

Recommendation

ITU-T G.672 (05/2025)

SERIES G: Transmission systems and media, digital systems and networks

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

Characteristics of multi-degree reconfigurable optical add/drop multiplexers

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Recommendation ITU-T G.672

Characteristics of multi-degree reconfigurable optical add/drop multiplexers

Summary

Recommendation ITU-T G.672 provides a description of the relevant characteristics of multi-degree reconfigurable optical add/drop multiplexer (MD-ROADM) network elements. The MD-ROADM is intended to be used in optical networks based on dense wavelength division multiplexing (DWDM), to enhance network scalability and to support enhanced service provisioning and resilience features. Recommendation ITU-T G.672 also provides classification criteria and a list of optical transfer parameters for MD-ROADMs appropriate for both fixed and flexible DWDM grid applications. In this edition of Recommendation ITU-T G.672, classification examples and configuration examples of MD-ROADM are added.

History*

Edition	Recommendation	Approval	Study Group	Unique ID
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Keywords

DWDM, flexible grid, OADM, ROADM.

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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.672

Characteristics of multi-degree reconfigurable optical add/drop multiplexers

1 Scope

This Recommendation deals with the classification and the characteristics of multi-degree reconfigurable optical add/drop multiplexers (MD-ROADMs), including two-degree ROADMs. Some examples of MD-ROADM configurations and applications are given in the appendices.

Photonic cross connects (PXC), which are a special category of MD-ROADM characterized by a unique switching matrix (see Figures 7-4, 7-5, 7-6, 7-7, 9-2 and I.4 of [ITU-T G.680]), lie outside the scope of this Recommendation.

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 standalone document, the status of a Recommendation.

- [[ITU-T G.661](#)] Recommendation ITU-T G.661 (2025), *Definitions and test methods for the relevant generic parameters of optical amplifier devices and subsystems*.
- [[ITU-T G.671](#)] Recommendation ITU-T G.671 (2025), *Transmission characteristics of optical components and subsystems*.
- [[ITU-T G.680](#)] Recommendation ITU-T G.680 (2007), *Physical transfer functions of optical network elements*.
- [[ITU-T G.694.1](#)] Recommendation ITU-T G.694.1 (2020), *Spectral grids for WDM applications: DWDM frequency grid*.
- [[ITU-T G.806](#)] Recommendation ITU-T G.806 (2012), *Characteristics of transport equipment – Description methodology and generic functionality*.
- [[ITU-T G.870](#)] Recommendation ITU-T G.870/Y.1352 (2016), *Terms and definitions for optical transport networks*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

- 3.1.1 adjacent channel isolation** [ITU-T G.671]
- 3.1.2 channel addition/removal (steady-state) gain response** [ITU-T G.661]
- 3.1.3 channel extinction** [ITU-T G.671]
- 3.1.4 channel frequency range** [ITU-T G.671]
- 3.1.5 channel gain** [ITU-T G.661]
- 3.1.6 channel input power range** [ITU-T G.661]

- 3.1.7 channel insertion loss (WDM devices)** [ITU-T G.671]
- 3.1.8 channel insertion loss deviation (WDM devices)** [ITU-T G.671]
- 3.1.9 channel output power range** [ITU-T G.661]
- 3.1.10 channel polarization dependent loss (PDL) (for OADM type subsystems)** [ITU-T G.671]
- 3.1.11 channel signal-spontaneous noise figure** [ITU-T G.661]
- 3.1.12 channel spacing** [ITU-T G.671]
- 3.1.13 defect** [ITU-T G.806]
- 3.1.14 flexible DWDM grid**
NOTE – The term is described in clause 7 of [ITU-T G.694.1]. In this Recommendation, the term is also shortened to "flexible grid".
- 3.1.15 group delay** [ITU-T G.671]
- 3.1.16 input reflectance** [ITU-T G.661]
- 3.1.17 maximum reflectance tolerable at input** [ITU-T G.661]
- 3.1.18 maximum reflectance tolerable at output** [ITU-T G.661]
- 3.1.19 maximum total output power** [ITU-T G.661]
- 3.1.20 multichannel gain-change difference (inter-channel gain change difference)** [ITU-T G.661]
- 3.1.21 multichannel gain tilt (inter-channel gain-change ratio)** [ITU-T G.661]
- 3.1.22 non-adjacent channel isolation** [ITU-T G.671]
- 3.1.23 polarization mode dispersion (PMD)** [ITU-T G.671].
NOTE – This Recommendation uses the equivalent term "channel differential group delay".
- 3.1.24 reconfigure time (for ROADMs)** [ITU-T G.680]
- 3.1.25 reflectance** [ITU-T G.671]
- 3.1.26 ripple** [ITU-T G.671]
- 3.1.27 specified by application (sba)** [ITU-T G.671]
- 3.1.28 optical transport module (OTM n[r].m)** [ITU-T G.870]
- 3.1.29 output reflectance** [ITU-T G.661]
- 3.1.30 transfer matrix (for optical branching and WDM devices)** [ITU-T G.671]
- 3.1.31 transient duration** [ITU-T G.661]
- 3.1.32 transient gain increase** [ITU-T G.661]
- 3.1.33 transient gain reduction** [ITU-T G.661]

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 channel asymmetric group delay: Between optical lines, the difference between the group delay from an optical line #n input port to an optical line #m output port and the group delay from an optical line #m input port to an optical line #n output port for the same channel. Between an optical line and add/drop port, the difference between the group delay from an optical line #n input port to an optical drop port #m and the group delay from an optical add port #m to an optical line #n output port for the same channel.

3.2.2 cumulative port isolation: Within the operating wavelength range, the minimum value of the ratio of the transfer coefficient from an input port to an output port in the on-state to the sum of the transfer coefficients from all other input ports to the same output port in the off-state for the same wavelength.

It is given by the following formula:

$$CPI = 10\log_{10} \left(\frac{t_{xow}}{\sum_{s,s \neq x} t_{sow}^0} \right)$$

The terms t_{xow} and t_{sow}^0 are elements of the transfer matrix (defined in clause 3.2.3.13 of [ITU-T G.671]), where o is the output port number, w is the (channel) wavelength number of the considered channel, x is the input port number that is in the on-state to the output port for the channel w , and s represents the input port numbers that are in the off-state to the output port for channel w . Each input port s is in the on state for the wavelength w to that output port other than o , for which the term t_{sow}^0 is maximized.

3.2.3 degree of a multi-degree reconfigurable optical add/drop multiplexer: The number of bidirectional optical lines that can be connected between the multi-degree reconfigurable optical add/drop multiplexer (MD-ROADM) and other optical network elements. It is also the number of reconfigurable wavelength add/drop devices (R-WADDs) that are installed in the MD-ROADM.

3.2.4 hitless operation: An operation performed on an optical network element embedded in an optical network is hitless when, considering the full time period from the start of the operation to its end, the following two conditions are satisfied:

- no defects are detected on any of the unswitched optical channels managed by that optical network element or their related client signals;
- the bit error ratio (BER) measured at the receiver interfaces of those client signals is less than or equal to the maximum BER allowed for them.

See Figure 1.

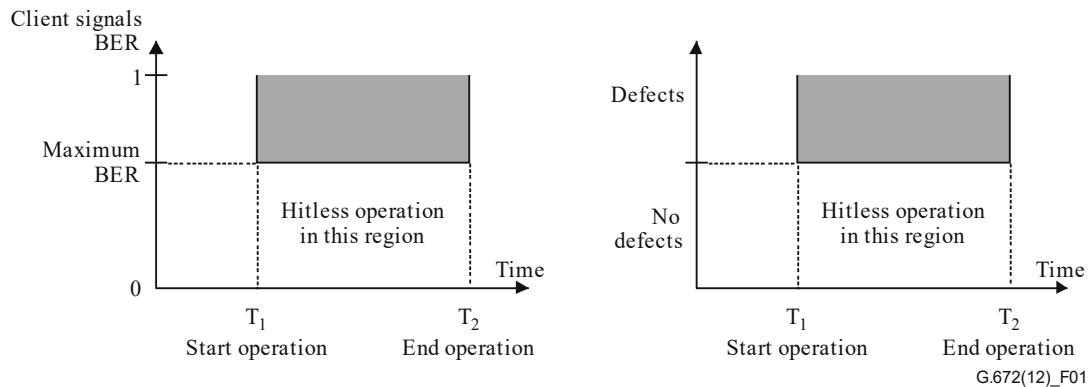


Figure 1 – Illustration of hitless operation conditions

3.2.5 multi-degree reconfigurable optical add/drop multiplexer (MD-ROADM): An element of an optical transport network capable of transferring any wavelength from one optical line to any other optical line, by means of reconfigurable wavelength add/drop devices (R-WADDs), and also to transfer local add/drop wavelengths to/from optical lines, by means of reconfigurable local add/drop devices (R-LADDs). Moreover, for an MD-ROADM, it should be possible to increase or decrease the optical node degree (i.e., to add or remove optical lines) up to the maximum supported, without any impact on live traffic. See Figure 2.

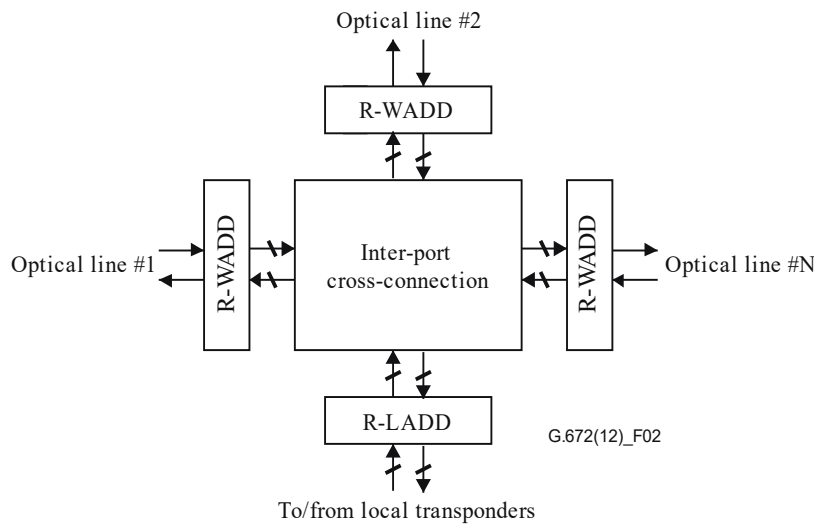


Figure 2 – MD-ROADM reference diagram

3.2.6 reconfigurable local add drop/device (R-LADD) $N \times M$: A wavelength selective branching device which has a reconfigurable "drop" function in which wavelengths coming from any of N optical input ports can be transferred either to one specific port, or to a subset, or to any of M optical drop ports, and also has a reconfigurable "add" function in which wavelengths presented to any of M optical add ports (that are wavelength compatible) can be transferred either to one specific port, or to a subset, or to any of N optical output ports.

See Figure 3.

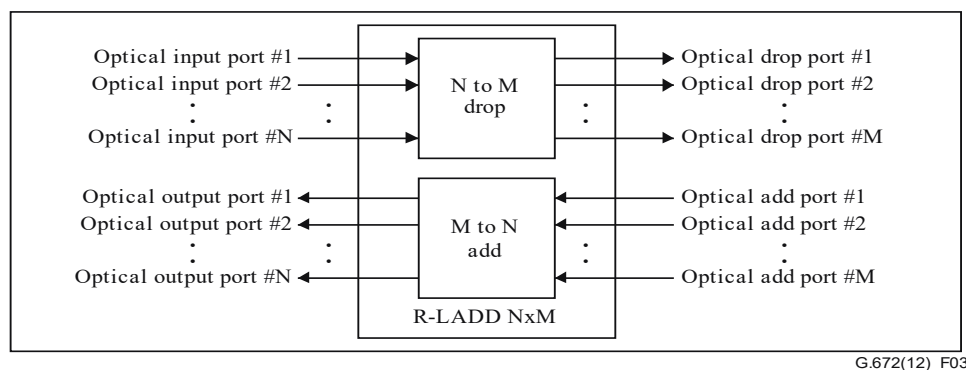


Figure 3 – R-LADD $N \times M$ reference diagram

3.2.7 reconfigurable wavelength add/drop device (R-WADD) $1 \times N$: A reconfigurable wavelength selective branching device capable of transferring wavelengths from one optical line input port to any of N optical output ports, and also capable of transferring wavelengths coming from any of N optical input ports to the optical line output port while avoiding transferring the same wavelength from more than one input to the optical line output.

See Figure 4.