THE SOCIALIST REPUBLIC OF VIETNAM

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National Technical Regulation

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

(This translation is for reference only)

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Foreword

QCVN 7:2010/BTTTT was prepared on basis of revision and transferring of TCN 68-173:1998 "Optical interface for equipment and systems relating to the synchronous digital hierarchy - Technical requirements " with the enclosure of Decision No. 759/1998/QD-BBCVT dated December 09th, 1998 by the Minister of the Posts, Telecommunications Ministry (now as Ministry of Information and Communications).

Technical regulations and test methods of QCVN 7:2010/BTTTT are in accordance with recommendations G.957, G.958, G.691, G.959.1, G.693 of world telecom union (ITU-T)

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

1. GENERAL REGULATIONS

1. Scope

This regulation specifies technical requirements on optical interfaces for optical imformation equipments relating to SDH

This regulation may be applied optical channel single systems, in which one transmission direction using a optical fiber.

For optical amplifier systems, this regulation applies only for systems which using power amplification devices or/ and pre – amplifier device. This regulation doesn't apply for systems with repeater station amplification

1.2. Objectives of application

This regulation applies to the telecommunications business which setup network and service providers in Vietnam during the agreement, connect network with other businesses through optical network interconnection equipment SDH.

1.3. Normative references

1. ITU-T Recommendation G.957 (2006) Optical interfaces for equipments and systems relating to the Synchronous digital hierachy

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 interface

4. ITU-T Recommendation G.693(2005) Optical interfaces for intra – office systems

5. ITU-T Recommendation G.651(02/98) Characteristics of 50/125 m 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. Interpretation

1.4.1. The baseline configuration of the optical interface

- For systems not using optical amplifiers:

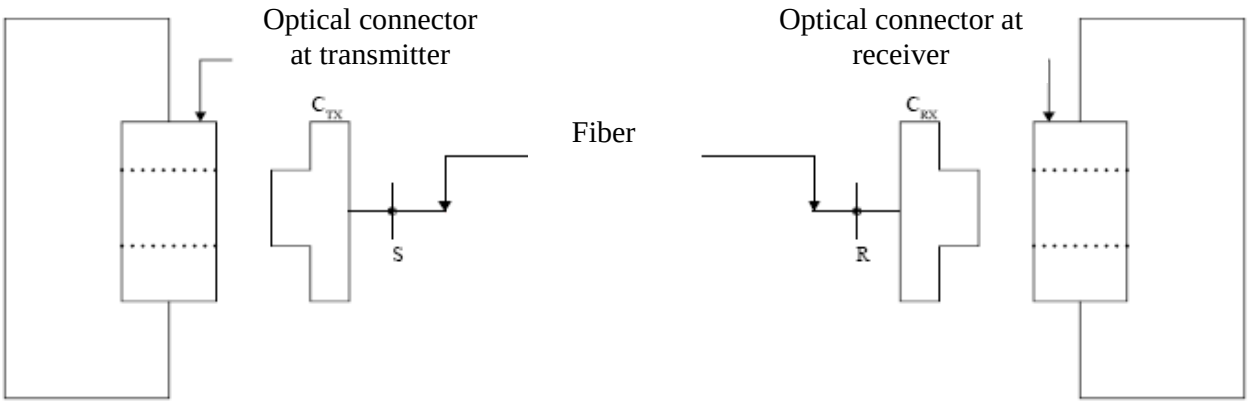

Figure 1 – Baseline configuration of the optical interface for the system doesn't use optical amplifiers

Norms of the optical interface in the transmitter defined in the point S (is the benchmark on optical fiber, after optical connectors at the transmitter), in the receives determined at the point R (is the benchmark on optical fiber, optical connector before at the receiver) and the line between the points S and R.

- For systems using optical amplifiers:

Figure 2 - Baseline configuration of the optical interface for systems using optical amplifiers

Norms of the optical interface in the transmitter defined in the MPI-S, in the receiver is defined in the MPI-R and the line between points MPI-S and MPI-R.

1.4.2. Spectral width

- RMS width: For LED and MLM, the spectral width is calculated by the maximum effective value (also known as MRS value) for normal operating conditions. To measure the RMS width should take all mode not less than 20dB compared with peak mode.

- Spectral width -20 dB: for SLM, the spectral width is calculated by maximum width of the radiation spectrum at center wavelengths measured at the point is lower than 20 dB compared with the maximum amplitude of the center wavelength in normal operating conditions.

1.4.3. Side mode compression ratio

Side mode compression ratio is the ratio between power of largest peak and second large peak in the transmitter source spectrum.

1.4.4. Mean lauched power

The mean lauched power at point S (or point MPI-S) is the average power of a pseudo-random sequence by transmitter devices into fiber. This value is used to calculate sensitivity and overload point of the receiver at point R (or point MPI-R) (see Appendix B).

1.4.5. Extinction ratio

Extinction ratio (EX) is calculated according to the formula:

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

In which: A- is mean optical power for logical “1”

B- is mean optical power for logical “0”

1.4.6 Attenuation range

Attenuation range specified in this regulation is the value calculated for the worst case, including attenuation due to weld, connector, optical attenuators (if used), or other passive optical components and any spare capacity for:

- The changes in the future for cable configuration (such as adding welds, increased cable length ...);
- Changes the fiber quality due to environment influence;

- Quality deterioration of the connectors, the optical attenuators or any passive optical components that lie between two points S and R (or between two points MPI-S and MPI-R).

1.4.7. Maximum chromatic dispersion

This parameter defines the maximum chromatic dispersion value of the optical line that system can be accepted without using any dispersion compensation method

1.4.8. Polarization mode dispersion

Polarization mode dispersion is group delay deviation Tp (in ps) between two orthogonally polarization mode

1.4.9. Differential group delay

Differential group delay is the difference in time between the transmitted pulses by the two main polarization mode of an optical signal.

Maximum differential group delay is defined as the differential group delay values that the system should be withstood with the intensity of the signal attenuation is 1dB.

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 according to the formula:

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

In which: - P'_s is the power response to transmitter source measured in the point S / MPI-S;

- P_s is the power into optical fibers measured in the S / MPI-S.

1.4.11. Receiver sensitivity

Receiver sensitivity is value of the smallest mean receiver power at the point R (or point MPI-R) to achieve:

- BER = 10^{-10} for STM-1, STM-4, STM-16 system does not use optical amplifiers.

- BER = 10^{-12} for STM-64 system and other systems use optical amplifiers.

1.4.12. Receiver overload

Receiver overload is value of the largest mean power can be accepted at point R (or point MPI-R) to achieve:

- BER = 10^{-10} for STM-1, STM-4, STM-16 system does not use optical amplifiers.

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

1.4.13 Optical path power penalty

Optical path power penalty is attenuation value of receiver sensitivity due to signal distortion when transmitted over optical fiber. In which cause the signal distortion due to radiation, the interference between symbols, the mode competition and due to the frequency shift of the laser.

1.4.14. Receiver reflectance

Receiver reflectance is retro - reflective from the receiver to fiber optic calculated by the formula:

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

In which: - P'_R is the power responded to the optical fiber measured at the R / MPI-R;

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

1.5. 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 Conformable
NRZ	None return to zero
OA	Optical amplifier
ORL	Optical return loss
PCH	Prechirp
PDC	Passive dispersion compensator
PIN	Positive intrinsic Negative
PMD	Polarization Mode Dispersion
RMS	Root Mean square
Rx	Receiver
SLM	Single – Longitudinal mode

SMSR	Side mode suppression ratio
SPM	Self phase modulation
Tx	Transmitter
UI	Unit interval

2. TECHNICAL REGULATIONS

2.1.General regulations

2.1.1. Technical Parameters

All the parameters in this regulation are calculated in the worst case, assuming full satisfaction of standardized operating conditions of the equipment (eg the conditions of temperature, humidity ...), including the effects of the aging effect to achieve:

- BER = 10^{-10} for STM-1, STM-4, STM-16 system does not use optical amplifiers.

- BER = 10^{-12} for STM-64 system and other systems use optical amplifiers.

2.1.2 Classification of optical interface

Classification of optical interface is specified in Table 1. Distance values are selected for the classification system code based on the parameter values can be achieved with current technology and these issues are to be in accordance with the requirements of the network.

Table 1 - Classification of optical interface by application filed

Application filed	I	S			L			V			U	
Wavelength 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
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		
Distance, km		~20	~40	~40	~40	~80	~80	~80	~120	~120	-	-
STM - 64		S-64.1	S-64.2	S-64.3	L-64.1	L-64.2	L-64.3	V-64.1	V-64.2	V-64.3		

NOTE: The distance values in Table 1 used for classification but are not norms to design system.

Specifying the system code in Table 1: Application filed - the STM. Suffix number

- Application filed is I, S, L, V, (I is used for communication applications in one station, S, L, V, U is application used for communication between stations together).

+ I (Intra office): the connection in a station or between stations (range 0.6 - 25 km);

+ S (Short haul): short-range (20-40 km);

+ L (Long haul): average distance (40 -80 km);

+ V (Very Long haul): large distances (60-120 km);

+ U (Ultra Long Haul): very large distances (120-160 km).

- The suffix number is one of the following:

+ Leave blank or "1" for the system that work at wavelength of 1310 nm over fiber according to standard G.652;

+ "2": For the system that work at wavelength of 1550 nm over fiber according to standard G.652 or G.654;

+ "3": For the system that work at wavelength of 1550 nm over fiber according to standard G.652 or G.653;

2.2.Optical interfaces criteria for SDH system not using optical amplifier

2.2.1. For STM-1 system

Optical interfaces criteria for STM-1 system not using optical amplifier is specified in Table 2 and 3

Table 2 - Optical interfaces criteria for STM-1 system not using optical amplifier

Signal - Nominal rate, kbit/s		STM -1 155 520			
Application code		I -1.1	S-1.1	S-1.2	
Wavelength range	nm	1260-1360	1261-1360	1430-1576	1430-1580
Transmit section at the point S					
- Source type		MLM / LED	MLM	MLM	SLM
- Spectrum characteristics:					
+ maximum width of RMS (σ)	Nm	40 / 80	7.7	2.5	-
+ maximum spectrum width of – 20dB	Nm	- / -	-	-	1
+ minimum SMSR	dB	- / -	-	-	30
- Mean lauched power:					
+ The largest value	dBm	-8	-8	-8	
+ The smallest value	dBm	-15	-15	-15	
- The smallest EX	dB	-8.2	8.2	8.2	
Eye mask of optical signals		Defined on table 13			
Transmission route, between the S and R					
Attenuation range	dB	0-7	0-12	0-12	
Maximum dispersion	ps/nm	18 / 25	96	296 / NA	
Minimum value of ORL of cable at the point S (including connectors)	dB	NA	NA	NA	
Maximum discrete reflex between the S and R	dB	NA	NA	NA	
Receiving section at the point R					
The smallest receiver sensitivity (at BER = 10^{-10})	dBm	-23	-28	-28	
The smallest overload (at BER = 10^{-10})	dBm	-8	-8	-8	
The disadvantaged of maximum optical flow	dB	1	1	1	
Maximum reflex of the receiver measured at the point R	dB	NA	NA	NA	

Table 3 - Optical interfaces criteria for STM-1 system not using optical amplifier (continuous)

Signal - Nominal rate, kbit/s		STM -1 155 520			
Application code		L -1.1	L-1.2	L-1.2	
Wavelength range	nm	1263-1360	1480-1580	1534-1566/1523-1577	1480-1580
Transmit section at the point S					
- Source type		MLM / SLM	SLM	MLM	SLM
- Spectrum characteristics:					
+ maximum width of RMS (σ)	Nm	3 / -	-	3/2.5	-
+ maximum spectrum width of – 20dB	Nm	- / 1	1	-	1
+ minimum SMSR	dB	- / 30	30	-	30
- Mean lauched power:					
+ the largest value	dBm	0	0	0	
+ the smallest value	dBm	-5	-5	-5	
- The smallest EX	dB	-10	-10	-10	
Eye mask of optical signals		Defined on table 13			
Transmission route, between the S and R					
Attenuation range	dB	10-28	10-28	10-28	
Maximum dispersion	ps/nm	246 / NA	NA	246/296 / NA	
Minimum value of ORL of cable at the point S (including connectors)	dB	NA	20	NA	
Maximum discrete reflex between the S and R	dB	NA	-25	NA	
Receiving section at the point R					
The smallest receiver sensitivity (at BER = 10^{-10})	dBm	-34	-34	-34	
The smallest overload (at BER = 10^{-10})	dBm	-10	-10	-10	
The disadvantaged of maximum optical flow	dB	1	1	1	
Maximum reflex of the receiver measured at the point R	dB	NA	-25	NA	

2.2.2. For STM-4 system

Optical interfaces criteria for STM-4 system not using optical amplifier is specified in Tables 4 and 5

Table 4 - Optical interfaces criteria for STM-4 systems not using optical amplifier

Signal - Nominal rate, kbit/s		STM -4 622 080		
Application code		I -4	S -4.1	S-4.2
Wavelength range	nm	1261-1360	1293-1334/ 1274-1356	1430-1580
Transmit section at the point S				
- Source type		MLM | LED	MLM	SLM
- Spectrum characteristics:				
+ maximum width of RMS (σ)	Nm	14.5 | 35	4/2.5	-
+ maximum spectrum width of – 20dB	Nm	- | -	-	1
+ minimum SMSR	dB	- | -	-	30
- Mean lauched power:				
+ the largest value	dBm	8	8	8
+ the smallest value	dBm	-15	-15	-15
-The smallest EX	dB	-8.2	-8.2	-8.2
Eye mask of optical signals		Defined on table 13		
Transmission route, between the S and R				
Attenuation range	dB	0-7	0-12	0-12
Maximum dispersion	ps/nm	13 | 14	46/74	NA
Minimum value of ORL of cable at the point S (including connectors)	dB	NA	NA	24
Maximum discrete reflex between the S and R	dB	NA	NA	-27
Receiving section at the point R				
The smallest receiver sensitivity (at BER = 10^{-10})	dBm	-23	-28	-28
The smallest Overload (at BER = 10^{-10})	dBm	-8	-8	-8
The disadvantaged of maximum optical flow	dB	1	1	1
Maximum reflex of the receiver measured at the point R	dB	NA	NA	-27

Table 5 - Optical interfaces criteria for STM-4 system not using optical amplifier (continuous)

Signal - Nominal rate, kbit/s		STM -4 622 080			
Application code		L -4		L -4.2	L-4.3
Wavelength range	nm	1300-1325/1296-1330	1280-1335	1480-1580	1480-1580
Transmit section at the point S					
- Source type		MLM	SLM	SLM	SLM
- Spectrum characteristics:					
+ maximum width of RMS (σ)	Nm	2.0/1.7	-	_	-
+ maximum spectrum width of – 20dB	Nm	-	1	<1	1
+ minimum SMSR	dB	-	30	30	30
- Mean lauched power:					
+ the largest value	dBm	+2		+2	+2
+ the smallest value	dBm	-3		-3	-3
- The smallest EX	dB	10		10	10
Eye mask of optical signals	-	Defined on table 13			
Transmission route, between the S and R					
Attenuation range	dB	10-24		10-24	10-24
Maximum dispersion	ps/nm	92/109	NA	1600	NA
Minimum value of ORL of cable at the point S (including connectors)	dB	20		24	20
Maximum discrete reflex between the S and R	dB	-25		-27	-25
Receiving section at the point R					
The smallest receiver sensitivity (at BER = 10^{-10})	dBm	-28		-28	-28
The smallest overload (at BER = 10^{-10})	dBm	-8		-8	-8
The disadvantaged of maximum optical flow	dB	1		1	1
Maximum reflex of the receiver measured at the point R	dB	-14		-27	-14

2.2.3. For STM -16 system

Optical interfaces criteria for STM-16 system not using optical amplifier is specified in Tables 6 and 7

Table 6 - Optical interfaces criteria for STM-16 system not using optical amplifier

Signal - Nominal rate, kbit/s		STM -16 2 488 320		
Application code		I -16	S-16.1	S-16.2
Wavelength range	nm	1266-1360	1260-1580	1430-1580
Transmit section at the point S				
- Source type		MLM	SLM	SLM
- Spectrum characteristics:				
+ maximum width of RMS (σ)	Nm	4	_	-
+ maximum spectrum width of – 20dB	Nm	-	1	<1
+ minimum SMSR	dB	-	30	30
- Mean lauched power:				
+ the largest value	dBm	-3	0	0
+ the smallest value	dBm	-10	-5	-5
- The smallest EX	dB	8.2	8.2	8.2
Eye mask of optical signals	-	Defined on table 13		
Transmission route, between the S and R				
Attenuation range	dB	0-7	0-12	0-12
Maximum dispersion at above wavelength limit	ps/nm	12	NA	800
Maximum dispersion at below wavelength limit	ps/nm	12	NA	420
Minimum value of ORL of cable at the point S (including connectors)	dB	24	24	24
Maximum discrete reflex between the S and R	dB	-27	-27	-27
Receiving section at the point R				
The smallest receiver sensitivity (at BER = 10^{-10})	dBm	-18	-18	-18
The smallest overload (at BER = 10^{-10})	dBm	-3	0	0
The disadvantaged of maximum optical flow	dB	1	1	1
Maximum reflex of the receiver measured at the point R	dB	-27	-27	-27

Table 7 - Optical interfaces criteria for STM-16 system not using optical amplifier (continuous)

Signal - Nominal rate, kbit/s		STM -16 2 488 320		
Application code		L -16	L-16.2	L-16.3
Wavelength range	nm	1280-1335	1500-1580	1500-1580
Transmit section at the point S				
- Source type		SLM	SLM	SLM
- Spectrum characteristics:				
+ maximum width of RMS (σ)	Nm	_	_	-
+ maximum spectrum width of – 20dB	Nm	1	<1	<1
+ minimum SMSR	dB	30	30	30
- Mean lauched power:				
+ The largest value	dBm	+3	+3	+3
+ The smallest value	dBm	-2	-2	-2
- The smallest EX	dB	8.2	8.2	8.2
Eye mask of optical signals	-	Defined on table 13		
Transmission route, between the S and R				
Attenuation range	dB	12-24	12-24	12-24
Maximum dispersion at above wavelength limit	ps/nm	NA	1600	450
Maximum dispersion at below wavelength limit	ps/nm	NA	1200	450
Minimum value of ORL of cable at the point S (including connectors)	dB	24	24	24
Maximum discrete reflex between the S and R	dB	-27	-27	-27
Receiving section at the point R				
The smallest receiver sensitivity (at BER = 10^{-10}	dBm	-27	-28	-27
The smallest overload (at BER = 10^{-10})	dBm	-9	-9	-9
The disadvantaged of maximum optical flow	dB	1	2	1
Maximum reflex of the receiver measured at the point R	dB	-27	-27	-27

2.2.4. For STM – 64 system

Optical interfaces criteria for STM-64 system does not use optical amplifier are specified in Tables 8

.Table 8 - Optical interfaces criteria for STM- 64 system not 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 information	-					
Maximum channel	-	1	1	1	1	1
Largest error ratio	-	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
Transmit section at the point S	-					
Working wavelength range	Nm	1290- 1330	1530- 1565	1530- 1565	1530- 1565	1530- 1565
Source type			SLM	SLM	SLM	SLM
Maximum spectrum width	-		NC	NC	NC	NC
The smallest side mode compression ratio	mW/10MHz dB	NC 30	30	30	30	30
The largest mean transmission power	dBm	+5	-1	+2	-1	+2
The smallest mean transmission power	dBm	+1	-5	-1	-5	-1
The smallest distinguish coefficient	dB	6	8.2	8.2	8.2	8.2
Eye Masks		NC	NC	NC	NC	NC
Transmission route, between the S and R						
The largest Attenuation range	dB	11	11	11	11	11
The smallest Attenuation range	dB	6	7	3	7	3
Maximum dispersion value	ps/nm	70	800	800	130	130
The smallest reflex attenuation of cable at the point S	dB	14	24	24	24	24
Maximum discrete reflex between the S and R	dB	-27	-27	-27	-27	-27
Maximum differential group delay	ps	30	30	30	30	30

At the MPI-R receiver						
The largest mean input power	dBm	-1	-8	-1	-8	-1
Minimum receiver sensitivity	dBm	-11	-18	-14	-17	-13
The disadvantaged of maximum optical flow	dB	1	2	2	1	1
Maximum reflection of optical network element	dB	-14	-27	-27	-27	-27
NOTE: "a" uses APD receivers, "b" uses PIN receivers						

2.3. Optical interfaces criteria for SDH system using optical amplifier

2.3.1. For STM-4 system

Optical interfaces criteria for STM-4 system using optical amplifiers is specified in Table 9

Table 9 - Optical interfaces criteria for STM-4 system using optical amplifier

Signal - Nominal rate, kbit/s		STM -4 622080				
Application code		V – 4.1	V-4.2	V-4.3	U-4.2	U-4.3
Transmit section at the point MPI-S						
- Working Wavelength range	nm	1290-1330	1530-1565	1530-1565	1530-1565	1530-1565
- Mean power:						
+ the largest value	dBm	4	4	4	15	15
+ the smallest value	dBm	0	0	0	12	12
- Spectrum characteristics:						
+ maximum spectrum width of – 20dB	nm	NC	NC	NC	NC	NC
+ the smallest SMSR	dB	NC	NC	NC	NC	NC
- The smallest Minimum EX	dB	10	10	10	10	10
Eye mask of optical signals	-	Defined on table 14				
Transmission route, between the S and R						
Attenuation range	dB	22-33	22-33	22-33	33-44	33-44
Maximum dispersion	ps/nm	200	2400	400	3200	530
Maximum differential group delay	ps	480	480	480	480	480
Minimum value of ORL of cable at the point MPI-S (including connectors)	dB	24	24	24	24	24
Maximum discrete reflex between the MPI-S and MPI-R	dB	-27	-27	-27	-27	-27
Receiving section at the point MPI-R						
Receiver sensitivity (at BER = 10^{-12})	dBm	≤ -34	≤ -34	≤ -34	≤ -34	≤ -34
Overload (at BER = 10^{-12})	dBm	≥ -18	≥ -18	≥ -18	≥ -18	≥ -18
The disadvantaged of maximum optical flow	dB	1	1	1	2	1
Maximum reflex of the receiver measured at the point MPI-R	dB	-27	-27	-27	-27	-27

2.3.2. For STM-16 system

Optical interfaces criteria for STM-16 system using optical amplifiers is specified in Table 10

Table 10- Optical interfaces criteria for STM-16 system using optical amplifier

Signal - Nominal rate, kbit/s		STM -16 2 488 320	
Application code		V-16.2	V-16.3
Transmit section at the point MPI-S			
Working Wavelength range	nm	1530-1565	1530-1565
- Mean power:			
+ the largest value	dBm	13	13
+ the smallest value	dBm	10	10
- Spectrum characteristics:			
+ maximum spectrum width of – 20dB	nm	NC	NC
+ the smallest SMSR	dB	NC	NC
- The smallest EX	dB	8.2	8.2
Eye mask of optical signals		**Defined on table 14**	
Transmission route, between the S and R			
Attenuation range	dB	22-33	22-33
Maximum dispersion	ps/nm	2400	400
Maximum differential group delay	ps	120	120
Minimum value of ORL of cable at the point MPI-S (including connectors)	dB	24	24
Maximum discrete reflex between the MPI-S and MPI-R	dB	-27	-27
Receiving section at the point MPI-R			
Receiver sensitivity (at BER = 10^{-12})	dBm	≤ -25	≤ -24
Overload (at BER = 10^{-12})	dBm	≥ -9	≥ -9
The disadvantaged of maximum optical flow	dB	2	1
Maximum reflex of the receiver measured at the point MPI-R	dB	-27	-27

2.2.3. For STM-64 system

Optical interfaces criteria for STM-64 system using optical amplifiers is specified in Table 11 and Table 12

Table 11: Optical interfaces criteria for STM-64 system using optical amplifier

Signal - Nominal rate, kbit/s		STM -64 9 953 280				
Application code		L– 64.1	L– 64.2a	L– 64.2b	L– 64.2c	L– 64.3
Working Wavelength range		1290-1320	1530-1565	1530-1565	1530-1565	1530-1565
Transmit section at the point MPI-S						
- Spectrum characteristics:						
+ maximum spectrum width of – 20dB	nm	NC	NC	NC	NC	NC
+ The smallest SMSR	dB	30	NC	NC	NC	NC
- Mean power:						
+ The largest value	dBm	+7	+2	13	+2	13
+ The smallest value	dBm	+3	-2	10	-2	10
- The smallest EX	dB	6	10	8.2	10	8.2
Eye mask of optical signals		NC				
Transmission route, between the S and R						
Attenuation range	dB	16-22	11-22	11-22	11-22	11-22
Maximum dispersion	ps/nm	130	1600	1600	1600	1600
Maximum differential group delay	ps	30	30	30	30	30
Minimum value of ORL or cable at the point MPI-S (including connectors)	dB	24	24	24	24	24
Maximum discrete reflex between the MPI-S and MPI-R	dB	-27	-27	-27	-27	-27
Receiving section at the point MPI-R						
Receiver sensitivity (at BER = 10^{-12})	dBm	≤ -20	≤ -26	≤ -14	≤ -26	≤ -13
Overload (at BER = 10^{-12})	dBm	≥ -9	≥ -9	≥ -3	≥ -9	≥ -3
The disadvantaged of maximum optical flow	dB	1	2	2	2	1
Maximum reflex of the receiver measured at the point MPI-R	dB	-27	-27	-27	-27	-27

NOTE:

-L-64.2a uses PDC as DA, L-64.2c uses PCH as DA

- L-64.2b uses PDC as DA, L-64.2d uses PCH as DA

Table 12 - Optical interfaces criteria for STM-64 system using optical amplifier (continuous)

Signal - Nominal rate, kbit/s		STM -64 9 953 280		
Application code		V– 64.2a	V– 64.2b	V– 64.3
Working Wavelength range		1530-1565	1530-1565	1530-1565
Transmit section at the point MPI-S				
- Mean power:				
+ The largest value	nm	13	15	13
+ The smallest value	dB	10	12	10
- Spectrum characteristics:				
+ maximum spectrum width of – 20dB	dBm	NC	NC	NC
+ The smallest SMSR	dBm	NC	NC	NC
- The smallest EX	dB	10	8.2	8.2
Eye mask of optical signals		NC		
Transmission route, between the MPI- S and MPI-R				
Attenuation range	dB	22-33	22-33	22-33
Maximum dispersion	ps/nm	2400	2400	400
Maximum differential group delay	ps	30	30	30
Minimum value of ORL or cable at the point MPI-S (including connectors)	dB	24	24	24
Maximum discrete reflex between the MPI-S and MPI-R	dB	-27	-27	-27
Receiving section at the point MPI-R				
Receiver sensitivity (at BER = 10^{-12})	dBm	≤ -25	≤ -23	≤ -24
Overload (at BER = 10^{-12})	dBm	≥ -9	≥ -7	≥ -9
The disadvantaged of maximum optical flow	dB	2	2	1
Maximum reflex of the receiver measured at the point MPI-R	dB	-27	-27	-27

NOTE: V-64.2a uses PDC as DA

Table 13 - Parameters specify the eye mask of optical signals at the transmitter for optical interfaces of the systems without optical amplifier

	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 specify the eye mask of the transmitter optical signals for optical interfaces of the systems with optical amplifier

	STM -4	STM -16
x_1/x_4	0.25/0.75	-
X_2/x	0.49/0.60	-
$X_3 - x$	-	0.2
Y_1/y_2	0.20/0.80	0.25/0.75

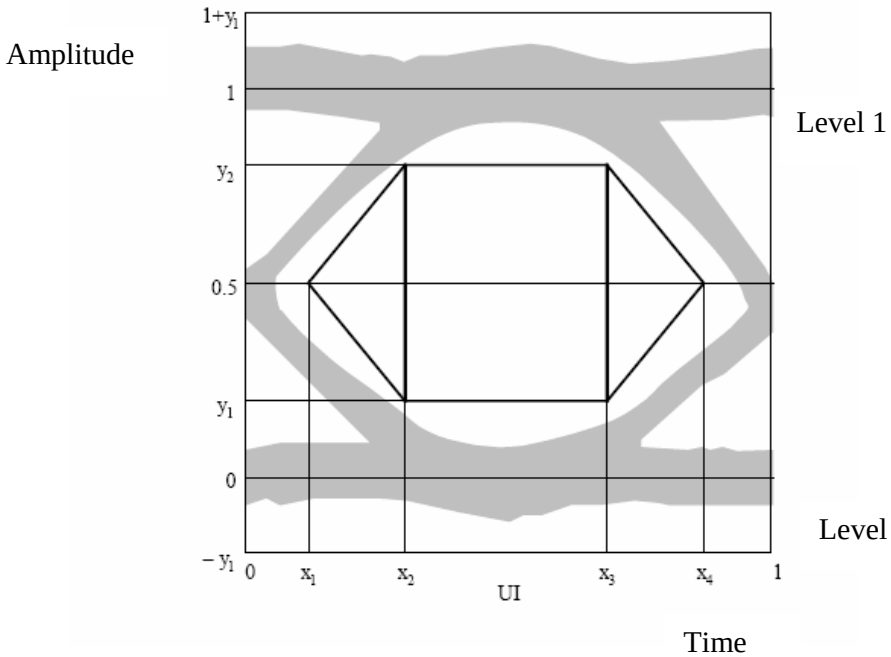

Figure 3 - Eye mask of optical signal at the transmitter

3. MANAGEMENT REGULATIONS

3.1. The connection interfaces between the telecommunications business using SDH transmission equipment must comply with the technical regulations and methods of measurement of SDH optical interfaces specified in this regulation.

3.2. Interconnection interface between equipment systems within the network of telecommunication business is not required to comply with the technical regulations specified in this regulation

3.3. In case of telecommunication business achieve network connection agreement deal with this regulation, and other contents should be specified in the connection agreement. The telecom business is responsible for solving arising problems.

4. RESPONSIBILITIES OF ORGANIZATIONS, INDIVIDUALS

4.1. The telecommunication businesses when interconnection agreement on telecommunications network with the other businesses to ensure the connection point with interconnection interface accordance with this regulation.

4.2. In case of dispute on network connection, businesses must check the connection interface at the connection point in this regulation and this regulation used as a technical basis to resolve disputes

5. IMPLEMENTATION ORGANIZATION

5.1. Quality Management Bureau of telecommunication have responsibility for instruction, organization management of telecommunication network interconnection accordance with this Regulation.

5.2. This Regulation is replaced for Standard TCN 68-173:1998 “optical interfaces for network interconnection equipments relating to the Synchronous Digital Hierarchy. Technical requirements”

5.3. In case there are any modifications, supplementations or replacements for regulation shown in this Regulation, the regulation in new version shall be applied.

Annex A

(Normative)

Method of measurement of the eye mask of optical signal at the transmitter

A.1 Metering circuit

Metering circuit of the eye mask of optical signal at the transmitter is set up as in the below figure:

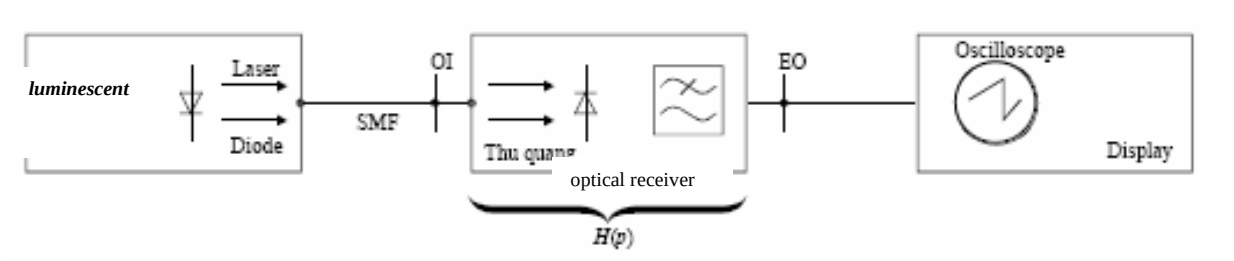

Figure A.1- Metering circuit of the eye mask of the transmitter optical signal

In which:

- H (p): Transfer function of standard optical receiver (including optical receivers and low-pass filter)

- SMF: fiber length <10 m (accordance with G.652, G.653 or G.654)

- OI: benchmark for optical signal input

- EO: benchmark for optical signal output

Allow to use more of the optical attenuators to create appropriate optical power levels at the OI, and use the power amplifier to generate the appropriate electrical signal at the EO.

A.2 Transfer function of standard optical receiver

Nominal transfer function of the standard optical receiver is characterized by the Bessel-Thomson grade 4 as follows: $H(p) = (105 + 105y + 45y^2 + 10y^3 + y^4) .1/105$

In which:

$$p = j\frac{\omega}{\omega_r} \; ; \; y = 2.1140p; \; \omega_r = 1.5\pi f_o \; ; \; f_o = \text{Bit rate}$$

Standard frequency is $fr = 0.75 f_o$. Nominal attenuation at this frequency is 3 dB.

In table A.1 is attenuation value and nominal group delay distortion of standard optical receiver at different frequencies.

Table A.1 - Attenuation value and the nominal group delay distortion of standard optical receiver

f/fo	f/fr	Attenuation (dB)	Group delay distortion(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

Allowable between the actual attenuation value measured and nominal attenuation value of standard optical receiver should not exceed the value specified in Table A.2

Table A.2 - Attenuation tolerances value of standard optical receiver

f/fr	Δa(dB)		
	STM -1	STM-4	STM -16
0.001…1	± 0.3	± 0.3	± 0.5
1…2	± 0.3… ± 0.2	± 0.3… ± 0.2	± 0.5… ± 3.0

Annex B

(Normative)

The relationship between the optical parameters

The optical parameters in this regulation have relationship as below figure:

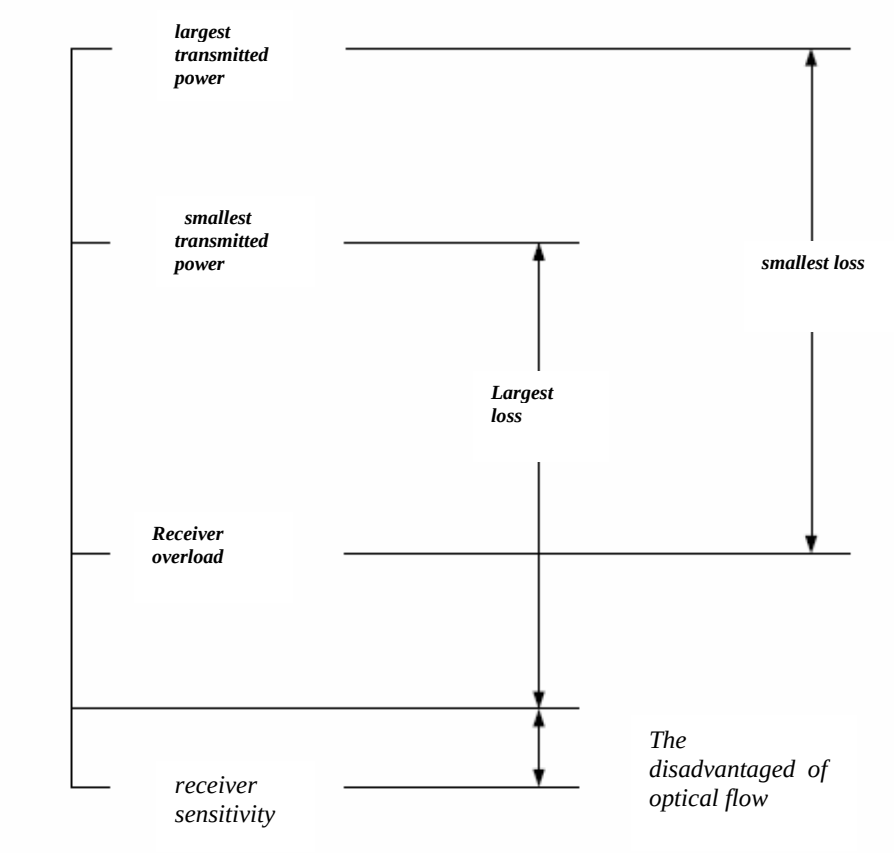

Figure B.1 – The relationship between the optical parameters

Annex C
(Normative)
Dispersion compensation method

For the STM -64 system works at wavelength of 1550 nm on G.652 fiber, and assuming the spectrum of the transmission source is ideal, due to the dispersive limit, the distance between repeater stations of this system reached only a maximum about 60 km. In this regulation, dispersion compensation techniques are used to extend the transmission range of the STM-64 system and for each dispersion compensation method is required on private interface norm.

C.1. Dispersion compensation by PDC method

- This method uses the passive dispersion compensation (PDC) to overcome the limitation of transmission distance caused by dispersion. When placed PDC on the line, insertion attenuation of the device (about a few dB) will reduce the attenuation range of the system. So, in this regulation, PDC placed front of the optical power amplifier at the transmitter and then placed back of receiver amplifier at the receiver. Amplification factor of the amplifiers will compensate for attenuation caused by the PDC without reducing the system power.

- Using the PDC in the STM-64 systems:

+ S-64.2 is located about 40 km, so there is no need to use PDC

+ L-64.2 and V-64.2 with the corresponding distance of about 80 km and 120 km should be used PDC. Each PDC lengthen distance approximately by 40 km and nominal dispersion value of each PDC is -680 ps/ nm at wavelength of 1550 nm.

- Using PDC at the transmitter then should be used the power amplifier at the receiver to compensate for the attenuation caused by the PDC. However, PDC is linear dispersion compensation, so the power from amplifier must be controlled so that does not happen the nonlinear effects (because signal nonlinear distortion in the transmitter will influence to dispersion compensate of PDC). So limit the use of PDC in the transmitter

+ L-64.2 using PDC in the receiver

+ V-64.2 using PDC in the transmitter and the receiver

C.2. Dispersion compensation using SPM technique

-SPM use the nonlinear Kerr effect for pulse compression. This technique requires a power level of signals to be done in the nonlinear area of optical fiber. Hence, dispersion compensation by using SPM which occurred near the transmitter (area which the optical power is enough large to cause non-linear effects)

- When the signal transfers to about 15-40 km (with signal power levels as prescribed for system L-64.2 and V-64.2), the signal power is reduced and not enough to cause nonlinear effects of SPM. Hence, the remaining distance, signal transmission is linear. Thus can be combined for using SPM in the transmitter and PDC at the receiver to compensate dispersion (as in V-64.2b).

C.3. Specifications dispersion compensation by PCH technique

PCH also based frequency spectrum shift rule of transmitter to perform pulse compression. Dispersion compensation equipment with PCH technique is placed in the transmitter. However, using high-power transmission source in this case will cause the PCH and SPM, it will be difficult to control the dispersion compensation. So PCH is used with a low power source and the optical pre-amplifier in the receiver (as in L-64.2c).

C.4. Dispersion compensation by DST technique

DST is positive dispersion compensation technique, in which incorporates using frequency modulation and intensity modulation to compensate dispersion.

- Equipment emitted optical signal modulated optical frequency properly:

+ Logic level "1", v_1 frequency (corresponding to higher optical power level is P_1)

+ Logic level "0", v_o frequency (corresponding to low optical power levels are Vo)

After transmission over fiber with length l, the signal components with different wavelengths will propagate on the fiber and to the other end of the fiber at different times. Deviation time $\Delta T = \Delta \lambda .D.L$

(In which $\Delta \lambda = (v_1 - v_o) \lambda^2/2$. Thus, the frequency modulation signal at the transmitter due to the dispersion effects of fiber was converted into amplitude modulation signal at the receiver (Figure C.1)

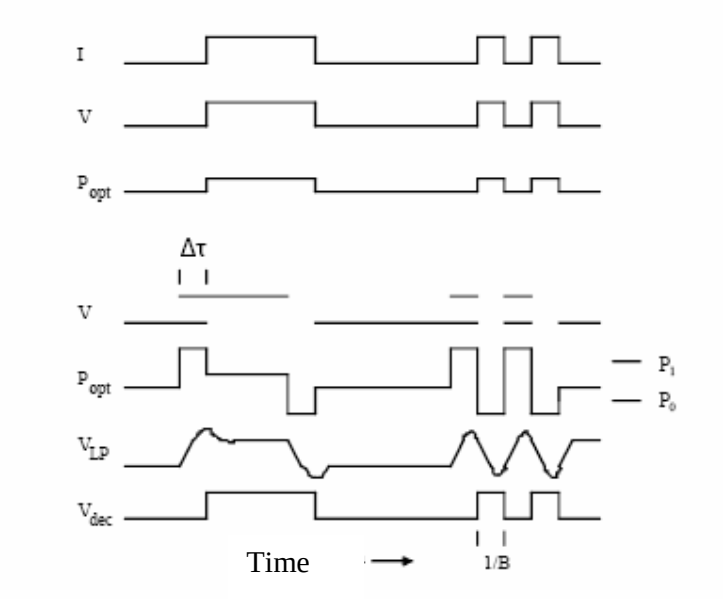

Figure C.1- Dispersion compensation by DST technique

In which: P_{0pt} is optical power

$V_{I.P}$ is out put voltage of low -pass filter circuit

V_{dec} is out put voltage of decision circuit