



(19) **United States**

(12) **Patent Application Publication**
Ho et al.

(10) **Pub. No.: US 2011/0299373 A1**

(43) **Pub. Date: Dec. 8, 2011**

(54) **APPARATUS HAVING SWITCHABLE SERVO GAINS AND OFFSETS FOR OPTICAL DISK DRIVE AND METHOD THEREOF**

(30) **Foreign Application Priority Data**

Nov. 19, 2003 (TW) 092132463

Publication Classification

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(51) **Int. Cl.**
G11B 7/00 (2006.01)

(52) **U.S. Cl.** **369/44.29**; G9B/7

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(57) **ABSTRACT**

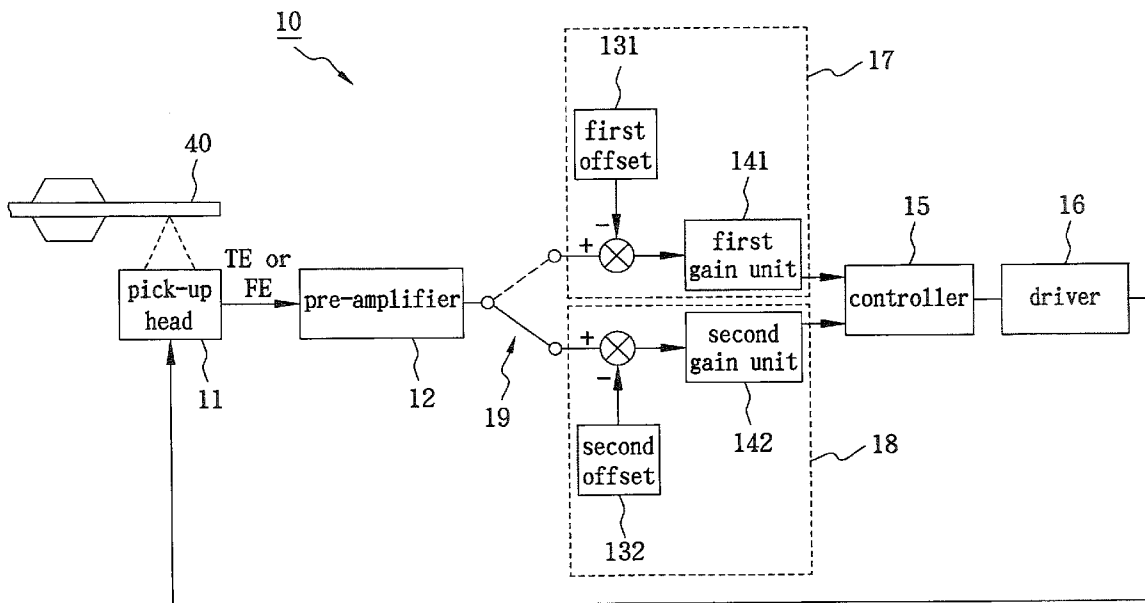
(21) Appl. No.: **13/214,309**

(22) Filed: **Aug. 22, 2011**

An apparatus having switchable servo gains and offsets for an optical disk drive adjusts its gains and offsets through the coupling of a servo signal and a switch with several changeable paths. The servo signals are either designated to undergo signal reduction with respect to a first offset through the switch and then be output after a first gain unit performed proportional conversion, or designated to undergo signal reduction with respect to a second offset and then be output after a second gain unit performed proportional conversion. The switch is switched on/off in the light of the working status of the pick-up head, for example, seeking or tracking, at a data area or at a blank area, and at a groove area or at a land area, so as to choose different offsets and gains to have the conversion of the servo signals.

Related U.S. Application Data

(60) Continuation of application No. 12/468,565, filed on May 19, 2009, now Pat. No. 8,027,230, Division of application No. 11/837,898, filed on Aug. 13, 2007, now abandoned, Division of application No. 10/710,416, filed on Jul. 8, 2004, now Pat. No. 7,272,085.



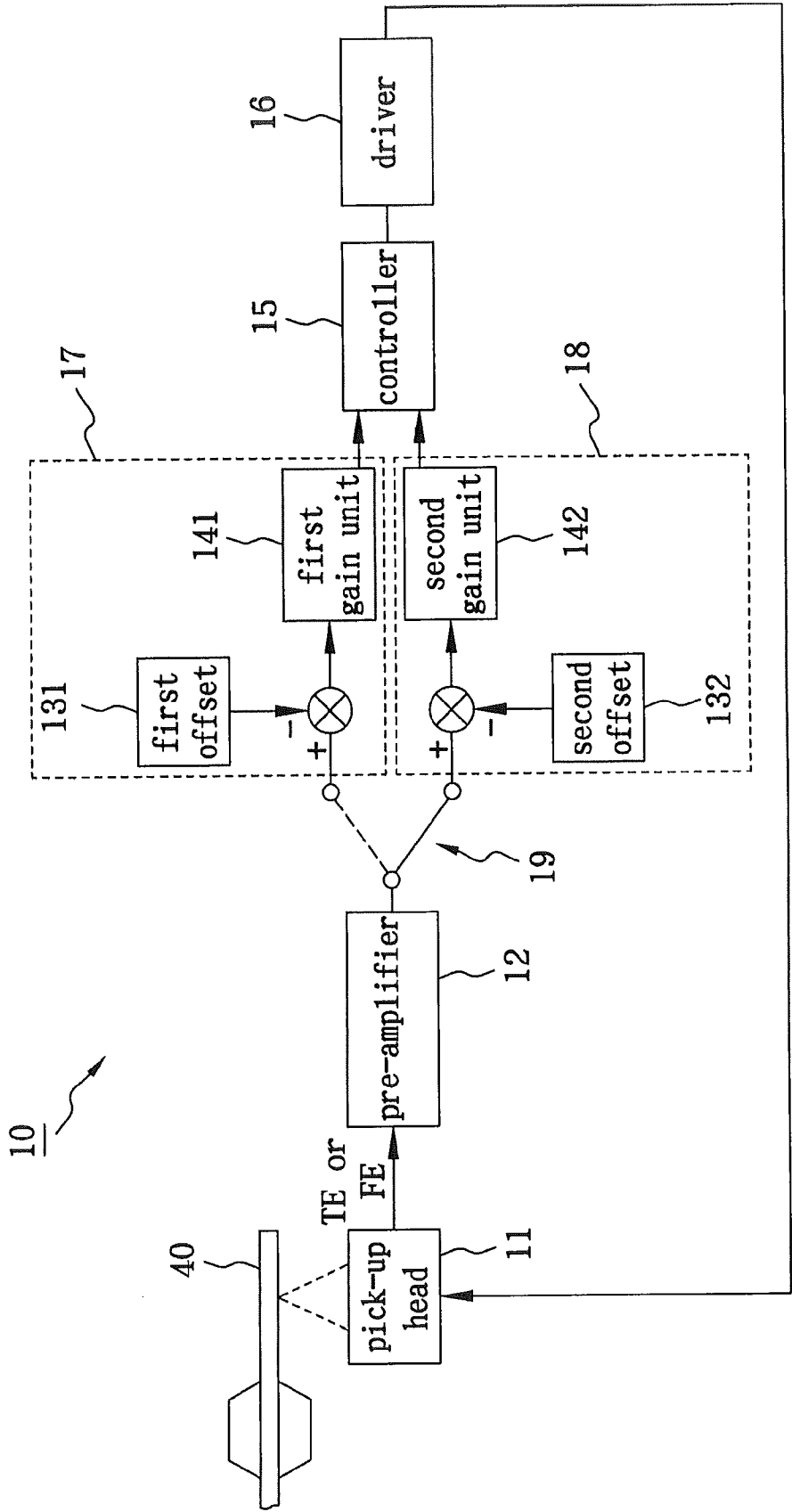


FIG. 1

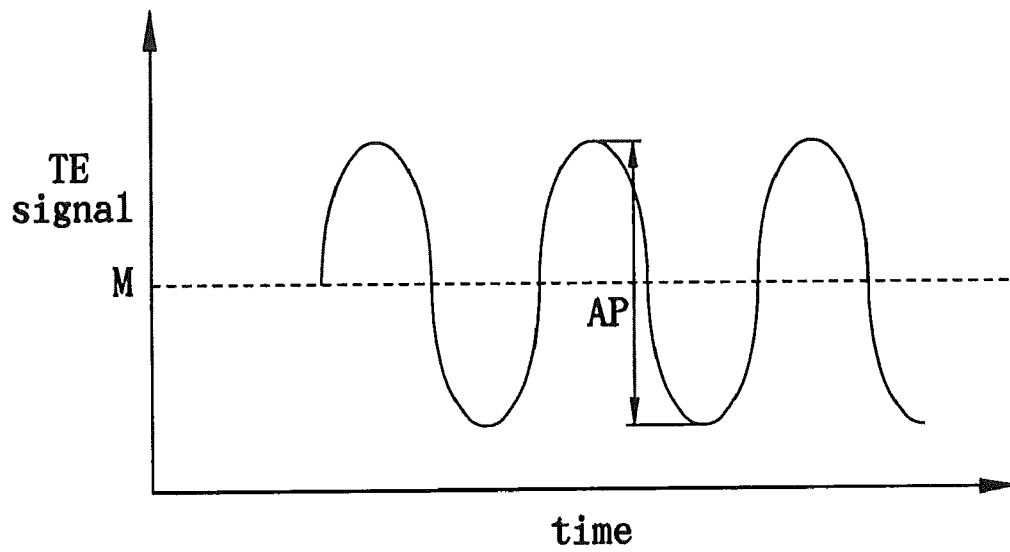


FIG. 2

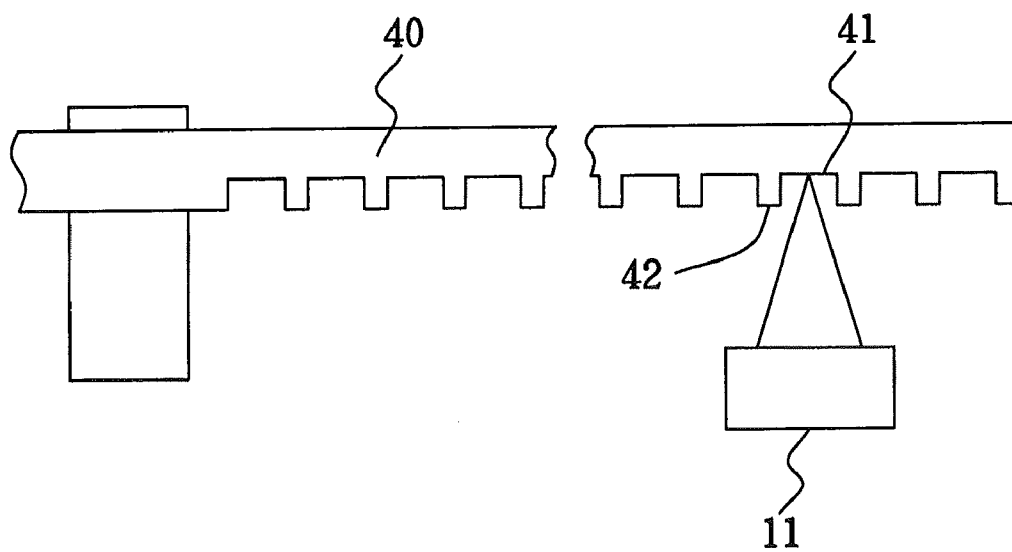


FIG. 3

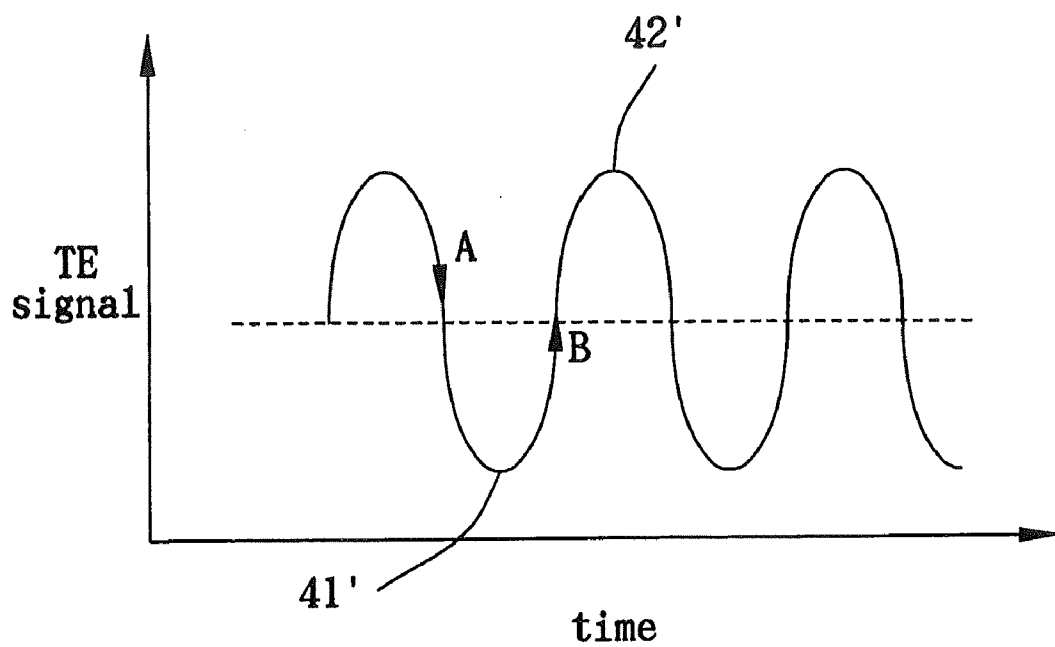


FIG. 4

APPARATUS HAVING SWITCHABLE SERVO GAINS AND OFFSETS FOR OPTICAL DISK DRIVE AND METHOD THEREOF

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation application of U.S. application Ser. No. 12/468,565 filed May 19, 2009 which is a divisional application of U.S. application Ser. No. 11/837,898 filed Aug. 13, 2007 which is a divisional application of U.S. Pat. No. 7,272,085 filed Jul. 8, 2004, and is based on and claims priority from Taiwanese Patent Application No. 092132463 filed Nov. 19, 2003.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to an apparatus having switchable servo gains and offsets for an optical disk device and the method thereof, and more particularly, to a servo control system of an optical disk device that makes adjustments in the gains and offsets according to the working status of the pick-up head.

[0004] 2. Description of the Related Art

[0005] The more progressive information technology is, the more versatile the kind of data storage is. In this regard, the optical disk drive has apparently become an important data storage tool available on the market. For an optical disk drive to operate, an electromechanical actuator drives a pick-up head so as to focus laser beams to be points on an optical disk. Then, any stored binary data is read and judged by the magnitude of the light rays received by a photo-detector; meanwhile, the received rays function as servo control signals for driving the pick-up head. In other words, the laser points are accurately focused on an adequate track, using such an optical signal to drive the pick-up head.

[0006] During the seeking process carried out by an optical disk drive, focus error (FE) signals is interfered with crosstalk that arises from the motion of the pick-up head along the radial direction of an optical disk. In other words, a carrier wave is induced on the FE signal from the interference of a tracking error (TE) signal. However, during the following or tracking process, the pick-up head moves from an inner portion to an outer portion along a spiral groove where data is recorded, thus the TE signal is almost inactive and the FE signal is free from the interference of the crosstalk effect on itself.

[0007] It is not feasible to adjust the gain of a conventional servo loop system for optical disk drives in the light of the working status of a pick-up head; thus, servo control is usually unstable, as it hardly converges. For instance, it is impossible to diminish the gain of the focusing loop system whenever seeking is underway; as a result, an inadequate response arises from that the interfering crosstalk signals are mistaken for normal FE signals. However, if the gain is set to a relatively small value, the response speed of the focusing loop control is compromised during the tracking process.

[0008] On the other hand, in regard to an ordinary optical disk, the reflectivity of a data area is different from that of a blank area. Hence, the photodetector of the pick-up head detects various reflective signals while it is passing the aforesaid areas. Data is saved in both the groove areas and the land areas of a DVD-RAM disk. Similarly, the reflective signals generated in the groove areas are different from those gener-

ated in the land areas where refractive indices are lower than the land areas' in terms of their characteristics. However, it is not also feasible to adjust the gain and the offset of the conventional servo loop system according to the position of the pick-up head where a data area or a blank area exists or where a groove area or a land area exists. By the same token, the servo control is unstable, as it hardly converges.

SUMMARY OF THE INVENTION

[0009] The objective of the present invention is to provide an apparatus having switchable servo gains and offsets for an optical disk drive and the method thereof, wherein the adjustments of the servo gains and offsets are depended on the working status of the pick-up head so as to stabilize the servo loop control system of the optical disk drive.

[0010] In order to achieve the objective, the present invention is to provide an apparatus having switchable servo gains and offsets for an optical disk drive and the method thereof, wherein adjustments in gains and offsets are achieved through the coupling of a servo signal and a switch with several changeable paths. The servo signals are to be either designated to be deducted a first offset through the switch and then output a converted signal in proportion to a first gain unit, or designated to be deducted a second offset, and then output a converted signal in proportion to a second gain unit. The switch is switched on/off in the light of the working status of the pick-up head, for example, seeking or tracking, at a data area or at a blank area, and at a groove area or at a land area, so as to choose different offsets and gains to have the conversion of the servo signals.

[0011] The input signal of the switch is a signal that results from the synthesis and amplification of a track error or a focusing error with a pre-amplifier. The input signal is subjected to conversion conducted by the first gain unit or the second gain unit, and then it is coupled to a controller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The invention will be described according to the appended drawings in which:

[0013] FIG. 1 is a schematic diagram of a servo control system for an optical disk drive in accordance with the present invention;

[0014] FIG. 2 is a waveform diagram of a TE signal;

[0015] FIG. 3 is a schematic diagram showing that a pick-up head writes or reads data on an optical disk; and

[0016] FIG. 4 is a waveform diagram of a TE signal in response to a DVD-RAM disk.

PREFERRED EMBODIMENT OF THE PRESENT INVENTION

[0017] FIG. 1 is a schematic diagram of a servo control system of an optical disk drive in accordance with the present invention. The seeking or tracking servo control system 10 of the optical disk device is equipped with a pick-up head 11 intended to read data recorded in an optical disk 40. The pick-up head 11 generates a TE signal or a FE signal that functions as an input signal to the servo control system 10. The input signal is sent to a pre-amplifier 12 to have signal synthesis and amplification. With a switch 19, the amplified control signal is allowed to couple to either a first gain circuit 17 or a second gain circuit 18; with the first gain circuit 17, the amplified control signal has a slice level shift in response to a first offset 131, and then it is converted at a constant propor-

tion by a first gain unit **141** before it is output; similarly, with the second gain circuit **18**, the amplified control signal has a slice level shift in response to a second offset **132**, and then it is converted at another constant proportion by a second gain unit **142** before it is output. The servo gain may be greater or less than one, or even a negative value.

[0018] The objective of the present invention is to normalize the input signals of a controller **15** by either the first gain unit **141** or the second gain unit **142**, so as to enhance the stability of the servo control system. The control signal generated by the controller **15** makes a driver **16** output a driving signal, and the pick-up head **11** responds after it receives the driving signal.

[0019] According to the present invention, the switch **19** is switched on/off in light of the working status of the pick-up head **11**. Its application to three statuses is as follows:

I. Seeking/Tracking

[0020] If the pick-up head **11** seeks tracks, the seeking or focusing servo control system makes the switch **19** switch to the second gain circuit **18** so as to reduce the sensitivity of the servo loop to noise signals by diminishing its servo gain. Conversely, if the pick-up head **11** is changed to track tracks, the switch **19** is switched to the first gain circuit **17**, and the servo gain of the second gain circuit **18** is less than that of the first gain circuit **17**.

[0021] The first offset **131** of the first gain circuit **17** and the magnitude of the gain of the first gain unit **141** can be determined by a track error or a focusing error intended for actual off-line detection (the second offset **132** and the gain value of the second gain unit **142** are determined in the same way). As shown in FIG. 2, it is a waveform diagram of a TE signal, wherein AP denotes the peak-to-peak (or crest-to-trough) interval of a TE signal, and M denotes a slice level, or a DC component. Also, servo control system designs always entail setting the peak-to-peak interval and the DC component. AP divided by a default peak-to-peak interval equals a quotient, and the quotient is designated as the gain of the first gain unit **141**. Furthermore, the difference between the DC component actually measured and a default DC component is designated as the magnitude of the first offset **131**.

II. Blank Area/Data Area

[0022] If the pick-up head **11** stays in a blank area, the servo control system makes the switch **19** switch to the second gain circuit **18** so as to decrease its servo gain. Conversely, if the pick-up head **11** stays in a data area to read data from there, the switch **19** is switched to the first gain circuits **17** so as to increase its servo gain.

[0023] Similarly, the corresponding magnitude of the gains and offsets can be obtained by the TE signal that is generated by the pick-up head staying either in the blank area or data area on-line. The calculating method of the magnitude is the same as the aforesaid descriptions.

III. Groove Area/Land Area

[0024] FIG. 3 is a schematic diagram showing how a pick-up head writes or reads data on an optical disk. Optical disks with ordinary specifications, such as CD-R, DVD-R and DVD-RW, always have data stored in their groove areas **41**. However, DVD-RAM stores data in both the groove areas **41** and the land areas **42**; for its corresponding TE signal, please refer to the trough **41'** and the peak **42'** in FIG. 4. The conver-

gence direction A of the trough **41'** is opposite to the convergence direction B of the peak **42'**. Hence, the gain of the first gain circuit **17** and that of the second gain circuit **18** have opposite signs, where not only do their offsets have opposite signs, but also the magnitude of their offsets differ.

[0025] If the pick-up head **11** is in a groove area **41**, the switch **19** is switched to the first gain circuit **17**. If the pick-up head **11** is in a land area **42**, the switch **19** is switched to the second gain circuit **18**.

[0026] Digital signal processing (DSP) technique may be applied to the present invention, that is, the real-time status of a pick-up head is detected on-line while programs are running, so that switching occurs automatically in response to the various statuses mentioned earlier. With a DSP or an analog circuit, the peak and the trough of the servo signals can be measured so as to figure out the corresponding offset and gain. In other words, if an optical drive is at a read or write state, the peak-trough interval and the DC component determine the magnitude of the offset and the gain, as far as the real-time calculated TE signal (or FE signal) are concerned.

[0027] Furthermore, it is feasible to calculate the offset and the gain in an off-line, such as a free track-locking status and a focusing servo control status, that is, directly calculate the gain and the offset of a TE signal or a FE signal, using an open loop.

[0028] The above-described embodiments of the present invention are intended to be illustrative only. Numerous alternative embodiments may be devised by persons skilled in the art without departing from the scope of the following claims.

What is claimed is:

1. A method for switching servo gains for an optical disk drive, the method comprising:
 - determining the location of a pick-up head on an optical disk based upon a reflective ratio on the optical disk;
 - outputting a signal after converting a servo signal by a first gain if the pick-up head is in a tracking status; and
 - outputting a normalized signal with respect to a level of the converted servo signal by multiplying the servo signal by a second gain less than the first gain if the pick-up head is in a seeking status.
2. The method for switching servo gains for an optical disk drive of claim 1, further comprising the step of:
 - determining the values of the first gain and the second gain by means of on-line detecting the servo signal.
3. The method for switching servo gains for an optical disk drive of claim 2, further comprising the step of:
 - determining the values of the first gain and the second gain by means of off-line detecting the servo signal.
4. A method for switching servo gains for an optical disk drive, the method comprising:
 - determining a working status of a pick-up head based upon a reflective ratio on the optical disk; and
 - selectively processing a servo signal from the pick-up head in response to the determined working status of the pick-up head, wherein the servo signal is amplified by a first gain when the pick-up head is in a tracking status and the servo signal is amplified by a second gain less than the first gain when the pick-up head is in a seeking status.
5. The method of claim 4, further comprising outputting a normalized control signal comprising the servo signal amplified by the second gain when the pick-up head is in a seeking status.

6. The method of claim 5, further comprising driving the pick-up head by using the normalized control signal.

7. The method of claim 4, further comprising outputting a control signal comprising the servo signal amplified by the first gain when the pick-up head is in a tracking status.

8. The method of claim 4, further comprising selectively adding an offset to the servo signal in response to the determined working status of the pick-up head.

9. A method for switching servo offsets for an optical disk drive, the method comprising:

determining the location of a pick-up head on an optical disk based upon a reflective ratio on the optical disk; outputting a signal after converting a servo signal by a first offset if the pick-up head is in a tracking status; and outputting a normalized signal with respect to a level of the converted servo signal by multiplying the servo signal by a second offset less than the first offset if the pick-up head is in a seeking status.

10. The method for switching servo offsets for an optical disk drive of claim 9, further comprising the step of:

determining the values of the first offset and the second offset by means of on-line detecting the servo signal.

11. The method for switching servo offsets for an optical disk drive of claim 10, further comprising the step of:

determining the values of the first offset and the second offset by means of off-line detecting the servo signal.

12. A method for switching servo offsets for an optical disk drive, the method comprising:

determining a working status of a pick-up head based upon a reflective ratio on the optical disk; and

selectively processing a servo signal from the pick-up head in response to the determined working status of the pick-up head,

wherein the servo signal is amplified by a first offset when the pick-up head is in a tracking status and the servo signal is amplified by a second offset less than the first offset when the pick-up head is in a seeking status.

13. The method of claim 12, further comprising outputting a normalized control signal comprising the servo signal amplified by the second offset when the pick-up head is in a seeking status.

14. The method of claim 13, further comprising driving the pick-up head by using the normalized control signal.

15. The method of claim 12, further comprising outputting a control signal comprising the servo signal amplified by the first offset when the pick-up head is in a tracking status.

16. The method of claim 12, further comprising selectively adding an offset to the servo signal in response to the determined working status of the pick-up head.

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