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Palo Alto, CA 94301 (US). MISSEY, Mark, J.; 1377 Arbor Park Dr., San Jose, CA 95126 (US). DOMINIC, Vincent, G.; 38419 Acacia Street, Fremont, CA 94536 (US). MATHUR, Atul; 2469 Michele Jean Way, Santa Clara, CA 95050 (US). PETERS, Frank, H.; 1170 Wilhelmina Way, San Jose, CA 95120 (US). JOYNER, Charles, H.; 374 Redondo Terrace, Sunnyvale, CA 94086 (US). SCHNEIDER, Richard, P.; 1759 Cherrytree Lane, Mountain View, CA 94040 (US). CHIANG, Ting-Kuang; 20885 Wardell Road, Saratoga, CA 95070 (US).

(74) Agent: CAROTHERS, W., Douglas; Infinera Corporation, 1322 Bordeaux Drive, Sunnyvale, CA 94089 (US).

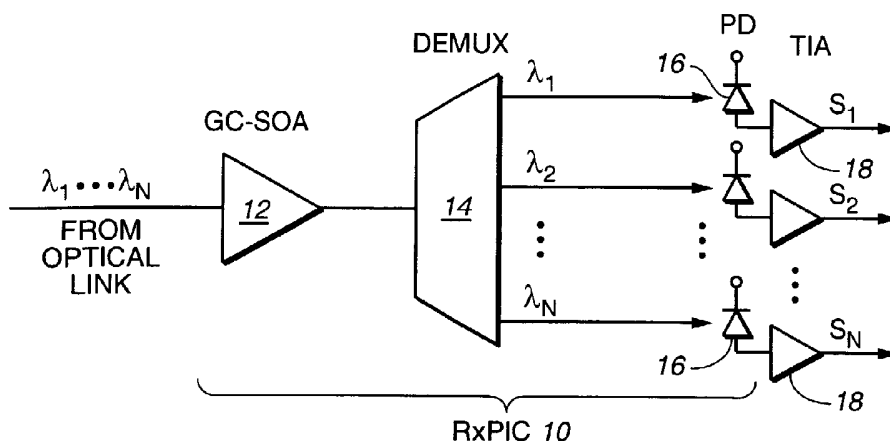
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- (71) Applicant: INFINERA CORPORATION [US/US]; 1322 Bordeaux Drive, Sunnyvale, CA 94089 (US).
- (72) Inventors: WELCH, David, F.; 1845 White Oak Drive, Menlo Park, CA 94025 (US). NAGARAJAN, Radhakrishnan, L.; 7800 Creekline Drive, Cupertino, CA 95014 (US). KISH, Fred, A., Jr.; 335 Everett Avenue,

(54) Title: DEMULTIPLEXING OPTICAL SIGNAL RECEIVER PHOTONIC INTEGRATED CIRCUIT (RxPIC) AND ASSOCIATED TRANSMITTER AND METHOD OF TESTING A PHOTONIC INTEGRATED CIRCUIT



(57) Abstract: A photonic integrated circuits (PICs), also referred to as opto-electronic integrated circuits (OEICs), and more particularly to a PIC in the form of an optical receiver PIC or RxPIC for use in an optical transport networks. Also, an optical transmitter PIC (TxPIC) is also disclosed in conjunction with an RxPIC in an optical transport network. The chip is cast from an InP wafer and is made from Group III-V elemental materials in the InGaAsP/InP regime with fabrication accomplished through selective metalorganic vapor phase epitaxy (MOVPE) or also known as metalorganic chemical vapor deposition (MOCVD). Integrated on the chip, starting at the input end which is coupled to receive multiplexed optical data signals from an optical transport network is an optical amplifier, an optical demultiplexer, and a plurality of on-chip photodiodes (PDs) each to receive a demultiplexed data signal from the AWG DEMUX for optical-to-electrical signal conversion. The optical input amplifier may be an onchip gain clamped semiconductor optical amplifier (GC-SOA) or an off-chip fiber amplifier. The optical input amplifier may be optional if the channel signal demultiplexer provides for minimal insertion loss which is optimum with a properly designed arrayed waveguide grating (AWG) demultiplexer. A method of in-wafer testing of RxPIC chips is also described.

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Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),  
European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,  
ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK,  
TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,  
GW, ML, MR, NE, SN, TD, TG).

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A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 G02B6/34

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 G02B H01S H04B H04J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, IBM-TDB, INSPEC, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 809 184 A (DOERR CHRISTOPHER RICHARD ET AL) 15 September 1998 (1998-09-15) column 3, line 34 - column 4, line 47; figure 2	1-3, 57-59
X	----- ZIRNGIBL M ET AL: "WDM RECEIVER BY MONOLITHIC INTEGRATION OF AN OPTICAL PREAMPLIFIER, WAVEGUIDE GRATING ROUTER AND PHOTODIODE ARRAY" ELECTRONICS LETTERS, IEE STEVENAGE, GB, vol. 31, no. 7, 30 March 1995 (1995-03-30), pages 581-582, XP000504325 ISSN: 0013-5194 cited in the application	57-59
Y	----- the whole document	1-3,17, 60,61
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Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

° Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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- "P" document published prior to the international filing date but later than the priority date claimed

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- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

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Name and mailing address of the ISA  
European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Ciarrocca, M

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/US 02/32110

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DOUSSIÈRE P ET AL: "CLAMPED GAIN TRAVELLING WAVE SEMICONDUCTOR OPTICAL AMPLIFIER FOR WAVELENGTH DIVISION MULTIPLEXING APPLICATIONS" PROCEEDINGS OF THE INTERNATIONAL SEMICONDUCTOR LASER CONFERENCE. MAUI, HAWAII, SEPT. 19 - 23, 1994, NEW YORK, IEEE, US, vol. CONF. 14, 19 September 1994 (1994-09-19), pages 185-186, XP000514864 ISBN: 0-7803-1755-6 the whole document	1-3,17, 60,61
A	----- DOUSSIÈRE P ET AL: "1550 nm polarization independent DBR gain clamped SOA with high dynamic input power range" ECOC '96. 22ND EUROPEAN CONFERENCE ON OPTICAL COMMUNICATION (IEEE CAT. NO.96TH8217), PROCEEDINGS OF EUROPEAN CONFERENCE ON OPTICAL COMMUNICATION, OSLO, NORWAY, 15-19 SEPT. 1996, pages 169-172 vol.3, XP010303139 1996, Kjeller, Norway, Telenor, Norway ISBN: 82-423-0418-1 the whole document	1,17,60, 61
A	----- THOURHOUT VAN D ET AL: "ELIMINATION OF CROSSTALK IN THE COMMON OUTPUT AMPLIFIER OF A MULTI-WAVELENGTH SOURCE BY GAIN CLAMPING" OFC/IOOC '99 OPTICAL FIBER COMMUNICATION CONFERENCE / INTERNATIONAL CONFERENCE ON INTEGRATED OPTICS AND OPTICAL FIBER COMMUNICATION. SAN DIEGO, CA, FEB. 21 - 26, 1999, OPTICAL FIBER COMMUNICATION CONFERENCE / INTERNATIONAL CONFERENCE ON INTEGRATED OP, 21 February 1999 (1999-02-21), pages THB4-1-THB4-3, XP000966987 ISBN: 0-7803-5430-3 the whole document	1,60
A	----- DOUSSIÈRE P ET AL: "1.55 μM POLARISATION INDEPENDENT SEMICONDUCTOR OPTICAL AMPLIFIER WITH 25 DB FIBER TO FIBER GAIN" IEEE PHOTONICS TECHNOLOGY LETTERS, IEEE INC. NEW YORK, US, vol. 6, no. 2, 1 February 1994 (1994-02-01), pages 170-172, XP000439743 ISSN: 1041-1135 cited in the application the whole document	1
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## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/US 02/32110

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>STEENBERGEN C A M ET AL: "System performance of a 4-channel PHASAR WDM receiver operating at 1.2 Gbit/s" OFC'96. OPTICAL FIBER COMMUNICATION. VOL.2. 1996 TECHNICAL DIGEST SERIES. CONFERENCE EDITION (IEEE CAT. NO.96CH35901), OFC '96 - CONFERENCE ON OPTICAL FIBER COMMUNICATION, SAN JOSE, CA, USA, 25 FEB.-1 MARCH 1996, pages 310-311, XP010540020 1996, Washington, DC, USA, Opt. Soc. America, USA the whole document</p> <p style="text-align: center;">-----</p>	50-52, 57-59
X	<p>SUZUKI H ET AL: "Optical signal quality monitor built into WDM linear repeaters using semiconductor arrayed waveguide grating filter monolithically integrated with eight photodiodes" ELECTRONICS LETTERS, IEE STEVENAGE, GB, vol. 35, no. 10, 13 May 1999 (1999-05-13), pages 836-837, XP006012157 ISSN: 0013-5194 the whole document</p> <p style="text-align: center;">-----</p>	50-52, 57-59
A	<p>PATENT ABSTRACTS OF JAPAN vol. 2000, no. 03, 30 March 2000 (2000-03-30) -&amp; JP 11 340920 A (NIPPON TELEGR &amp;TELEPH CORP &amp;LT;NTT&amp;GT;), 10 December 1999 (1999-12-10) abstract</p> <p style="text-align: center;">-----</p>	1,2
X	<p>US 6 094 298 A (SRIVASTAVA ATUL K ET AL) 25 July 2000 (2000-07-25)</p> <p style="text-align: center;">-----</p>	50-52, 57-59
A	<p>column 3, line 1 - line 38; figure 1 column 4, line 61 - line 63</p> <p style="text-align: center;">-----</p>	1
A	<p>SOOLE J B D ET AL: "Monolithic WDM Sources And Detectors For The Long Wavelength Fiber Band Based On An InP Grating Multiplexer/demultiplexer" LEOS '92, CONFERENCE PROCEEDINGS. IEEE LASERS AND ELECTRO-OPTICS SOCIETY, 1992 ANNUAL MEETING BOSTON, MA, USA 16-19 NOV. 1992, NEW YORK, NY, USA, IEEE, US, 16 November 1992 (1992-11-16), pages 690-691, XP010103170 ISBN: 0-7803-0526-4 the whole document</p> <p style="text-align: center;">-----</p>	1,57

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US 02/32110

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
  
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this International application, as follows:

see additional sheet

1.  As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3.  As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4.  No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-52, 57-61

Remark on Protest

- The additional search fees were accompanied by the applicant's protest.
- No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-52,57-61

Monolithic WDM receiver with amplifier having equalized spectral amplification (gain-clamped semiconductor amplifier or fiber amplifier); Monolithic WDM receiver with amplifier  
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2. claims: 53-56,94,95

Monolithic AWG based WDM receiver with selection of best amplifier from a plurality of semiconductor optical amplifiers  
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3. claims: 62-72

Arrangement of output waveguides in an AWG based monolithic WDM receiver  
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4. claims: 73-78,92,93

Transport network and converter with monolithic AWG transmitter and monolithic AWG receiver having matched passbands  
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5. claims: 79-83

Monolithic WDM receiver with AWG equalising gain from amplifier  
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6. claims: 84-91

Monolithic AWG based WDM receiver with noise detection and transimpedance circuit  
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7. claims: 96-99

Method of testing an integrated circuit having a photodetector  
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8. claims: 100-108

FEC enhanced optical transport network having a WDM transmitter and receiver and FEC encoders and decoders for bit error rate based control  
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No  
PCT/US 02/32110

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5809184	A	15-09-1998	NONE	
JP 11340920	A	10-12-1999	NONE	
US 6094298	A	25-07-2000	US 6008932 A	28-12-1999