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QUY CHUẨN KỸ THUẬT QUỐC GIA VỀ GIAO DIỆN QUANG CHO THIẾT BỊ KẾT NỐI MẠNG SDH

National technical regulation on optical interfaces for network interconnection equipments relating to the Synchronous Digital Hierarchy

(for information only)

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Foreword

QCVN 07:2010/BTTTT is based on ITU Rec. G.691, G.693, G.957, G.958, G.959.1.

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QUY CHUẨN KỸ THUẬT QUỐC GIA
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National technical regulation
on optical interfaces for network interconnection equipments relating to the Synchronous Digital Hierarchy

1. GENERAL

1.1. Scope

This technical regulation defines physical and electrical characteristics of the interfaces at hierarchical bit rates (64 kbit/s, 2048 kbit/s, 34368 kbit/s, 139264 kbit/s, 155520 kbit/s and 2048 kbit/s synchronous interfaces) to enable the interconnection of digital network components (digital sections, multiplex equipment, exchanges) to form an international digital link or connection.

1.2. Objectives

This technical regulation applies to telecommunication companies for establishing and providing services when they are in negotiating for network connecting with others via SDH optical interconnection equipments.

1.3. Tài liệu viện dẫn

1. ITU-T Recommendation G.957 (2006) Optical interfaces for equipments and systems relating to the synchronous digital hierarchy.
2. ITU-T Recommendation G.691 (2006) Optical interfaces for single channel SDH systems with optical amplifiers, and STM-64 systems.
3. ITU-T Recommendation G.959.1 (2003), Optical transport network physical layer interfaces.
4. ITU-T Recommendation G.693 (2005), Optical interfaces for intra-office systems.
5. ITU-T Recommendation G.651 (02/98) Characteristics of a 50/125 µm multimode graded index optical fibre cable.
6. ITU-T Recommendation G.652 (06/05) Characteristics of a single-mode optical fibre and cable.
7. ITU-T Recommendation G.653 (12/03) Characteristics of a dispersion-shifted single-mode optical fibre and cable.
8. ITU-T Recommendation G.654 (06/04) Characteristics of a cut-off shifted single-mode optical fibre and cable.
9. ITU-T Recommendation G.655 (03/06) Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable.
10. ITU-T Recommendation G.656 (06/04) Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport.

1.4. Definitions

1.4.1. Standard configuration of optical interface

- Systems without using optical amplifier:

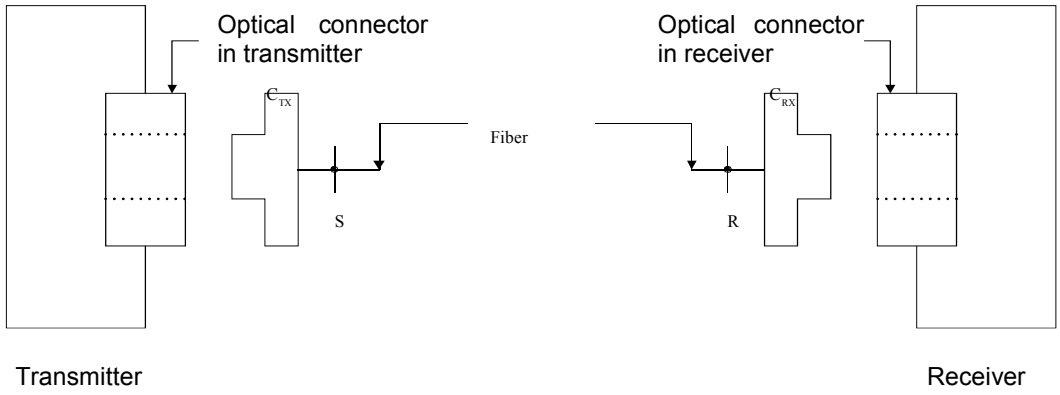

Figure 1 - Standard configuration of optical interface for systems without using optical amplifier

Optical interface characteristics in the transmitter are specified at S point (reference point on the fiber, right behind connector in transmitter), and in the receiver are specified at R point (reference point on the fiber, right front connector in receiver) and main path is between S and R.

- Systems using optical amplifier:

Figure 2 - Standard configuration of optical interface for systems using optical amplifier

Optical interface characteristics are specified at MPI-S point in the transmitter and MPI-R point in the receiver, and main path is between MPI-S and MPI-R.

1.4.2. Spectral width

- RMS width: for LED and MLM, spectral width is in maximum rms in normal operating conditions. RMS width is measured with all modes which are equal or greater than peak mode of 20 dB.

- -20 dB width: for SLM, width is calculated by maximum width of radiated spectrum at central frequency measured at the level of 20dB lower in comparasion with maximum amplitude of central frequency in normal operating conditions.

1.4.3. Side mode suppression ratio

Side mode suppression ratio is the ratio between maximum and 2nd peak power in the spectrum of the transmitter.

1.4.4. Mean lauched power

Mean lauched power at S point (or MPI-S point) is mean power of pseudo-random chain which transmitter injected to fiber. This value is used for calculation of sensitivity and overload of receiver at R point (or MPI-R) (see Annex B).

1.4.5. Extinction ratio

Extinction ratio (EX) is calculated by the following equation:

$$EX = 10 \lg (A/B)$$

In which: - A is mean optical power for "1" logical level;

- B is mean optical power for "0" logical level.

1.4.6. Attenuation range

Attenuation range is calculated in severe circumstances, including attenuation of weld connections, connectors, attenuators (if any), or other passive optical components and any compensation powers for:

- future changes in cable configuration (adding weld connections, cable length changes...);

- fiber quality changes because of environmental impacts;

- degradation of connectors, attenuators or other passive optical components between S and R (or MPI-S and MPI-R).

1.4.7. Maximum chromatic dispersion

Maximum chromatic dispersion is maximum chromatic dispersion value of main path that can be accepted by system when no dispersion accomodation method applied.

1.4.8. Polarization mode dispersion

Polarization mode dispersion is time deviation of group delay τ_p (in ps) between 2 orthogonal polarization modes.

1.4.9. Differential group delay

Differential group delay is the diference in time between pulses propagate in 2 main polarizations of an optical signal.

Maximum differential group delay is differential group delay value that the system can sustain with 1 dB degradation in signal intensity.

1.4.10. Optical return loss of cable plant at S/MPI-S

Optical return loss of cable plant at S/MPI-S (ORL) is calculated as following:

$$ORL = -10 \lg (P'_s/P_s)$$

In which: - P'_s is feedback power to transmitter measured at S/MPI-S;

- P_s is power injected to the fiber at S/MPI-S.

1.4.11. Receiver sensitivity

Receiver sensitivity is minimum mean receiving power at R point (or MPI-R) to achieve:

- BER = 10^{-10} for STM-1, STM-4, STM-16 systems without using OA.

- BER = 10^{-12} for STM-64 and other systems using OA.

1.4.12. Receiver overload

Receiver overload is maximum mean power acceptable at R point (or MPI-R) to achieve:

- BER = 10^{-10} for STM-1, STM-4, STM-16 systems without using OA.

- BER = 10^{-12} for STM-64 and other systems using OA.

1.4.13. Optical path power penalty

Optical path power penalty is sensitivity degradation value because of signal distortion propagating on the fiber. Signal distortion is by emisions, interferences between symbols, mode competitions and frequency-hops of laser.

1.4.14. Receiver reflectance

Receiver reflectance is versa reflectance from receiver to the fiber, and is calculated as following:

$$R = 10 \lg (P'_R/P_R)$$

In which:

- P'_R is feedback power to the fiber measured at R/MPI-R;

- P_R is power to the receiver at R/MPI-R.

1.4. Abbreviations

APD	Avalanche photodiode
BER	Bit Error Ratio
DA	Dispersion Accommodation
DST	Dispersion Supported Transmission
EX	Extinction ratio
LED	Light-Emitting Diode
MLM	Multi-Longitudinal Mode
MPI	Main Path Interface
NA	Not Applicable
NC	Not Comformable
NRZ	Non-Return to Zero
OA	Optical Amplifier
ORL	Optical Return Loss
PCH	Prechirp
PDC	Passive Dispersion Compensator
PIN	"p-type" – intrinsic – "n-type"
PMD	Polarization Mode Dispersion
RMS	Root Mean Square

Rx	Receiver
SDH	Synchronous Digital Hierarchy
SLM	Single-Longitudinal Mode
SMSR	Side Mode Suppression Ratio
SPM	Self Phase Modulation
Tx	Transmitter
UI	Unit Interval

2. TECHNICAL REQUIREMENTS

2.1. General requirements

2.1.1. Technical parameters

Parameters specified in this technical regulation are all calculated in severe circumstances with standard operation conditions of equipments (i.e, temperature, humidity conditions) and lifetime acceleration effects to achieve:

- BER = 10^{-10} for STM-1, STM-4, STM-16 systems without using OA;

- BER = 10^{-12} for STM-64 and other systems using OA.

2.1.2. Classification of optical interfaces

Classification of optical interfaces define in Table 1. Target distances of application codes were chosen basing on parameters of existing technologies and networks.

Table 1 – Classification of optical interfaces based on application

Applications	I	S			L			V			U	
Wave length, Nm	1 310	1 310	1 550	1 550	1 310	1 550	1 550	1 310	1 550	1 550	1 550	1 550
Fiber type	G.652	G.652	G.652	G.653	G.652	G.652/ G.654	G.653	G.652	G.652/ G.654	G.653	G.652/ G.654	G.653
Tar. Distance, km	~2	~15	~15	-	~40	~80	~80	~80	~120	~120	~160	~160
STM-1	I-1	S-1.1	S-1.2	-	L-1.1	L-1.2	L-1.3	-	-	-	-	-
STM-4	I-4	S-4.1	S-4.2	-	L-4.1	L-4.2	L-4.3	V-4.1	V-4.2	V-4.3	U-4.2	U-4.3
STM-16	I-16	S-16.1	S-16.2	-	L-16.1	L-16.2	L-16.3		V-16.2	V-16.3		
Tar. distance, km STM-64		~20 S-64.1	~40 S-64.2	~40 S-64.3	~40 L-64.1	~80 L-64.2	~80 L-64.3	~80 V-64.1	~120 V-64.2	~120 V-64.3	-	-

NOTE: Target distance are to be used for classifications and not for specifications.

System codes in Table 1: Application – STM level. suffix

- Applications are including I, S, L, V (I is application for communication in 1 station; S, L, V, U are applications for communication between stations).

+ I (Intra office): connecting in one station or between stations (distance between 0,6 -25 km);

+ S (Short haul) (20 - 40 km);

+ L (Long haul) (40 - 80 km);

+ V (Very long haul) (60 - 120 km);

+ U (Ultra long haul) (120 - 160 km).

- Suffix are:

+ Empty or “1” for systems operating in the wavelength of 1310 nm on G.652 fiber;

+ “2”: for systems operating in the wavelength of 1550 nm on G.652 or G.654 fiber;

+ “3”: for systems operating in the wavelength of 1550 nm on G.653 fiber.

2.2. Optical interface parameters for SDH systems without using optical amplifier

2.2.1. STM-1 systems

Optical interface parameters for STM-1 systems without using optical amplifier are specified in Table 2 and 3.

Table 2 - Optical interface parameters for STM-1 systems without using optical amplifier

Optical path - Nominal speed, kbit/s		STM-1 155 520				
Application code		I-1.1		S-1.1	S-1.2	
Operating wavelength range	nm	1260 - 1360		1261-1360	1430-1576	1430-1580
Transmitter at reference point S						
- Source type		MLM	LED	MLM	MLM	SLM
- Spectral characteristics:						
+ Maximum RMS width (σ)	nm	40	80	7,7	2,5	-
+ Maximum –20 dB width	nm	-	-	-	-	1
+ Minimum SMSR	dB	-	-	-	-	30
- Mean launched power:						
+ Maximum	dBm	-8		-8	-8	
+ Minimum	dBm	-15		-15	-15	
- Minimum EX	dB	8,2		8,2	8,2	
Eye-mask of optical signal		Specified in Table 13				
Main optical path, S to R						
Attenuation range	dB	0 - 7		0 - 12	0 - 12	
Maximum chromatic dispersion	ps/nm	18	25	96	296	NA
Minimum ORL of cable plant at S point (including any connectors)	dB	NA		NA	NA	
Maximum discrete reflectance between S and R	dB	NA		NA	NA	
Receiver at referenced point R						
Minimum sensitivity (at BER = 10^{-10})	dBm	-23		-28	-28	
Minimum overload (at BER = 10^{-10})	dBm	-8		-8	-8	
Maximum optical path penalty	dB	1		1	1	
Maximum reflectance of receiver measured at R	dB	NA		NA	NA	

Table 3 - Optical interface parameters for STM-1 systems without using optical amplifier (cont.)

Optical path - Nominal speed, kbit/s		STM-1 155 520				
Application code		L-1.1		L-1.2	L-1.3	
Operating wavelength range	nm	1263 - 1360		1480-1580	1534-1566/ 1523-1577	1480-1580
Transmitter at reference point S						
- Source type		MLM	SLM	SLM	MLM	SLM
- Spectral characteristics:						
+ Maximum RMS width (σ)	nm	3	-	-	3/2,5	-
+ Maximum –20 dB width	nm	-	1	1	-	1
+ Minimum SMSR	dB	-	30	30	-	30
- Mean launched power:						
+ Maximum	dBm	0		0	0	
+ Minimum	dBm	-5		-5	-5	
- Minimum EX	dB	10		10	10	
Eye-mask of optical signal		Specified in Table 13				
Main optical path, S to R						
Attenuation range	dB	10 - 28		10 - 28	10 - 28	
Maximum chromatic dispersion	ps/nm	246	NA	NA	246/296	NA
Minimum ORL of cable plant at S point (including any connectors)	dB	NA		20	NA	
Maximum discrete reflectance between S and R	dB	NA		-25	NA	
Receiver at referenced point R						
Minimum sensitivity (at BER = 10^{-10})	dBm	-34		-34	-34	
Minimum overload (at BER = 10^{-10})	dBm	-10		-10	-10	
Maximum optical path penalty	dB	1		1	1	
Maximum reflectance of receiver measured at R	dB	NA		-25	NA	

2.2.2. STM-4 systems

Optical interface parameters for STM-4 systems without using optical amplifier are specified in Table 4 and 5.

Table 4 - Optical interface parameters for STM-4 systems without using optical amplifier

Optical path - Nominal speed, kbit/s		STM-4 622 080			
Application code		I-4		S-4.1	S-4.2
Operating wavelength range	nm	1261 - 1360		1293-1334/ 1274 -1356	1430 - 1580
Transmitter at reference point S					
- Source type		MLM	LED	MLM	SLM
- Spectral characteristics:					
+ Maximum RMS width (σ)	nm	14.5	35	4/2.5	-
+ Maximum –20 dB width	nm	-	-	-	1
+ Minimum SMSR	dB	-	-	-	30
- Mean launched power:					
+ Maximum	dBm	-8		-8	-8
+ Minimum	dBm	-15		-15	-15
- Minimum EX	dB	8,2		8,2	8,2
Eye-mask of optical signal		Specified in Table 13			
Main optical path, S to R					
Attenuation range	dB	0 - 7		0 – 12	0 - 12
Maximum chromatic dispersion	ps/nm	13	14	46/74	NA
Minimum ORL of cable plant at S point (including any connectors)	dB	NA		NA	24
Maximum discrete reflectance between S and R	dB	NA		NA	-27
Receiver at referenced point R					
Minimum sensitivity (at BER = 10^{-10})	dBm	-23		-28	-28
Minimum overload (at BER = 10^{-10})	dBm	-8		-8	-8
Maximum optical path penalty	dB	1		1	1
Maximum reflectance of receiver measured at R	dB	NA		NA	-27

Table 5 - Optical interface parameters for STM-4 systems without using optical amplifier (cont.)

Optical path - Nominal speed, kbit/s		STM-4 622 080			
Application code		L-4.1		L-4.2	L-4.3
Operating wavelength range	nm	1300-1325/ 1296-1330	1280-1335	1480-1580	1480-1580
Transmitter at reference point S					
- Source type		MLM	SLM	SLM	SLM
- Spectral characteristics:					
+ Maximum RMS width (σ)	nm	2,0/1,7	-	-	-
+ Maximum –20 dB width	nm	-	1	<1	1
+ Minimum SMSR	dB	-	30	30	30
- Mean launched power:					
+ Maximum	dBm	+2		+2	+2
+ Minimum	dBm	-3		-3	-3
- Minimum EX	dB	10		10	10
Eye-mask of optical signal	-	Specified in Table 13			
Main optical path, S to R					
Attenuation range	dB	10 - 24		10 - 24	10 - 24
Maximum chromatic dispersion	ps/nm	92/109	NA	1600	NA
Minimum ORL of cable plant at S point (including any connectors)	dB	20		24	20
Maximum discrete reflectance between S and R	dB	-25		-27	-25
Receiver at referenced point R					
Minimum sensitivity (at BER = 10^{-10})	dBm	-28		-28	-28
Minimum overload (at BER = 10^{-10})	dBm	-8		-8	-8
Maximum optical path penalty	dB	1		1	1
Maximum reflectance of receiver measured at R	dB	-14		-27	-14

2.2.3. STM-16 systems

Optical interface parameters for STM-16 systems without using optical amplifier are specified in Table 6 and 7.

Table 6 - Optical interface parameters for STM-4 systems without using optical amplifier

Optical path - Nominal speed, kbit/s		STM-16 2 488 320		
Application code		I-16	S-16.1	S-16.2
Operating wavelength range	nm	1266 - 1360	1260 - 1360	1430 - 1580
Transmitter at reference point S				
- Source type		MLM	SLM	SLM
- Spectral characteristics:				
+ Maximum RMS width (σ)	nm	4	-	-
+ Maximum –20 dB width	nm	-	1	<1
+ Minimum SMSR	dB	-	30	30
- Mean launched power:				
+ Maximum	dBm	-3	0	0
+ Minimum	dBm	-10	-5	-5
- Minimum EX	dB	8,2	8,2	8,2
Eye-mask of optical signal	-	Specified in Table 13		
Main optical path, S to R				
Attenuation range	dB	0 - 7	0 - 12	0 - 12
Maximum chromatic dispersion	ps/nm	12	NA	800
Minimum ORL of cable plant at S point (including any connectors)	ps/nm	12	NA	420
Maximum discrete reflectance between S and R	dB	24	24	24
Receiver at referenced point R	dB	-27	-27	-27
Minimum sensitivity (at BER = 10^{-10})				
Minimum overload (at BER = 10^{-10})	dBm	-18	-18	-18
Maximum optical path penalty	dBm	-3	0	0
Maximum reflectance of receiver measured at R	dB	1	1	1
	dB	-27	-27	-27

Table 7 - Optical interface parameters for STM-16 systems without using optical amplifier (cont.)

Optical path - Nominal speed, kbit/s		STM-16 2 488 320		
Application code		L-16.1	L-16.2	L-16.3
Operating wavelength range	nm	1280 - 1335	1500 - 1580	1500 - 1580
Transmitter at reference point S				
- Source type		SLM	SLM	SLM
- Spectral characteristics:				
+ Maximum RMS width (σ)	nm	-	-	-
+ Maximum –20 dB width	nm	1	<1	<1
+ Minimum SMSR	dB	30	30	30
- Mean launched power:				
+ Maximum	dBm	+3	+3	+3
+ Minimum	dBm	-2	-2	-2
- Minimum EX	dB	8,2	8,2	8,2
Eye-mask of optical signal		Specified in Table 13		
Main optical path, S to R				
Attenuation range	dB	12 - 24	12 - 24	12 - 24
Maximum chromatic dispersion	ps/nm	NA	1600	450
Minimum ORL of cable plant at S point (including any connectors)	ps/nm	NA	1200	450
Maximum discrete reflectance between S and R	dB	24	24	24
Receiver at referenced point R	dB	-27	-27	-27
Minimum sensitivity (at BER = 10^{-10})				
Minimum overload (at BER = 10^{-10})	dBm	-27	-28	-27
Maximum optical path penalty	dBm	-9	-9	-9
Maximum reflectance of receiver measured at R	dB	1	2	1
	dB	-27	-27	-27

2.2.4. STM-64 systems

Optical interface parameters for STM-16 systems without using optical amplifier are specified in Table 8.

Table 8 - Optical interface parameters for STM-16 systems without using optical amplifier

Application code		S-64.1	S-64.2a	S-64.2b	S-64.3a S-64.5a	S-64.3b S-64.5b
General	–					
Maximum channel	–	1	1	1	1	1
Maximum BER	–	10^{-12}	10^{-12}	10^{-12}	10^{-12}	10^{-12}
Fiber type	–	G.652	G.652	G.652	G.653, G.655	G.653, G.655
Transmitter at reference point S						
Operating wavelength range	nm	1290-1330	1530-1565	1530-1565	1530-1565	1530-1565
Source type	–		SLM	SLM	SLM	SLM
Maximum spectral width	mW/ 10 MHz	NC	NC	NC	NC	NC
Minimum side mode compression ratio	dB	30	30	30	30	30
Maximum launched power	dBm	+5	−1	+2	−1	+2
Maximum launched power	dBm	+1	−5	−1	−5	−1
Minimum differential ratio	dB	6	8,2	8,2	8,2	8,2
Eye-mask				NC		
Main optical path, S to R						
Maximum attenuation range	dB	11	11	11	11	11
Minimum attenuation range	dB	6	7	3	7	3
Maximum chromatic dispersion	ps/nm	70	800	800	130	130
Minimum attenuation of cable at S point	dB	14	24	24	24	24
Maximum discrete reflectance S to R	dB	–27	−27	−27	−27	−27

Maximum diferential group delay	ps	30	30	30	30	30
Receiver at MPI-R						
Maximum input power	dBm	–1	−8	−1	−8	−1
Minimum sensitivity	dBm	–11	−18	−14	−17	−13
Maximum optical path penalty	dB	1	2	2	1	1
Maximum reflectance of optical network elements	dB	–14	−27	−27	−27	−27
NOTE: "a" using receiver with APD, “b” using receiver with PIN.						

2.3. Optical interface parameters for SDH systems using optical amplifier

2.3.1. STM-4 systems

Optical interface parameters for STM-4 systems using optical amplifier are specified in Table 9.

Table 9 - Optical interface parameters for STM-4 systems using optical amplifier

Optical path - Nominal speed, kbit/s		STM-4 622080				
Application code		V-4.1	V-4.2	V-4.3	U-4.2	U-4.3
Transmitter at reference point MPI-S						
- Operating wavelength range	nm	1290-1330	1530-1565	1530-1565	1530-1565	1530-1565
- Mean power						
+ Maximum	dBm	4	4	4	15	15
+ Minimum	dBm	0	0	0	12	12
- Spectral characteristics						
+ Maximum -20 dB width	nm	NC	NC	NC	NC	NC
+ Minimum SMSR	dB	NC	NC	NC	NC	NC
- Minimum EX	dB	10	10	10	10	10
- Eye-mask		Specified in Table 14				
Main optical path, MPI-S to MPI-R						
- Attenuation range	dB	22- 33	22-33	22-33	33-44	33-44

- Maximum chromatic dispersion	ps/nm	200	2400	400	3200	530
- Maximum diferential group delay	ps	480	480	480	480	480
- Minimum ORL of cable at MPI-S (including any connectors)	dB	24	24	24	24	24
- Maximum discrete reflectance between MPI-S and MPI-R	dB	-27	-27	-27	-27	-27
Receiver at reference point MPI-R						
- Sensitivity (at BER = 10^{-12})	dBm	≤-34	≤-34	≤-34	≤-34	≤-33
- Overload level (at BER = 10^{-12})	dBm	≥ -18	≥ -18	≥ -18	≥ -18	≥ -18
- Maximum optical path penalty	dB	1	1	1	2	1
- Maximum reflectance of receiver measured at point MPI-R	dB	-27	-27	-27	-27	-27

2.3.2. STM-16 systems

Optical interface parameters for STM-16 systems using optical amplifier are specified in Table 10.

Table 10 - Optical interface parameters for STM-16 systems using optical amplifier

Optical path		STM-16	
- Nominal speed, kbit/s		2 488 320	
Application code		V-16.2	V-16.3
Transmitter at reference point MPI-S			
- Operating wavelength range	nm	1530-1565	1530-1565
- Mean power			
+ Maximum	dBm	13	13
+ Minimum	dBm	10	10
- Spectral characteristics			
+ Maximum -20 dB width	nm	NC	NC
+ Minimum SMSR	dB	NC	NC
- Minimum EX	dB	8,2	8,2
- Eye-mask		Specified in Table 14	
Main optical path, MPI-S to MPI-R			
- Attenuation range	dB	22 - 33	22 - 33
- Maximum chromatic dispersion	Ps/nm	2400	400

- Maximum diferential group delay	ps	120	120
- Minimum ORL of cable at MPI-S (including any connectors)	dB	24	24
- Maximum discrete reflectance between MPI-S and MPI-R	dB	-27	-27
Receiver at reference point MPI-R			
- Sensitivity (at BER = 10^{-12})	dBm	≤-25	≤-24
- Overload level (at BER = 10^{-12})	dBm	≥ -9	≥ -9
- Maximum optical path penalty	dB	2	1
- Maximum reflectance of receiver measured at point MPI-R	dB	-27	-27

2.3.3. STM-64 systems

Optical interface parameters for STM-16 systems using optical amplifier are specified in Table 11 and 12.

Table 11 - Optical interface parameters for STM-64 systems using optical amplifier

Optical path - Nominal speed, kbit/s		STM-64 9 953 280				
Application code		L-64.1	L-64.2a	L-64.2b	L-64.2c	L-64.3
- Operating wavelength range	nm	1290-1320	1530-1565	1530-1565	1530-1565	1530-1565
Transmitter at reference point MPI-S						
- Spectral characteristics						
+ Maximum -20 dB width	nm	NC	NC	NC	NC	NC
+ Minimum SMSR	dB	30	NC	NC	NC	NC
- Mean power						
+ Maximum	dBm	+7	+2	13	+2	13
+ Minimum	dBm	+3	-2	10	-2	10
- Minimum EX	dB	6	10	8,2	10	8,2
- Eye-mask	NC					
Main optical path, MPI-S to MPI-R						
- Attenuation range	dB	16 - 22	11 - 22	16 - 22	11 - 22	16 - 22
- Maximum chromatic dispersion	ps/nm	130	1600	1600	1600	260

- Maximum diferential group delay	ps	30	30	30	30	30
- Minimum ORL of cable at MPI-S (including any connectors)	dB	24	24	24	24	24
- Maximum discrete reflectance between MPI-S and MPI-R	dB	-27	-27	-27	-27	-27
Receiver at reference point MPI-R						
- Sensitivity (at BER = 10^{-12})	dBm	≤-20	≤-26	≤-14	≤-26	≤-13
- Overload level (at BER = 10^{-12})	dBm	≥ -9	≥ -9	≥ -3	≥ -9	≥ -3
- Maximum optical path penalty	dB	1	2	2	2	1
- Maximum reflectance of receiver measured at point MPI-R	dB	-27	-27	-27	-27	-27

NOTE:

- L-64.2a using PDC as DA - L-64.2c using PCH as DA;

- L-64.2b using SPM as DA- L-64.2d using DST as DA.

Table 12 - Optical interface parameters for STM-64 systems using optical amplifier (cont.)

Optical path - Nominal speed, kbit/s		STM-64 9 953 280		
Application code		V-64.2a	V-64.2b	V-64.3
- Operating wavelength range	nm	1530 - 1565	1530 - 1565	1530 - 1565
Transmitter at reference point MPI-S				
- Mean power				
+ Maximum	dBm	13	15	13
+ Minimum	dBm	10	12	10
- Spectral characteristics				
+ Maximum -20 dB width	nm	NC	NC	NC
+ Minimum SMSR	dB	NC	NC	NC
- Minimum EX	dB	10	8.2	8.2
- Eye-mask		NC		
Main optical path, MPI-S to MPI-R				

- Attenuation range	dB	22 - 33	22 - 33	22 - 33
- Maximum chromatic dispersion	ps/nm	2400	2400	400
- Maximum diferential group delay	ps	30	30	30
- Minimum ORL of cable at MPI-S (including any connectors)	dB	24	24	24
- Maximum discrete reflectance between MPI-S and MPI-R	dB	-27	-27	-27
Receiver at reference point MPI-R				
- Sensitivity (at BER = 10^{-12})	dBm	≤-25	≤-23	≤-24
- Overload level (at BER = 10^{-12})	dBm	≥ -9	≥ -7	≥ -9
- Maximum optical path penalty	dB	2	2	1
- Maximum reflectance of receiver measured at point MPI-R	dB	-27	-27	-27

NOTE: V-64.2a using PDC as DA.

Table 13 – Parameters for eye-mask of transmit signals for systems without using optical amplifiers

	STM-1	STM-4
x_1/x_4	0,15/0,85	0,25/0,75
x_2/x_3	0,35/0,65	0,40/0,60
x_1/y_2	0,20/0,80	0,20/0,80

STM-16	
x_3-x_2	0,2
y_1/y_2	0,25/0,75

Table 14 – Parameters for eye-mask of transmit signals for systems using optical amplifiers

	STM-4	STM-16
x_1/x_4	0,25/0,75	-
x_2/x_3	0,40/0,60	-
x_3-x_2	-	0,2
y_1/y_2	0,20/0,80	0,25/0,75

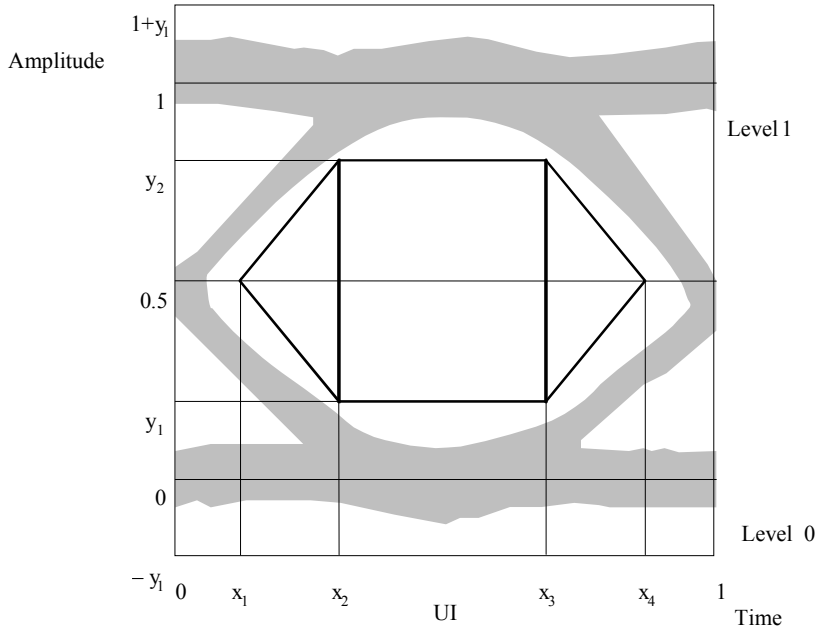

Figure 3 - Mask of the eye diagram for optical transmit signals

3. REGULATION ON MANAGEMENT

3.1. Interfaces in 1.1 must comply with requirements in this technical regulation.

3.2. Interfaces in local networks of telecommunication operatos are encourged to comply with requirements in this technical regulation.

3.3. If the agreement is included with requirements which are not in this technical rgulation, operators shall be responsible with relating problems.

4. RESPONSIBILITY OF ORGANISATIONS/INDIVIDUALS

4.1. Telecommunication operators in Vietnam are responsible to comply with this technical regulation when negotiating for connection with others.

and to accept supervision of regulatory authority as existing regulations.

4.2. This technical regulation shall be the technical basis for resolving disputes.

5. IMPLEMENTATION

5.1. Telecommunication Authorities are responsible to instruct and implement this technical regulation.

5.2. This technical regulation superseded TCN 68-173:1998.

5.2. In cases of referencing regulations changed, modified or superseded, new versions is applied.

ANNEX A
(Normative)
Eye-mask measurement method for optical transmit signals

A.1. Measurement diagram

Eye-mask measurement diagram for optical transmit signals is shown in Figure A.1.

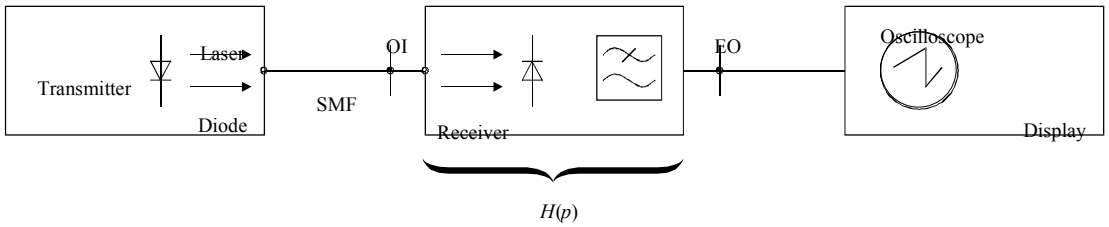

Figure A.1 - Eye-mask measurement diagram for optical transmit signals

- H(p): function of standard optical receiver (including optical receiver and electrical lowband filter)

- SMF: optical fiber with length shorter than 10 m (fiber type as in G.652, G.653 or G.654)

- OI: reference point of input optical signal

- EO: reference point of output optical signal

Optical attenuator can be used to have an appropiate optical power at OI, and electrical amplifier is used to have an appropiate electrical signal level at EO.

A.2. Function of standard optical receiver

Nominal function of standard optical receiver is characterised by 4^{th} order Bessel-Thomson respon as following:

$$H(p) = (105 + 105\,y + 45\,y^2 + 10\,y^3 + y^4).1/105$$

In which:

$p = j\frac{\omega}{\omega_r}$; $y = 2{,}1140p$; $\omega_r = 1.5\pi f_0$; f_0 = speed

Standard frequency $f_r = 0{,}75f_0$

Nominal attenuation at the frequency is 3 dB.

Attenuation and nominal group delay of standard optical receiver at frequencies are shown in Table A.1.

Table A.1 – Attenuation and nominal group delay of standard optical receiver

f/f_0	f/f_r	Attenuation (dB)	Nominal group delay (UI)
0,15	0,2	0,1	0
0,3	0,4	0,4	0
0,45	0,6	1,0	0
0,6	0,8	1,9	0,002
0,75	1,0	3,0	0,008
0,9	1,2	4,5	0,025
1,0	1,33	5,7	0,044
1,05	1,4	6,4	0,055
1,2	1,6	8,5	0,10
1,35	1,8	10,9	0,14
1,5	2,0	13,4	0,19
2,0	2,67	21,5	0,30

Tolerance attenuation shall not excess values specified in Figure A.2.

Table A.2 – Tolerance attenuation of standard optical receiver

f/f_r	Δa (dB)		
	STM-1	**STM-4**	**STM-16**
0,001 … 1	± 0,3	± 0,3	± 0,5
1… 2	± 0,3 … ± 2,0	± 0,3 … ± 2,0	± 0,5 … ± 3,0

ANNEX B
(Normative)

Relations between optical parameters

Relations between optical parameters are shown in Figure B.1.

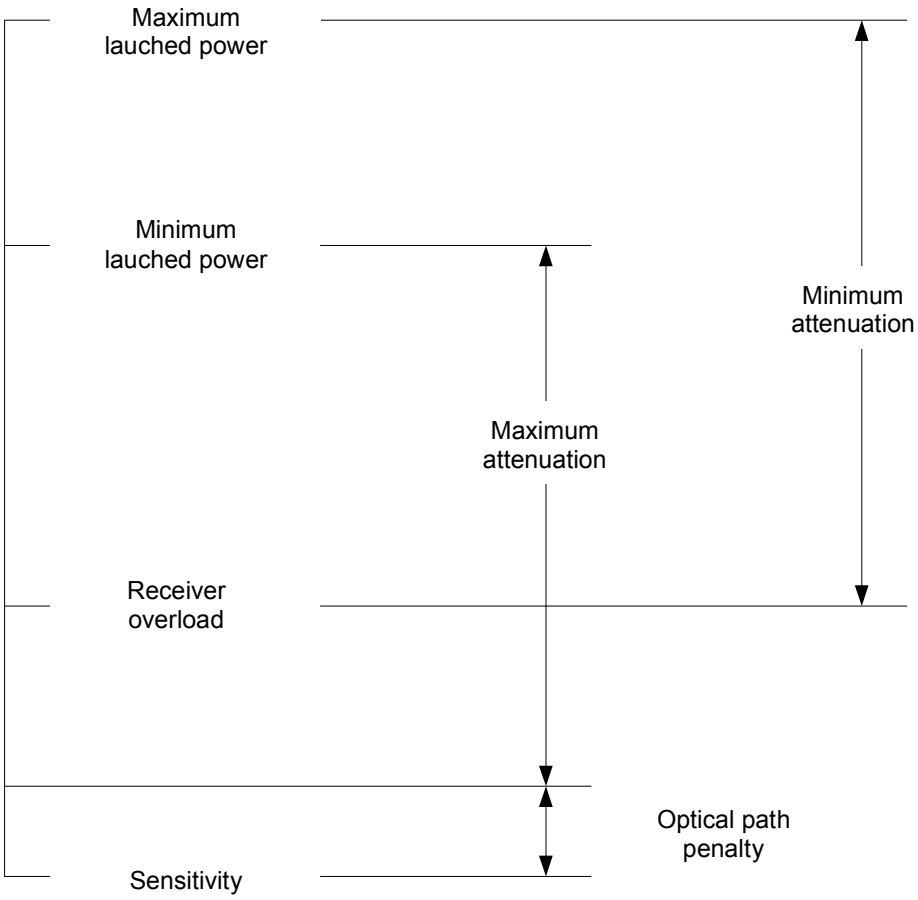

Figure B.1 - Relations between optical parameters

ANNEX C
(Normative)
Dispersion accomodation (DA) method

For STM-64 systems operating on1550 nm wavelength with G.652 fibre, the typical dispersion limit is about 60 km when using an ideal (transform limited) source spectrum. In this technical regulation, a DA technique is any method used to span longer distances on a STM-64 system and DA technique can require a specific interface characteristics.

C.1. Passive dispersion compensator (PDC)

This method is to add a Passive Dispersion Compensator (PDC) to the transmitter, the receiver, or both to fix distance limitations because of the dispersion. When PDC is inserted into the main path, since the insertion loss of the device (presently several dBs) would decrease the system attenuation range. In this regulation, the PDC is normally added before an optical power amplifier or after an optical preamplifier. The gain of the amplifiers is used to compensate for the insertion loss of the PDC without detracting from the system power budget.

- The use of PDCs in STM-64 systems:

+ S-64.2 is that the S-systems at 40 km which does not use the PDC.

+ L-64.2 and V-64.2, a PDC for each additional 40 km is added, the nominal dispersion value for each PDC then becomes –680 ps/nm at 1550 nm.

The use of a PDC at the transmitter side implies the use of an optical booster amplifier to compensate for the loss of the PDC. The PDC is, however, a linear dispersion compensator, and the non-linear distortion of the transmitted signal may degrade the linear dispersion compensation if applied at the transmitter. So that, PDC is not used in the transmitter:

+ L-64.2 system, placement of the PDC is at the receiver.

+ V-64.2 system, placement of the PDC is at the transmitter and receiver.

C.2. Self Phase Modulation (SPM)

Self Phase Modulation uses the non-linear Kerr effect in the G.652 fibre to obtain a pulse compression that increases the transmission distance. Since this technique requires the power level of the signal to be in the non-linear regime of the fibre, the SPM dispersion compensation effect is caused by the transmitted power and occurs in the transmission fibre close to the transmitter.

When the signal has propagated on the order of 15-40 km (with the power levels used in the L- and V-64.2 systems), it has been attenuated so that it is no longer in the non-linear regime. The rest of the propagation is therefore linear. This gives the possibility to combine SPM on the transmitter side with a PDC on the receiver side (as in V-64.2b).

C.3. Prechirp (PCH)

Prechirp method is based on the princple of spectral shift of the transmitter to obtain a pulse compression effect. DA element is inserted in the transmitter. However, the

use of a high-power transmitter in this case would give rise to both prechirp and SPM at the same time, and it hard to control the level of DA. So that, PCH normally use with low power and optical preamplifier in the receiver.

C.4. Dispersion Supported Transmission (DST)

Dispersion Supported Transmission (DST) is a active DA method, which uses a combination of intensity and frequency modulation instead of intensity modulation to counter the dispersion.

Optical signal generator is modulated at an appropriate optical frequency:

+ "1" logical level, v_1 frequency (optical power level is high, P_1).

+ "0" logical level, v_0 frequency (optical power level is low, P_0).

After transmitted on a fiber with L length, signal components with diferent wavelengths will propagate to the end at diferent times. Time deviation is $\Delta\tau = \Delta\lambda.D.L$ (in which $\Delta\lambda = (v_1-v_0).\lambda^2/2$). Thus, FM signal in the transmitter is transformed to AM signal in the receiver because of the dispersion (Figure C.1).

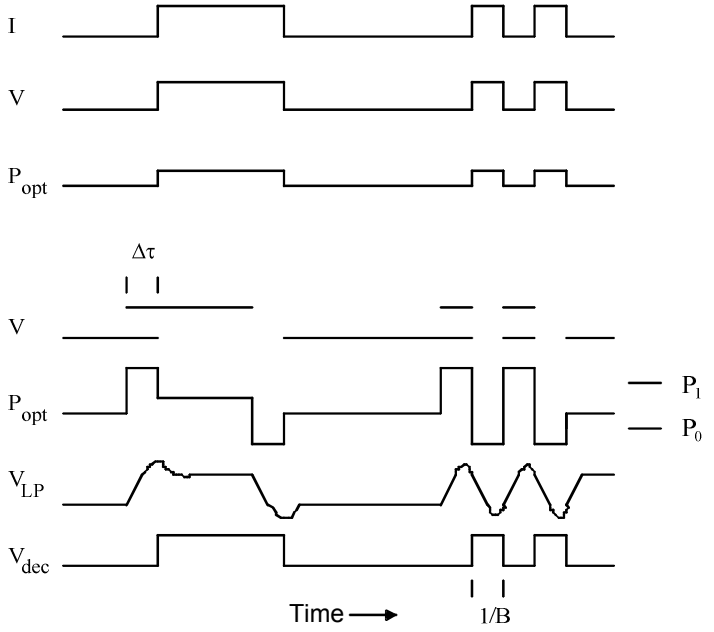

Figure C.1 - Dispersion Supported Transmission (DST)

In which: P_{0pt} is optical power level;

$V_{l.P}$ is output voltage of the lowband filter;

V_{dec} is output voltage of the decision circuit.