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(54) **METHOD AND DEVICE FOR BIAS CONTROL OF A LASER MODULATOR**

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(57) **ABSTRACT**

The present invention discloses a method and device for the bias control of an MZ modulator. The method comprises: during startup of an MZ modulator, inputting a linearly changing bias control voltage to the bias electrode of the MZ modulator and obtaining the output optical power of the MZ modulator so as to determine a bias control voltage corresponding to a preset operating point; then enabling a communication electrical signal to be input to the radio frequency electrode of the MZ modulator, carrying out an amplitude modulation on the communication electrical signal by a low-frequency sinusoidal pilot signal, and inputting the determined bias control voltage to the bias electrode simultaneously; and sampling the output optical signals of the MZ modulator, comparing the sampled optical signal with the pilot signal, and adjusting the bias control voltage input to the bias electrode according to the result of the comparison.

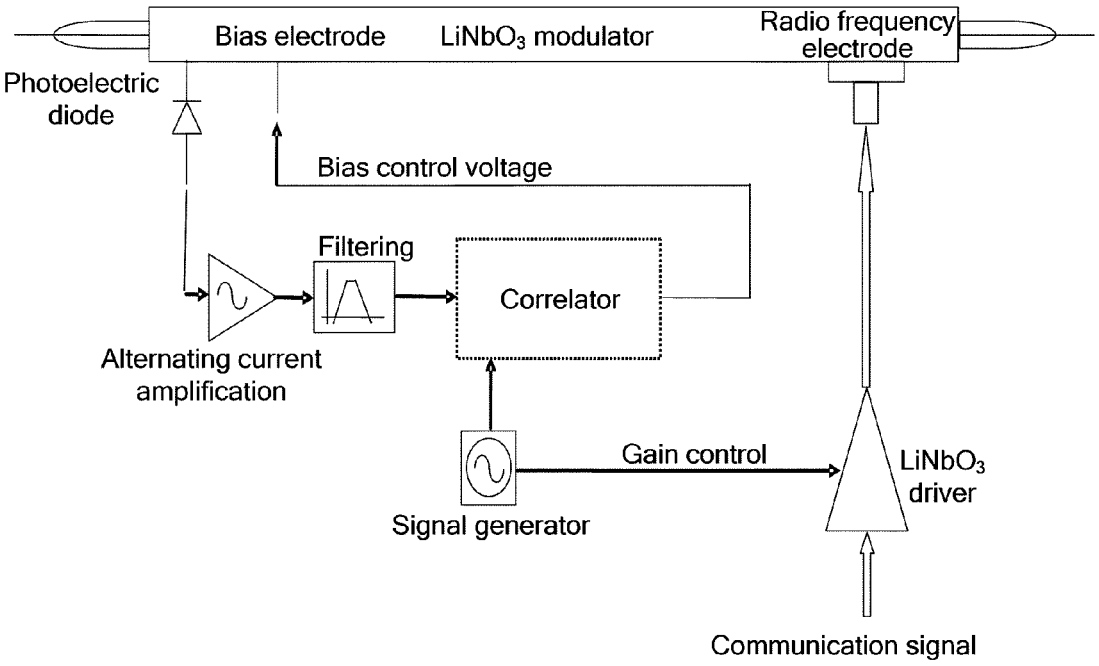


Fig. 1

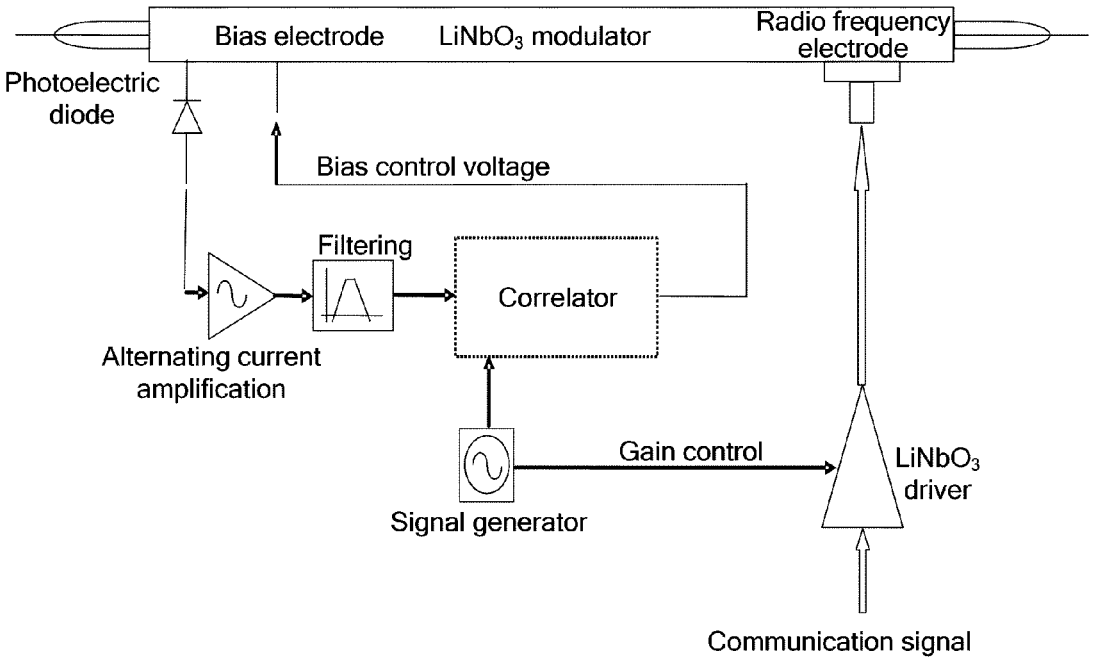

Bias electrode
$LiNbO_3$ modulator
Radio frequency electrode
Photoelectric diode
Bias control voltage
Filtering
Correlator
Alternating current amplification
Gain control
$LiNbO_3$ driver
Signal generator
Communication signal

Fig. 2

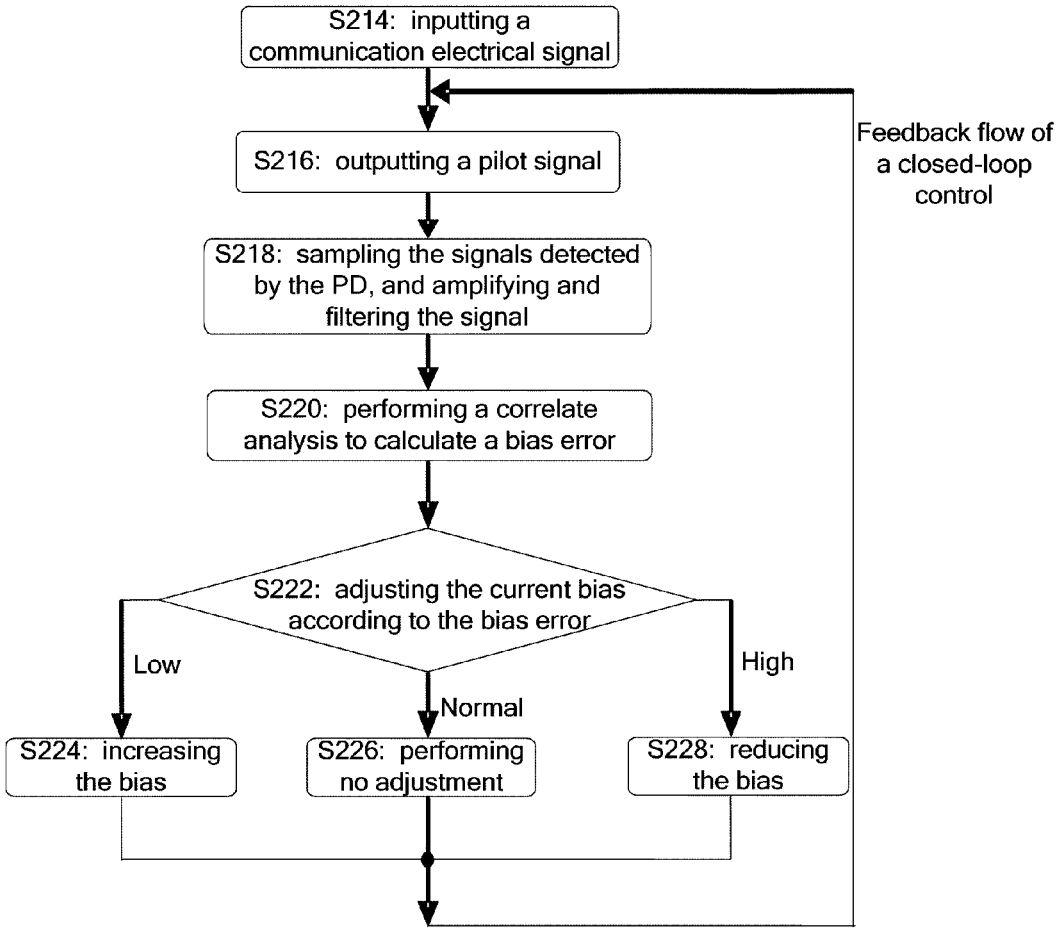

S214: inputting a communication electrical signal
S216: outputting a pilot signal
S218: sampling the signals detected by the PD, and amplifying and filtering the signal
S220: performing a correlate analysis to calculate a bias error
S222: adjusting the current bias according to the bias error
Low
Normal
High
S224: increasing the bias
S226: performing no adjustment
S228: reducing the bias
Feedback flow of a closed-loop control

Fig. 3

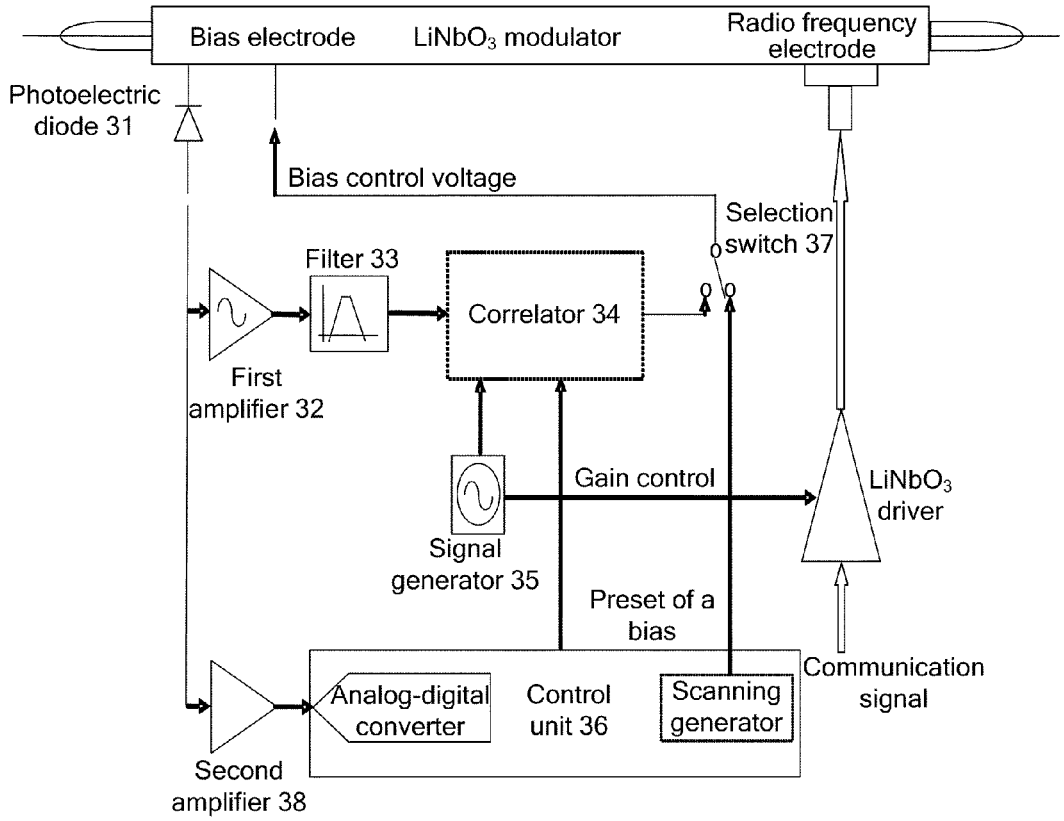

Bias electrode
$LiNbO_3$ modulator
Radio frequency electrode
Photoelectric diode 31
Bias control voltage
Selection switch 37
Filter 33
Correlator 34
First amplifier 32
Signal generator 35
Gain control
$LiNbO_3$ driver
Preset of a bias
Communication signal
Analog-digital converter
Control unit 36
Scanning generator
Second amplifier 38

Fig. 4

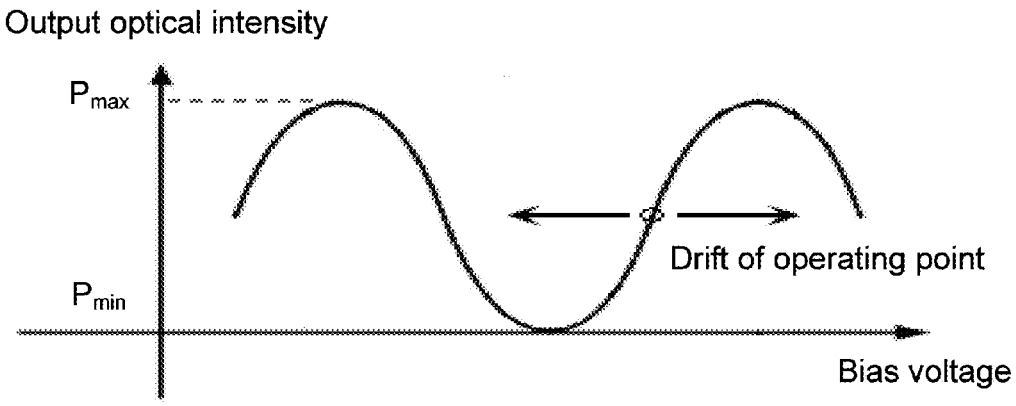

Output optical intensity
P_{max}
P_{min}
Drift of operating point
Bias voltage

Fig. 5

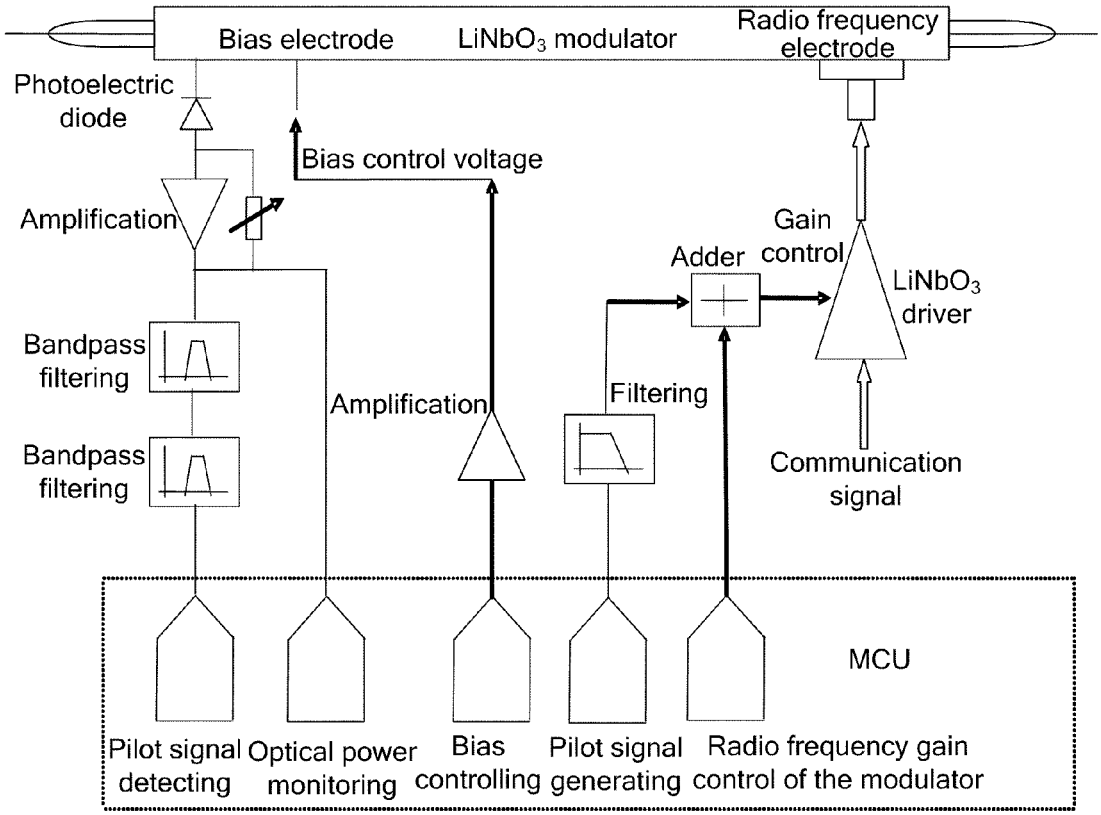

Bias electrode
$LiNbO_3$ modulator
Radio frequency electrode
Photoelectric diode
Bias control voltage
Amplification
Gain control
Adder
$LiNbO_3$ driver
Bandpass filtering
Bandpass filtering
Amplification
Filtering
Communication signal
MCU
Pilot signal detecting
Optical power monitoring
Bias controlling
Pilot signal generating
Radio frequency gain control of the modulator

Fig. 6

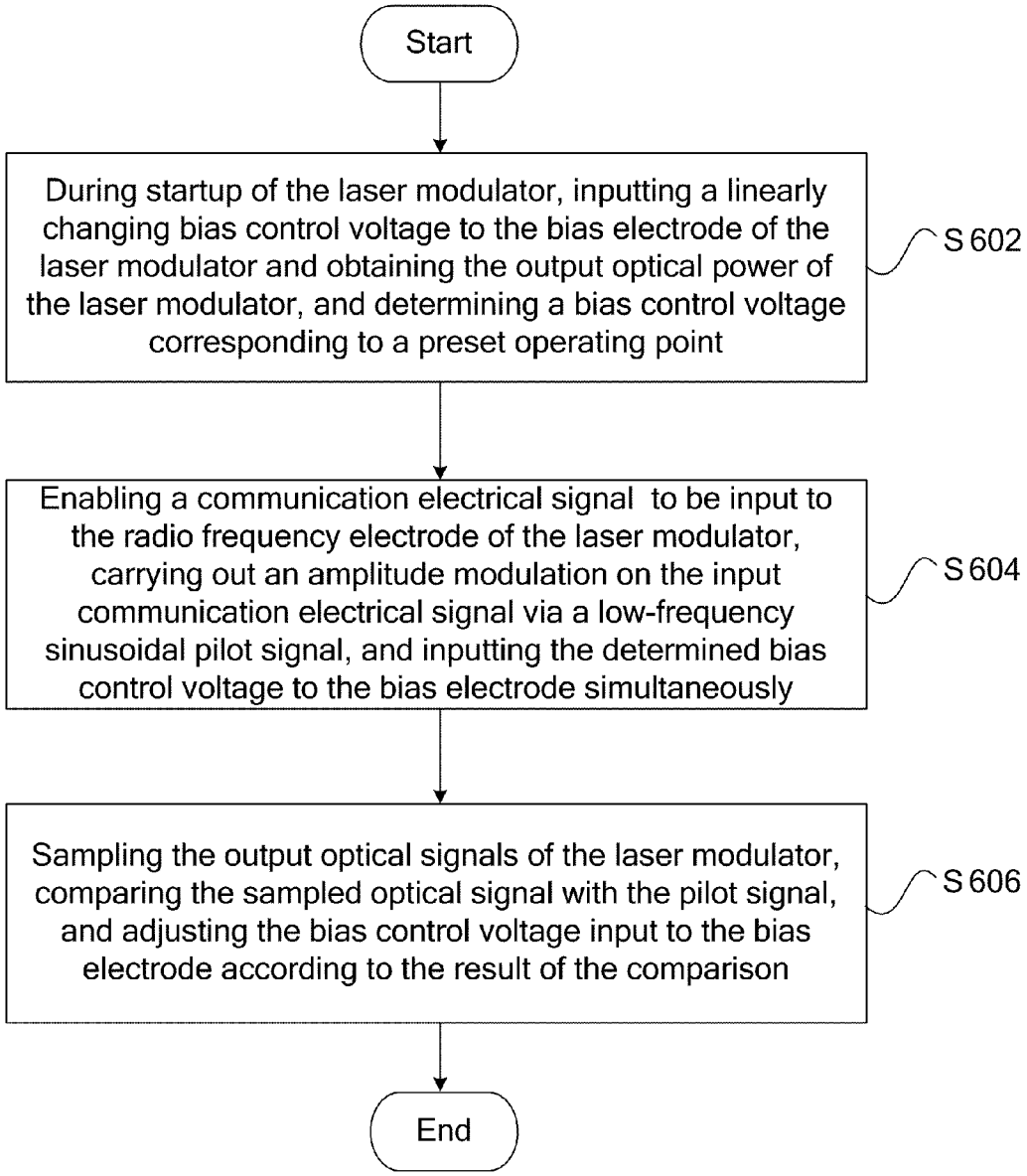

Start
During startup of the laser modulator, inputting a linearly changing bias control voltage to the bias electrode of the laser modulator and obtaining the output optical power of the laser modulator, and determining a bias control voltage corresponding to a preset operating point
S 602
Enabling a communication electrical signal to be input to the radio frequency electrode of the laser modulator, carrying out an amplitude modulation on the input communication electrical signal via a low-frequency sinusoidal pilot signal, and inputting the determined bias control voltage to the bias electrode simultaneously
S 604
Sampling the output optical signals of the laser modulator, comparing the sampled optical signal with the pilot signal, and adjusting the bias control voltage input to the bias electrode according to the result of the comparison
S 606
End

Fig. 7

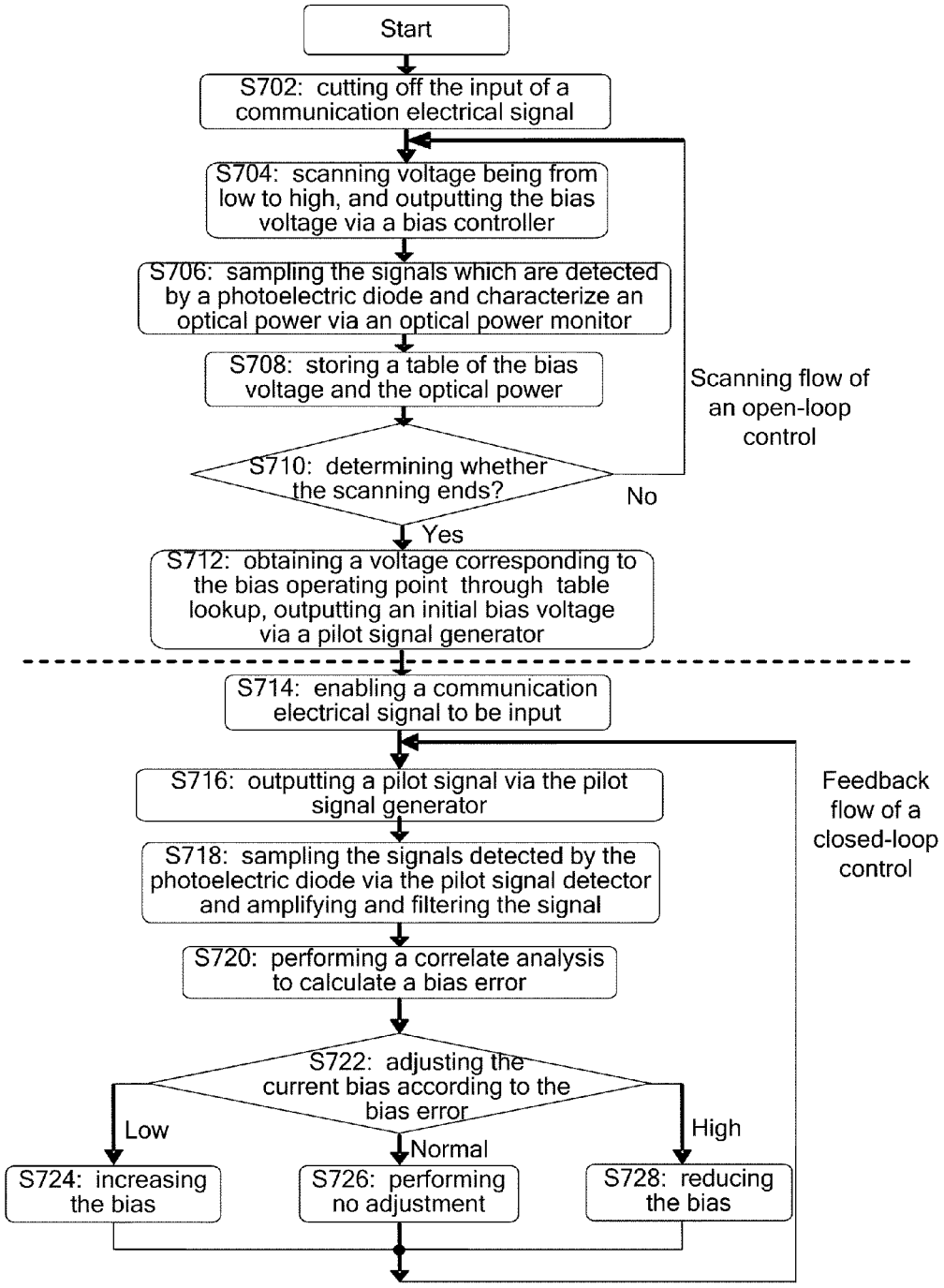

Start
S702: cutting off the input of a communication electrical signal
S704: scanning voltage being from low to high, and outputting the bias voltage via a bias controller
S706: sampling the signals which are detected by a photoelectric diode and characterize an optical power via an optical power monitor
S708: storing a table of the bias voltage and the optical power
S710: determining whether the scanning ends?
No
Yes
Scanning flow of an open-loop control
S712: obtaining a voltage corresponding to the bias operating point through table lookup, outputting an initial bias voltage via a pilot signal generator
S714: enabling a communication electrical signal to be input
S716: outputting a pilot signal via the pilot signal generator
S718: sampling the signals detected by the photoelectric diode via the pilot signal detector and amplifying and filtering the signal
S720: performing a correlate analysis to calculate a bias error
S722: adjusting the current bias according to the bias error
Low
Normal
High
S724: increasing the bias
S726: performing no adjustment
S728: reducing the bias
Feedback flow of a closed-loop control

Fig. 8A

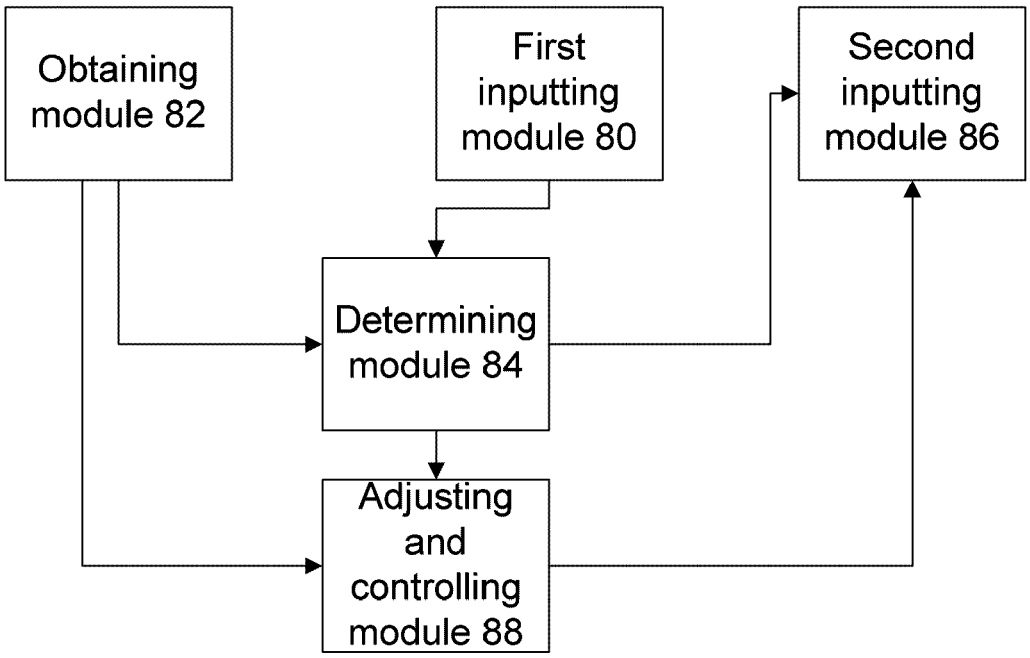
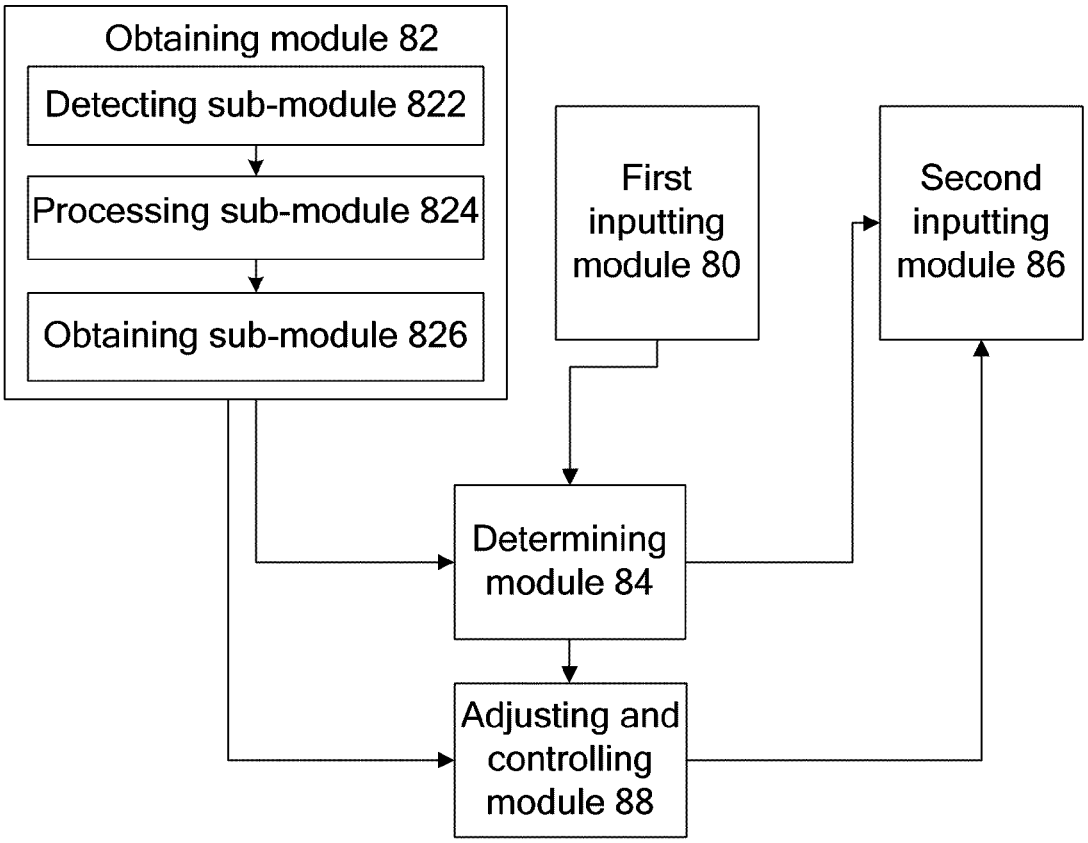

Obtaining module 82
First inputting module 80
Second inputting module 86
Determining module 84
Adjusting and controlling module 88

Fig. 8B


Obtaining module 82
Detecting sub-module 822
Processing sub-module 824
Obtaining sub-module 826
First inputting module 80
Second inputting module 86
Determining module 84
Adjusting and controlling module 88

METHOD AND DEVICE FOR BIAS CONTROL OF A LASER MODULATOR

TECHNICAL FIELD

[0001] The present invention relates to the technical field of communications, and in particular to a method and device for the bias control of an MZ modulator.

BACKGROUND

[0002] Due to its advantages of high speed, large extinction ratio, high input optical power, adjustable chirp and insensitivity to wavelength, external modulation is capable of increasing the transmission distance of a wavelength division system and improving transmission speed and is thus widely applied to wavelength division systems. However, phase shift occurs in an MZ (Mach-Zehnder) modulator based on $LiNbO_3$ material as the operating point of such modulator is influenced by temperature, mechanical stress and the aging of components, the output performance of optical signal is consequently degraded, therefore, when such modulator is used, a feedback control is required for the bias operating point of such modulator to form a closed loop to guarantee a stable bias.

[0003] As shown in FIG. **1**, the conventional bias control device mainly consists of a modulator, a driver, a signal generator, an amplifier, a correlator and other components, and the operating principle of the bias control device is as follows: the signal generator generates a low-frequency sinusoidal pilot signal; by controlling the gain control end of the $LiNbO_3$ driver, an amplitude modulation (AM for short) is conducted on a high-speed communication electrical signal in an extremely small proportion; a Mach-Zehnder modulation is carried out by the $LiNbO_3$ modulator to convert the high-speed communication electrical signal to an optical signal, and then the optical signal is output to an optical fiber line; part of light is detected by a photoelectric diode (PD for short) attached to the $LiNbO_3$ modulator, amplified, filtered and compared with the initial input pilot signal, and then a correlate analysis is carried out to obtain an error voltage for a bias control, and a closed-loop feedback control is carried out on a bias point of the modulator with the error voltage.

[0004] FIG. **2** shows a flow chart of a conventional $LiNbO_3$ bias control method, which is a typical combination of a relevant detection and a proportional integral algorithm and mainly comprises the following steps:

[0005] step S**214**: inputting a communication electrical signal to the input end of a modulator;

[0006] step S**216**: carrying out an electrical-optical conversion on a pilot signal output from the output end and detecting the converted signal by a PD;

[0007] step S**218**: sampling the signals detected by the PD via a control program, amplifying and filtering the signal, and inputting the amplified and filtered signal to a correlator;

[0008] step S**220**: performing a correlate analysis by the correlator according to the input signal and the pilot signal to calculate the current bias error;

[0009] step S**222**: adjusting the current bias control voltage according to the magnitude and the polarity of the current bias error so that the bias is adjusted toward a correct operating point; specifically, executing step S**224** to increase the bias control voltage when the current bias error is low; executing step S**226** to perform no adjustment on the bias voltage when the current bias error is normal; and executing step S**228** to reduce the bias control voltage when the current bias error is high.

[0010] As mentioned above, in the current bias control technologies, a small-amplitude low-frequency pilot signal is inserted into the communication signal of the radio frequency (RF for short) electrode of a modulator to modulate the communication signal into an optical signal, and then a spectrophotometric detection is carried out on the modulated pilot signal at a signal output position. The detected signal is compared with the initial signal in amplitude and phase through a correlate analysis to detect a bias error, the bias error is integrated and amplified and then output to the bias electrode of the modulator to control the bias phase of the modulator and keep the operating point stable.

[0011] In this control method, as the amplitude of the bias control voltage is small in each adjustment, the convergence speed is low during startup of the MZ modulator, and as a consequence, the time for achieving a stable operating point of the MZ modulator is long, sometimes up to several seconds or even tens of seconds.

SUMMARY

[0012] On this account, the present invention provides a method and device for the bias control of an MZ modulator, which solves the problem of low convergence speed and long control time in existing bias control methods.

[0013] According to one aspect of the present invention, a method for the bias control of an MZ modulator is provided.

[0014] The method for the bias control of an MZ modulator provided in the present invention comprises: during startup of an MZ modulator, inputting a linearly changing bias control voltage to a bias electrode of the MZ modulator and obtaining output optical power of the MZ modulator so as to determine a bias control voltage corresponding to a preset operating point; then enabling a communication electrical signal to be input to a radio frequency electrode of the MZ modulator, carrying out an amplitude modulation on the communication electrical signal by a low-frequency sinusoidal pilot signal, and inputting the determined bias control voltage to the bias electrode simultaneously; and sampling output optical signals of the MZ modulator, comparing the sampled optical signal with the pilot signal, and adjusting the bias control voltage input to the bias electrode according to the result of the comparison.

[0015] According to another aspect of the present invention, a device for the bias control of an MZ modulator is provided.

[0016] The device for the bias control of an MZ modulator provided in the present invention comprises: a photoelectric diode, a first amplifier, a filter, a correlator, a control unit and a selection switch, wherein the photoelectric diode is used for detecting output optical power of the MZ modulator; the control unit is used for inputting a linearly changing bias control voltage to a bias electrode of the MZ modulator and determining a bias control voltage corresponding to a preset operating point according to the output optical power detected by the photoelectric diode; the correlator is used for inputting the bias control voltage determined by the control unit to the bias electrode of the MZ modulator; and the selection switch is used for connecting the linearly changing bias control voltage output by the control unit to the bias electrode during startup of the MZ modulator, and connecting the bias

control voltage output by the correlator to the bias electrode during the normal operating process of the MZ modulator.

[0017] According to another aspect of the present invention, another device for the bias control of an MZ modulator is provided.

[0018] Another device for the bias control of an MZ modulator provided in the present invention comprises: a first inputting module, an obtaining module, a determining module, a second inputting module and an adjusting and controlling module, wherein the first inputting module is used for inputting a linearly changing bias control voltage to a bias electrode of the MZ modulator; the obtaining module is used for obtaining output optical power of the MZ modulator; the determining module is used for determining a bias control voltage corresponding to a preset operating point according to the bias control voltage input by the first inputting module and the output optical power obtained by the obtaining module; the second inputting module is used for inputting the bias control voltage determined by the determining module to the bias electrode during the normal operating process of the MZ modulator; and the adjusting and controlling module is used for adjusting the bias control voltage input by the second inputting module according to the output optical power of the MZ modulator and an input pilot signal during the normal operating process of the MZ modulator.

[0019] By means of at least one of the above solutions, a linearly changing bias control voltage is input to the bias electrode of an MZ modulator during startup of the MZ modulator to scan the characteristics of the modulator so as to obtain a bias control voltage corresponding to a preset operating point, and the bias control voltage is taken as an initial bias control voltage to perform a closed-loop feedback control on the MZ modulator, thus the time for achieving the stabilization of the MZ modulator is shortened and the accuracy of bias control is improved.

[0020] Other characteristics and advantages of the present invention are illustrated in the following specification, part of which become apparent from the specification or can be understood by implementing the method and device disclosed in the present invention. The purpose and other advantages of the present invention can be realized and obtained through the structures especially specified in the specification, claims and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The accompanying drawings illustrated here are provided to make the present invention understood better and to form part of this application; and the exemplary embodiments of the present invention and the description thereof are provided for explaining the present invention, instead of constituting an improper limitation to the present invention. In these accompanying drawings:

[0022] FIG. **1** is a block diagram illustrating the constitution of an existing bias control device;

[0023] FIG. **2** is a flow chart of an existing $LiNbO_3$ bias control method;

[0024] FIG. **3** is a structural block diagram illustrating a device for the bias control of an MZ modulator according to an embodiment of the present invention;

[0025] FIG. **4** is a characteristic curve diagram of the output optical power of an MZ modulator input with a linearly changing bias control voltage according to an embodiment of the present invention;

[0026] FIG. **5** is a structural block diagram illustrating a bias control device according to a preferred embodiment of the present invention;

[0027] FIG. **6** is a flow chart illustrating a method for the bias control of an MZ modulator according to an embodiment of the present invention;

[0028] FIG. **7** is a flow chart illustrating the specific implementation of a method for the bias control of an MZ modulator according to an embodiment of the present invention;

[0029] FIG. **8**A is a structural block diagram illustrating another device for the bias control of an MZ modulator according to an embodiment of the present invention; and

[0030] FIG. **8**B is a structural block diagram illustrating another device for the bias control of an MZ modulator according to a preferred embodiment of the present invention.

DETAILED DESCRIPTION

Function Overview

[0031] The present invention provides a solution for the bias control of an MZ modulator in view of the problem that the existing MZ modulator requires a long time to achieve a stable operation during its startup; in this solution, during startup of an MZ modulator, a linear changing bias control voltage is input to the bias electrode of the MZ modulator under the circumstance that the input of a communication signal is cut off, and the input/output characteristics of the modulator are scanned so as to determine a bias control voltage corresponding to a preset operating point; and the bias control voltage, as an initial bias control voltage, is input to the bias electrode of the modulator during the normal operating process of the modulator to carry out a closed-loop feedback control on the MZ modulator.

[0032] Preferred embodiments of the present invention are illustrated below in combination with the accompanying drawings, it should be understood that the preferred embodiments described here are only provided for illustrating and explaining the present invention but not limiting the present invention.

[0033] According to an embodiment of the present invention, a device for the bias control of an MZ modulator is provided first.

[0034] FIG. **3** is a structural block diagram illustrating a device for the bias control of an MZ modulator according to an embodiment of the present invention; it can be seen from FIG. **3** that the bias control device according to the embodiment of the present invention further includes a control unit and a selection switch on the basis of the conventional bias control device (as shown in FIG. **1**). As shown in FIG. **3**, the device for the bias control of an MZ modulator according to the embodiment of the present invention comprises a photoelectric diode PD **31**, a first amplifier **32**, a filter **33**, a signal generator **35**, a correlator **34**, a control unit **36** and a selection switch **37**, each of which is described below in combination with the accompanying drawings.

[0035] The photoelectric diode PD **31** is used for detecting the output optical power of the MZ modulator.

[0036] The first amplifier **32**, one end of which is connected with the PD **31**, and the other end of which is connected with the filter **33**, is used for amplifying the output optical power detected by the PD **31** and inputting the amplified output optical power to the filter **33**.

[0037] The filter **33**, one end of which is connected with the first amplifier **32**, and the other end of which is connected

with the correlator **34**, is used for filtering the output optical power amplified by the first amplifier **32** and inputting the filtered output optical power to the correlator **34**.

[0038] One end of the correlator **34** is connected with the filter **33**, and the other end is connected with the bias electrode of the MZ modulator via the selection switch **37**, moreover, the correlator **34** is further connected with the signal generator **35** and the control unit **36**; and the correlator **34** is used for inputting the bias control voltage input by the control unit **36** to the bias electrode of the MZ modulator, comparing the output optical power which is detected by the PD **31** and processed by the first amplifier **32** and the filter **33** with the pilot signal received by the signal generator **35**, and adjusting the bias control voltage input to the bias electrode according to the result of the comparison.

[0039] The selection switch **37** is connected with the control unit **36** and the correlator **34**; and the selection switch **37** is used for connecting the linearly changing bias control voltage output by the control unit **36** to the bias electrode during startup of the MZ modulator and connecting the bias control voltage output by the correlator **34** to the bias electrode during the normal operating process of the MZ modulator.

[0040] In order to facilitate the processing of the output optical power obtained by the control unit **36**, a second amplifier **38** may be added between the control unit **36** and the PD **31** to amplify the optical power detected by the PD **31**, as shown in FIG. **3**.

[0041] In order to convert the obtained output optical power from an analog signal to a digital signal, an analog-digital converter may be contained in the control unit **36** to convert the output optical power into a digital value. Moreover, the control unit **36** may further comprise a scanning generator for generating and outputting a linearly changing bias control voltage so that the output optical power of the MZ modulator can present the sinusoidal variation shown in FIG. **4** in the case of the continuous input of the bias control voltage.

[0042] As shown in FIG. **4**, the output optical power of a $LiNbO_3$ modulator periodically varies in accordance with the law of trigonometric functions when the bias electrode is input with a linearly changing bias control voltage and the RF electrode is input with no signal.

[0043] FIG. **5** is a structural diagram illustrating the above specific bias control device in specific implementation. The bias control device employs an analog-digital mixed circuit architecture. Its hardware part consists of an MCU microprocessor, a transimpedance amplifier, a two-stage filter, a bias amplifier and an adder; compared with the conventional solution, the bias control device is added with very few components, including a pilot signal detector ADC**0**, an optical power monitor ADC**1**, a bias controller DAC**0**, a pilot signal generator DAC**1**, and a radio frequency gain controller DAC**2** for a driver; and control flow of steps is mainly achieved through MCU software programming. The conventional control flow is divided into the following two steps by an additional open-loop control loop: first, an open-loop control is performed, the output characteristic of an MZ modulator is detected to obtain a bias control voltage corresponding to a preset operating point; then, the obtained bias control voltage, as an initial value, is input to the bias electrode, to perform a closed-loop control and track characteristic drift, thus the time for a stabilization control is shortened.

[0044] According to an embodiment of the present invention, a method for the bias control of an MZ modulator is further provided, which can be realized by the bias control device above.

[0045] FIG. **6** is a control flow illustrating a method for the bias control of an MZ modulator according to an embodiment of the present invention, as shown in FIG. **6**, the method for the bias control of an MZ modulator mainly comprises the following processing steps:

[0046] step S**602**: during startup of the MZ modulator, inputting a linearly changing bias control voltage to the bias electrode of the MZ modulator and obtaining the output optical power of the MZ modulator, scanning the input/output characteristics of the modulator, and determining a bias control voltage corresponding to a preset operating point;

[0047] step S**604**: enabling a signal to be input to the radio frequency electrode of the MZ modulator, carrying out an amplitude modulation on the input signal via a low-frequency sinusoidal pilot signal, and inputting the above determined bias control voltage to the bias electrode simultaneously; and

[0048] step S**606**: sampling the output optical signals of the MZ modulator, comparing the sampled optical signal with the pilot signal, and adjusting the bias control voltage input to the bias electrode according to the result of the comparison.

[0049] Each of the processing above is described below in detail.

[0050] (1) Step S**602**

[0051] The input of a communication signal to the RF electrode of the MZ modulator and the input to the correlator are cut off during startup of the MZ modulator, then a linearly changing bias control voltage is input to the bias electrode of the MZ modulator via the scanning generator of the control unit; the output end of the MZ modulator can output the output optical power presenting the sinusoidal variation shown in FIG. **4** under the effect of the bias voltage; the PD can detect the output optical power, an amplification and analog-digital conversion are carried out on the output optical power, and then the corresponding relation between the input bias control voltage and the output optical power can be obtained.

[0052] As the preset operating point is generally the point corresponding to the maximum value, the minimum value or the intermediate value of the output optical power, therefore the bias control voltage corresponding to the output optical power corresponding to the preset operating point, that is, the bias control voltage corresponding to the preset operating point, is obtained after the corresponding relation between the input bias control voltage and the output optical power is obtained.

[0053] The processing of this step is actually an open-loop control process, which aims to obtain the bias control voltage corresponding to the preset operating point, and in this step, the communication signal is cut off, the corresponding relation between the input bias control voltage and the output optical power can be detected in tens of milliseconds, thereby the bias control voltage of the correct operating point is obtained.

[0054] (2) Step S**604**

[0055] In this step, the input of a communication signal to the RF electrode of the MZ modulator is activated, a low-frequency sinusoidal pilot signal is generated by the signal generator to carry out an amplitude modulation on the communication signal before the communication signal is input to the RF electrode; the control unit outputs the bias control

voltage determined in step S602 to the correlator, and the correlator outputs the determined bias control voltage, as an initial control voltage, to the bias control electrode.

[0056] (3) Step S606

[0057] In this step, the PD carries out an optical-electrical conversion on the output optical signal of the MZ modulator to obtain an output signal; the obtained output signal is amplified and filtered and then output to the correlator; the correlator compares the input optical signal with the pilot signal input by the signal generator, and adjusts the bias control voltage of the bias electrode according to the result of the comparison.

[0058] The processing of this step is identical to the conventional bias control process, in the operating process of the MZ modulator, the operating point of the modulator is kept at the position where the optical power is Pmax, Pmin or equal to (Pmax+Pmin)/2 by adjusting the bias control voltage in the case of a curve drift, when there is left or right drift in the characteristic curve of the output optical power due to external factors such as temperature, stress and aging. As the output of the correlator is already the correct bias operating point, the control loop only needs to track the drift of the bias operating point caused by external factors, therefore the time for achieving the stabilization of the modulator is greatly shortened.

[0059] The method according to the embodiment of the present invention overcomes the shortcomings of low convergence speed and long control time in the existing bias control technologies and thereby shortens the time for realizing a stabilization control and improves control accuracy.

[0060] FIG. 7 is a flow chart illustrating the specific implementation of a method for the bias control of an MZ modulator according to an embodiment of the present invention, as shown in FIG. 7, the specific implementation of the method mainly comprises the following steps:

[0061] step S702: cutting off a communication electrical signal;

[0062] step S704: inputting a control voltage to perform linear scanning, outputting the control voltage to the bias control end of the modulator via a DAC1, the output optical power varies in accordance with the current bias electric-optical modulation characteristic of the modulator under the effect of the bias scanning voltage;

[0063] step S706: sampling, via an ADC1, the PD voltage signals which are detected and by the PD and amplified and characterize an optical power;

[0064] step S708: storing the optical power corresponding to every bias voltage;

[0065] step S710: determining whether the scanning ends, if so, executing step S712, otherwise, returning to step S704;

[0066] after the scanning ends, the bias characteristic table of the modulator can be obtained according to the stored optical power corresponding to every bias voltage; and

[0067] step S712: obtaining a voltage corresponding to the bias operating point through table lookup as required and outputting the obtained voltage via the DAC1, then the initial bias can be established rapidly, and the scanning flow of an open-loop control is completed;

[0068] the steps S702-S712 above are the scanning flow of the open-loop control;

[0069] the feedback flow of a closed-loop control is substantially identical to the conventional $LiNbO_3$ bias control method shown in FIG. 2, which mainly comprises the following steps:

[0070] step S714: controlling and enabling a communication electrical signal;

[0071] step S716: outputting, via a DAC1, a pilot signal which is then detected by a PD after being subjected to an electrical-optical conversion;

[0072] step S718: sampling the signals detected by the PD via an ADC0, and amplifying and filtering the signal;

[0073] step S720: performing a correlate analysis using the amplified and filtered signal and the pilot signal to calculate the current bias error; and

[0074] step S722: adjusting the current bias voltage according to the magnitude and the polarity of the current bias error; specifically, executing step S724 to increase the bias control voltage when the current bias error is low, executing step S726 to perform no adjustment on the bias control voltage when the current bias error is normal, and executing step S728 to reduce the bias control voltage when the current bias error is high; as the initial bias control voltage has already been established in the scanning flow of the open-loop control, a bias stabilization can be realized without requiring much adjustment in the feedback flow of the closed-loop control.

[0075] According to an embodiment of the present invention, a device for the bias control of an MZ modulator is further provided, which is capable of realizing the method above.

[0076] FIG. 8A is a structural block diagram illustrating a device for the bias control of an MZ modulator according to an embodiment of the present invention; FIG. 8B is a structural block diagram illustrating a device for the bias control of an MZ modulator according to a preferred embodiment of the present invention. As shown in FIG. 8A, the device for the bias control of an MZ modulator according to the embodiment of the present invention comprises: a first inputting module 80, an obtaining module 82, a determining module 84, a second inputting module 86 and an adjusting and controlling module 88. Each of the modules above is described below in combination with the accompanying drawings:

[0077] the first inputting module 80 is connected with the bias electrode of the MZ modulator, and used for inputting a linearly changing bias control voltage to the bias electrode of the MZ modulator;

[0078] the obtaining module 82 is connected with the output end of the MZ modulator, and used for obtaining the output optical power of the MZ modulator;

[0079] the determining module 84 is connected with the first inputting module 80 and the obtaining module 82, and used for determining a bias control voltage corresponding to a preset operating point according to the bias control voltage input by the first inputting module 80 and the output optical power obtained by the obtaining module 82;

[0080] the second inputting module 86 is connected with the determining module 84 and the bias electrode of the MZ modulator, and used for inputting the bias control voltage determined by the determining module 84 to the bias electrode; and

[0081] the adjusting and controlling module 88 is connected with the obtaining module 82 and the second inputting module 86, and used for adjusting the bias control voltage input by the second inputting module 86 according to the output optical power of the MZ modulator obtained by the obtaining module 82 and an input pilot signal.

[0082] Further, as shown in FIG. 8B, the obtaining module 82 may further comprise: a detecting sub-module 822, a processing sub-module 824, and an obtaining sub-module

826, wherein the detecting sub-module **822** is used for detecting the output optical power of the MZ modulator when the first inputting module **80** inputs a bias control voltage; the processing sub-module **824** is connected with the detecting sub-module **822** and used for carrying out an amplification and analog-digital conversion on the output optical power detected by the detecting sub-module **822**; and the obtaining sub-module **826** is connected with the processing sub-module **824** to obtain the output optical power processed by the processing sub-module **824**.

[0083] As stated above, by means of the present invention, the input/output characteristics of the MZ modulator are scanned by cutting off the communication signal and inputting the linearly changing bias control voltage to the bias electrode of the MZ modulator during startup of the MZ modulator, thereby a bias control voltage corresponding to the operating point of the MZ modulator is obtained, and the bias control voltage is input to the bias control electrode as the initial bias control voltage of the MZ modulator during the normal operation of the MZ modulator and adjusted according to the drift generated in the operation. As the initial bias control voltage can be detected in tens of milliseconds after the communication signal is cut off and only the drift of the bias operating point caused by external factors is required to be tracked during operation process, therefore the time for achieving the stabilization of the MZ modulator is shortened, the control precision is improved, and the setup time of an optical transmitter is also shortened.

[0084] Apparently, it should be understood by those skilled in the art that various modules or steps of the present invention can be realized by a universal computing device, centralized in a single computing device or distributed in a network consisting of multiple computing devices, and optionally realized by program codes executable to computing devices; therefore the modules or steps can be stored in a storage device to be executed by a computing device or separately made into respective integrated circuit module, or some of the modules or steps are made into a single integrated circuit module. Thus the present invention is not limited to combination of any specific hardware and software.

[0085] The mentioned above is only preferred embodiments of the present invention but not limitation to the present invention, various modification and variations can be devised by those skilled in the art, any modification, equivalent substitution and improvement devised without departing from the spirit and scope of the present invention shall be included in the protection scope of the present invention.

1. A method for the bias control of an MZ modulator, comprising:

during startup of an MZ modulator, inputting a linearly changing bias control voltage to a bias electrode of the MZ modulator and obtaining output optical power of the MZ modulator so as to determine a bias control voltage corresponding to a preset operating point;

enabling a communication electrical signal to be input to a radio frequency electrode of the MZ modulator, carrying out an amplitude modulation on the communication electrical signal by a low-frequency sinusoidal pilot signal, and inputting the determined bias control voltage to the bias electrode simultaneously; and

sampling output optical signals of the MZ modulator, comparing the sampled optical signal with the pilot signal, and adjusting the bias control voltage input to the bias electrode according to the result of the comparison.

2. The method according to claim **1**, wherein the step of inputting a linearly changing bias control voltage to the bias electrode of the MZ modulator specifically comprises:

inputting a linearly changing bias control voltage in order that the output optical power of the MZ modulator varies sinusoidally.

3. The method according to claim **1**, wherein the step of determining a bias control voltage corresponding to a preset operating point specifically comprises:

determining a corresponding relation between the input bias control voltage and the output optical power; and

obtaining the bias control voltage corresponding to the preset operating point according to the corresponding relation and the output optical power corresponding to the preset operating point.

4. The method according to claim **3**, wherein the step of determining the corresponding relation between the input bias control voltage and the output optical power specifically comprises:

detecting the output optical power and carrying out an amplification and analog-digital conversion on the optical power to obtain the value of the converted output optical power; and

obtaining the corresponding relation between the output optical power and the input bias control voltage according to the value of the input bias control voltage and the value of the converted output optical power.

5. The method according to claim **1**, wherein the preset operating point comprises the points corresponding to the maximum, the minimum and the intermediate values of the output optical power.

6. A device for the bias control of an MZ modulator, comprising a photoelectric diode, a first amplifier, a filter, a correlator, and further comprising a control unit and a selection switch, wherein

the photoelectric diode being used for detecting output optical power of the MZ modulator;

the control unit being used for inputting a linearly changing bias control voltage to a bias electrode of the MZ modulator and determining a bias control voltage corresponding to a preset operating point according to the output optical power detected by the photoelectric diode;

the correlator being used for inputting the bias control voltage, as an initial bias control voltage and determined by the control unit, to the bias electrode of the MZ modulator; and

the selection switch being used for connecting the linearly changing bias control voltage output by the control unit to the bias electrode during startup of the MZ modulator, and connecting the bias control voltage output by the correlator to the bias electrode during the normal operating process of the MZ modulator.

7. The device according to claim **6**, further comprising:

a second amplifier for amplifying the output optical power detected by the photoelectric diode and then inputting the amplified output optical power to the control unit.

8. The device according to claim **6**, wherein the control unit comprises:

a scanning generator for generating a linearly changing bias control voltage and inputting the linearly changing bias control voltage to the bias electrode of the MZ modulator; and

an analog-digital converter for converting the output optical power detected by the photoelectric diode into a digital value.

9. A device for the bias control of an MZ modulator, comprising:

a first inputting module for inputting a linearly changing bias control voltage to a bias electrode of the MZ modulator;

an obtaining module for obtaining output optical power of the MZ modulator;

a determining module for determining a bias control voltage corresponding to a preset operating point according to the bias control voltage input by the first inputting module and the output optical power obtained by the obtaining module;

a second inputting module for inputting the bias control voltage determined by the determining module to the bias electrode during the normal operating process of the MZ modulator; and

an adjusting and controlling module for adjusting the bias control voltage input by the second inputting module according to the output optical power of the MZ modulator and an input pilot signal during the normal operating process of the MZ modulator.

10. The device according to claim **9**, wherein the obtaining module comprises:

a detecting sub-module for detecting the output optical power of the MZ modulator when the first inputting module inputs the bias control voltage;

a processing sub-module for carrying out an amplification and analog-digital conversion on the output optical power detected by the detecting sub-module; and

an obtaining sub-module for obtaining the output optical power processed by the processing sub-module.

11. The method according to claim **2**, wherein the step of determining a bias control voltage corresponding to a preset operating point specifically comprises:

determining a corresponding relation between the input bias control voltage and the output optical power; and

obtaining the bias control voltage corresponding to the preset operating point according to the corresponding relation and the output optical power corresponding to the preset operating point.

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