for international digital paths and multiplex sections, based on ITU-T Rec. G.828

Tables have been prepared for each path level from VC-1 to VC-4 and for each section level from STM-0 to STM-64. These table are based on ITU-T Rec. G.828.

– Table D.1: VC-1 and VC-2;
– Table D.2: VC-3;
– Table D.3: VC-4;
– Table D.4: VC-4-4c and VC-4-16c;
– Table D.5: STM-0;
– Table D.6: STM-1;
– Table D.7: STM-4;
– Table D.8: STM-16;
– Table D.9: STM-64.

Table D.1/M.2101 – BIS performance limits for VC-1 and VC-2 based on ITU-T Rec. G.828

	15 min			2 hours			24 hours		
	ES	SES	BBE	ES	SES	BBE	ES	SES	BBE
Path Alloc.	**S15**	**S15**	**S15**	**S2**	**S2**	**S2**	**S24**	**S24**	**S24**
0.2%	0	0	0	0	0	0	0	0	***0***
0.5%	0	0	0	0	0	0	0	0	***4***
1.0%	0	0	0	0	0	0	0	0	***12***
1.5%	0	0	0	0	0	0	0	0	***21***
2.0%	0	0	0	0	0	0	0	0	***30***
2.5%	0	0	0	0	0	0	1	0	39
3.0%	0	0	0	0	0	***1***	1	0	49
3.5%	0	0	0	0	0	***1***	2	0	58
4.0%	0	0	0	0	0	***2***	3	0	68
4.5%	0	0	0	0	0	***2***	3	0	77
5.0%	0	0	0	0	0	***3***	4	0	87
5.5%	0	0	0	0	0	***4***	5	0	97
6.0%	0	0	0	0	0	***4***	6	0	107
6.5%	0	0	0	0	0	***5***	7	0	117
7.0%	0	0	0	0	0	***6***	7	0	127
7.5%	0	0	0	0	0	***6***	8	0	137
8.0%	0	0	0	0	0	***7***	9	0	147
8.5%	0	0	0	0	0	***7***	10	0	157
9.0%	0	0	0	0	0	***8***	11	0	167
9.5%	0	0	0	0	0	***9***	11	0	177
10.0%	0	0	0	0	0	***10***	12	0	187
10.5%	0	0	0	0	0	***10***	13	0	197
11.0%	0	0	0	0	0	***11***	14	0	207
11.5%	0	0	0	0	0	***12***	15	1	217
12.0%	0	0	0	0	0	***12***	16	1	227
12.5%	0	0	0	0	0	***13***	17	1	237
13.0%	0	0	0	0	0	***14***	17	1	247
13.5%	0	0	0	0	0	***14***	18	1	257
14.0%	0	0	0	0	0	***15***	19	1	268
14.5%	0	0	0	0	0	***16***	20	1	278
15.0%	0	0	0	0	0	***17***	21	1	288
15.5%	0	0	0	0	0	***17***	22	2	298
16.0%	0	0	0	0	0	***18***	23	2	308
16.5%	0	0	0	0	0	***19***	24	2	319
17.0%	0	0	0	0	0	***20***	25	2	329
17.5%	0	0	0	0	0	***20***	26	2	339
18.0%	0	0	0	0	0	***21***	26	2	349
18.5%	0	0	0	0	0	***22***	27	2	360
19.0%	0	0	0	0	0	***23***	28	2	370

	15 min			2 hours			24 hours		
	ES	SES	BBE	ES	SES	BBE	ES	SES	BBE
Path Alloc.	**S15**	**S15**	**S15**	**S2**	**S2**	**S2**	**S24**	**S24**	**S24**
19.5%	0	0	0	0	0	***23***	29	3	380
20.0%	0	0	0	0	0	***24***	30	3	390
20.5%	0	0	0	0	0	***25***	31	3	401
21.0%	0	0	0	0	0	***26***	32	3	411
21.5%	0	0	0	0	0	***26***	33	3	421
22.0%	0	0	1	0	0	***27***	34	3	432
22.5%	0	0	1	0	0	***28***	35	3	442
23.0%	0	0	1	0	0	***29***	36	4	452
23.5%	0	0	1	0	0	***29***	37	4	463
24.0%	0	0	1	0	0	***30***	37	4	473
24.5%	0	0	1	0	0	***31***	38	4	483
25.0%	0	0	1	0	0	***32***	39	4	494
25.5%	0	0	1	0	0	***32***	40	4	504
26.0%	0	0	1	0	0	***33***	41	5	514
26.5%	0	0	1	0	0	***34***	42	5	525
27.0%	0	0	1	0	0	***35***	43	5	535
27.5%	0	0	1	1	0	35	44	5	545
28.0%	0	0	1	1	0	36	45	5	556
28.5%	0	0	1	1	0	37	46	5	566
29.0%	0	0	1	1	0	38	47	5	576
29.5%	0	0	1	1	0	39	48	6	587
30.0%	0	0	2	1	0	39	49	6	597
30.5%	0	0	2	1	0	40	50	6	607
31.0%	0	0	2	1	0	41	51	6	618
31.5%	0	0	2	1	0	42	52	6	628
32.0%	0	0	2	1	0	42	52	6	639
32.5%	0	0	2	1	0	43	53	7	649
33.0%	0	0	2	1	0	44	54	7	659
33.5%	0	0	2	1	0	45	55	7	670
34.0%	0	0	2	1	0	46	56	7	680
34.5%	0	0	2	1	0	46	57	7	691
35.0%	0	0	2	1	0	47	58	7	701
35.5%	0	0	2	1	0	48	59	8	711
36.0%	0	0	2	1	0	49	60	8	722
36.5%	0	0	2	1	0	49	61	8	732
37.0%	0	0	3	1	0	50	62	8	743
37.5%	0	0	3	2	0	51	63	8	753
38.0%	0	0	3	2	0	52	64	8	764
38.5%	0	0	3	2	0	53	65	8	774

Table D.1/M.2101 – BIS performance limits for VC-1 and VC-2 based on ITU-T Rec. G.828

	15 min			2 hours			24 hours		
	ES	**SES**	**BBE**	**ES**	**SES**	**BBE**	**ES**	**SES**	**BBE**
Path Alloc.	**S15**	**S15**	**S15**	**S2**	**S2**	**S2**	**S24**	**S24**	**S24**
39.0%	0	0	3	2	0	53	66	9	784
39.5%	0	0	3	2	0	54	67	9	795
40.0%	0	0	3	2	0	55	68	9	805
40.5%	0	0	3	2	0	56	69	9	816
41.0%	0	0	3	2	0	57	70	9	826
41.5%	0	0	3	2	0	57	71	9	837
42.0%	0	0	3	2	0	58	72	10	847
42.5%	0	0	3	2	0	59	73	10	857
43.0%	0	0	3	2	0	60	74	10	868
43.5%	0	0	4	2	0	61	75	10	878
44.0%	0	0	4	2	0	61	76	10	889
44.5%	0	0	4	2	0	62	77	10	899
45.0%	0	0	4	2	0	63	77	11	910
45.5%	0	0	4	2	0	64	78	11	920
46.0%	0	0	4	3	0	65	79	11	931
46.5%	0	0	4	3	0	65	80	11	941
47.0%	0	0	4	3	0	66	81	11	951
47.5%	0	0	4	3	0	67	82	11	962
48.0%	0	0	4	3	0	68	83	12	972
48.5%	0	0	4	3	0	69	84	12	983
49.0%	0	0	4	3	0	69	85	12	993
49.5%	0	0	4	3	0	70	86	12	1004
50.0%	0	0	5	3	0	71	87	12	1014
50.5%	0	0	5	3	0	72	88	12	1025
51.0%	0	0	5	3	0	73	89	13	1035
51.5%	0	0	5	3	0	73	90	13	1046
52.0%	0	0	5	3	0	74	91	13	1056
52.5%	0	0	5	3	0	75	92	13	1067
53.0%	0	0	5	3	0	76	93	13	1077
53.5%	0	0	5	3	0	77	94	13	1088
54.0%	0	0	5	3	0	77	95	14	1098
54.5%	0	0	5	4	0	78	96	14	1109
55.0%	0	0	5	4	0	79	97	14	1119
55.5%	0	0	5	4	0	80	98	14	1130
56.0%	0	0	6	4	0	81	99	14	1140
56.5%	0	0	6	4	0	82	100	15	1151
57.0%	0	0	6	4	0	82	101	15	1161
57.5%	0	0	6	4	0	83	102	15	1172
58.0%	0	0	6	4	0	84	103	15	1182
58.5%	0	0	6	4	0	85	104	15	1193
59.0%	0	0	6	4	0	86	105	15	1203
59.5%	0	0	6	4	0	86	106	16	1214
60.0%	0	0	6	4	0	87	107	16	1224
60.5%	0	0	6	4	0	88	108	16	1235
61.0%	0	0	6	4	0	89	109	16	1245
61.5%	0	0	6	4	0	90	110	16	1256
62.0%	0	0	6	4	0	90	111	16	1266
62.5%	0	0	7	5	0	91	112	17	1277
63.0%	0	0	7	5	0	92	113	17	1287

NOTE – For ***bold, italic*** entries, the corresponding ES limit is 0 ; for a BBE test to be successful, the corresponding ES measurement must not exceed 1.

Table D.2/M.2101 –- BIS performance limits for VC-3 based on ITU-T Rec. G.828

	15 min			2 hours			24 hours		
	ES	SES	BBE	ES	SES	BBE	ES	SES	BBE
Path Alloc.	**S15**	**S15**	**S15**	**S2**	**S2**	**S2**	**S24**	**S24**	**S24**
0.2%	0	0	0	0	0	***0***	0	0	***9***
0.5%	0	0	0	0	0	***0***	0	0	***30***
1.0%	0	0	0	0	0	***2***	0	0	***68***
1.5%	0	0	0	0	0	***4***	1	0	107
2.0%	0	0	0	0	0	***7***	3	0	147
2.5%	0	0	0	0	0	***10***	4	0	187
3.0%	0	0	0	0	0	***12***	6	0	227
3.5%	0	0	0	0	0	***15***	7	0	268
4.0%	0	0	0	0	0	***18***	9	0	308
4.5%	0	0	0	0	0	***21***	11	0	349
5.0%	0	0	0	0	0	***24***	12	0	390
5.5%	0	0	1	0	0	***27***	14	0	432
6.0%	0	0	1	0	0	***30***	16	0	473
6.5%	0	0	1	0	0	***33***	17	0	514
7.0%	0	0	1	0	0	***36***	19	0	556
7.5%	0	0	2	0	0	***39***	21	0	597
8.0%	0	0	2	0	0	***42***	23	0	639
8.5%	0	0	2	0	0	***46***	25	0	680
9.0%	0	0	2	0	0	***49***	26	0	722
9.5%	0	0	3	0	0	***52***	28	0	764
10.0%	0	0	3	0	0	***55***	30	0	805
10.5%	0	0	3	0	0	***58***	32	0	847
11.0%	0	0	4	0	0	***61***	34	0	889
11.5%	0	0	4	0	0	***65***	36	1	931
12.0%	0	0	4	0	0	***68***	37	1	972
12.5%	0	0	5	0	0	***71***	39	1	1014
13.0%	0	0	5	0	0	***74***	41	1	1056
13.5%	0	0	5	0	0	***77***	43	1	1098
14.0%	0	0	6	1	0	81	45	1	1140
14.5%	0	0	6	1	0	84	47	1	1182
15.0%	0	0	6	1	0	87	49	1	1224
15.5%	0	0	6	1	0	90	51	2	1266
16.0%	0	0	7	1	0	94	52	2	1308
16.5%	0	0	7	1	0	97	54	2	1350
17.0%	0	0	7	1	0	100	56	2	1392
17.5%	0	0	8	1	0	104	58	2	1434
18.0%	0	0	8	1	0	107	60	2	1476
18.5%	0	0	8	1	0	110	62	2	1518
19.0%	0	0	9	2	0	113	64	2	1561
19.5%	0	0	9	2	0	117	66	3	1603
20.0%	0	0	10	2	0	120	68	3	1645
20.5%	0	0	10	2	0	123	70	3	1687
21.0%	0	0	10	2	0	127	72	3	1729
21.5%	0	0	11	2	0	130	74	3	1771
22.0%	0	0	11	2	0	133	76	3	1814
22.5%	0	0	11	2	0	137	77	3	1856
23.0%	0	0	12	3	0	140	79	4	1898
23.5%	0	0	12	3	0	143	81	4	1940
24.0%	0	0	12	3	0	147	83	4	1983
24.5%	0	0	13	3	0	150	85	4	2025
25.0%	0	0	13	3	0	153	87	4	2067
25.5%	0	0	13	3	0	157	89	4	2109
26.0%	0	0	14	3	0	160	91	5	2152
26.5%	0	0	14	3	0	163	93	5	2194
27.0%	0	0	14	3	0	167	95	5	2236
27.5%	0	0	15	4	0	170	97	5	2279
28.0%	0	0	15	4	0	173	99	5	2321
28.5%	0	0	16	4	0	177	101	5	2363
29.0%	0	0	16	4	0	180	103	5	2405
29.5%	0	0	16	4	0	183	105	6	2448
30.0%	0	0	17	4	0	187	107	6	2490
30.5%	0	0	17	4	0	190	109	6	2533
31.0%	0	0	17	4	0	193	111	6	2575
31.5%	0	0	18	5	0	197	113	6	2617
32.0%	0	0	18	5	0	200	115	6	2660
32.5%	0	0	18	5	0	203	117	7	2702
33.0%	0	0	19	5	0	207	119	7	2744
33.5%	0	0	19	5	0	210	121	7	2787
34.0%	0	0	20	5	0	214	123	7	2829
34.5%	0	0	20	5	0	217	125	7	2872
35.0%	0	0	20	6	0	220	127	7	2914
35.5%	0	0	21	6	0	224	129	8	2956
36.0%	0	0	21	6	0	227	131	8	2999
36.5%	0	0	21	6	0	230	133	8	3041
37.0%	0	0	22	6	0	234	135	8	3084
37.5%	0	0	22	6	0	237	137	8	3126
38.0%	0	0	23	6	0	241	139	8	3169
38.5%	0	0	23	6	0	244	141	8	3211

Table D.2/M.2101 – BIS performance limits for VC-3 based on ITU-T Rec. G.828

	15 min			2 hours			24 hours		
	ES	SES	BBE	ES	SES	BBE	ES	SES	BBE
Path Alloc.	S15	S15	S15	S2	S2	S2	S24	S24	S24
39.0%	0	0	23	7	0	247	143	9	3254
39.5%	0	0	24	7	0	251	145	9	3296
40.0%	0	0	24	7	0	254	147	9	3338
40.5%	0	0	24	7	0	257	149	9	3381
41.0%	0	0	25	7	0	261	151	9	3423
41.5%	0	0	25	7	0	264	153	9	3466
42.0%	0	0	26	7	0	268	155	10	3508
42.5%	0	0	26	7	0	271	157	10	3551
43.0%	0	0	26	8	0	274	159	10	3593
43.5%	0	0	27	8	0	278	161	10	3636
44.0%	0	0	27	8	0	281	163	10	3678
44.5%	0	0	27	8	0	285	165	10	3721
45.0%	0	0	28	8	0	288	167	11	3763
45.5%	0	0	28	8	0	291	169	11	3806
46.0%	0	0	29	8	0	295	171	11	3848
46.5%	0	0	29	9	0	298	173	11	3891
47.0%	0	0	29	9	0	302	175	11	3933
47.5%	0	0	30	9	0	305	177	11	3976
48.0%	0	0	30	9	0	308	179	12	4018
48.5%	0	0	30	9	0	312	181	12	4061
49.0%	0	0	31	9	0	315	183	12	4103
49.5%	0	0	31	9	0	319	185	12	4146
50.0%	0	0	32	10	0	322	187	12	4189
50.5%	0	0	32	10	0	325	189	12	4231
51.0%	0	0	32	10	0	329	191	13	4274
51.5%	0	0	33	10	0	332	193	13	4316
52.0%	0	0	33	10	0	336	195	13	4359
52.5%	0	0	34	10	0	339	197	13	4401
53.0%	0	0	34	10	0	343	199	13	4444
53.5%	0	0	34	10	0	346	201	13	4486
54.0%	0	0	35	11	0	349	203	14	4529
54.5%	0	0	35	11	0	353	205	14	4572
55.0%	0	0	35	11	0	356	207	14	4614
55.5%	0	0	36	11	0	360	209	14	4657
56.0%	0	0	36	11	0	363	211	14	4699
56.5%	0	0	37	11	0	366	213	15	4742
57.0%	0	0	37	11	0	370	215	15	4784
57.5%	0	0	37	12	0	373	217	15	4827
58.0%	0	0	38	12	0	377	219	15	4870
58.5%	0	0	38	12	0	380	221	15	4912
59.0%	0	0	39	12	0	384	223	15	4955
59.5%	0	0	39	12	0	387	225	16	4997
60.0%	0	0	39	12	0	390	227	16	5040
60.5%	0	0	40	12	0	394	229	16	5083
61.0%	0	0	40	13	0	397	231	16	5125
61.5%	0	0	40	13	0	401	233	16	5168
62.0%	0	0	41	13	0	404	235	16	5210
62.5%	0	0	41	13	0	408	237	17	5253
63.0%	0	0	42	13	0	411	239	17	5296

NOTE – For ***bold, italic*** entries, the corresponding ES limit is 0 ; for a BBE test to be successful, the corresponding ES measurement must not exceed 1.

Table D.3/M.2101 – BIS performance limits for VC-4 based on ITU-T Rec. G.828

	15 min			2 hours			24 hours		
	ES	**SES**	**BBE**	**ES**	**SES**	**BBE**	**ES**	**SES**	**BBE**
Path Alloc.	**S15**	**S15**	**S15**	**S2**	**S2**	**S2**	**S24**	**S24**	**S24**
0.2%	0	0	0	0	0	***0***	0	0	***23***
0.5%	0	0	0	0	0	***2***	0	0	***68***
1.0%	0	0	0	0	0	***7***	3	0	147
1.5%	0	0	0	0	0	***12***	6	0	227
2.0%	0	0	0	0	0	***18***	9	0	308
2.5%	0	0	0	0	0	***24***	12	0	390
3.0%	0	0	1	0	0	***30***	16	0	473
3.5%	0	0	1	0	0	***36***	19	0	556
4.0%	0	0	2	0	0	***42***	23	0	639
4.5%	0	0	2	0	0	***49***	26	0	722
5.0%	0	0	3	0	0	***55***	30	0	805
5.5%	0	0	4	0	0	***61***	34	0	889
6.0%	0	0	4	0	0	***68***	37	0	972
6.5%	0	0	5	0	0	***74***	41	0	1056
7.0%	0	0	6	1	0	81	45	0	1140
7.5%	0	0	6	1	0	87	49	0	1224
8.0%	0	0	7	1	0	94	52	0	1308
8.5%	0	0	7	1	0	100	56	0	1392
9.0%	0	0	8	1	0	107	60	0	1476
9.5%	0	0	9	2	0	113	64	0	1561
10.0%	0	0	10	2	0	120	68	0	1645
10.5%	0	0	10	2	0	127	72	0	1729
11.0%	0	0	11	2	0	133	76	0	1814
11.5%	0	0	12	3	0	140	79	1	1898
12.0%	0	0	12	3	0	147	83	1	1983
12.5%	0	0	13	3	0	153	87	1	2067
13.0%	0	0	14	3	0	160	91	1	2152
13.5%	0	0	14	3	0	167	95	1	2236
14.0%	0	0	15	4	0	173	99	1	2321
14.5%	0	0	16	4	0	180	103	1	2405
15.0%	0	0	17	4	0	187	107	1	2490
15.5%	0	0	17	4	0	193	111	2	2575
16.0%	0	0	18	5	0	200	115	2	2660
16.5%	0	0	19	5	0	207	119	2	2744
17.0%	0	0	20	5	0	214	123	2	2829
17.5%	0	0	20	6	0	220	127	2	2914
18.0%	0	0	21	6	0	227	131	2	2999
18.5%	0	0	22	6	0	234	135	2	3084
19.0%	0	0	23	6	0	241	139	2	3169

	15 min			2 hours			24 hours		
	ES	**SES**	**BBE**	**ES**	**SES**	**BBE**	**ES**	**SES**	**BBE**
Path Alloc.	**S15**	**S15**	**S15**	**S2**	**S2**	**S2**	**S24**	**S24**	**S24**
19.5%	0	0	23	7	0	247	143	3	3254
20.0%	0	0	24	7	0	254	147	3	3338
20.5%	0	0	25	7	0	261	151	3	3423
21.0%	0	0	26	7	0	268	155	3	3508
21.5%	0	0	26	8	0	274	159	3	3593
22.0%	0	0	27	8	0	281	163	3	3678
22.5%	0	0	28	8	0	288	167	3	3763
23.0%	0	0	29	8	0	295	171	4	3848
23.5%	0	0	29	9	0	302	175	4	3933
24.0%	0	0	30	9	0	308	179	4	4018
24.5%	0	0	31	9	0	315	183	4	4103
25.0%	0	0	32	10	0	322	187	4	4189
25.5%	0	0	32	10	0	329	191	4	4274
26.0%	0	0	33	10	0	336	195	5	4359
26.5%	0	0	34	10	0	343	199	5	4444
27.0%	0	0	35	11	0	349	203	5	4529
27.5%	0	0	35	11	0	356	207	5	4614
28.0%	0	0	36	11	0	363	211	5	4699
28.5%	0	0	37	11	0	370	215	5	4784
29.0%	0	0	38	12	0	377	219	5	4870
29.5%	0	0	39	12	0	384	223	6	4955
30.0%	0	0	39	12	0	390	227	6	5040
30.5%	0	0	40	13	0	397	231	6	5125
31.0%	0	0	41	13	0	404	235	6	5210
31.5%	0	0	42	13	0	411	239	6	5296
32.0%	0	0	42	13	0	418	243	6	5381
32.5%	0	0	43	14	0	425	247	7	5466
33.0%	0	0	44	14	0	432	251	7	5551
33.5%	0	0	45	14	0	438	255	7	5637
34.0%	0	0	46	15	0	445	259	7	5722
34.5%	0	0	46	15	0	452	264	7	5807
35.0%	0	0	47	15	0	459	268	7	5892
35.5%	0	0	48	15	0	466	272	8	5978
36.0%	0	0	49	16	0	473	276	8	6063
36.5%	0	0	49	16	0	480	280	8	6148
37.0%	0	0	50	16	0	487	284	8	6234
37.5%	0	0	51	17	0	494	288	8	6319
38.0%	0	0	52	17	0	500	292	8	6404
38.5%	0	0	53	17	0	507	296	8	6490

Table D.3/M.2101 – BIS performance limits for VC-4 based on ITU-T Rec. G.828

	15 min			2 hours			24 hours		
	ES	SES	BBE	ES	SES	BBE	ES	SES	BBE
Path Alloc.	S15	S15	S15	S2	S2	S2	S24	S24	S24
39.0%	0	0	53	17	0	514	300	9	6575
39.5%	0	0	54	18	0	521	304	9	6660
40.0%	0	0	55	18	0	528	308	9	6746
40.5%	0	0	56	18	0	535	313	9	6831
41.0%	0	0	57	19	0	542	317	9	6916
41.5%	0	0	57	19	0	549	321	9	7002
42.0%	0	0	58	19	0	556	325	10	7087
42.5%	0	0	59	20	0	563	329	10	7173
43.0%	0	0	60	20	0	569	333	10	7258
43.5%	0	0	61	20	0	576	337	10	7343
44.0%	0	0	61	20	0	583	341	10	7429
44.5%	0	0	62	21	0	590	345	10	7514
45.0%	0	0	63	21	0	597	349	11	7600
45.5%	0	0	64	21	0	604	353	11	7685
46.0%	0	0	65	22	0	611	358	11	7770
46.5%	0	0	65	22	0	618	362	11	7856
47.0%	0	0	66	22	0	625	366	11	7941
47.5%	0	0	67	23	0	632	370	11	8027
48.0%	0	0	68	23	0	639	374	12	8112
48.5%	0	0	69	23	0	646	378	12	8198
49.0%	0	0	69	23	0	652	382	12	8283
49.5%	0	0	70	24	0	659	386	12	8369
50.0%	0	0	71	24	0	666	390	12	8454
50.5%	0	0	72	24	0	673	395	12	8540
51.0%	0	0	73	25	0	680	399	13	8625
51.5%	0	0	73	25	0	687	403	13	8711
52.0%	0	0	74	25	0	694	407	13	8796
52.5%	0	0	75	26	0	701	411	13	8882
53.0%	0	0	76	26	0	708	415	13	8967
53.5%	0	0	77	26	0	715	419	13	9053
54.0%	0	0	77	26	0	722	423	14	9138
54.5%	0	0	78	27	0	729	427	14	9224
55.0%	1	0	79	27	0	736	432	14	9309
55.5%	1	0	80	27	0	743	436	14	9395
56.0%	1	0	81	28	0	750	440	14	9480
56.5%	1	0	82	28	0	757	444	15	9566
57.0%	1	0	82	28	0	764	448	15	9651
57.5%	1	0	83	29	0	770	452	15	9737
58.0%	1	0	84	29	0	777	456	15	9822
58.5%	1	0	85	29	0	784	460	15	9908
59.0%	1	0	86	29	0	791	465	15	9993
59.5%	1	0	86	30	0	798	469	16	10079
60.0%	1	0	87	30	0	805	473	16	10164
60.5%	1	0	88	30	0	812	477	16	10250
61.0%	1	0	89	31	0	819	481	16	10335
61.5%	1	0	90	31	0	826	485	16	10421
62.0%	1	0	90	31	0	833	489	16	10507
62.5%	1	0	91	32	0	840	494	17	10592
63.0%	1	0	92	32	0	847	498	17	10678

NOTE – For ***bold, italic*** entries, the corresponding ES limit is 0 ; for a BBE test to be successful, the corresponding ES measurement must not exceed 1.

Table D.4/M.2101 – BIS performance limits for VC-4-4c and VC-4-16c based on ITU-T Rec. G.828

	15 min			2 hours			24 hours		
	ES	SES	BBE	ES	SES	BBE	ES	SES	BBE
Path Alloc.	S15	S15	S15	S2	S2	S2	S24	S24	S24
0.2%	NA	0	0	NA	0	0	NA	0	23
0.5%	NA	0	0	NA	0	2	NA	0	68
1.0%	NA	0	0	NA	0	7	NA	0	147
1.5%	NA	0	0	NA	0	12	NA	0	227
2.0%	NA	0	0	NA	0	18	NA	0	308
2.5%	NA	0	0	NA	0	24	NA	0	390
3.0%	NA	0	1	NA	0	30	NA	0	473
3.5%	NA	0	1	NA	0	36	NA	0	556
4.0%	NA	0	2	NA	0	42	NA	0	639
4.5%	NA	0	2	NA	0	49	NA	0	722
5.0%	NA	0	3	NA	0	55	NA	0	805
5.5%	NA	0	4	NA	0	61	NA	0	889
6.0%	NA	0	4	NA	0	68	NA	0	972
6.5%	NA	0	5	NA	0	74	NA	0	1056
7.0%	NA	0	6	NA	0	81	NA	0	1140
7.5%	NA	0	6	NA	0	87	NA	0	1224
8.0%	NA	0	7	NA	0	94	NA	0	1308
8.5%	NA	0	7	NA	0	100	NA	0	1392
9.0%	NA	0	8	NA	0	107	NA	0	1476
9.5%	NA	0	9	NA	0	113	NA	0	1561
10.0%	NA	0	10	NA	0	120	NA	0	1645
10.5%	NA	0	10	NA	0	127	NA	0	1729
11.0%	NA	0	11	NA	0	133	NA	0	1814
11.5%	NA	0	12	NA	0	140	NA	1	1898
12.0%	NA	0	12	NA	0	147	NA	1	1983
12.5%	NA	0	13	NA	0	153	NA	1	2067
13.0%	NA	0	14	NA	0	160	NA	1	2152
13.5%	NA	0	14	NA	0	167	NA	1	2236
14.0%	NA	0	15	NA	0	173	NA	1	2321
14.5%	NA	0	16	NA	0	180	NA	1	2405
15.0%	NA	0	17	NA	0	187	NA	1	2490
15.5%	NA	0	17	NA	0	193	NA	2	2575
16.0%	NA	0	18	NA	0	200	NA	2	2660
16.5%	NA	0	19	NA	0	207	NA	2	2744
17.0%	NA	0	20	NA	0	214	NA	2	2829
17.5%	NA	0	20	NA	0	220	NA	2	2914
18.0%	NA	0	21	NA	0	227	NA	2	2999
18.5%	NA	0	22	NA	0	234	NA	2	3084
19.0%	NA	0	23	NA	0	241	NA	2	3169

	15 min			2 hours			24 hours		
	ES	SES	BBE	ES	SES	BBE	ES	SES	BBE
Path Alloc.	S15	S15	S15	S2	S2	S2	S24	S24	S24
19.5%	NA	0	23	NA	0	247	NA	3	3254
20.0%	NA	0	24	NA	0	254	NA	3	3338
20.5%	NA	0	25	NA	0	261	NA	3	3423
21.0%	NA	0	26	NA	0	268	NA	3	3508
21.5%	NA	0	26	NA	0	274	NA	3	3593
22.0%	NA	0	27	NA	0	281	NA	3	3678
22.5%	NA	0	28	NA	0	288	NA	3	3763
23.0%	NA	0	29	NA	0	295	NA	4	3848
23.5%	NA	0	29	NA	0	302	NA	4	3933
24.0%	NA	0	30	NA	0	308	NA	4	4018
24.5%	NA	0	31	NA	0	315	NA	4	4103
25.0%	NA	0	32	NA	0	322	NA	4	4189
25.5%	NA	0	32	NA	0	329	NA	4	4274
26.0%	NA	0	33	NA	0	336	NA	5	4359
26.5%	NA	0	34	NA	0	343	NA	5	4444
27.0%	NA	0	35	NA	0	349	NA	5	4529
27.5%	NA	0	35	NA	0	356	NA	5	4614
28.0%	NA	0	36	NA	0	363	NA	5	4699
28.5%	NA	0	37	NA	0	370	NA	5	4784
29.0%	NA	0	38	NA	0	377	NA	5	4870
29.5%	NA	0	39	NA	0	384	NA	6	4955
30.0%	NA	0	39	NA	0	390	NA	6	5040
30.5%	NA	0	40	NA	0	397	NA	6	5125
31.0%	NA	0	41	NA	0	404	NA	6	5210
31.5%	NA	0	42	NA	0	411	NA	6	5296
32.0%	NA	0	42	NA	0	418	NA	6	5381
32.5%	NA	0	43	NA	0	425	NA	7	5466
33.0%	NA	0	44	NA	0	432	NA	7	5551
33.5%	NA	0	45	NA	0	438	NA	7	5637
34.0%	NA	0	46	NA	0	445	NA	7	5722
34.5%	NA	0	46	NA	0	452	NA	7	5807
35.0%	NA	0	47	NA	0	459	NA	7	5892
35.5%	NA	0	48	NA	0	466	NA	8	5978
36.0%	NA	0	49	NA	0	473	NA	8	6063
36.5%	NA	0	49	NA	0	480	NA	8	6148
37.0%	NA	0	50	NA	0	487	NA	8	6234
37.5%	NA	0	51	NA	0	494	NA	8	6319
38.0%	NA	0	52	NA	0	500	NA	8	6404
38.5%	NA	0	53	NA	0	507	NA	8	6490

Table D.4/M.2101 – BIS performance limits for VC-4-4c and VC-4-16c based on ITU-T Rec. G.828

	15 min			2 hours			24 hours		
	ES	SES	BBE	ES	SES	BBE	ES	SES	BBE
Path Alloc.	S15	S15	S15	S2	S2	S2	S24	S24	S24
39.0%	NA	0	53	NA	0	514	NA	9	6575
39.5%	NA	0	54	NA	0	521	NA	9	6660
40.0%	NA	0	55	NA	0	528	NA	9	6746
40.5%	NA	0	56	NA	0	535	NA	9	6831
41.0%	NA	0	57	NA	0	542	NA	9	6916
41.5%	NA	0	57	NA	0	549	NA	9	7002
42.0%	NA	0	58	NA	0	556	NA	10	7087
42.5%	NA	0	59	NA	0	563	NA	10	7173
43.0%	NA	0	60	NA	0	569	NA	10	7258
43.5%	NA	0	61	NA	0	576	NA	10	7343
44.0%	NA	0	61	NA	0	583	NA	10	7429
44.5%	NA	0	62	NA	0	590	NA	10	7514
45.0%	NA	0	63	NA	0	597	NA	11	7600
45.5%	NA	0	64	NA	0	604	NA	11	7685
46.0%	NA	0	65	NA	0	611	NA	11	7770
46.5%	NA	0	65	NA	0	618	NA	11	7856
47.0%	NA	0	66	NA	0	625	NA	11	7941
47.5%	NA	0	67	NA	0	632	NA	11	8027
48.0%	NA	0	68	NA	0	639	NA	12	8112
48.5%	NA	0	69	NA	0	646	NA	12	8198
49.0%	NA	0	69	NA	0	652	NA	12	8283
49.5%	NA	0	70	NA	0	659	NA	12	8369
50.0%	NA	0	71	NA	0	666	NA	12	8454
50.5%	NA	0	72	NA	0	673	NA	12	8540
51.0%	NA	0	73	NA	0	680	NA	13	8625
51.5%	NA	0	73	NA	0	687	NA	13	8711
52.0%	NA	0	74	NA	0	694	NA	13	8796
52.5%	NA	0	75	NA	0	701	NA	13	8882
53.0%	NA	0	76	NA	0	708	NA	13	8967
53.5%	NA	0	77	NA	0	715	NA	13	9053
54.0%	NA	0	77	NA	0	722	NA	14	9138
54.5%	NA	0	78	NA	0	729	NA	14	9224
55.0%	NA	0	79	NA	0	736	NA	14	9309
55.5%	NA	0	80	NA	0	743	NA	14	9395
56.0%	NA	0	81	NA	0	750	NA	14	9480
56.5%	NA	0	82	NA	0	757	NA	15	9566
57.0%	NA	0	82	NA	0	764	NA	15	9651
57.5%	NA	0	83	NA	0	770	NA	15	9737
58.0%	NA	0	84	NA	0	777	NA	15	9822
58.5%	NA	0	85	NA	0	784	NA	15	9908
59.0%	NA	0	86	NA	0	791	NA	15	9993
59.5%	NA	0	86	NA	0	798	NA	16	10079
60.0%	NA	0	87	NA	0	805	NA	16	10164
60.5%	NA	0	88	NA	0	812	NA	16	10250
61.0%	NA	0	89	NA	0	819	NA	16	10335
61.5%	NA	0	90	NA	0	826	NA	16	10421
62.0%	NA	0	90	NA	0	833	NA	16	10507
62.5%	NA	0	91	NA	0	840	NA	17	10592
63.0%	NA	0	92	NA	0	847	NA	17	10678

Table D.5/M.2101 – BIS performance limits for STM-0 based on ITU-T Rec. G.828

Path Alloc.	24 hours		
	ES	SES	BBE
	S24	S24	S24
0.2%	0	0	17
0.5%	0	0	52
35.0%	19	0	4699

Table D.6/M.2101 – BIS performance limits for STM-1 based on ITU-T Rec. G.828

Path Alloc.	24 hours		
	ES	SES	BBE
	S24	S24	S24
0.2%	0	0	140
0.5%	0	0	374
35.0%	45	0	28 690

Table D.7/M.2101 – BIS performance limits for STM-4 based on ITU-T Rec. G.828

Path Alloc.	24 hours		
	ES	SES	BBE
	S24	S24	S24
0.2%	NA	0	612
0.5%	NA	0	1577
35.0%	NA	0	115 440

Table D.8/M.2101 – BIS performance limits for STM-16 based on ITU-T Rec. G.828

Path Alloc.	24 hours		
	ES	SES	BBE
	S24	S24	S24
0.2%	NA	0	2551
0.5%	NA	0	6473
35.0%	NA	0	463 123

Table D.9/M.2101 – BIS performance limits for STM-64 based on ITU-T Rec. G.828

Path Alloc.	24 hours		
	ES	SES	BBE
	S24	S24	S24
0.2%	NA	0	10 411
0.5%	NA	0	26 216
35.0%	NA	7	1 855 219

Annex E

Default unacceptable performance level threshold values

Table E.1 provides the default unacceptable performance level set and reset thresholds for international digital paths and multiplex sections.

Table E.1/M.2101 – Default unacceptable performance level threshold values for international synchronous digital paths and multiplex sections at a fixed 15-minute period

Digital paths – Set thresholds									
Allocation %	**VC-1, VC-2**			**VC-3**			**VC-4**		
	ES*	BBE	SES*	ES*	BBE	SES*	ES*	BBE	SES*
0.2-34	80	200	10	100	700	10	120	700	10
35-63	120	300	15	150	1 100	15	180	1 100	15
Digital paths – Reset thresholds									
Allocation %	**VC-1, VC-2**			**VC-3**			**VC-4**		
	ES	BBE	SES	ES	BBE	SES	ES	BBE	SES
0.2-34	1	6	0	1	25	0	1	25	0
35-63	2	12	0	3	50	0	4	50	0
Multiplex Sections – Set thresholds									
Allocation %	**STM-0**			**STM-1**			**STM-4**		
	ES	BBE	SES*	ES	BBE	SES*	ES	BBE	SES*
0.2-34	34	5 000	6	67	16 000	6	NA	64 000	6
35-63	57	9 000	10	114	27 000	10	NA	110 000	10
Multiplex Sections – Reset thresholds									
Allocation %	**STM-0**			**STM-1**			**STM-4**		
	ES	BBE	SES	ES	BBE	SES	ES	BBE	SES
0.2-34	1	200	0	2	600	0	NA	2 500	0
35-63	2	400	0	4	1 100	0	NA	4 500	0

* Since a 15-minute period is not significant for ES and SES, these are practical values.

NOTE – Rates above VC-4 and STM-4 are for further study.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series B	Means of expression: definitions, symbols, classification
Series C	General telecommunication statistics
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	**TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits**
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks and open system communications
Series Y	Global information infrastructure and Internet protocol aspects
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2003