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

Transmission media and optical systems characteristics –
Characteristics of optical components and subsystems

Optical safety procedures and requirements for optical transmission systems

Recommendation ITU-T G.664

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Recommendation ITU-T G.664

Optical safety procedures and requirements for optical transmission systems

Summary

Recommendation ITU-T G.664 provides guidelines and requirements for techniques to enable optically safe working conditions (for the human eye and skin) on optical interfaces of the optical transport network, in particular, for systems employing high-power Raman amplification techniques, for equipment in restricted and controlled locations.

Due to revisions of relevant IEC requirements, the automatic laser shut-down (ALS) procedure, defined in a previous version of this Recommendation for synchronous digital hierarchy (SDH) systems, is no longer necessary and has therefore been moved to an informative appendix. Furthermore, this Recommendation provides new guidelines on automatic power reduction (APR) procedures for systems employing high-power Raman amplification techniques and this latest version includes Raman-based GPON reach extension systems.

History

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2.0	ITU-T G.664	2003-03-16	15
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3.0	ITU-T G.664	2006-03-29	15
4.0	ITU-T G.664	2012-02-13	15
5.0	ITU-T G.664	2012-10-29	15

FOREWORD

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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.

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Recommendation ITU-T G.664

Optical safety procedures and requirements for optical transmission systems

1 Scope

This Recommendation provides guidelines and requirements for techniques to enable optically safe working conditions (for the human eye and skin) on optical interfaces of optical networks, for both access and transport applications, including conventional synchronous digital hierarchy (SDH) systems, for equipment in both restricted and controlled locations.

The actual definition and specification of optically safe levels are considered outside the scope of this Recommendation (they are provided by IEC).

The main fields of application are systems designed for the optical networks, both in access and transport applications, employing Raman amplification and dense wavelength division multiplexing (DWDM) systems with large channel counts. For the purpose of ease of operating these systems, this Recommendation focuses on automatic power reduction (APR) techniques with automatic restart.

As backwards compatibility with earlier Recommendations on the subject of optical safety is desired, this Recommendation provides some descriptions for safety procedures in the case of single and multichannel SDH systems with and without line amplifiers. Clarification is given as to why procedures employing restart pulses for automatic laser shut-down (ALS) and automatic power shut-down (APSD), defined in a previous version of this Recommendation, are no longer appropriate or necessary for applications given in [ITU-T G.691], [ITU-T G.693], [ITU-T G.695], [ITU-T G.957] and [ITU-T G.959.1].

The impact of bidirectional transmission as described in [ITU-T G.692] has also been considered.

Some references are provided for keeping fibres damage-free when being operated at high optical power levels.

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 G.662] | Recommendation ITU-T G.662 (2005), <i>Generic characteristics of optical amplifier devices and subsystems</i> . |
| [ITU-T G.665] | Recommendation ITU-T G.665 (2005), <i>Generic characteristics of Raman amplifiers and Raman amplified subsystems</i> . |
| [ITU-T G.691] | Recommendation ITU-T G.691 (2006), <i>Optical interfaces for single channel STM-64 and other SDH systems with optical amplifiers</i> . |
| [ITU-T G.692] | Recommendation ITU-T G.692 (1998), <i>Optical interfaces for multichannel systems with optical amplifiers</i> . |
| [ITU-T G.693] | Recommendation ITU-T G.693 (2009), <i>Optical interfaces for intra-office systems</i> . |

- [ITU-T G.695] Recommendation ITU-T G.695 (2010), *Optical interfaces for coarse wavelength division multiplexing applications.*
- [ITU-T G.698.1] Recommendation ITU-T G.698.1 (2009), *Multichannel DWDM applications with single channel optical interfaces.*
- [ITU-T G.698.2] Recommendation ITU-T G.698.2 (2009), *Amplified multichannel dense wavelength division multiplexing applications with single channel optical interfaces.*
- [ITU-T G.783] Recommendation ITU-T G.783 (2006), *Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks.*
- [ITU-T G.798] Recommendation ITU-T G.798 (2010), *Characteristics of optical transport network hierarchy equipment functional blocks.*
- [ITU-T G.872] Recommendation ITU-T G.872 (2001), *Architecture of optical transport networks.*
- [ITU-T G.957] Recommendation ITU-T G.957 (2006), *Optical interfaces for equipments and systems relating to the synchronous digital hierarchy.*
- [ITU-T G.959.1] Recommendation ITU-T G.959.1 (2009), *Optical transport network physical layer interfaces.*
- [ITU-T G.983.x] Recommendation ITU-T G.983.x series, *Broadband optical access systems based on Passive Optical Networks (PON).*
- [ITU-T G.984.x] Recommendation ITU-T G.984.x series, *Gigabit-capable passive optical networks (GPON).*
- [ITU-T G.984.6] Recommendation ITU-T G.984.6 (2008), *Gigabit-capable passive optical networks (GPON): Reach extension.*
- [ITU-T G.985] Recommendation ITU-T G.985 (2003), *100 Mbit/s point-to-point Ethernet based optical access system.*
- [ITU-T G.986] Recommendation ITU-T G.986 (2010), *1 Gbit/s point-to-point Ethernet-based optical access system.*
- [ITU-T G.987.x] Recommendation ITU-T G.987.x series, *10-Gigabit-capable passive optical network (XG-PON) systems.*
- [IEC 60825-1] IEC 60825-1 edition 2.0 (2007), *Safety of laser products – Part 1: Equipment classification and requirements.*
- [IEC 60825-2] IEC 60825-2 edition 3.2 (2010), *Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS).*
- [IEC/TR 61292-4] IEC/TR 61292-4 edition 2.0 (2010), *Optical amplifiers – Part 4: Maximum permissible optical power for the damage-free and safe use of optical amplifiers, including Raman amplifiers.*

3 Terms and definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 controlled locations: [IEC 60825-2].

3.1.2 hazard level: [IEC 60825-2].

- 3.1.3 **laser class:** [IEC 60825-1].
- 3.1.4 **Loss of Signal (LOS):** [ITU-T G.783].
- 3.1.5 **LOS overhead (LOS-O):** [ITU-T G.798].
- 3.1.6 **LOS payload (LOS-P):** [ITU-T G.798].
- 3.1.7 **optical multiplex section (OMS):** [ITU-T G.872].
- 3.1.8 **optical supervisory channel (OSC):** [ITU-T G.692].
- 3.1.9 **optical transmission section (OTS):** [ITU-T G.872].
- 3.1.10 **restricted locations:** [IEC 60825-2].
- 3.1.11 **unrestricted locations:** [IEC 60825-2].

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

- 3.2.1 **automatic laser shut-down (ALS):** A technique (procedure) to automatically shut down the output power of laser transmitters and optical amplifiers to avoid exposure to hazardous levels.
- 3.2.2 **automatic power reduction (APR):** A technique (procedure) to automatically reduce the output power of optical amplifiers to avoid exposure to hazardous levels.
- 3.2.3 **automatic power shut-down (APSD):** A technique (procedure) to automatically shut down the output power of optical amplifiers to avoid exposure to hazardous levels; within the context of this Recommendation, the term APSD is equivalent to the term ALS.
- 3.2.4 **loss of continuity (of an optical link):** Any event which may cause hazardous optical power levels to be emitted from some point along the path of an optical transmission system. Common causes of loss of continuity of an optical link are a cable break, equipment failure, connector unplugging, etc.
- 3.2.5 **main (optical) path:** The fibre plant between the source main path interface reference point (MPI-S), S or S' point of the transmitting equipment and the receive main path interface reference point (MPI-R), R or R' point of the receiving equipment.
- 3.2.6 **main path interfaces:** The interfaces to the fibre plant.
- 3.2.7 **optical auxiliary channel (OAC):** An optical signal that fails in the event of loss of fibre continuity but does not require hazardous power levels to operate satisfactorily. One implementation of an OAC is the use of an optical supervisory channel (OSC).

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AEL	Accessible Emission Limit
ALS	Automatic Laser Shut-down
APR	Automatic Power Reduction
APSD	Automatic Power Shut-down
ASE	Amplified Spontaneous Emission
BA	Booster Amplifier
DEMUX	Demultiplexer
dLOS	Loss Of Signal defect

DS	Downstream
DWDM	Dense Wavelength Division Multiplexing
IaDI	Intra-Domain Interface
LA	Line Amplifier
LOS	Loss Of Signal
LOS-O	LOS Overhead
LOS-P	LOS Payload
MPE	Maximum Permissible Exposure
MPI	Main Path Interface
MPI-R	Receive Main Path Interface reference point
MPI-S	Source Main Path Interface reference point
MSP	Multiplex Section Protection
MUX	Multiplexer
OA	Optical Amplifier
OAC	Optical Auxiliary Channel
OAN	Optical Access Network
OAR	Optically Amplified Receiver
OAT	Optically Amplified Transmitter
OMS	Optical Multiplex Section
ONU	Optical Network Unit
OSC	Optical Supervisory Channel
OTN	Optical Transport Network
OTS	Optical Transmission Section
PA	Preamplifier
RE	Reach Extender
SDH	Synchronous Digital Hierarchy
US	Upstream
WDM	Wavelength Division Multiplexing

5 General considerations

5.1 Safety considerations for avoiding damage to the human eye and skin

[IEC 60825-2] provides a clarification of the difference between laser class and hazard level. The text below is taken from [IEC 60825-2]¹.

"Class: The word "Class" refers to a scheme by which, based on emission levels, a product or internal emitter can be grouped with respect to its safety. These levels are described in the Accessible Emission Limit Tables in [IEC 60825-1]. Classes range from Class 1, which is safe

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