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

Transmission media and optical systems characteristics –
Characteristics of optical systems

Multichannel DWDM applications with single-channel optical interfaces

Recommendation ITU-T G.698.1



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

Recommendation ITU-T G.698.1

Multichannel DWDM applications with single-channel optical interfaces

Summary

Recommendation ITU-T G.698.1 provides optical parameter values for physical layer interfaces of dense wavelength division multiplexing (DWDM) systems primarily intended for metro applications. Applications are defined using optical interface parameters at the single-channel connection points between optical transmitters and the optical multiplexer, as well as between optical receivers and the optical demultiplexer in the DWDM system. This Recommendation uses a methodology which fixes the maximum attenuation of the multiplexer/demultiplexer and fibre together and, therefore, does not specify the maximum fibre-link length explicitly. This Recommendation includes unidirectional DWDM applications at 2.5 and 10 Gbit/s with 100-GHz channel frequency spacing, as well as applications at 10 Gbit/s with 50 GHz channel frequency spacing.

This latest revision of Recommendation ITU-T G.698.1 includes the use of optical add-drop multiplexers (OADMs) within the black link.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T G.698.1	2005-06-29	15
2.0	ITU-T G.698.1	2006-12-14	15
3.0	ITU-T G.698.1	2009-11-13	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.

NOTE

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

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

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at <http://www.itu.int/ITU-T/ipr/>.

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Recommendation ITU-T G.698.1

Multichannel DWDM applications with single-channel optical interfaces

1 Scope

The purpose of this Recommendation is to provide optical interface specifications towards the realization of transversely compatible dense wavelength division multiplexing (DWDM) systems primarily intended for metro applications.

This Recommendation defines and provides values for single-channel optical interface parameters of physical point-to-point and ring DWDM applications (with transmission distance in the range of about 30 km to about 80 km) on single-mode optical fibres through the use of the "black link" approach.

Applications containing amplifiers within the black link are outside of the scope of this Recommendation.

This Recommendation describes DWDM systems that include the following features:

- Channel frequency spacing: 50 GHz and wider (defined in [ITU-T G.694.1]);
- Bit rate of signal channel: up to 10 Gbit/s.

Specifications are organized according to application codes.

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.652] Recommendation ITU-T G.652 (2005), *Characteristics of a single-mode optical fibre and cable*.
- [ITU-T G.653] Recommendation ITU-T G.653 (2006), *Characteristics of a dispersion-shifted single-mode optical fibre and cable*.
- [ITU-T G.655] Recommendation ITU-T G.655 (2006), *Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable*.
- [ITU-T G.664] Recommendation ITU-T G.664 (2006), *Optical safety procedures and requirements for optical transport systems*.
- [ITU-T G.671] Recommendation ITU-T G.671 (2009), *Transmission characteristics of optical components and subsystems*.
- [ITU-T G.691] Recommendation ITU-T G.691 (2006), *Optical interfaces for single channel STM-64 and other SDH systems with optical amplifiers*.
- [ITU-T G.692] Recommendation ITU-T G.692 (1998), *Optical interfaces for multichannel systems with optical amplifiers*.
- [ITU-T G.694.1] Recommendation ITU-T G.694.1 (2002), *Spectral grids for WDM applications: DWDM frequency grid*.

- [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.709] Recommendation ITU-T G.709/Y.1331 (2003), *Interfaces for the optical transport network (OTN)*.
- [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 (2008), *Optical transport network physical layer interfaces*.
- [IEC 60825-1] IEC 60825-1 (2007), *Safety of laser products – Part 1: Equipment classification and requirements*.
- [IEC 60825-2] IEC 60825-2 (2007), *Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS)*.

3 Terms and definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

- 3.1.1 channel insertion loss** [ITU-T G. 671]
- 3.1.2 channel spacing** [ITU-T G.671]
- 3.1.3 completely standardized OTUk (OTUk)** [ITU-T G.709]
- 3.1.4 dense wavelength division multiplexing (DWDM) device** [ITU-T G.671]
- 3.1.5 differential group delay** [ITU-T G. 671]
- 3.1.6 frequency grid** [ITU-T G.694.1]
- 3.1.7 joint engineering** [ITU-T G.957]
- 3.1.8 optical tributary signal** [ITU-T G.959.1]
- 3.1.9 optical tributary signal class NRZ 10G** [ITU-T G.959.1]
- 3.1.10 optical tributary signal class NRZ 2.5G** [ITU-T G.959.1]
- 3.1.11 reflectance** [ITU-T G. 671]
- 3.1.12 ripple** [ITU-T G.671]
- 3.1.13 transverse compatibility** [ITU-T G.957]

3.2 Terms defined in this Recommendation

This Recommendation does not define any terms.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ASE	Amplified Spontaneous Emission
BER	Bit Error Ratio
DGD	Differential Group Delay
EX	Extinction Ratio

FEC	Forward Error Correction
NA	Not Applicable
NE	Network Element
NRZ	Non-Return to Zero
OA	Optical Amplifier
OADM	Optical Add-Drop Multiplexer
OD	Optical Demultiplexer
OM	Optical Multiplexer
ONE	Optical Network Element
OTU _k	Completely standardized optical channel transport unit – k
PMD	Polarization Mode Dispersion
RP _R	Link reference point at the DWDM network element aggregate input
RP _S	Link reference point at the DWDM network element aggregate output
R _S	Single-channel reference point at the DWDM network element tributary output
S _S	Single-channel reference point at the DWDM network element tributary input
WDM	Wavelength Division Multiplexing

5 Classification of optical interfaces

5.1 Applications

This Recommendation provides the physical layer parameters and values for single-channel interfaces of DWDM multichannel optical systems in physical point-to-point and ring applications. These DWDM systems with single-channel interfaces are primarily intended to be used in metropolitan area networks for a variety of clients, services, and protocols.

The specification method in this Recommendation uses a "black link" approach, which means that optical interface parameters for only (single-channel) optical tributary signals are specified. Additional specifications are provided for the black link parameters such as maximum attenuation, chromatic dispersion, ripple and polarization mode dispersion. This approach enables transverse compatibility at the single-channel point using a direct wavelength-multiplexing configuration. However, it does not enable transverse compatibility at the multichannel points. In this approach, the OM and OD are treated as a single set of optical devices and OADMs can be included.

This Recommendation only considers DWDM applications where the black link does not contain optical amplifiers.

5.2 Reference points

5.2.1 Unidirectional applications

Figure 5-1 shows a set of reference points, for the linear "black link" approach, for single-channel connection (S_S and R_S) between transmitters (Tx) and receivers (Rx). Here, the DWDM network elements include an OM and an OD, which are used as a pair with the opposing element, and may also include one or more OADMs.

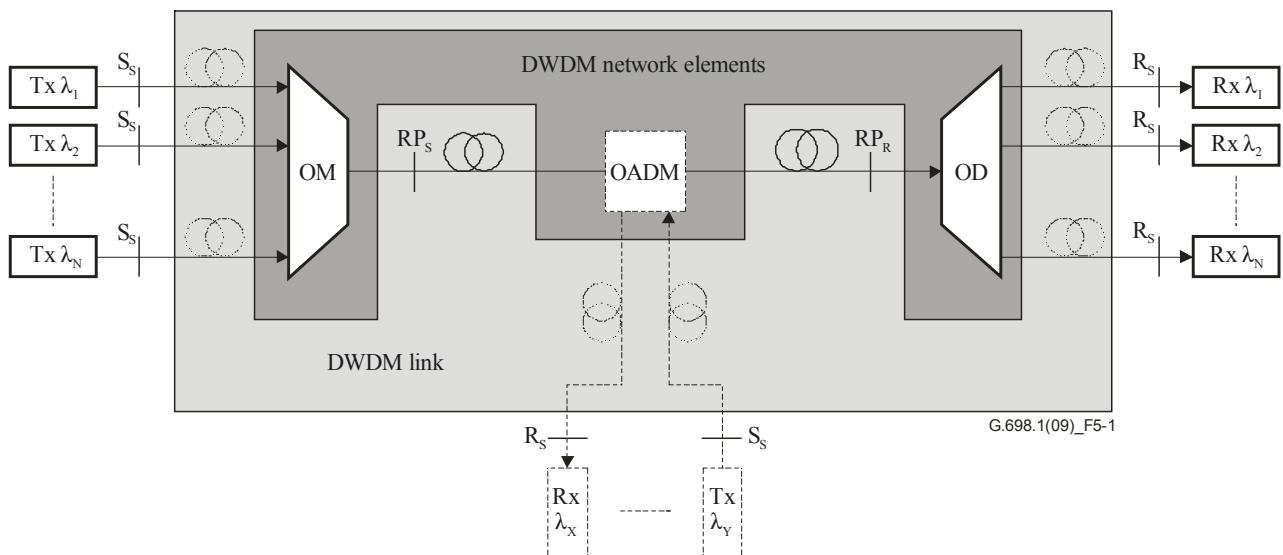


Figure 5-1 – Linear "black link" approach

As indicated in Figure 5-1, in cases where the transmitter or receiver is some distance from the OM, OD or OADM, the fibre between point S_s or R_s and the DWDM network element is considered to be part of the black link.

Figure 5-2 shows a corresponding set of reference points for the ring "black link" approach, for single-channel connection (S_s and R_s) between transmitters (Tx) and receivers (Rx). Here, the DWDM network elements include two or more OADMs connected in a ring.

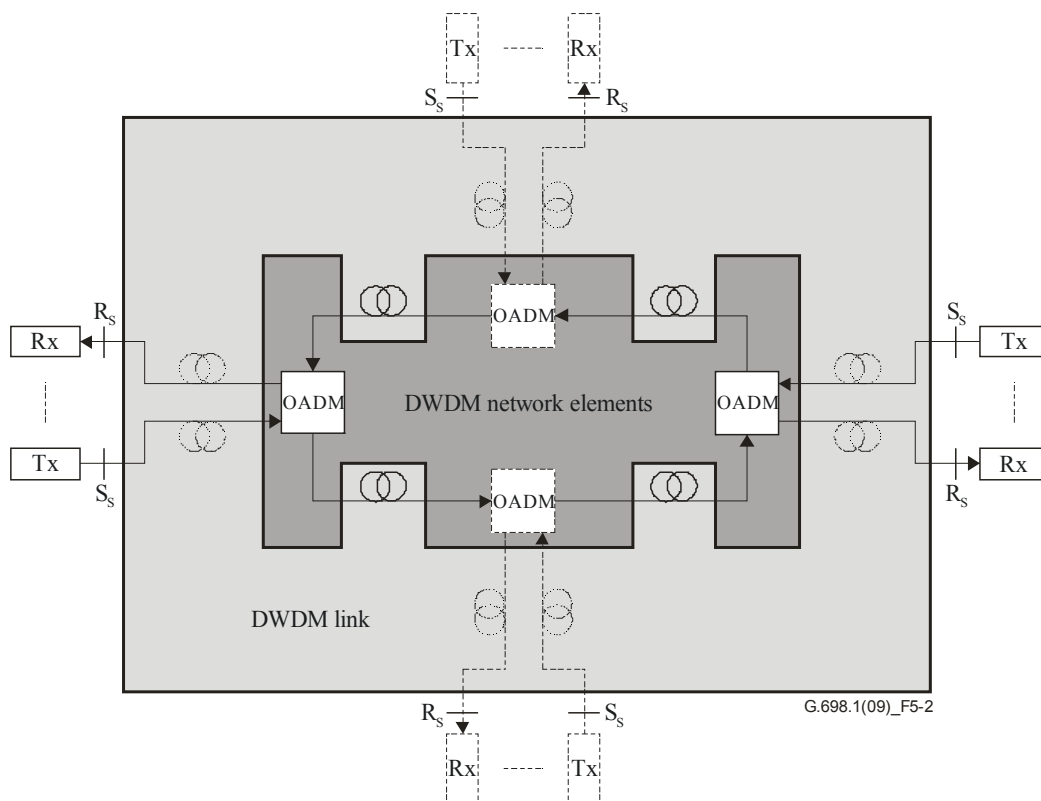


Figure 5-2 – Ring "black link" approach

These reference models do not include any optical amplifiers in the DWDM system. The reference points in Figures 5-1 and 5-2 are defined as follows:

- S_S is a single-channel reference point at the DWDM network element tributary input;
- R_S is a single-channel reference point at the DWDM network element tributary output;
- RP_S is a link reference point at the DWDM network element aggregate output;
- RP_R is a link reference point at the DWDM network element aggregate input.

Here, single-channel reference points S_S and R_S are applied to systems for the (linear or ring) "black link" approach where every path from S_S to its corresponding R_S must comply with the parameter values of the application code.

Note that RP_S and RP_R are only defined to provide information for the fibre link and not to provide signal characteristics at these points.

5.2.2 Bidirectional applications

While this Recommendation does not currently contain any bidirectional applications, it is expected that they will be added in a future revision. Figure 5-3 shows a set of reference points, for the single-fibre bidirectional linear "black link" approach, for single-channel connection (S_S and R_S) between transmitters (Tx) and receivers (Rx). Here, the DWDM network elements include an OM/OD, which is used as a pair with the opposing element and may also include one or more OADMs.

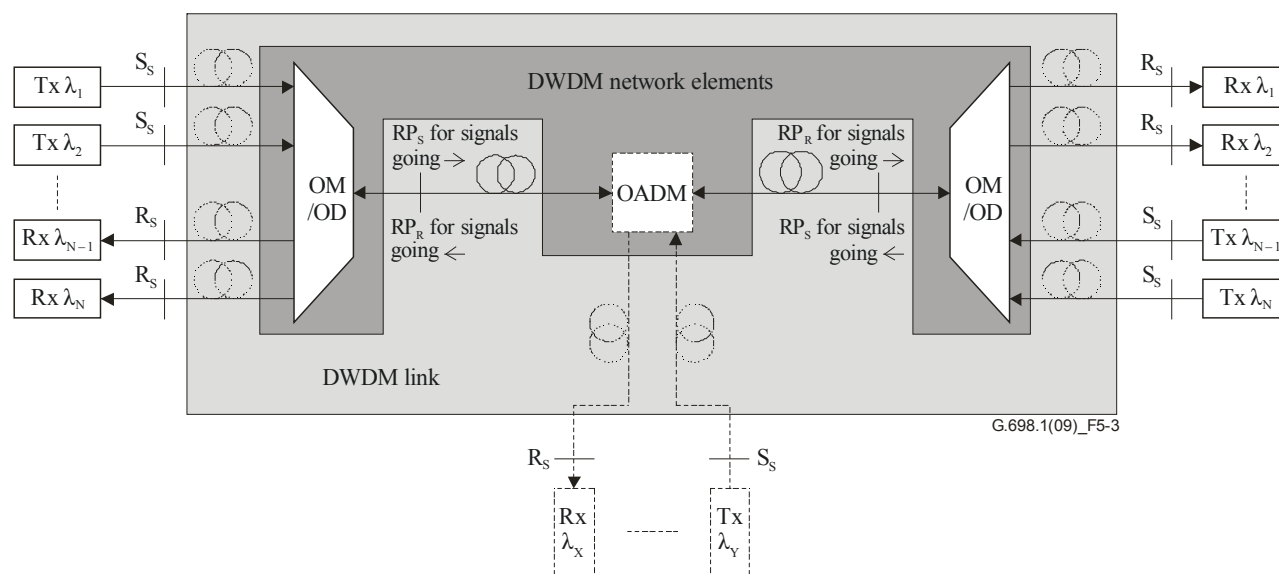


Figure 5-3 – Linear "black link" approach for bidirectional applications

Figure 5-4 shows a corresponding set of reference points for the single-fibre bidirectional ring "black link" approach, for a single-channel connection (S_S and R_S) between transmitters (Tx) and receivers (Rx). Here, the DWDM network elements include two or more OADMs connected in a ring.