International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.672
(10/2012)

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

Recommendation ITU-T G.672

ITU-T

ITU-T G-SERIES RECOMMENDATIONS

TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

INTERNATIONAL TELEPHONE CONNECTIONS AND CIRCUITS	G.100–G.199
GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS	G.200–G.299
INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES	G.300–G.399
GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES	G.400–G.449
COORDINATION OF RADIOTELEPHONY AND LINE TELEPHONY	G.450–G.499
TRANSMISSION MEDIA AND OPTICAL SYSTEMS CHARACTERISTICS	G.600–G.699
General	G.600–G.609
Symmetric cable pairs	G.610–G.619
Land coaxial cable pairs	G.620–G.629
Submarine cables	G.630–G.639
Free space optical systems	G.640–G.649
Optical fibre cables	G.650–G.659
Characteristics of optical components and subsystems	**G.660–G.679**
Characteristics of optical systems	G.680–G.699
DIGITAL TERMINAL EQUIPMENTS	G.700–G.799
DIGITAL NETWORKS	G.800–G.899
DIGITAL SECTIONS AND DIGITAL LINE SYSTEM	G.900–G.999
MULTIMEDIA QUALITY OF SERVICE AND PERFORMANCE – GENERIC AND USER-RELATED ASPECTS	G.1000–G.1999
TRANSMISSION MEDIA CHARACTERISTICS	G.6000–G.6999
DATA OVER TRANSPORT – GENERIC ASPECTS	G.7000–G.7999
PACKET OVER TRANSPORT ASPECTS	G.8000–G.8999
ACCESS NETWORKS	G.9000–G.9999

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

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. This Recommendation also provides classification criteria and a list of optical transfer parameters (without values in the current version) for MD-ROADMs. In this version of this Recommendation, characteristics, classification criteria and optical transfer parameters are applied to MD-ROADMs appropriate for fixed DWDM grid applications.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T G.672	2012-10-29	15

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

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.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

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/.

© ITU 2013

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without the prior written permission of ITU.

Table of Contents

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, I.4 of [ITU-T G.680]) are 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 stand-alone document, the status of a Recommendation.

[ITU-T G.661] Recommendation ITU-T G.661 (2007), *Definitions and test methods for the relevant generic parameters of optical amplifier devices and subsystems*.

[ITU-T G.671] Recommendation ITU-T G.671 (2012), *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.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 (2010), *Terms and definitions for Optical Transport Networks (OTN)*.

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 differential group delay (see "polarization mode dispersion (PMD)") [ITU-T G.671]

3.1.4 channel extinction [ITU-T G.671]

3.1.5 channel frequency range [ITU-T G.671]

3.1.6 channel gain [ITU-T G.661]

3.1.7 channel input power range [ITU-T G.661]

3.1.8 channel insertion loss [ITU-T G.671]

3.1.9 channel insertion loss deviation [ITU-T G.671]

3.1.10 channel output power range [ITU-T G.661]

3.1.11 channel polarization dependent loss (PDL) [ITU-T G.671]

3.1.12 channel signal-spontaneous noise figure [ITU-T G.661]

3.1.13 channel spacing [ITU-T G.671]

3.1.14 defect [ITU-T G.806]

3.1.15 input reflectance [ITU-T G.661]

3.1.16 maximum reflectance tolerable at input [ITU-T G.661]

3.1.17 maximum reflectance tolerable at output [ITU-T G.661]

3.1.18 maximum total output power [ITU-T G.661]

3.1.19 multichannel gain-change difference (inter-channel gain change difference) [ITU-T G.661]

3.1.20 multichannel gain tilt (inter-channel gain-change ratio) [ITU-T G.661]

3.1.21 non-adjacent channel isolation [ITU-T G.671]

3.1.22 reconfigure time [ITU-T G.680]

3.1.23 reflectance [ITU-T G.671]

3.1.24 ripple [ITU-T G.671]

3.1.25 optical transport module (OTM n[r].m) [ITU-T G.870]

3.1.26 output reflectance [ITU-T G.661]

3.1.27 transient duration [ITU-T G.661]

3.1.28 transient gain increase [ITU-T G.661]

3.1.29 transient gain reduction [ITU-T G.661]

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 degree of an MD-ROADM: The degree of an MD-ROADM is the number of bidirectional optical lines which can be connected between the MD-ROADM and other optical network elements. It is also the number of R-WADDs which are installed in the MD-ROADM.

3.2.2 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 both 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 measured at the receiver interfaces of those client signals is less than or equal to the maximum bit error ratio allowed for them.

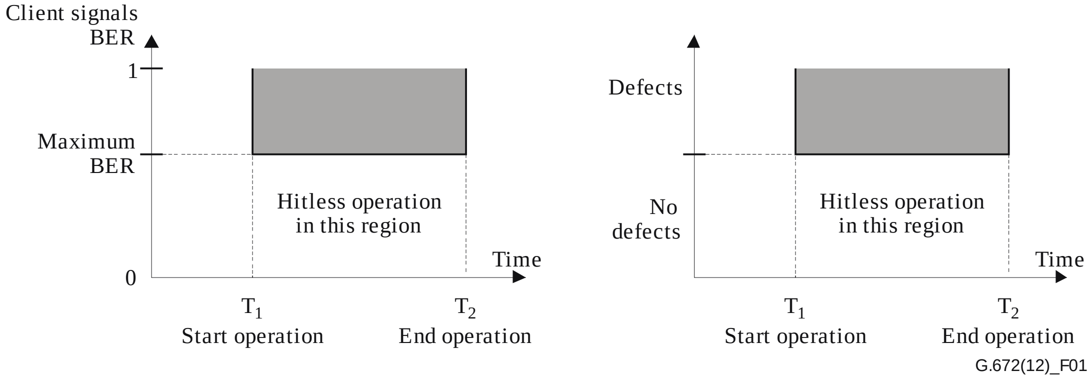

Figure 1 – Illustration of hitless operation conditions

3.2.3 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-WADD), and also to transfer local add/drop wavelengths to/from optical lines, by means of reconfigurable local add/drop devices (R-LADD). 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.

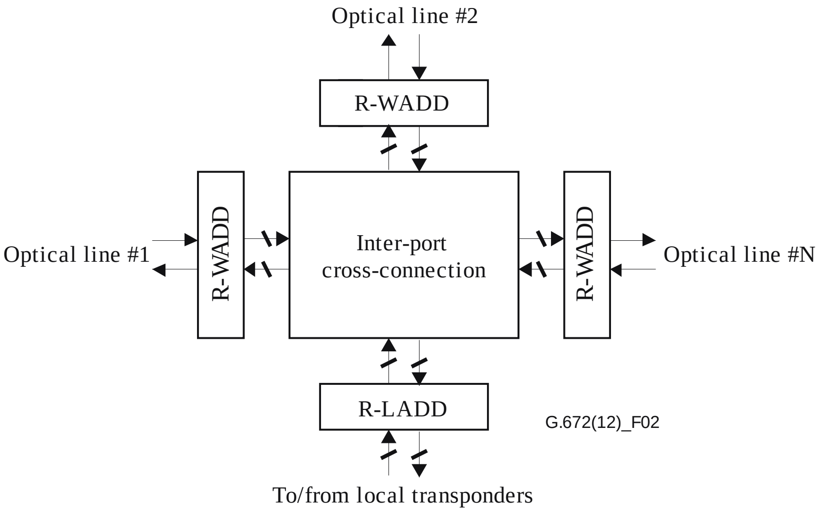

Figure 2 – MD-ROADM reference diagram

3.2.4 reconfigurable local add drop/devices (R-LADD) NxM: 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 to any of M optical drop ports, and also it has a reconfigurable "add" function in which wavelengths presented to any of M optical add ports can be transferred to any of N optical output ports.

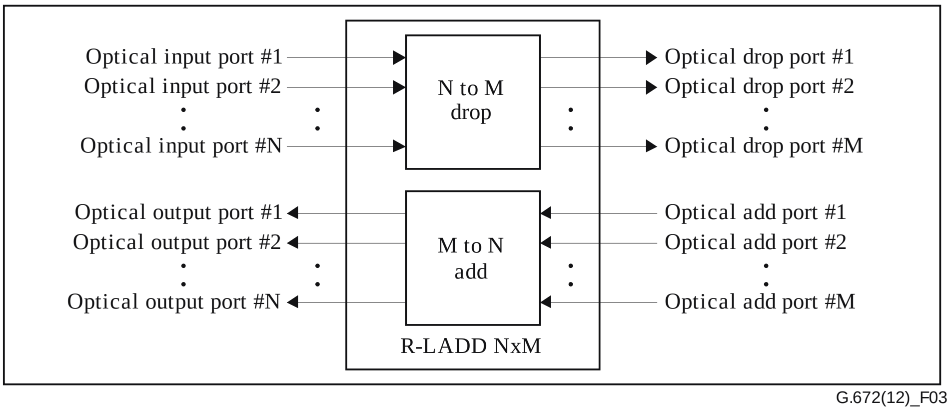

Figure 3 – R-LADD NxM reference diagram

3.2.5 reconfigurable wavelength add/drop device (R-WADD) 1xN: 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.

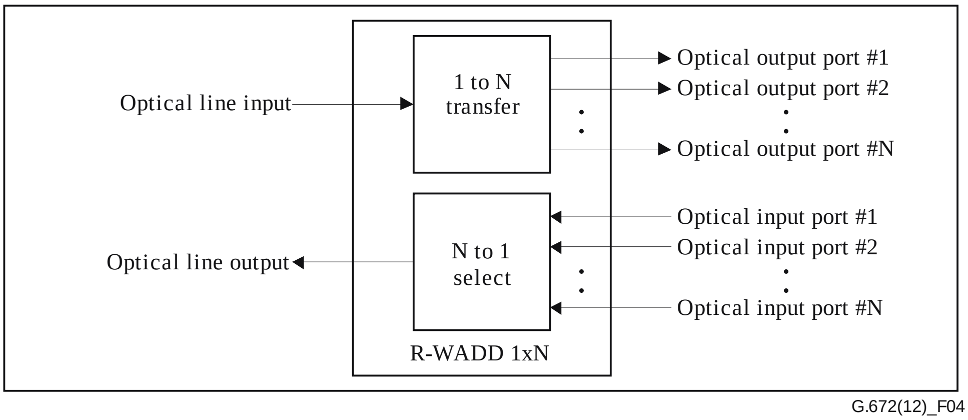

Figure 4 – R-WADD 1xN reference diagram

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

BER	Bit Error Ratio
DWDM	Dense Wavelength Division Multiplexing
MD-ROADM	Multi-Degree Reconfigurable Optical Add/Drop Multiplexer
OTF	Optical Transfer Function
OTM	Optical Transport Module
PDL	Polarization Dependent Loss
PMD	Polarization Mode Dispersion
R-LADD	Reconfigurable Local Add/Drop Device
R-WADD	Reconfigurable Wavelength Add/Drop Device
WSS	Wavelength Selective Switch

5 Classification criteria

In 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. Consequently, the total number of wavelengths which can be managed both for node pass-through and also for local add/drop, can change dynamically. The following criteria are defined:

– **Maximum node degree**: the maximum number of bidirectional optical lines supported by an MD-ROADM.

– **Maximum node channel count**: the total number of channels which can be managed on all of the bidirectional optical lines. It is the maximum number of incoming wavelengths per line multiplied by the maximum node degree.

– **Minimum channel spacing**: the minimum value of the channel spacing as defined in [ITU-T G.671].

– **Maximum add/drop ports**: the number of add/drop ports provided by the MD-ROADM at its maximum add/drop capability.

– **Maximum add/drop ratio**: the maximum add/drop ports divided by the maximum node channel count (expressed as a percentage).

In an MD-ROADM, the R-LADD feature should provide both the "wavelength-dependent" add/drop of optical channels, as well as the "wavelength-independent" add/drop. Therefore, the following criteria are defined:

– **Coloured local add/drop**: an MD-ROADM with a coloured local add/drop feature is able to add/drop an optical channel with a specific wavelength.

– **Colourless local add/drop**: an MD-ROADM with a colourless local add/drop feature is able to add/drop an optical channel with any supported wavelength.

In an MD-ROADM, the R-LADD feature should also provide either the "direction-dependent" or "direction-independent" add/drop of optical channels, and allow the reuse of the same wavelength for different directions. Therefore, the following criteria are defined:

– **Directional local add/drop**: an MD-ROADM with a directional local add/drop feature is able to add or drop an optical channel to/from a specific optical line port.

– **Directionless local add/drop**: an MD-ROADM with a directionless local add/drop feature is able to add or drop an optical channel to/from any optical line port.

– **Contention-less local add/drop**: an MD-ROADM with a contention-less local add/drop feature is able to add or drop more than one optical channel with the same wavelength to/from different optical line ports.

Classification criteria which take account of flexible DWDM grids are for further study.

The above criteria are not mutually exclusive, for example, an MD-ROADM could provide a local add/drop with coloured, directionless and colourless features, on different local add/drop ports. So, it is useful to define some criteria about the add/drop capability, to help categorizing MD-ROADM:

– **Maximum coloured and directional add/drop ratio**: the maximum number of add/drop ports with a coloured and directional local add/drop feature, divided by the maximum node channel count (expressed as a percentage).

– **Maximum coloured and directionless add/drop ratio**: the maximum number of add/drop ports with a coloured and directionless local add/drop feature, divided by the maximum node channel count (expressed as a percentage).

– **Maximum coloured, directionless and contention-less add/drop ratio**: the maximum number of add/drop ports with a coloured, directionless and contention-less local add/drop feature, divided by the maximum node channel count (expressed as a percentage).

– **Maximum colourless and directional add/drop ratio**: the maximum number of add/drop ports with a colourless and directional local add/drop feature, divided by the maximum node channel count (expressed as a percentage).

– **Maximum colourless and directionless add/drop ratio**: the maximum number of add/drop ports with a colourless and directionless local add/drop feature, divided by the maximum node channel count (expressed as a percentage).

– **Maximum colourless, directionless and contention-less add/drop ratio**: the maximum number of add/drop ports with a colourless, directionless and contention-less local add/drop feature, divided by the maximum node channel count (expressed as a percentage).

All of the above criteria can be summarized in two tables, Table 1 relates to the availability of MD-ROADM general characteristics, and Table 2 relates to the MD-ROADM local add/drop ratio.

Table 1 – MD-ROADM general characteristics

Maximum node degree	Number
Maximum node channel count	Number
Minimum channel spacing	GHz
Maximum add/drop ports	Number
Maximum add/drop ratio	%
Coloured local add/drop	Yes/No
Colourless local add/drop	Yes/No
Directional local add/drop	Yes/No
Directionless local add/drop	Yes/No
Contention-less local add/drop	Yes/No

Table 2 – MD-ROADM local add/drop ratio parameters

Maximum coloured and directional add/drop ratio	%
Maximum coloured and directionless add/drop ratio	%
Maximum coloured, directionless and contention-less add/drop ratio	%
Maximum colourless and directional add/drop ratio	%
Maximum colourless and directionless add/drop ratio	%
Maximum colourless, directionless and contention-less add/drop ratio	%

6 Main characteristics

The following is the minimum list of MD-ROADM relevant characteristics.

– **Degree upgrade capability**: an MD-ROADM should provide the capability to increase the optical node degree (i.e., to install a new R-WADD) up to the maximum supported. The degree upgrade operation should be hitless.

– **Degree downgrade capability**: an MD-ROADM should provide the capability to decrease the optical node degree (i.e., to remove an installed R-WADD) down to the minimum supported. The degree downgrade operation should be hitless.

– **Optical channel set-up capability**: an MD-ROADM should provide the capability to set up an optical channel using any of the wavelength resources managed by the MD-ROADM. The MD-ROADM should be able to set up a new optical channel, as well as to modify an existing one, by switching or detuning the required wavelength-specific resources. If the required wavelength-specific resources are free and available on the related R-WADDs, as well as on the R-LADD, the optical channel set-up operation should be hitless for all channels except for the one being set up or modified.

– **Optical channel tear-down capability**: an MD-ROADM should provide the capability to tear down (remove) an existing optical channel, releasing the related wavelength-specific resources. The optical channel tear-down operation should be hitless for all channels except the one being removed.

– **R-WADD fault partition capability**: in an MD-ROADM, a fault in any of the installed R-WADDs should be hitless for all of the optical channels which are not managed by the faulty R-WADD.

7 MD-ROADM transfer parameters

7.1 Transfer parameters of MD-ROADMs without amplifiers

For the evaluation of the optical transfer function (OTF) of MD-ROADM without amplifiers, a list of optical transfer parameters is given in Table 3. In the current version of this Recommendation, no parameter values are given.

Table 3 – Transfer parameters of MD-ROADM without amplifiers

Parameter		Max	Min
Channel frequency range	GHz		
Channel insertion loss Line input to line output Line input to drop Add to line output	 dB dB dB		
Channel insertion loss deviation	dB		NA
Ripple	dB		NA
Channel chromatic dispersion	ps/nm		
Channel differential group delay (DGD) Line input to line output Line input to drop Add to line output	 ps ps ps		 NA NA NA
Channel polarization dependent loss (PDL) Line input to line output Line input to drop Add to line output	 dB dB dB		 NA NA NA
Reflectance	dB		NA
Adjacent channel isolation (line input to drop)	dB	NA	
Non-adjacent channel isolation (line input to drop)	dB	NA	
Channel extinction (line input to line output)	dB	NA	
Reconfigure time	ms		
Channel uniformity	dB		NA

7.2 Transfer parameters of MD-ROADMs with amplifiers

For the evaluation of the OTF of MD-ROADM with amplifiers, a list of optical transfer parameters is given in Table 4. In the current version of this Recommendation no parameter values are given.

Table 4 – Transfer parameters of MD-ROADM with amplifiers

Parameter		Max	Min
Channel frequency range	GHz		
Channel gain Line input to line output Line input to drop Add to line output	 dB dB dB		
Channel insertion loss deviation	dB		NA
Ripple	dB		NA
Channel chromatic dispersion	ps/nm		
Channel differential group delay (DGD) Line input to line output Line input to drop Add to line output	 ps ps ps		 NA NA NA
Channel polarization dependent loss (PDL) Line input to line output Line input to drop Add to line output	 dB dB dB		 NA NA NA
Reflectance	dB		NA
Adjacent channel isolation (line input to drop)	dB	NA	
Non-adjacent channel isolation (line input to drop)	dB	NA	
Channel extinction (line input to line output)	dB	NA	
Reconfigure time	ms		NA
Total input power range (line input)	dBm		
Channel input power range Line Input Add	 dBm dBm		
Channel output power range Line Output Drop	 dBm dBm		
Channel signal-spontaneous noise figure Line input to line output Line input to drop Add to line output	 dB dB dB		 NA NA NA
Input reflectance	dB		NA
Output reflectance	dB		NA
Maximum reflectance tolerable at input	dB	NA	
Maximum reflectance tolerable at output	dB	NA	
Maximum total output power (line output)	dBm		NA
Channel addition/removal (steady-state) gain response	dB		
Transient duration	ms		NA
Transient gain increase	dB		NA
Transient gain reduction	dB		NA
Multichannel gain-change difference (inter-channel gain-change difference)	dB		NA

Table 4 – Transfer parameters of MD-ROADM with amplifiers

Parameter		Max	Min
Multichannel gain tilt (inter-channel gain-change ratio)	dB/dB		NA
Channel uniformity	dB		NA

Appendix I

MD-ROADM classification examples

(This appendix does not form an integral part of this Recommendation.)

I.1 Example 1

In Figure I.1, a 2-degree MD-ROADM is depicted at "day one" (shown as continuous lines). The optical lines can contain up to 80 optical channels (OTM-80r.m) with 50 GHz spacing, and each R-WADD can provide up to four multi-channel ports, which can be connected either to another R-WADD, or to an R-LADD. A colourless and directional local add/drop feature for 40 channels is provided for each of the two optical lines. A coloured and directionless add/drop feature for 40 channels is also provided: each of these wavelengths can be added/dropped to/from four directions, but it is not possible to reuse the same wavelength, because this device is not wavelength contention-less.

Starting from this "day one" configuration, it is possible to upgrade the MD-ROADM with one degree more. It is reasonable to have an R-WADD with the same characteristic (OTM-80r.m), providing a colourless and directional add/drop feature as before, and to have the coloured and directionless feature by connecting the new R-WADD to the coloured/directionless device already installed. In Figure I.1, the upgrading is depicted by the dashed lines. The maximum number of optical channels that this MD-ROADM is able to add/drop is equal to 160.

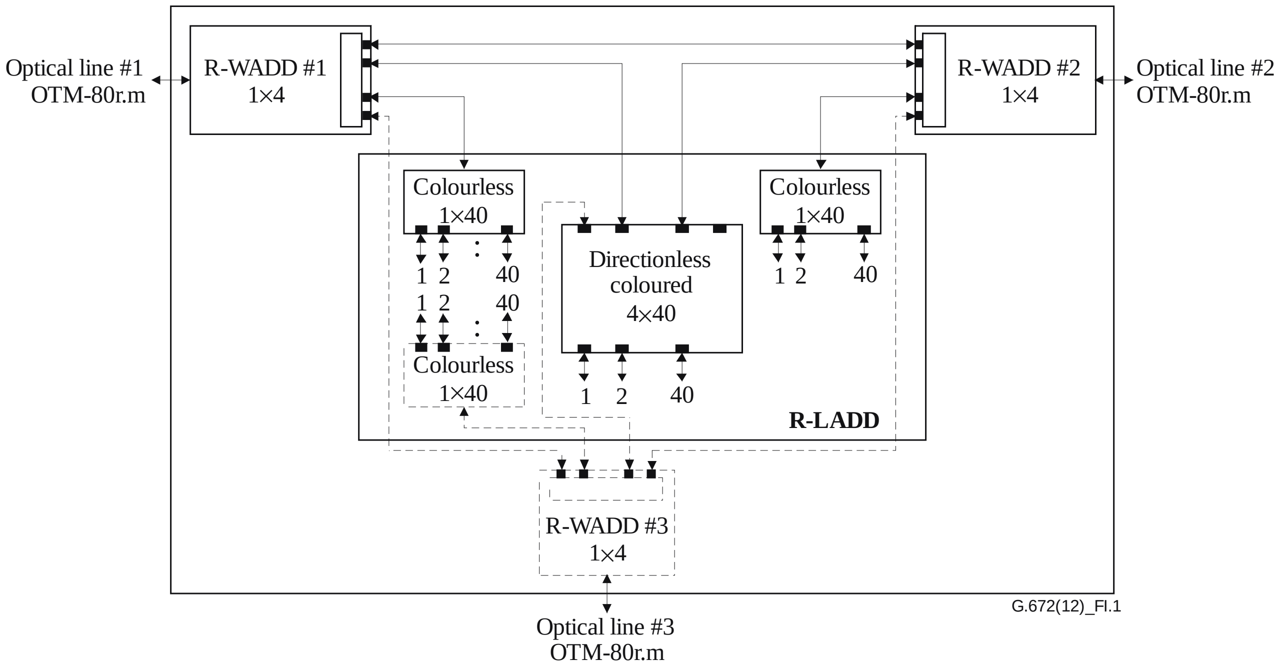

Figure I.1 – MD-ROADM scheme for example 1

The classification according to clause 5 is shown in Tables I.1 and I.2.

Table I.1 – MD-ROADM Example 1: general characteristics

Maximum node degree	3
Maximum node channel count	240
Maximum add/drop ports	160
Minimum channel spacing	50 GHz
Maximum add/drop ratio	66%
Coloured local add/drop	Yes
Colourless local add/drop	Yes
Directional local add/drop	Yes
Directionless local add/drop	Yes
Contention-less local add/drop	Yes

Table I.2 – MD-ROADM Example 1: local add/drop ratio parameters

Maximum coloured and directional add/drop ratio	0%
Maximum coloured and directionless add/drop ratio	16%
Maximum coloured, directionless and contention-less add/drop ratio	0%
Maximum colourless and directional add/drop ratio	50%
Maximum colourless and directionless add/drop ratio	0%
Maximum colourless, directionless and contention-less add/drop ratio	0%

I.2 Example 2

In this example, some requirements for an MD-ROADM deployment are given. This MD-ROADM should provide a 3 degree OTM-80r.m, 50 GHz spacing, with a maximum add/drop ratio of 60%, consisting of 50% with a colourless, directionless and contention-less feature, and 10% with a coloured and directional feature, at "day one". The MD-ROADM should provide a maximum degree equal to 6. Moreover, it has to provide protection against a single failure in the colourless, directionless and contention-less subsystem.

The classification according to clause 5 is shown in Tables I.3 and I.4.

Table I.3 – MD-ROADM Example 2: general characteristics

Maximum node degree	6
Maximum node channel count	480
Maximum add/drop ports	288
Minimum channel spacing	50 GHz
Maximum add/drop ratio	60%
Coloured local add/drop	Yes
Colourless local add/drop	Yes
Directional local add/drop	Yes
Directionless local add/drop	Yes
Contention-less local add/drop	Yes

Table I.4 – MD-ROADM Example 2: local add/drop ratio parameters

Maximum coloured and directional add/drop ratio	10%
Maximum coloured and directionless add/drop ratio	0%
Maximum coloured, directionless and contention-less add/drop ratio	0%
Maximum colourless and directional add/drop ratio	0%
Maximum colourless and directionless add/drop ratio	0%
Maximum colourless, directionless and contention-less add/drop ratio	50%

An example of the resulting MD-ROADM scheme at "day one" is shown in Figure I.2. Optical connections (shown as continuous lines) refer to connections between R-WADDs for wavelength pass-through, while dashed lines refer to connections between the R-WADDs and R-LADD.

To reach the maximum node degree, three multi-channel ports should still be available on each R-WADD.

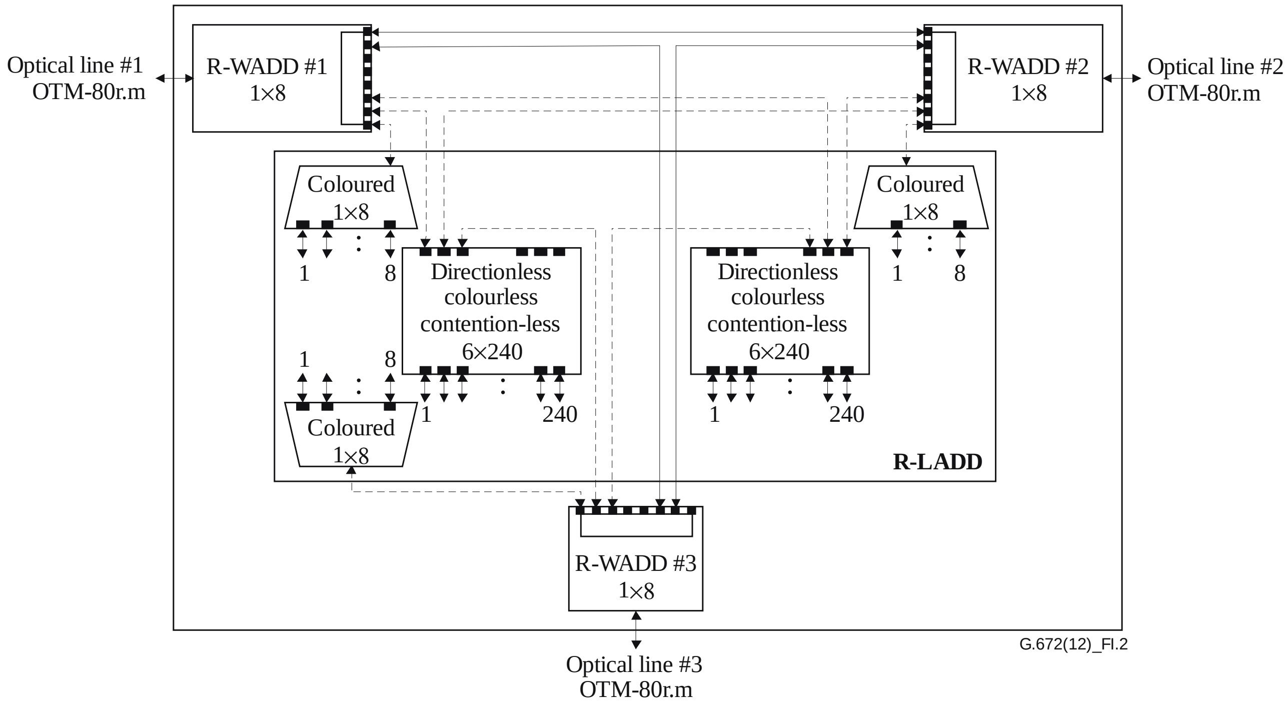

Figure I.2 – MD-ROADM scheme for Example 2

Appendix II

Configuration examples of MD-ROADM

(This appendix does not form an integral part of this Recommendation.)

II.1 Example of direction/degree expansion of MD-ROADM

In order to illustrate the direction/degree expansion of MD-ROADM, an example configuration is shown in Figure II.1. A 2-degree MD-ROADM with optical amplifiers is first constructed by using two multi-port R-WADDs and when expanding to a new direction, another multi-port R-WADD shown with dashed lines is included by connecting with fibre jumpers. The maximum direction/degree is then expanded to three, and consequently, the total number of wavelengths which are locally added/dropped and managed for node pass-through, can change dynamically.

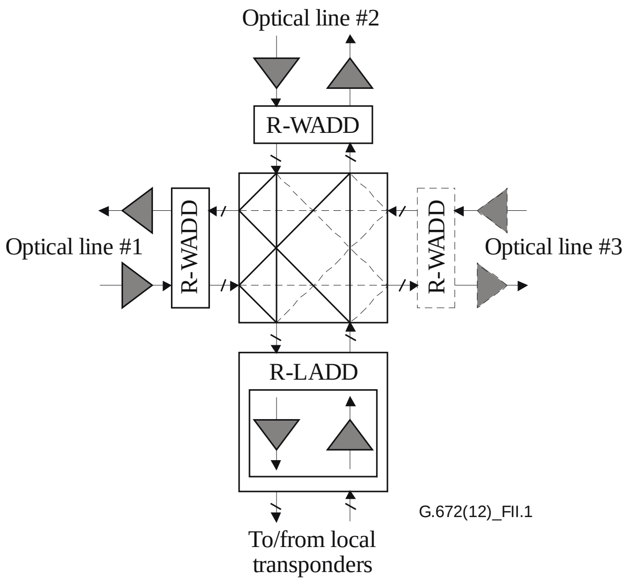

Figure II.1 – Configuration of the direction/degree expansion example

II.2 Example of an MD-ROADM with the directionless and colourless feature

An MD-ROADM with the directionless and colourless feature is depicted in Figure II.2 and the L-WADD device is realized by using wavelength selective switches (WSSs). In an MD-ROADM, the L-WADD feature should provide both the "wavelength-independent" add/drop of optical channels, as well as the "direction-independent" add/drop. Any wavelength from any direction or originating at that node can then be multicast to all the directions to/from any optical line port.

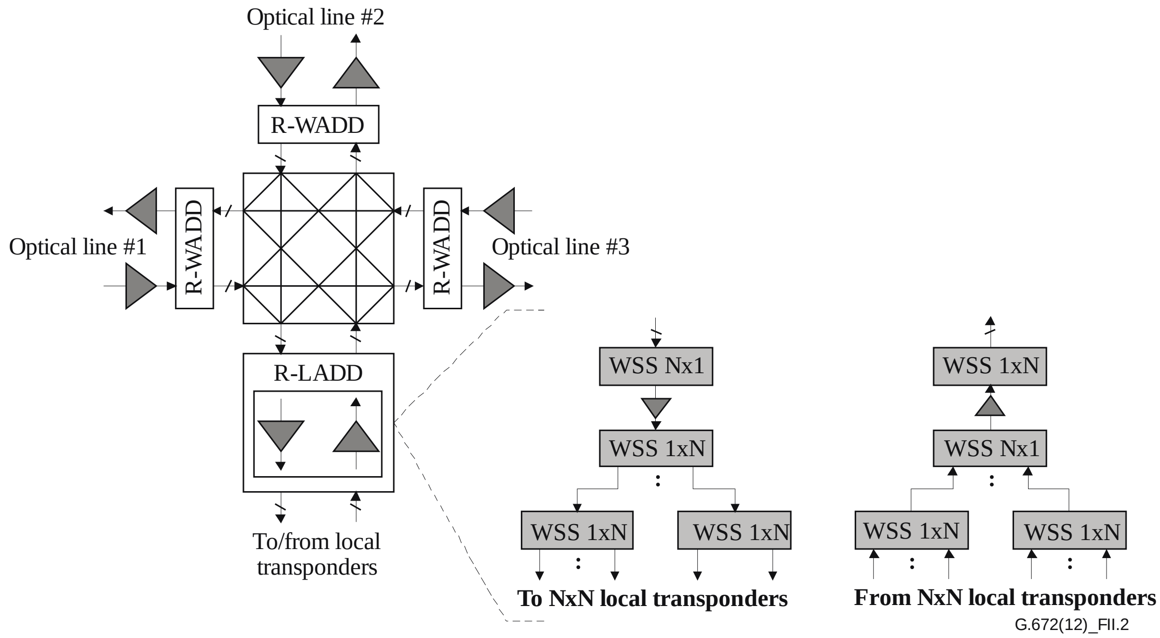

Figure II.2 – Configuration of an MD-ROADM with the directionless and colourless feature

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	**Transmission systems and media, digital systems and networks**
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Terminals and subjective and objective assessment methods
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects and next-generation networks
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2013