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(71) Applicant *(for all designated States except US)*: **KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY** [KR/KR]; 373-1, Guseong-dong Yuseong-gu, Daejeon 305-701 (KR).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **LEE, Chang-Hee** [KR/KR]; 102 Ho 110 Dong Hanwool Apt., Shinseong-dong Yuseong-gu, Daejeon 305-345 (KR). **LEE, Sang-Mook** [KR/KR]; 302 Ho Hyundai Billa, 52-25 Goijung-dong Seo-gu, Daejeon 302-200 (KR). **KIM, Min-Hwan** [KR/KR]; 323 Dong 402 Ho Jonggoongyo Apt., Shinbong-dong Yuseong-gu, Daejeon 305-154 (KR).

(74) Agent: **SONG, Byeong Ok**; Shinwon B/D 3F, 648-15 Yeoksam-dong, Gangnam-gu, Seoul 135-911 (KR).

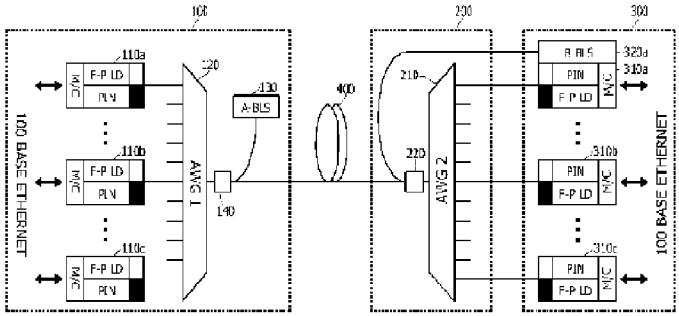
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(54) **Title:** THE LONG-REACH WAVELENGTH DIVISION MULTIPLEXING PASSIVE OPTICAL NETWORKS BY USING THE POSITION ADJUSTMENT OF BROADBAND LIGHT SOURCE



(57) **Abstract:** The present invention relates to a wavelength division multiplexing passive optical network (WDM-PON) for long-reach transmission using a position adjustment of a broadband light source (BLS), and particularly relates to a WDM-PON which extends s transmission distance of the WDM-PON by adjusting a position of a BLS so as to procure a high quality of service (QoS) and to reduce transmission costs in an optical network. A WDM-PON for long-reach transmission using a position adjustment of a broadband light source (BLS) in accordance with the present invention comprises a central office (CO) comprising an A-band BLS to be injected into a light source for downstream signals, an A-band BLS coupling device for coupling the A-band BLS, a first wavelength-division multiplexer/de¬ multiplexer connected to the A-band BLS coupling device for multiplexing/demultiplexing, and a plurality of first optical transceivers connected to the first wavelength-division multiplexer/d emultiplexer; a remote node (RN) comprising a B-band BLS coupling device and a second wavelength-division multiplexer/demultiplexer connected to the B-band BLS coupling device for multiplexing/demultiplexing, and being connected to the CO through an optical fiber; and a plurality of optical network terminations (ONTs) including a plurality of second optical transceivers connected to the second wavelength-division multiplexer/demultiplexer, wherein either the RN or one of the plurality of ONTs further includes a B-band BLS to be injected to a light source for upstream signals.

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Description

THE LONG-REACH WAVELENGTH DIVISION MULTIPLEXING PASSIVE OPTICAL NETWORKS BY USING THE POSITION ADJUSTMENT OF BROADBAND LIGHT SOURCE

Technical Field

[1] The present invention relates to a wavelength division multiplexing passive optical network (WDM-PON) for long-reach transmission using a position adjustment of a broadband light source (BLS). More specifically, the present invention relates to a WDM-PON which extends s transmission distance of the WDM-PON by adjusting a position of a BLS so as to procure a high quality of service (QoS) and to reduce transmission costs in an optical network.

Background Art

[2] Demand on a wider bandwidth per each subscriber is increased as voice and text oriented services have evolved to video based services due to a rapid expansion of Internet. To meet this demand, a study on passive optical network (PON) technologies based on optical fiber has actively carried out. The PON technologies are classified as a time division multiplexing passive optical network (TDM-PON) and a WDM-PON.

[3] Generally, a maximum transmission distance between a central office (CO) and each subscriber in a PON is limited to be 20Km. However, if a long-reach transmission is possible from CO to each subscriber, a region to be serviced by one CO can be increased greatly. For example, when extending the maximum transmission distance of a PON to 60Km, it is possible to provide services for a certain area by using only one CO, while the same area may be provided with services by using 9 COs when using a PON having a maximum transmission distance of 20Km. In this case, because signals can be transmitted through optical fibers from a subscriber to CO, a metro network and any equipments for a metro network provided between a subscriber and CO can be removed and thus it is possible to procure a high QoS of signals easily.

[4] Therefore, when using a PON capable of a long-reach transmission, it is possible to reduce the number of CO greatly in a whole optical network. As a result, it is possible to reduce the costs for provision since a large area for installing CO is not required and the number of equipments to be provided for CO decreased. Further, it is possible to enhance QoS of signals provided for a subscriber because information can be possibly transmitted by a single hop from a subscriber to CO.

[5] In addition, in case of a metropolis, it is possible to provide a high quality of services having a wide bandwidth stably by installing a CO at the suburbs of the metropolis without need of installing several COs compactly in a central area thereof

and by connecting the installed CO to each subscriber located at an inner area of the metropolis using a PON capable of a long-reach transmission.

[6] Due to the advantages described above, a PON capable of a long-reach transmission may reduce the initial installation costs of an optical network greatly, increase QoS of signals by decreasing the number of hops, and reduce the maintenance costs for maintaining the optical network.

[7] In a TDM-PON having the above advantages, studies on extension of a transmission distance from CO to each subscriber are published in recent articles by D. Nesset, et al., entitled "Demonstration of 100km Reach Amplified PONs with Upstream Bit-rates of 2.5Gb/s and 10Gb/s," in Proc. of ECOC 2004, paper We2.6.3, 2004 and by Giuseppe Talli, et al., entitled "Feasibility Demonstration of 100km Reach DWDM Super PON with Upstream Bit Rates of 2.5Gb/s and 10Gb/s," in Proc. Conf. Optic. Fiber Commun. OFC 2005, paper OFI1, March, 2005.

[8] However, it is inevitable to employ an optical amplifier between CO and a subscriber in order to compensate splitting loss in optical power splitters and loss in a long-reach optical fiber used for a TDM-PON. Further, in a TDM-PON, it is required to increase a transmission bit rate to guarantee a high bandwidth per subscriber and therefore a device for compensating dispersion of an optical fiber to accomplish a long-reach transmission. Using an optical amplifier and a device for compensating dispersion results in disadvantages that costs are increased in a PON and reliability of a system is decreased.

[9] Fig. 1 illustrates a view of prior art WDM-PON for long-reach transmission. As illustrated in Fig. 1, prior art WDM-PON uses, as its light source, wavelength-locked Fabry-Perot Laser Diode (F-P LD) 11a, 11b, 11c, 31a, 31b, and 31c which have been suggested in Korean Registered Patent No. 325687 entitled "A light source for WDM-PON using a wavelength-locked Fabry-Perot laser diode by an injected broadband light source" (hereinafter referred to "'687 Patent"). In case of BLS 13 for upstream signals, loss due to optical fiber 40 positioned between CO 10 and optical network termination (ONT) 30 is inevitably incurred because both BLS 13 for upstream signals and BLS 14 for downstream signals are positioned at CO 10 in the prior art WDM-PON shown in Fig. 1. The content disclosed in '687 Patent is incorporated by reference into the present invention herein.

[10] As described above, output power of BLS 13 for upstream signals must be increased as a transmission distance is increased, because BLS 13 for upstream signals positioned at CO 10 is injected into F-P LD 31a, 31b, and 31c positioned at ONT 30 after undergoing loss of optical fiber 40. However, there are some disadvantages that the costs for BLS are sharply increased and embodying BLS becomes difficult, as the output power is increased. In addition, it is not easy to handle the high power BLS.

Disclosure of Invention

Technical Problem

[11] The object of the present invention is to solve the prior art problems and provide a WDM-PON for long-reach transmission capable of procuring QoS economically and stably without employing an optical amplifier and a dispersion compensation device by positioning BLS for upstream signals at ONT in a WDM-PON system which uses injection of spectrum-sliced BLS so that limitation to a transmission distance due to the decrease of optical power of the injected BLS is mitigated.

Technical Solution

[12] According to one aspect of the present invention, the present invention provides a wavelength-division multiplexing passive optical network for long-reach transmission using a position adjustment of a broadband light source (BLS) comprising a central office (CO) comprising an A-band BLS to be injected into a light source for downstream signals, an A-band BLS coupling device for coupling the A-band BLS, a first wavelength-division multiplexer/demultiplexer connected to the A-band BLS coupling device for multiplexing/demultiplexing, and a plurality of first optical transceivers connected to the first wavelength-division multiplexer/demultiplexer; a remote node (RN) comprising a B-band BLS coupling device and a second wavelength-division multiplexer/demultiplexer connected to the B-band BLS coupling device for multiplexing/demultiplexing, and being connected to the CO through an optical fiber; and a plurality of optical network terminations (ONTs) including a plurality of second optical transceivers connected to the second wavelength-division multiplexer/demultiplexer, wherein either the RN or one of the plurality of ONTs further includes a B-band BLS to be injected to a light source for upstream signals.

[13] Further features and advantages of the present invention can be obviously understood with reference to the accompanying drawings where same or similar reference numerals indicate same components.

Advantageous Effects

[14] In a WDM-PON for long-reach transmission using a position adjustment of BLS according to the present invention, it is possible to embody a WDM-PON capable of a long-reach transmission economically without employing an optical amplifier and a device for compensating dispersion by positioning BLS for upstream signals at ONT in a WDM-PON system which uses injection of spectrum-sliced BLS so that limitation to a transmission distance due to the decrease of optical power of the injected BLS is solved. In addition, a WDM-PON for long-reach transmission according to the present invention greatly increases the area to be serviced by one optical network. Further, it is possible to decrease initial installation costs of a system by reducing greatly the

number of COs in a whole optical network and increase may reduce the initial installation costs of an optical network greatly, increase QoS of signals by decreasing the number of hops.

[15] Moreover, in a WDM-PON for long-reach transmission using a position adjustment of BLS according to the present invention, it is possible to provide a high quality of services having a wide bandwidth stably with low installation investment costs by installing a CO at the suburbs of a metropolis without need of installing several COs compactly in a central area thereof and by connecting the installed CO to each subscriber located at an inner area of the metropolis using a PON for long-reach transmission.

Brief Description of the Drawings

[16] Fig. 1 illustrates a view of prior art WDM-PON for long-reach transmission.

[17] Fig. 2 illustrates a view of WDM-PON for long-reach transmission in accordance with the present invention where BLS is positioned at a subscriber end.

[18] Fig. 3 illustrates a view of a coupling device in accordance with the present invention to connect A-band BLS positioned at CO to a system.

[19] Fig. 4 illustrates a view of a coupling device in accordance with the present invention to connect B-band BLS positioned at a subscriber end to a system.

[20] Fig. 5 illustrates a view of WDM-PON for long-reach transmission in accordance with the present invention where BLS is positioned at a remote node.

[21] Fig. 6 illustrates a view of WDM-PON for long-reach transmission in accordance with the present invention where each BLS for upstream signals is positioned at two or more different subscribers.

Best Mode for Carrying Out the Invention

[22] Hereinafter, structures and functions of preferred embodiments in accordance with the present invention are described in more detail with reference to the appended drawings.

[23] Fig. 2 illustrates a view of WDM-PON for long-reach transmission in accordance with the present invention where BLS is positioned at a subscriber end. As illustrated in Fig. 2, a WDM-PON for long-reach transmission where BLS is positioned at ONT mainly comprises CO 100, Remote Node (RN) 200 and a plurality of ONTs 300.

[24] CO 100 further comprises A-band BLS 130 to be injected into a light source for downstream signals, A-band BLS coupling device 140 for coupling the A-band BLS, a first wavelength-division multiplexer/demultiplexer 120 connected to the A-band BLS coupling device 140 for multiplexing/demultiplexing, and optical transceivers 110a, 110b, and 110c connected to the first wavelength-division multiplexer/demultiplexer 120. Further, B-band BLS may be included in at least one adjacent CO for the purpose

of system protection.

[25] RN 200 includes B-band BLS coupling device 220 for coupling B-band BLS 320a and a second wavelength-division multiplexer/demultiplexer 210 connected to the B-band BLS coupling device 220 for multiplexing/demultiplexing, and is connected to the CO 100 through an optical fiber 400.

[26] A plurality of ONTs 300 includes optical transceivers 310a, 310b, and 310c connected to the second wavelength-division multiplexer/demultiplexer 210. At least one of the plurality of ONTs 300 may further include B-band BLS 320a.

[27] In addition, a wavelength-locked F-P LD by a BLS being injected from outside as suggested in '687 Patent, or a semiconductor optical amplifier into which BLS is injected from outside may be used as a light source for upstream signals and downstream signals. The F-P LD, the wavelength of which is locked by a BLS being injected from outside, can be an anti-reflection coated F-P LD.

[28] Further, a frequency spacing between two adjacent lasing modes of the F-P LD, the wavelength of which is locked by a BLS being injected from outside, is narrower than a channel spacing of incoherent light being injected from outside.

[29] Moreover, in case that a frequency spacing between two adjacent lasing modes of the F-P LD, the wavelength of which is locked by a BLS being injected from outside, is n times of a channel spacing of incoherent light being injected from outside, n-numbered different ONTs are used where an oscillation wavelength of the F-P LD is regulated by controlling temperature thereof.

[30] Light emitting diode (LED), amplified spontaneous emission (ASE), super luminescent diode (SLD) or semiconductor laser may be used as BLS.

[31] Arrayed waveguide grating (AWG) or thin-film filter may be used as a first wavelength-division multiplexer/demultiplexer 120 and a second wavelength-division multiplexer/demultiplexer 210. In case of using AWG, bandwidth to be provided for a subscriber may be widened by using a different band in addition to A-band and B-band when using a periodic filtering characteristic of AWG.

[32] An optical power splitter may be used as A-band BLS coupling device 140 and B-band BLS coupling device 220.

[33] Error correction codes may be used for optical transceivers 110a, 110b, and 110c connected to the first wavelength-division multiplexer/demultiplexer 120 and optical transceivers 310a, 310b, and 310c connected to the second wavelength-division multiplexer/demultiplexer 210.

[34] Fig. 3 illustrates a view of a coupling device in accordance with the present invention to connect A-band BLS positioned at CO to a system. As illustrated in Fig. 3, a coupling device for coupling A-band BLS positioned at CO to a system comprises an optical circulator 141 and two A/B-band separating wavelength division multiplexer

(A/B WDM) 142, 143.

[35] A-band BLS for downstream signals positioned at CO are inputted into terminal 1 of optical circulator 141 and are outputted from terminal 2 thereof. The output signals from terminal 2 of optical circulator 141 are inputted into terminal A of A/B WDM1 142 and are outputted to terminal AB thereof and then are inputted into the first wavelength-division multiplexer/demultiplexer 120. A-band downstream signals, each of which is wavelength-locked at CO, are multiplexed at the first wavelength-division multiplexer/demultiplexer 120 and are inputted into terminal AB of A/B WDM1 142 and then are outputted to terminal A thereof. After that, these downstream signals are inputted into terminal 2 of optical circulator 121 and pass both terminal 3 of optical circulator 121 and terminal A of A/B WDM2 143 and then are outputted to terminal AB of A/B WDM2 143. The output signals from terminal AB of A/B WDM2 143 are transmitted downstream.

[36] B-band upstream signals transmitted from ONT are inputted into terminal AB of A/B WDM2 143 and are outputted to terminal B thereof. Then, the output signals from terminal B of A/B WDM2 143 are inputted into terminal B of A/B WDM1 142 and are outputted to terminal AB thereof. The output signals from terminal AB of A/B WDM1 142 are transmitted upstream.

[37] Fig. 4 illustrates a view of a coupling device in accordance with the present invention to connect B-band BLS positioned at a subscriber end to a system. As illustrated in Fig. 4, B-band BLS for upstream signals positioned at ONT are inputted into terminal 1 of optical circulator 221 and are outputted from terminal 2 thereof. The output signals from terminal 2 of optical circulator 221 are inputted into terminal B of A/B WDM4 223 and are outputted to terminal AB thereof and then are inputted into the second wavelength-division multiplexer/demultiplexer 210. B-band downstream signals, each of which is wavelength-locked at each subscriber end, are multiplexed at the second wavelength-division multiplexer/demultiplexer 210 and are inputted into terminal AB of A/B WDM4 223 and then are outputted to terminal B thereof. After that, these upstream signals are inputted into terminal 2 of optical circulator 221 and pass both terminal 3 of optical circulator 221 and terminal B of A/B WDM3 222 and then are outputted to terminal AB of A/B WDM3 222. The output signals from terminal AB of A/B WDM3 222 are transmitted upstream.

[38] A-band downstream signals transmitted from CO are inputted into terminal AB of A/B WDM3 222 and are outputted to terminal A thereof. Then, the output signals from terminal A of A/B WDM3 222 are inputted into terminal A of A/B WDM4 223 and are outputted to terminal AB thereof. The output signals from terminal AB of A/B WDM4 223 are transmitted downstream. In the meantime, an optical circulator may be used as a BLS coupling device if a power margin of a system is enough.

[39] Fig. 5 illustrates a view of WDM-PON for long-reach transmission in accordance with the present invention where BLS is positioned at a remote node. As illustrated in Fig. 5, an alternative embodiment for embodying a WDM-PON for long-reach transmission can be shown as a configuration of WDM-PON where BLS for upstream signals is positioned at RN 200.

[40] The remaining configuration of WDM-PON is substantially the same as the configuration of WDM-PON shown in Fig. 2, except the position of BLS for upstream signals. The embodiment shown in Fig. 5 may be preferably used when power is easily procured at an installation site of RN 200.

[41] At least one adjacent RN 200 may be constructed in a near site of RN 200 and B-band BLS 230 may be further included in the adjacent RN 200. In addition, B-band BLS may be further included in an at least one adjacent RN for the purpose of system protection.

[42] Fig. 6 illustrates a view of WDM-PON for long-reach transmission in accordance with the present invention where each BLS for upstream signals is positioned at two or more different subscribers. As illustrated in Fig. 6, even if a supply of BLS is stopped due to interruption of electric power or cut-off of optical fiber at one subscriber where BLS for upstream signals is positioned, BLS positioned at a different subscriber can supply continuously BLS for upstream signals and thus can protect the system.

[43] The following two methods may be used in a real running of BLS in terms of a protection function.

[44] The first method is to run two or more BLSs at all times in normal circumstances. In this case, even when emergency at one site where a BLS is positioned occurs, it is possible to run the system by using another BLS positioned at a different site.

[45] The second method is to run a single BLS only in normal circumstances and to monitor the single running BLS by using a monitoring control circuit. When running the single BLS is limited due to emergency, it is possible to run another BLS positioned at a different site.

[46] When a frequency spacing between two adjacent lasing modes of the F-P LD, the wavelength of which is locked by a BLS being injected from outside, is narrower than a channel spacing of incoherent light being injected from outside, at least one or more lasing modes always exist within a channel band of incoherent light being injected even though an external environment may vary. Therefore, it is possible to embody a wavelength-independent ONT because a large output can be obtained when incoherent light is injected into the two adjacent lasing modes.

[47]

[48] *A frequency spacing between two adjacent lasing modes in F-P LD is determined by a cavity length thereof and a frequency spacing of each common mode is reversely

proportional to a cavity length.

[49] Accordingly, it is preferable that the cavity length of F-P LD always equals to or is longer than a cavity length value equal to the channel spacing of incoherent light being injected from outside, in order to embody a wavelength-independent ONT.

[50] However, when the cavity length of F-P LD is lengthened, it is pretty much difficult to perform a packaging of laser.

[51] As a solution to the above difficulty, it is possible to embody a wavelength-independent ONT when using F-P LD where a frequency spacing between two adjacent lasing modes in F-P LD is the same as the channel spacing of incoherent light being injected. That is, it is possible to use F-P LD at any wavelength (i.e., at any ONT) if an oscillation wavelength of F-P LD can be regulated to be one of wavelengths of incoherent light being injected by controlling the temperature thereof. In case that a frequency spacing between two adjacent lasing modes in F-P LD is n times of a channel spacing of incoherent light, n-numbered different ONTs are used.

Industrial Applicability

[52] In a WDM-PON for long-reach transmission using a position adjustment of BLS according to the present invention, it is possible to embody a WDM-PON capable of a long-reach transmission economically without employing an optical amplifier and a device for compensating color dispersion by positioning BLS for upstream signals at ONT in a WDM-PON system which uses injection of spectrum-sliced BLS so that limitation to a transmission distance due to the decrease of electrical power of the injected BLS is solved. In addition, a WDM-PON for long-reach transmission according to the present invention greatly increases the area to be serviced by one optical network. Further, it is possible to decrease initial installation costs of a system by reducing greatly the number of COs in a whole optical network and increase may reduce the initial installation costs of an optical network greatly, increase QoS of signals by decreasing the number of hops.

[53] Moreover, in a WDM-PON for long-reach transmission using a position adjustment of BLS according to the present invention, it is possible to provide a high quality of services having a wide bandwidth stably with low installation investment costs by installing a CO at the suburbs of a metropolis without need of installing several COs compactly in a central area thereof and by connecting the installed CO to each subscriber located at an inner area of the metropolis using a PON for long-reach transmission.

[54] As various modifications could be made in the constructions and method herein described and illustrated without departing from the scope of the present invention, it is intended that all matter contained in the foregoing description or shown in the ac-

companying drawings shall be interpreted as illustrative rather than limiting. Thus, the breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims appended hereto and their equivalents.

Claims

[1] A wavelength-division multiplexing passive optical network for long-reach transmission using a position adjustment of a broadband light source (BLS) comprising:

a central office (CO) comprising an A-band BLS to be injected into a light source for downstream signals, an A-band BLS coupling device for coupling the A-band BLS, a first wavelength-division multiplexer/demultiplexer connected to the A-band BLS coupling device for multiplexing/demultiplexing, and a plurality of first optical transceivers connected to the first wavelength-division multiplexer/demultiplexer;

a remote node (RN) comprising a B-band BLS coupling device and a second wavelength-division multiplexer/demultiplexer connected to the B-band BLS coupling device for multiplexing/demultiplexing, and being connected to the CO through an optical fiber; and

a plurality of optical network terminations (ONTs) including a plurality of second optical transceivers connected to the second wavelength-division multiplexer/demultiplexer,

wherein either the RN or one of the plurality of ONTs further includes a B-band BLS to be injected to a light source for upstream signals.

[2] The wavelength-division multiplexing passive optical network for long-reach transmission of claim 1, wherein the B-band BLS is included in either at least one adjacent CO or at least one adjacent RN.

[3] The wavelength-division multiplexing passive optical network for long-reach transmission of claim 1, wherein the B-band BLS is included in at least one ONT out of the plurality of ONTs.

[4] The wavelength-division multiplexing passive optical network for long-reach transmission of claim 1, wherein the light source for downstream signals and the light source for upstream signals are respectively either a F-P LD by a BLS being injected from outside, or a semiconductor optical amplifier into which a BLS is injected from outside.

[5] The wavelength-division multiplexing passive optical network for long-reach transmission of claim 4, wherein the F-P LD by a BLS being injected from outside is anti-reflection coated.

[6] The wavelength-division multiplexing passive optical network for long-reach transmission of claim 4, wherein a frequency spacing between two adjacent lasing modes in the F-P LD by a BLS being injected from outside is narrower than a channel spacing of incoherent light being injected from outside.

[7] The wavelength-division multiplexing passive optical network for long-reach transmission of claim 4, wherein in case that a frequency spacing between two adjacent lasing modes of the F-P LD by a BLS being injected from outside is n times of a channel spacing of incoherent light being injected from outside, n-numbered different ONTs are used where an oscillation wavelength of the F-P LD is regulated by controlling temperature thereof.

[8] The wavelength-division multiplexing passive optical network for long-reach transmission of anyone of claims 1 to 6, wherein the BLS is any one of a light emitting diode (LED), an amplified spontaneous emission (ASE), a super luminescent diode (SLD) and a semiconductor laser.

[9] The wavelength-division multiplexing passive optical network for long-reach transmission of claim 1, wherein the first wavelength-division multiplexer/demultiplexer and the second wavelength-division multiplexer/demultiplexer are respectively either an arrayed waveguide grating (AWG) or a thin-film filter.

[10] The wavelength-division multiplexing passive optical network for long-reach transmission of claim 1, wherein the A-band BLS coupling device comprises:
a first optical circulator having a means for inputting the A-band BLS into a first terminal 1 thereof and for outputting the A-band BLS to a first terminal 2 thereof and a means for inputting wavelength-locked A-band downstream signals into the first terminal 2 thereof and for outputting the wavelength-locked A-band downstream signals to a first terminal 3 thereof;
a first band separating wavelength division multiplexer having a means for inputting the A-band BLS into a first terminal A thereof and for outputting the A-band BLS to a first terminal AB thereof, a means for inputting the wavelength-locked A-band downstream signals into the first terminal AB thereof and for outputting the wavelength-locked A-band downstream signals to the first terminal A thereof, and a means for inputting B-band upstream signals transmitted from a subscriber end into a first terminal B thereof and for outputting the B-band upstream signals to the first terminal AB thereof; and
a second band separating wavelength division multiplexer having a means for inputting the wavelength-locked A-band downstream signals into a second terminal A thereof and for outputting the wavelength-locked A-band downstream signals to a second terminal AB thereof and a means for inputting the B-band upstream signals transmitted from the subscriber end into the second terminal AB thereof and for outputting the B-band upstream signals to a second terminal B thereof.

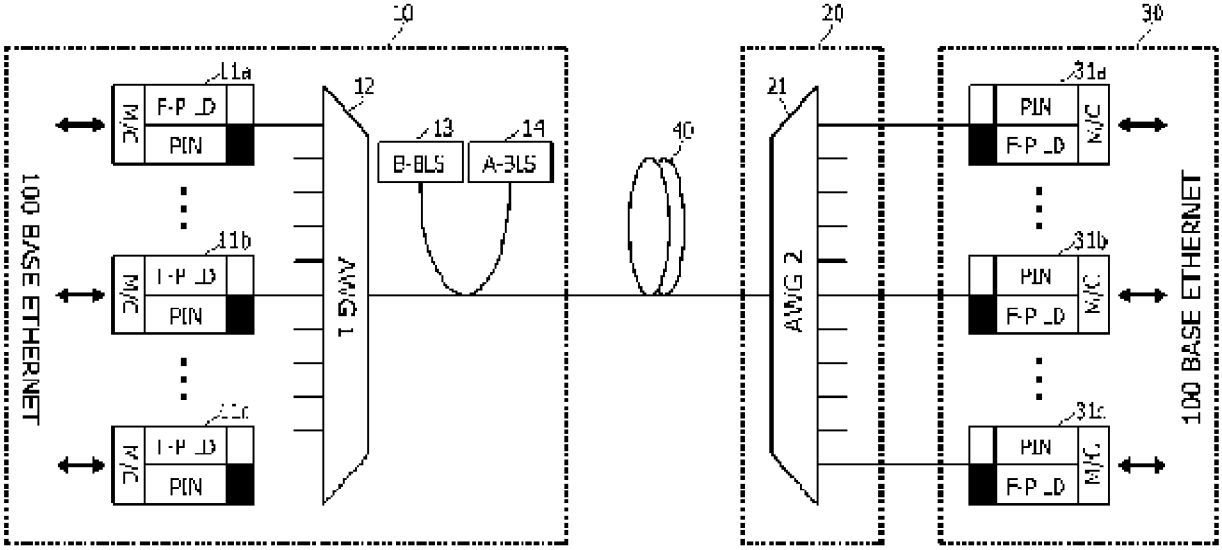
[11] The wavelength-division multiplexing passive optical network for long-reach transmission of claim 1, wherein the B-band BLS coupling device comprises:

a second optical circulator having a means for inputting the B-band BLS into a second terminal 1 thereof and for outputting the B-band BLS to a second terminal 2 thereof and a means for inputting wavelength-locked B-band downstream signals into the second terminal 2 thereof and for outputting the wavelength-locked B-band downstream signals to a second terminal 3 thereof;
a fourth band separating wavelength division multiplexer having a means for inputting the B-band BLS into a fourth terminal B thereof and for outputting the B-band BLS to a fourth terminal AB thereof, a means for inputting the wavelength-locked B-band upstream signals into the fourth terminal AB thereof and for outputting the wavelength-locked B-band upstream signals to the fourth terminal B thereof, and a means for inputting A-band downstream signals transmitted from the CO into a fourth terminal A thereof and for outputting the A-band downstream signals to the fourth terminal AB thereof; and
a third band separating wavelength division multiplexer having a means for inputting the wavelength-locked B-band upstream signals into a third terminal B thereof and for outputting the wavelength-locked B-band upstream signals to a third terminal AB thereof and a means for inputting the A-band downstream signals transmitted from the CO into the third terminal AB thereof and for outputting the A-band downstream signals to a third terminal A thereof.

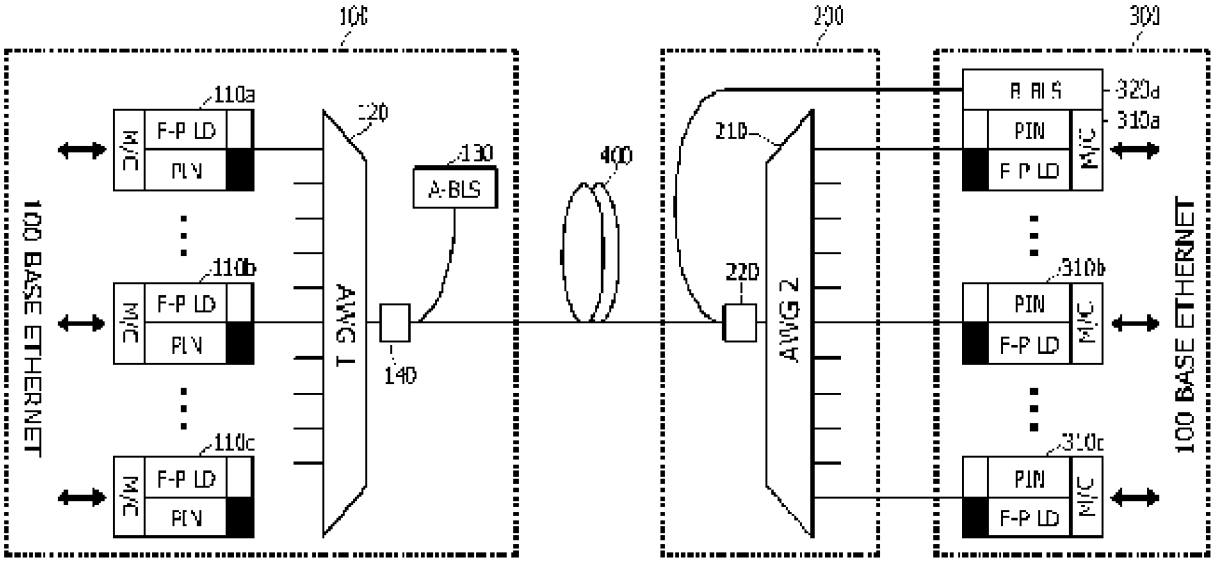
[12] The wavelength-division multiplexing passive optical network for long-reach transmission of anyone of claims 1, 10 and 11, wherein the A-band BLS coupling device and the B-band BLS coupling device are respectively either an arrayed waveguide grating (AWG) or a thin-film filter.

[13] The wavelength-division multiplexing passive optical network for long-reach transmission of claim 1, wherein an error correction code is used for the plurality of first optical transceivers connected to the first wavelength-division multiplexer/demultiplexer and the plurality of second optical transceivers connected to the second wavelength-division multiplexer/demultiplexer, respectively.

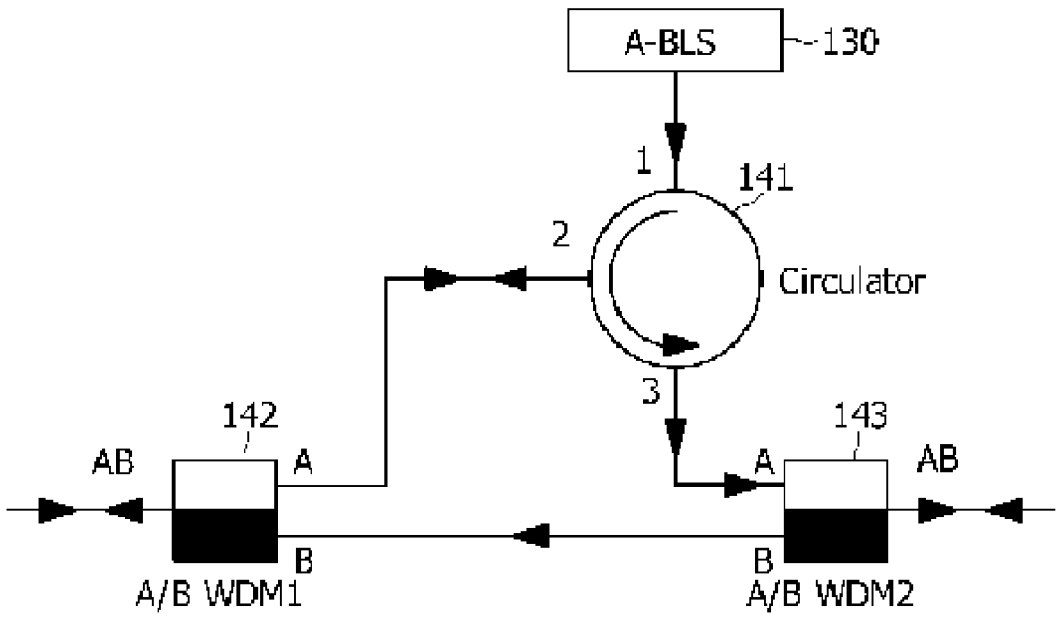
[Fig. 1]



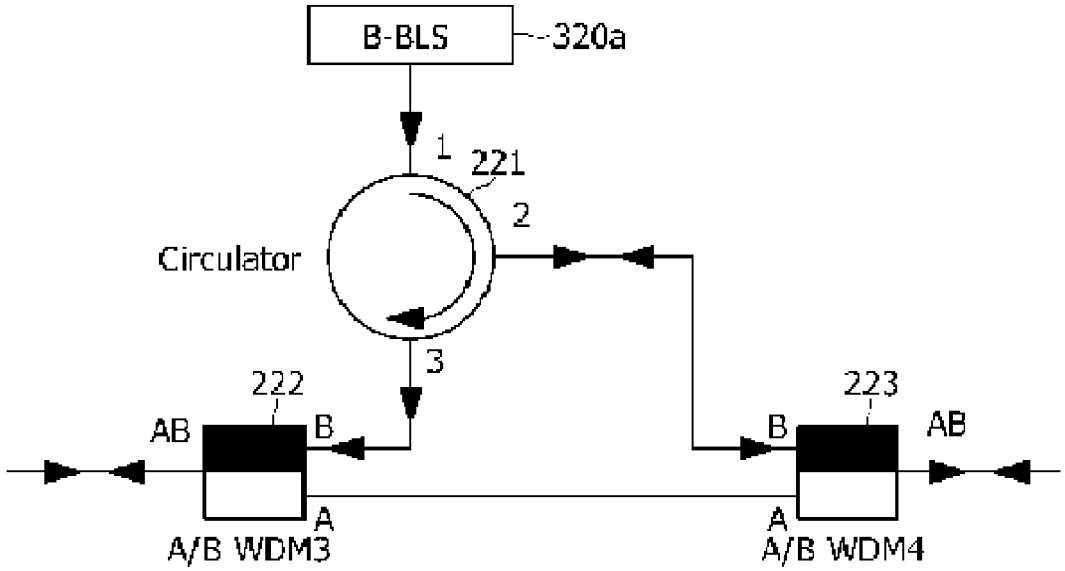
[Fig. 2]



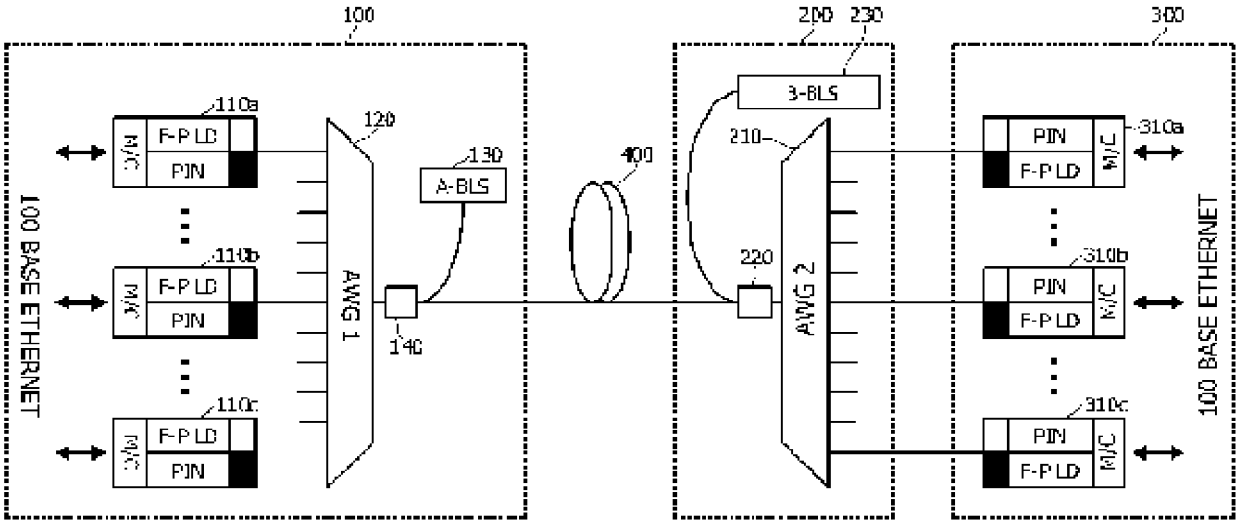
[Fig. 3]



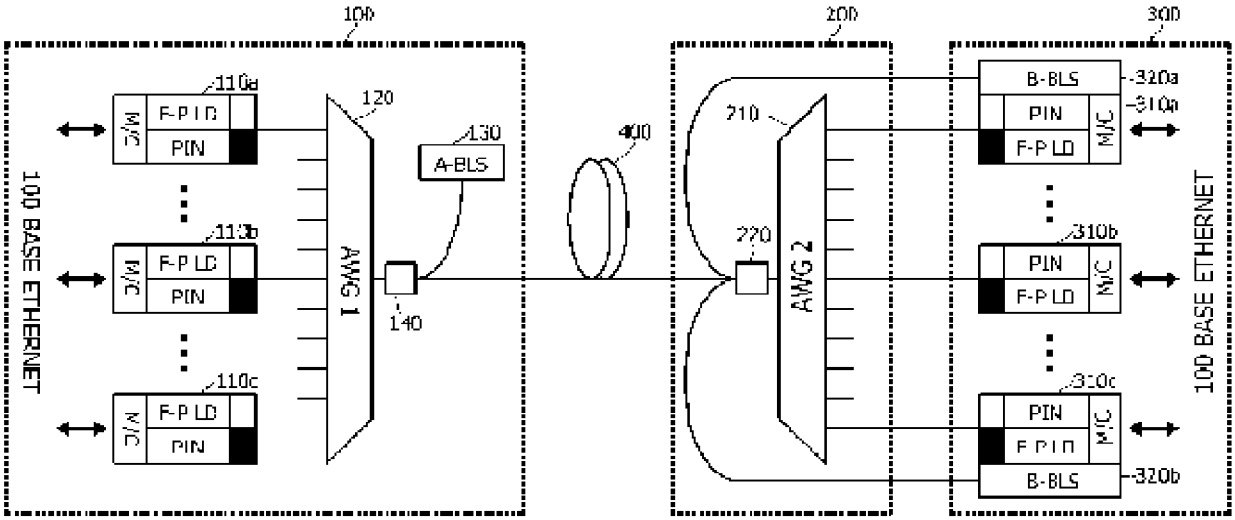
[Fig. 4]



[Fig. 5]



[Fig. 6]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2006/003075

A. CLASSIFICATION OF SUBJECT MATTER

H04B 10/12(2006.01)i

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)

IPC8: H04B, H04J

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

Korean Patents and applications for invention since 1975

Korean Utility models and applications for Utility Models since 1975

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

eKIPASS(KIPO internal) "Wavelength Division Multiplexing, Passive Optical Network, Broadband Light Source"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2005/0074240 A1 (JUNG, DAE-KWANG et al.) 7 April 2005 See abstract; claims 1-24; figures 1, 3, 4.	1-13
A	KR 10-2005-0010101 A (SAMSUNG ELECTRONICS CO., LTD.) 27 January 2005 See abstract; claims 1-9; figures 1, 3.	1-13
A	EP 1435701 A2 (SAMSUNG ELECTRONICS CO., LTD.) 7 July 2004 See abstract; claims 1-18; figures 3-5.	1-13
A	US 2005/0141892 A1 (PARK, SUNG-BUM et al.) 30 June 2005 See abstract; claims 1-19; figures 2, 7.	1-13

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 NOVEMBER 2006 (29.11.2006)	**01 DECEMBER 2006 (01.12.2006)**

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
920 Dunsan-dong, Seo-gu, Daejeon 302-701,
Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

LEE, Bo Hyung

Telephone No. 82-42-481-5701

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/KR2006/003075

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EP 1435701 A2	7 July 2004	EP 1435701 A3	29-06-2005
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		KR 10-2005-0069502 A	05-07-2005