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**SERIES G: TRANSMISSION SYSTEMS AND MEDIA,
DIGITAL SYSTEMS AND NETWORKS**

Digital sections and digital line system – Digital line
systems

**Optical interfaces for equipments and systems
relating to the synchronous digital hierarchy**

ITU-T Recommendation G.957

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ITU-T Recommendation G.957

Optical interfaces for equipments and systems relating to the synchronous digital hierarchy

Summary

This Recommendation specifies optical interface parameters for equipments and systems based on the Synchronous Digital Hierarchy to enable transverse compatibility.

Source

ITU-T Recommendation G.957 was approved on 29 March 2006 by ITU-T Study Group 15 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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Optical interfaces for equipments and systems relating to the synchronous digital hierarchy

1 Scope

This Recommendation covers optical interface parameter specifications for equipments and systems supporting the Synchronous Digital Hierarchy (SDH) defined in ITU-T Rec. G.707/Y.1322 and operating on single-mode optical fibres conforming to ITU-T Recs G.652, G.653 and G.654.

The purpose of this Recommendation is to provide specifications for the optical interfaces of SDH equipment, described in ITU-T Rec. G.783, to achieve the possibility of transverse (multivendor) compatibility on elementary cable sections, i.e., the possibility of mixing various manufacturers' equipments within a single optical section. However, the specifications in this Recommendation are also intended to be in accordance with ITU-T Rec. G.955 which provides the possibility to achieve longitudinal compatibility for equipment of comparable hierarchical level and application.

This Recommendation is based on the use of one fibre per direction. Any other optical arrangements may require different specifications and are for further study.

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 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-T Recommendation G.652 (2005), *Characteristics of a single-mode optical fibre and cable*.
- ITU-T Recommendation G.653 (2003), *Characteristics of a dispersion-shifted single-mode optical fibre and cable*.
- ITU-T Recommendation G.654 (2004), *Characteristics of a cut-off shifted single-mode optical fibre and cable*.
- ITU-T Recommendation G.655 (2006), *Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable*.
- ITU-T Recommendation G.707/Y.1322 (2003), *Network node interface for the synchronous digital hierarchy*.
- ITU-T Recommendation G.783 (2006), *Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks*.
- 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.955 (1996), *Digital line systems based on the 1544 kbit/s and the 2048 kbit/s hierarchy on optical fibre cables*.
- ITU-T Recommendation I.432.2 (1999), *B-ISDN user-network interface – Physical layer specification: 155 520 kbit/s and 622 080 kbit/s operation*.

- IEC 60825-1 (2001), *Safety of laser products – Part 1: Equipment classification, requirements and user's guide*.
- IEC 60825-2 (2005), *Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS)*.

3 Terms and definitions

3.1 Definitions

This Recommendation defines the following terms:

3.1.1 transverse compatibility: The capability to mix various manufacturers' equipments within a single optical section.

3.1.2 joint engineering: The process by which Administrations/operators agree on a set of interface characteristics of an optical link that meet agreed performance characteristics of the link when the available interface specifications in ITU-T Recommendations are insufficient to ensure the performance level.

3.2 Terms defined in other Recommendations

This Recommendation uses the following terms defined in other ITU-T Recommendations as indicated:

- S/R reference points: see ITU-T Rec. G.955.
- Synchronous Digital Hierarchy (SDH): see ITU-T Rec. G.707/Y.1322.
- Synchronous Transport Module (STM): see ITU-T Rec. G.707/Y.1322.
- Longitudinal compatibility: see ITU-T Rec. G.955.

4 Abbreviations

This Recommendation uses the following abbreviations:

BER	Bit Error Ratio
EX	Extinction ratio
LED	Light-Emitting Diode
MLM	Multi-Longitudinal Mode
NA	Not Applicable
NRZ	Non-Return to Zero
ORL	Optical Return Loss
RMS	Root-Mean-Square
SDH	Synchronous Digital Hierarchy
SLM	Single-Longitudinal Mode
STM	Synchronous Transport Module
UI	Unit Interval
WDM	Wavelength-Division Multiplexing

5 Classification of optical interfaces

It is expected that optical fibres will be used in SDH-based systems for both inter-office transport between stations and in intra-office applications for connecting equipment within a single station. By appropriate combinations of transmitters and receivers, power budgets for optical fibre line systems can be achieved which are optimized in terms of attenuation/dispersion and cost with respect to the various applications. However, to simplify the development of transverse compatible systems, it is desirable to limit the number of application categories and corresponding sets of optical interface specifications for standardization.

As shown in Table 1, this Recommendation recognizes three broad application categories:

- intra-office corresponding to interconnect distances less than approximately 2 km;
- short-haul inter-office corresponding to interconnect distances of approximately 15 km;
- long-haul inter-office corresponding to interconnect distances of approximately 40 km in the 1310 nm window and approximately 80 km in the 1550 nm window.

Table 1/G.957 – Classification of optical interfaces based on application and showing application codes

Application		Intra-office	Inter-office				
			Short-haul		Long-haul		
Source nominal wavelength (nm)		1310	1310	1550	1310	1550	
Type of fibre		G.652	G.652	G.652	G.652	G.652 G.654	G.653
Distance (km) ^{a)}		≤ 2	~ 15		~ 40	~ 80	
STM level	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
	STM-16	I-16	S-16.1	S-16.2	L-16.1	L-16.2	L-16.3
^{a)} These are target distances to be used for classification and not for specification. The possibility of applying the set of optical parameters in this Recommendation to single-channel systems on G.655 fibre is not to be precluded by the designation of the fibre types in the application codes.							

Within each category, it is possible to consider use of either nominal 1310 nm sources on optical fibre complying with ITU-T Rec. G.652 or nominal 1550 nm sources on optical fibre complying with ITU-T Recs G.652, G.653 or G.654. This Recommendation covers both possibilities for the two inter-office applications and considers only nominal 1310 nm sources on G.652 fibre for the intra-office application. Since the overall system characteristics and specific values for the optical parameters generally depend on system bit rate, it is convenient to classify the SDH optical interfaces based on applications considered in this Recommendation using the set of application codes shown in Table 1. This application code is constructed in the following way:

Application-STM level. Suffix number

with the application designations being I (Intra-office), S (Short-haul), or L (Long-haul), and the suffix number being one of the following:

- (blank) or 1 indicating nominal 1310 nm wavelength sources on G.652 fibre;
- 2 indicating nominal 1550 nm wavelength sources on G.652 fibre for short-haul applications and either G.652 or G.654 fibre for long-haul applications;
- 3 indicating nominal 1550 nm wavelength sources on G.653 fibre.

NOTE – The use of the term intra-office is not meant to exclude any other applications consistent with the set of optical parameters specified (e.g., B-ISDN user network interfaces – physical layer specifications defined in ITU-T Rec. I.432.2).

The distances chosen for the application codes in Table 1 are based on parameter values that are achievable with present technology and which are thought to suit network requirements. The intra-office and short-haul inter-office application codes have been proposed as low-cost equipment implementations. The long-haul application codes have been proposed to provide maximum length repeater spans consistent with limits set by present technology and the objective of transverse compatibility. The distances proposed may allow for the upgrading of present systems by exploiting the 1550 nm region. The distances in Table 1 represent approximate maximum repeater span distances. Specific distance limits consistent with the attenuation limits given in Tables 2 to 4, but including allowances for extra connectors or margins, can be derived through consideration of maximum fibre attenuation and dispersion values for each application in Tables 2 to 4.

Table 2/G.957 – Parameters specified for STM-1 optical interfaces

	Unit	Values									
Digital signal		STM-1 according to ITU-T Rec. G.707/Y.1322									
Nominal bit rate	kbit/s	155 520									
Application code (Table 1)		I-1	S-1.1	S-1.2		L-1.1	L-1.2	L-1.3			
Operating wavelength range	nm	1260 ^{a)} -1360	1261 ^{a)} -1360	1430-1576	1430-1580	1263 ^{a)} -1360	1480-1580	1534-1566/ 1523-1577	1480-1580		
Transmitter at reference point S											
Source type		MLM	LED	MLM	MLM	SLM	MLM	SLM	MLM	SLM	
Spectral characteristics:											
– maximum RMS width (σ)	nm	40	80	7.7	2.5	–	3	–	–	3/2.5	–
– maximum –20 dB width	nm	–	–	–	–	1	–	1	1	–	1
– minimum side mode suppression ratio	dB	–	–	–	–	30	–	30	30	–	30
Mean launched power:											
– maximum	dBm	–8	–8	–8	–8	0	0	0	0	0	0
– minimum	dBm	–15	–15	–15	–15	–5	–5	–5	–5	–5	–5
Minimum extinction ratio	dB	8.2	8.2	8.2	8.2	10	10	10	10	10	10
Optical path between S and R											
Attenuation range ^{b)}	dB	0-7	0-12	0-12	0-12	10-28	10-28	10-28	10-28	10-28	10-28
Maximum dispersion	ps/nm	18	25	96	296	NA	246	NA	NA	246/296	NA
Minimum optical return loss of cable plant at S, including any connectors	dB	NA	NA	NA	NA	NA	NA	20	NA	NA	NA
Maximum discrete reflectance between S and R	dB	NA	NA	NA	NA	NA	NA	–25	NA	NA	NA
Receiver at reference point R											
Minimum sensitivity ^{b)}	dBm	–23	–28	–28	–28	–34	–34	–34	–34	–34	–34
Minimum overload	dBm	–8	–8	–8	–8	–10	–10	–10	–10	–10	–10
Maximum optical path penalty	dB	1	1	1	1	1	1	1	1	1	1
Maximum reflectance of receiver, measured at R	dB	NA	NA	NA	NA	NA	NA	–25	NA	NA	NA
a) Some Administrations may require a limit of 1270 nm.											
b) See clause 6.											

Table 3/G.957 – Parameters specified for STM-4 optical interfaces

	Unit	Values						
Digital signal		STM-4 according to ITU-T Rec. G.707/Y.1322						
Nominal bit rate	kbit/s	622 080						
Application code (Table 1)		I-4	S-4.1	S-4.2	L-4.1		L-4.2	L-4.3
Operating wavelength range	nm	1261 ^{a)} -1360	1293-1334/ 1274-1356	1430-1580	1300-1325/ 1296-1330	1280-1335	1480-1580	1480-1580
Transmitter at reference point S								
Source type		MLM	LED	MLM	SLM	MLM	SLM	SLM
Spectral characteristics:								
– maximum RMS width (σ)	nm	14.5	35	4/2.5	–	2.0/1.7	–	–
– maximum –20 dB width	nm	–	–	–	1	–	1	1
– minimum side mode suppression ratio	dB	–	–	–	30	–	30	30
Mean launched power:								
– maximum	dBm	–8	–8	–8	–8	+2	+2	+2
– minimum	dBm	–15	–15	–15	–15	–3	–3	–3
Minimum extinction ratio	dB	8.2	8.2	8.2	8.2	10	10	10
Optical path between S and R								
Attenuation range ^{b)}	dB	0-7	0-12	0-12	0-12	10-24	10-24	10-24
Maximum dispersion	ps/nm	13	46/74	NA	NA	92/109	1600	NA
Minimum optical return loss of cable plant at S, including any connectors	dB	NA	NA	24	24	20	24	20
Maximum discrete reflectance between S and R	dB	NA	NA	–27	–27	–25	–27	–25
Receiver at reference point R								
Minimum sensitivity ^{b)}	dBm	–23	–28	–28	–28	–28	–28	–28
Minimum overload	dBm	–8	–8	–8	–8	–8	–8	–8
Maximum optical path penalty	dB	1	1	1	1	1	1	1
Maximum reflectance of receiver, measured at R	dB	NA	NA	–27	–27	–14	–27	–14
^{a)} Some Administrations may require a limit of 1270 nm.								
^{b)} See clause 6.								