

SINGLE-FIBER BIDIRECTIONAL OPTICAL ASSEMBLY

FIELD OF THE DISCLOSURE

[0001] The present disclosure relates to the technical field of optical communication technology, and specifically relates a single-fiber bidirectional optical assembly.

BACKGROUND OF THE DISCLOSURE

[0002] The optical module usually consists of an optical emitter assembly (including a semiconductor laser), an optical receiving assembly, a driving circuit, and a photo or electric interface, etc. The optical module is used for implementing a photo-electric signal conversion and an electric-photo signal conversion. In a transmit end, after an electric signal is processed by a driving chip, a laser is driven to emit a modulation optical signal with a corresponding velocity, and an optical power automatic controlled circuit outputs an optical signal with a stable power. In a receiving end, after an optical signal with a constant velocity is inputted to a module, the optical signal with a constant velocity is conversed into an electric signal by a photodetector, and then the electric signal with a corresponding velocity is outputted by a preamplifier.

[0003] Since the semiconductor laser generates heat during the operation process, the temperature of the semiconductor laser increases, the internal electric-photo conversion rate of the semiconductor laser decreases with the increasing temperature, and the output optical power is different at different temperatures, thus resulting in a large difference in the output optical power of optical assembly in high-temperature and low-temperature working

environments. In the existing technology, the output optical power at different temperatures is adjusted by adjusting the driving current of the semiconductor laser, but the driving current will affect the bandwidth and other performances, and the adjustment range of the traditional single-fiber bidirectional optical assembly is limited due to the influence of bandwidth.

SUMMARY OF THE DISCLOSURE

TECHNICAL PROBLEM

[0004] The objectives of the present disclosure are to provide a single-fiber bidirectional optical assembly.

SOLUTION OF THE PROBLEM

TECHNICAL SOLUTION

[0005] The present disclosure provides a single-fiber bidirectional optical assembly that comprises: an optical emitter, an optical receiver, a lens assembly, a first filter, a second filter, and an optical fiber interface end. The optical fiber interface end is used for being connected to an optical fiber, a downlink optical signal emitted by the optical emitter is focused by the lens assembly, and is then emitted to the optical fiber sequentially through the first filter and the optical fiber interface end, and is transmitted by the optical fiber. An uplink optical signal is transmitted through the optical fiber before through the second filter and is then received by the optical receiver.

[0006] The single-fiber bidirectional optical assembly further comprises at least one optical power attenuator, the optical power attenuator is arranged between the optical emitter and the optical fiber interface end, and a

transmittance of the optical power attenuator varies with a wavelength of an optical signal.

[0007] As a further improvement of the present disclosure, the transmittance of the optical power attenuator increases linearly with the wavelength of the optical signal.

[0008] As a further improvement of the present disclosure, the optical emitter is a semiconductor laser, the transmittance of the optical power attenuator increases linearly with the wavelength of the optical signal within a range from a first wavelength WL1 to a second wavelength WL2. The first wavelength WL1 is less than a wavelength lower limit of the downlink optical signal emitted by the semiconductor laser within an operating temperature range, and the second wavelength is greater than a wavelength upper limit of the downlink optical signal emitted by the semiconductor laser within the operating temperature range.

[0009] As a further improvement of the present disclosure, the optical emitter is a distributed feedback laser or an electro-absorption modulated laser.

[0010] As a further improvement of the present disclosure, the optical power attenuator comprises a substrate and a filter film coated a light passing surface of the substrate.

[0011] As a further improvement of the present disclosure, the single-fiber bidirectional optical assembly further comprises an lens assembly and an optical isolator that are arranged between the optical emitter and the first filter, the optical power attenuator is arranged between the optical isolator and the first filter, or is arranged between the optical isolator and the lens assembly, or is arranged between the optical emitter and the lens assembly.

[0012] As a further improvement of the present disclosure, the single-fiber bidirectional optical assembly further comprises an optical isolator attached to the optical fiber interface, the optical power attenuator is arranged between the first filter and the lens assembly, or is arranged between the optical emitter and the lens assembly.

[0013] As a further improvement of the present disclosure, the optical power attenuator comprises a filter film coated on the first filter.

[0014] As a further improvement of the present disclosure, the filter film is a film system with alternately stacked Ta₂O₅ and/or SiO₂ films.

[0015] As a further improvement of the present disclosure, the filter film is a wavelength division multiplexing film, and a transmittance of the wavelength division multiplexing film increases linearly with the wavelength within a pass-band wavelength range of the wavelength division multiplexing film.

BENEFICIAL EFFECT OF THE PRESENT DISCLOSURE

BENEFICIAL EFFECT

[0016] The beneficial effects of the present disclosure are that: the optical power attenuator whose transmittance increases linearly with the wavelength of the optical signal is arranged in the single-fiber bidirectional optical assembly, so that a synergistic action with the semiconductor laser is generated, and the output optical power difference of the single-fiber bidirectional optical assembly in high-temperature and low-temperature working environments is reduced, and , in a passive external modulation manner, the optical power adjustment range is extended to the maximum under the condition that high-frequency bandwidth and other properties of the optical emitter are not affected.

BRIEF DESCRIPTION OF THE DRAWINGS

DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 is a schematic diagram of a single-fiber bidirectional optical assembly of Embodiment 1 of the present disclosure.

[0018] FIG. 2 is the transmittance curves of an optical power attenuator in implementations of the present disclosure.

[0019] FIG. 3 is a schematic diagram of a single-fiber bidirectional optical assembly of Embodiment 2 of the present disclosure.

[0020] FIG. 4 is a schematic diagram of a single-fiber bidirectional optical assembly of Embodiment 3 of the present disclosure.

[0021] FIG. 5 is a schematic diagram of a single-fiber bidirectional optical assembly of Embodiment 4 of the present disclosure.

[0022] FIG. 6 is a schematic diagram of a single-fiber bidirectional optical assembly of Embodiment 5 of the present disclosure.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

THE EXEMPLARY EMBODIMENTS OF THE PRESENT DISCLOSURE

[0023] In order to make the purpose, technical solutions and advantages of the present disclosure clearer, the technical solutions of the present disclosure will be clearly and completely described below in conjunction with the specific implementation modes of the present disclosure and the corresponding drawings. Obviously, the described embodiments are only some of the embodiments of the present disclosure, but not all of them. Based on the embodiments in the present disclosure, all other embodiments obtained by those

of ordinary skill in the art without creative efforts fall within the scope of protection of the present disclosure.

[0024] Embodiments of the present disclosure are described in detail below. Examples of the embodiments are shown in the accompanying drawings; in which the same or similar reference numerals throughout represent the same or similar components or elements with the same or similar functions. The embodiments described below with reference to the drawings are exemplary and are only used to explain the present disclosure and are not to be construed as limitations of the present disclosure.

[0025] For convenience of explanation, this specification uses terms indicating relative positions in space, such as "upper", "lower", "back", "front", etc., to describe one unit or feature shown in the drawings relative to another. A relationship between a unit or a feature. Spatially relative terms may refer to different orientations of the device in use or operation in addition to the orientation illustrated in the figures. For example, if the device in the diagram is turned over, elements described as "below" or "above" other elements or features would then be oriented "below" or "above" the other elements or features. Thus, the exemplary term "below" may encompass both spatial orientations, below and above.

[0026] As shown in FIG. 1, a single-fiber bidirectional optical assembly 11 is provided by Embodiment 1 of the present disclosure. The single-fiber bidirectional optical assembly comprises an optical emitter 11, an optical receiver 12, a lens assembly 13, an optical isolator 14, a first filter 151 and a second filter 152, and an optical fiber interface end 16. The optical fiber interface end 16 is used for being connected to an optical fiber 2, and achieves

the transmission of an uplink optical signal and a downlink optical signal. The downlink optical signal is emitted by the optical emitter 1 and focused by the lens assembly 13, and is then emitted to the optical fiber 2 sequentially through the first filter 151 and the optical fiber interface end 16 and is transmitted by the optical fiber 2. The uplink optical signal transmitted by the optical fiber 2 is reflected by the first filter and is then received by the optical receiver 12 after through the second filter 152.

[0027] In Embodiment 1, the optical emitter 11 is a semiconductor laser 11a, and specifically, the optical emitter is a Distributed-feedback laser (DFB) or an Electro-absorption Modulated Laser (EML). In other embodiments, the optical emitter 11 also comprises other elements besides semiconductor lasers, such as lenses, splitters, etc. During the operating process of the semiconductor laser, a certain amount of heat will be generated, causing the temperature of the active area to rise, and with increasing temperature, the center wavelength of the downlink optical signal emitted by the semiconductor laser 11a will increase, that is, the center of the wavelength of the downlink optical signal emitted by the semiconductor laser 11a will move in a wavelength-lengthening direction. Moreover, the increasing temperature causes that the internal electric-photo conversion rate of the semiconductor laser 11a decreases with the temperature and makes the output optical power decrease, so that it can be seen that the output optical power of the semiconductor laser 11a gradually reduces as the center wavelength of the downlink optical signal increases.

[0028] The single-fiber bidirectional optical assembly 1 further comprises at least one optical power attenuator 17. The optical power attenuator 17 is arranged between the optical emitter 11 and the optical fiber interface end 16,

and the transmittance of the optical power attenuator 17 varies with a wavelength of an optical signal. The transmittance is the ratio of the radiant energy projected and transmitted through an object to the total radiant energy projected onto the object during the incident light luminous flux change from an irradiated surface or a media incident surface to another surface away process, and the greater the transmittance of the optical power attenuator 17 is, the less the power loss of the downlink optical signal through the optical power attenuator 17 is.

[0029] Specifically, the transmittance of the optical power attenuator 17 increases linearly with the wavelength of the optical signal. Since the output optical power of the semiconductor laser 11a gradually reduces as the center wavelength of the downlink optical signal increases, that is, the transmittance of the optical power attenuator 17 increases while the output optical power of the semiconductor laser 11a decreases, a synergistic action of both maintains the downlink optical signal inputted in optical fiber 2 within a smaller power fluctuation range when the output optical power of the semiconductor laser 11a has a larger fluctuation in the different wavelength ranges, which will reduce the difference of the output optical power of the single-fiber bidirectional optical assembly 1 in high-temperature and low-temperature working environments. The single-fiber bidirectional optical assembly of this embodiment ensures that the optical power adjustment range is extended to the maximum under the condition that the LD high-frequency bandwidth and other properties of the optical emitter are not affected.

[0030] As shown in FIG. 2, the minimum operating wavelength of the optical power attenuator 17 is the first wavelength WL1, and the maximum operating

wavelength of the optical power attenuator 17 is the second wavelength WL2. The transmittance of the optical power attenuator varies linearly basically within a range from a first wavelength WL1 to a second wavelength WL2, and when the present disclosure is in use, the optical power attenuator 17 can be maintained to always operate within the operating wavelength range, thereby further making the output optical power of the single-fiber bidirectional optical component 1 more stable.

[0031] Furthermore, the first wavelength WL1 is less than a wavelength lower limit of the downlink optical signal emitted by the semiconductor laser 11a within an operating temperature range, the second wavelength is greater than the wavelength upper limit of the downlink optical signal emitted by the semiconductor laser 11a within the operating temperature range, and the optical power attenuator 17 is ensured to be operated within a linear area in a full temperature operating range, such that the optical power attenuator 17 and the semiconductor laser 11a can be both in a good synergistic action.

[0032] In Embodiment 1, the optical power attenuator 17 is arranged between the optical isolator 14 and the first filter 151. The downlink optical signal is emitted to the optical fiber 2 sequentially through the lens assembly 13, the optical isolator 14, the optical power attenuator 17, and the first filter 151.

[0033] The optical power attenuator 17 comprises a substrate and a filter film coated a light passing surface of the substrate.

[0034] Specifically, the filter film is a film system with alternately stacked Ta₂O₅ and/or SiO₂ films, and the substrate is formed by certain materials with good light transmittance, such as transparent plastics, glasses, etc. The thickness of each film can be adjusted to adjust the transmittance and transmittance-

wavelength slope in a specific wavelength of the optical power attenuator 17, thus making the filter film suitable for a different type single-fiber bidirectional optical assembly 1. The specific structure of the optical power attenuator 17 will not be described again here.

[0035] A structure in which an additional optical power attenuator 17 is arranged to a conventional filter film assembly (that is the first filter 151) is used in the embodiment. Since the optical power attenuator 17 can use the product manufactured by the conventional technology, the optical power attenuator 17 is only necessary to be arranged to a slot for placing the optical power attenuator 17 in the corresponding area of the outer shell of the conventional single-fiber bidirectional optical assembly 1. The method is simple and easy to implement.

[0036] Embodiment 2

[0037] As shown in FIG. 3, Embodiment 2 of the present disclosure provides a single-fiber bidirectional optical assembly 1. The structure of Embodiment 2 is similar to the structure of Embodiment 1, and the difference between the embodiments is that the optical power attenuator 17 is arranged between the optical isolator 14 and the lens assembly 13.

[0038] Embodiment 3

[0039] As shown in FIG. 4, Embodiment 3 of the present disclosure provides a single-fiber bidirectional optical assembly 1. The structure of Embodiment 3 is similar to the structure of Embodiment 1, and the difference between the embodiments is that the optical power attenuator 17 is arranged between the optical emitter 11 and the lens assembly 13.

[0040] Embodiment 4

[0041] As shown in FIG. 5, Embodiment 4 of the present disclosure provides a single-fiber bidirectional optical assembly 1. The structure of Embodiment 4 is similar to the structure of Embodiment 1, and the difference between the embodiments is that the optical isolator 14 is attached to the optical fiber interface end 16 and is connected directly to the optical fiber 2, and the optical power attenuator 17 is arranged between the first filter 151 and the lens assembly 13. Similarly, the optical power attenuator 17 can be also arranged between the optical emitter 11 and the lens assembly 13.

[0042] In Embodiment 2 to Embodiment 4, the optical isolator 14 and the optical power attenuator 17 are arranged in different positions of the single-fiber bidirectional optical assembly 1, which can make the optical power attenuator 17 suitable for the single-fiber bidirectional optical assembly 1 with different structures.

[0043] Embodiment 5

[0044] As shown in FIG. 6, Embodiment 5 of the present disclosure provides a single-fiber bidirectional optical assembly 1. In Embodiment 5, the optical power attenuator 17 is a filter film coated on the first filter.

[0045] In the embodiment, instead of arranging an additional optical power attenuator 17, a filter film with the function of the optical power attenuator 17 is integrated into the existing filter films, such that it is unnecessary to adjust the structure of the single-fiber bidirectional optical assembly 1, and is only necessary to replace these filter films of different thickness. The first filter 151 here not only has filter and reflection functions of common filter film but also has a power adjusting function for through specific wavelength optical signal, that is, the transmittance of the optical signal through specific wavelength

increases linearly with the optical signal wavelength. When the temperature of the laser varies with the environmental temperature or other reasons so as to lead to variation of the output optical power of the laser, the final output optical power of the single-fiber bidirectional optical assembly 1 is ensured to remain constant.

[0046] For example, the Anti Reflection (AR) film on the existing filter film substrate can be replaced with a film system whose transmittance increases linearly with the wavelength of the optical signal or a Wavelength Division Multiplexing (WDM) film system on the existing filter film can be adjusted to make the transmittance increase linearly with the wavelength within a pass-band wavelength range.

[0047] To sum up, the optical power attenuator whose transmittance increases linearly with the wavelength of the optical signal is arranged in the single-fiber bidirectional optical assembly of the present disclosure, so that a synergistic action with the semiconductor laser is generated, and the output optical power difference of the single-fiber bidirectional optical assembly in high-temperature and low-temperature working environments is reduced, and in a passive external modulation manner, the optical power adjustment range is extended to the maximum under the condition that high-frequency bandwidth and other properties of the optical emitter are not affected.

[0048] It should be understood that although this specification is described in terms of implementations, not each implementation only contains an independent technical solution. This description of the specification is only for the sake of clarity. Persons skilled in the art should take the specification as a whole and understand each individual solution. The technical solutions in the

embodiments can also be appropriately combined to form other embodiments that can be understood by those skilled in the art.

[0049] The series of detailed descriptions listed above are only specific descriptions of feasible implementations of the present disclosure and are not intended to limit the scope of protection of the present disclosure. Any equivalent implementations or changes that do not depart from the technical spirit of the present disclosure should be included in the protection scope of the present disclosure.

CLAIMS

What is claimed is:

1. A single-fiber bidirectional optical assembly, comprising: an optical emitter, an optical receiver, a lens assembly, a first filter, and an optical fiber interface end,

wherein the optical fiber interface end is used for being connected to an optical fiber, a downlink optical signal emitted by the optical emitter is focused by the lens assembly, and is then emitted to the optical fiber sequentially through the first filter and the optical fiber interface end and is transmitted by the optical fiber; an uplink optical signal transmitted by the optical fiber is reflected by the first filter and is then received by the optical receiver,

wherein the single-fiber bidirectional optical assembly further comprises at least one optical power attenuator, the optical power attenuator is arranged between the optical emitter and the optical fiber interface end, and a transmittance of the optical power attenuator varies with a wavelength of an optical signal.
2. The single-fiber bidirectional optical assembly according to claim 1, wherein the transmittance of the optical power attenuator increases as the wavelength of the optical signal increases.
3. The single-fiber bidirectional optical assembly according to claim 2, wherein the optical emitter is a semiconductor laser, the transmittance of

the optical power attenuator increases linearly as the wavelength of the optical signal within a range from a first wavelength WL1 to a second wavelength WL2 increases, wherein the first wavelength WL1 is less than a wavelength lower limit of the downlink optical signal emitted by the semiconductor laser within an operating temperature range, and the second wavelength is greater than a wavelength upper limit of the downlink optical signal emitted by the semiconductor laser within the operating temperature range.

4. The single-fiber bidirectional optical assembly according to claim 3, wherein the optical emitter is a distributed feedback laser or an electro-absorption modulated laser.
5. The single-fiber bidirectional optical assembly according to claim 3, wherein the optical power attenuator comprises a substrate and a filter film coated a light passing surface of the substrate.
6. The single-fiber bidirectional optical assembly according to claim 5, wherein the single-fiber bidirectional optical assembly further comprises a lens assembly and an optical isolator that are arranged between the optical emitter and the first filter, the optical power attenuator is arranged between the optical isolator and the first filter, or between the optical isolator and the lens assembly, or between the optical emitter and the lens assembly.
7. The single-fiber bidirectional optical assembly according to claim 5,

wherein the single-fiber bidirectional optical assembly further comprises an optical isolator attached to the optical fiber interface end, the optical power attenuator is arranged between the first filter and the lens assembly, or between the optical emitter and the lens assembly.

8. The single-fiber bidirectional optical assembly according to claim 3, wherein the optical power attenuator comprises a filter film coated on the first filter.
9. The single-fiber bidirectional optical assembly according to claim 5 or 8, wherein the filter film is a film system with alternately stacked Ta_2O_5 and/or SiO_2 films.
10. The single-fiber bidirectional optical assembly according to claim 8, wherein the filter film is a wavelength division multiplexing film, and a transmittance of the wavelength division multiplexing film increases linearly as the wavelength within a pass-band wavelength range of the wavelength division multiplexing film increases.