

12 becomes relatively small, and therefore the initial gain value (CI) having a relatively small value is set.

5 In short, since the optimum initial value CI is set for each zone (during the switching of the zone) in the AGC operation of the AGC amplifier 13 necessary for the read operation, an adequate AGC acquisition time (gain control time) in the AGC operation can be realized. Thereby, since the data decoding by the
10 data decoder is possible with respect to the read signal having a constantly adequate signal amplitude in the read/write channel 10, accurate data is reproduced. Particularly, the present embodiment is remarkably effective in the disk drive of the
15 perpendicular magnetic recording method in which the differentiation circuit 12 is used.

Additionally, in the present embodiment, the method of switching the initial value CI for each zone has been described in which the ZBR method is assumed
20 from a practical viewpoint. However, the present invention can also naturally be applied to the switching of the initial value CI for each track in which an ideal CDR method is assumed.

(Characteristic of Perpendicular Magnetic Recording
25 Method)

The present embodiment is applied to a disk drive of the perpendicular magnetic recording method.

In general, for the perpendicular magnetic recording method, when data (0/1) is recorded in a data track 60 as shown in FIG. 6A, a magnetization region corresponding to the data is formed in a perpendicular direction (depth direction 62) of the disk (rotative direction 61). In the perpendicular magnetic recording method, as shown in FIG. 6B, the amplitude shifts in a magnetization transition region, and a read signal having a substantially rectangular wave whose amplitude corresponds to the direction of magnetization is read by the head.

Here, when the read signal obtained in the perpendicular magnetic recording method is differentiated, or the differentiation is executed in at least a band with signal components present therein, as shown in FIG. 6C, the read signal (differentiated waveform) is obtained similarly as in the longitudinal magnetic recording method. That is, the amplitude is maximized in the magnetization transition region, and a signal having a different amplitude polarity is obtained in accordance with the transition to a negative-direction magnetization from a positive-direction magnetization, or to the positive-direction magnetization from the negative-direction magnetization.

FIG. 7A shows a read signal waveform with respect to isolated magnetization transition in a case in

which the data recorded onto the disk by the perpendicular magnetic recording method is read by the read head. Here, the read head is an MR head. A read signal waveform 70 is a read signal waveform from the outermost peripheral track on the disk. Moreover, a read signal waveform 71 is a read signal waveform from the innermost peripheral track on the disk. The maximum amplitudes of these read signals with respect to the isolated magnetization transition are constant without depending on the position in the radial direction of the track (i.e., the linear speed), because the read head is the MR head. On the other hand, the transition time width of the isolated magnetization transition changes in proportion to the linear speed. Therefore, the transition time width of the isolated magnetization transition in the outermost peripheral track is narrowed by $1/2$ with respect to the transition time width in the innermost peripheral track having a relatively $1/2$ linear speed. In other words, the transition time width in the outermost peripheral track has a relatively double steep inclination.

FIG. 7B shows read signal waveforms 72, 73 obtained by subjecting the read signal waveforms 70, 71 shown in FIG. 7A to a differentiation processing by the differentiation circuit. The disk drive of the perpendicular magnetic recording method has

a differentiation circuit for differentiating the read signal as described above. The amplitude of the differentiated signal obtained by differentiating the read signal obtained from the isolated magnetization transition depends on the transition time width of the signal before the differentiation. When the inclination of transition becomes steep, the amplitude increases. As shown in FIG. 7B, the outermost peripheral track having a half transition time width (double transition inclination) in the signal before the differentiation has a differentiated signal amplitude which is twice the differentiated signal amplitude of the innermost peripheral track.

Moreover, FIG. 8A shows a read signal waveform 80 obtained from the outermost peripheral track and a read signal waveform 81 obtained from the innermost peripheral track in a case in which the data is repeatedly recorded on the disk with the same linear recording density by the perpendicular magnetic recording method. FIG. 8B shows differentiated signal waveforms 82 (signal corresponding to 80), 83 (signal corresponding to 81) obtained by subjecting the read signal waveforms to the differentiation processing.

As shown in FIG. 8A, since the linear recording density is the same, the frequency of the repeated data recorded in the outermost peripheral track becomes twice the frequency in the innermost

peripheral track. On the other hand, the transition time width in the outermost peripheral track is a half of the width of the innermost peripheral track. Therefore, the amplitude of the read signal obtained from the data recorded at the same linear recording density eventually becomes substantially constant regardless of the track position. However, the signal amplitudes obtained by differentiating these read signals are proportional to the frequency. Therefore, as shown in FIG. 8B, the signal amplitude of the read signal (differentiated signal) in the outermost peripheral track is twice the signal amplitude in the innermost peripheral track.

Additionally, FIG. 5A shows that the data (0/1) is recorded in a data track 50 in the longitudinal magnetic recording method. That is, the magnetization region (arrows 52) corresponding to the data is formed in a longitudinal direction (corresponding to a rotative direction 51) of a disk recording medium (hereinafter referred to simply as the disk). When the data is read from the disk by a magnetic head (referred to simply as the head), a read signal waveform 53 is obtained as shown in FIG. 5B. That is, the amplitude is maximized in the region (magnetization transition region) in which the direction of magnetization shifts, and the read signal waveform has a different amplitude polarity in

accordance with the transitions to the negative-
direction magnetization from the positive-direction
magnetization and to the positive-direction
magnetization from the negative-direction
5 magnetization.

As described above, in short, according to
the present embodiment, gain control of the AGC
amplifier can appropriately be executed by a method of
switching the initial gain value necessary for the
10 gain control for each track or each zone on the disk.
In other words, during the read operation for reading
the data from the disk to decode the data, the optimum
initial gain value can be set into the AGC amplifier,
for example, for each zone. Therefore, the AGC
15 amplifier operates for the constantly stable AGC
acquisition time (gain control time), and the
amplitude of the read signal is adjusted to be a
predetermined amplitude value. Thereby, even when the
amplitude of the read signal read for each zone
20 changes, data decode processing can securely be
executed from the read signal.

Therefore, the data can securely be decoded from
the read signal read from any track or zone on the
disk. Particularly, the present invention is
25 effective for the disk drive of the perpendicular
magnetic recording method in which the amplitude of
the read signal changes in proportion to the recording

WHAT IS CLAIMED IS:

1. A disk drive comprising:

a disk medium in which a plurality of data areas
with data recorded therein are constituted in a radial
5 direction;

a read head which executes a read operation of
the data with respect to said respective data areas;

an AGC amplifier which controls an amplitude of
a read signal read by said head;

10 a memory in which a plurality of gain value data
set as gain values for setting a gain of said AGC
amplifier for the respective data areas are stored so
as to be adapted for recording frequency
characteristics of said respective data areas; and

15 a controller which reads the gain value data
corresponding to the data areas as read objects from
said memory, and sets the data into said AGC amplifier
during the read operation by said read head.

2. A disk drive according to claim 1, wherein
20 the gain value data stored in said memory corresponds
to an initial gain for controlling the gain of said AGC
amplifier in an initial time of the read operation.

3. A disk drive according to claim 1, wherein
said respective data areas are recording areas
25 corresponding to a plurality of zones into which
a track group constituted in the radial direction on
said disk is formed.

4. A disk drive according to claim 1, wherein said respective data areas are recording areas corresponding to respective tracks of the track group constituted in the radial direction on said disk.

5 5. A disk drive according to claim 1, wherein said head has a read head which reads the data from the data area and a write head which writes the data into the data area.

6. A disk drive according to claim 1, wherein
10 said AGC amplifier comprises:

 a VGA amplifier having a variable gain function;
and

 an automatic gain controller which inputs initial gain data set from said controller, and uses the
15 initial gain data to output a gain control signal for controlling the gain of said VGA amplifier.

7. A disk drive according to claim 1, wherein said controller reads the corresponding initial gain data from said memory and sets the initial gain data
20 into said AGC amplifier only at a start of gain control of said AGC amplifier in an initial time of the read operation with respect to the data area as the read object.

8. A disk drive according to claim 3, wherein
25 said controller reads the corresponding initial gain data from said memory and sets the initial gain data into said AGC amplifier only at a start of gain control

of said AGC amplifier in a switching time of the zone as the read object.

9. A disk drive according to claim 3, wherein a servo sector with servo data recorded therein and
5 a data sector with user data recorded therein are disposed in each track on said disk,

a table constituted of initial gain data for servo corresponding to said servo sector and a plurality of initial gain data set for said respective zones in
10 accordance with the recording frequency characteristic of said user data is stored in said memory, and

said controller reads said initial gain data for servo from said memory during a servo control operation of reading the servo data from said servo sector, reads
15 the initial gain data corresponding to the zone as the read object from said memory during the read operation of reading said user data, and sets the data into said AGC amplifier.

10. A disk drive comprising:

20 a disk medium in which a group of tracks is constituted in a radial direction to record data by a perpendicular magnetic recording method and the track group is formed in a plurality of zones;

a read head which executes a read operation of
25 the data with respect to said respective tracks;

a read channel which includes a differentiation circuit to differentiate a read signal read from said

read head, and an AGC amplifier to adjust an amplitude of an output signal of the differentiation circuit, and which reproduces the data from the read signal;

5 a memory in which a plurality of initial gain data set as initial gain values for controlling a gain of said AGC amplifier for said respective zones in accordance with a recording frequency characteristic are stored; and

10 a controller which reads the initial gain data corresponding to the zone as a read object from said memory during the read operation, and transmits the initial gain data to said read channel so as to set the data into said AGC amplifier.

11. A disk drive according to claim 10, wherein
15 said AGC amplifier comprises:

a VGA amplifier having a variable gain function;
and

20 an automatic gain controller which uses amplitude error value data corresponding to the amplitude of the output signal of the VGA amplifier and the initial gain data set from said controller to output a gain control signal for controlling the gain of said VGA amplifier.

12. A disk drive according to claim 10, wherein
25 said controller reads the corresponding initial gain data from said memory, and sets the initial gain data into said AGC amplifier only at a start of gain control of said AGC amplifier in a switching time of the zone

as the read object.

13. A disk drive according to claim 10, wherein
a servo sector with servo data recorded therein and
a data sector with user data recorded therein are
5 disposed in each track on said disk,

table information constituted of initial gain data
for servo corresponding to said servo sector in
addition to the initial gain data for said each zone is
stored in said memory, and

10 said controller reads said initial gain data for
servo from said memory during a servo control operation
of reading the servo data from said servo sector, reads
the initial gain data corresponding to the zone as the
read object from said memory during the read operation
15 of reading said user data, and sets the data into said
AGC amplifier.

14. A method of reading data from a disk by a read
head in a disk drive, the disk drive including said
disk in which a plurality of data areas with the data
20 recorded therein are constituted in a radial direction,
an AGC amplifier which controls an amplitude of a read
signal read by said read head, and a memory in which
a plurality of initial gain data set as initial gain
values for controlling a gain of said AGC amplifier for
25 the respective data areas in accordance with recording
frequency characteristics of said respective data areas
are stored,

said method comprising:

reading the initial gain data corresponding to
the data areas as read objects from said memory during
a read operation;

5 setting the initial gain data read from said
memory into said AGC amplifier; and

reproducing the data from said read signal whose
amplitude is controlled by said AGC amplifier.