The invention relates to a circuit arrangement for automatic gain control.

Automatic gain control, frequently abbreviated to AGC, is used e.g. in radio receivers, in order to regulate the maximum output level to a constant value independent of fluctuations of the received field strength.

In a CD-player or a magneto-optical recording- and reproduction device a laser beam radiates onto an optical recording medium, which reflects the laser beam onto a photodetector consisting of a plurality of photodiodes. From the output signals of the photodiodes there are generated in addition to the data signal a focus error signal for the focus control circuit and a tracking error signal for the tracking control circuit.

When the laser power or the reflecting behaviour of the optical recording medium vary, the loop gain of the focus- and of the tracking-control-circuit varies too.

In an optical reproduction device, which is described in US-A-4,835,755, the analog focus error signal, the analog tracking error signal and the analog control signal for controlling the speed of the disc drive motor are converted by means of a plurality of analog-to-digital converters into digital signals, which are evaluated in a microprocessor. The microprocessor supplies digital control signals, which by means of a digital-to-analog converter are converted back to analog control signals for the control elements of the focus- and tracking-control circuit and for the disc drive motor.

A known solution to control the loop gain to a constant value, which is realized in the component AD 533 from Analog Devices, provides an analog dividing circuit, in

which the focus error signal and the tracking error signal are divided by a value, which is proportional to the total incident light energy on the photodetector. The focus-error- and the tracking-error-signal are thus normalized relative to the total incident light energy. This known solution has two considerable drawbacks, however, because the analog dividing circuit is relatively expensive and requires a very sophisticated tuning.

It is therefore an object of the invention, to provide a circuit arrangement for automatic gain control such that it can easily be manufactured and no longer requires tuning.

The invention achieves this object in that the input signal to be amplified is supplied via a controllable switch and a first low-pass filter to an amplifier and via a second low-pass filter and the analog-to-digital-converter to the microprocessor, in that the output of the microprocessor is connected to the input of a pulse-width-modulator, the output of which is connected to he control input of the controllable switch, and in that the microprocessor generates a control signal for the pulse-width-modulator in dependence upon the digital value at the output of the analog-to-digital converter.

Figure 1 shows an embodiment of the invention;

Figures 2 and 3 show a practical embodiment of the invention.

With reference to Figure 1 the invention will now be described and explained.

The signal S to be amplified to an amplifier V is applied

to the input of a controllable switch SC, the output of which is connected via a low-pass filter TP1 to the input of the amplifier V, and to the input of a low-pass filter TP2, the output of which is connected to the input of an analog-to-digital converter AD. The output of the analog-to-digital converter AD is connected to the input of a microprocessor MP, the output of which is connected to the input of a pulse-width-modulator PM. The output of the pulse-width-modulator PM is connected to the control input of the controllable switch SC.

The microprocessor MP generates a control signal for the pulse-width-modulator PM in dependence upon the digital value at the output of the analog-to-digital converter AD e.g. by means of an algorithm, which thus varies the mark-space ratio of its output signal also in dependence upon the digital value at the output of the analog-to-digital converter AD. In order to regulate the maximum output level of the amplifier V to a constant value, the mark-space ratio, with which the controllable switch S is opened and closed, is lowered with a rising level of the input signal S, with a falling level however it is increased. In order, however, that fast level changes of the input signal S are not levelled out, which would lead to a permanently constant output level of the amplifier V, independent of the level of the input signal S, a low-pass filter TP1 is connected in front of the analog-to-digital converter AD. A further low-pass filter TP2 is provided between the controllable switch SC and the amplifier V in order to suppress the switching frequency of the control switch SC and its side bands.

The controllable switch SC, for which a fast analog switch is especially suitable, acts with the following low-pass filter TP1 as an electronically-controlled potentiometer. It is especially advantageous to select

the switching frequency at the output of the pulse-width-modulator PM very high.

The microprocessor MP can generate the control signal for the pulse-width-modulator PM e.g. also from the values of a table which are stored in a memory. Each digital value at the output of the analog-to-digital converter AD has assigned thereto a value in the memory. The individual values in the memory can e.g. determine the mark-space ratio of the signal of the pulse-width-modulator PM. In this way a certain mark-space ratio is assigned to each digital value at the output of the analog-to-digital converter AD.

The automatic gain control according to the invention is e.g. suitable for the tracking and the focus- control circuit of a CD-player or a magneto-optical recording- and reproduction device.

In Figure 2 this use is shown. The magneto-optical recording- and reproduction device can simultaneously read data from a recording medium, which are recorded both by means of pits and also in a magneto-optical layer of the recording medium. The optical scanning device of such a magneto-optical recording- and reproduction device is known from DE-OS 37 32 874; the associated recording medium, on which are both stored data using pits and also in a magneto-optical layer can be stored, is described in DE-OS 37 32 875.

The light radiated by a laser is reflected in known manner from the magneto-optical recording medium onto a four-quadrant-photodetector having four photodiodes A,B,C and D and onto a respective photodiode E and F lying to the right and left adjacent to the four-quadrant photodetector. In addition the recording medium reflects

the light radiated by the laser onto a photodiode G. The output currents of the photodiodes A to G are converted into voltages AS to GS by means of current-voltage-converters 1 to 7. The data signal MS = AS + BS + CS + DS - ES - FS - GS is formed by means of an adder and a subtractor 8, and contains the data stored in the magneto-optical layer of the recording medium.

The data signal PS, which contains the data stored in the pits, is formed in an adder 9: PS = AS + BS + CS + DS. The focus error signal FE = AS + CS - BS - DS is produced in an adder and subtractor 10. A differential amplifier 11 produces the tracking error signal TE = ES - FS. The output of the adder and subtractor 10 is connected to the control amplifier 16 of the focus control circuit via a controllable switch 12 and a low-pass filter 14, which is realized as an RC-member. The output of the differential amplifier 11 is connected to the control amplifier 17 of the tracking control circuit via a controllable switch 13 and low-pass filter 15 also realized as an RC-member. The output of the adder 9 is connected via a low-pass filter TP2 to the input of an analog-to-digital converter AD, the output of which is connected to the input of a microprocessor MP. The output of the microprocessor MP is connected to the input of a pulse-width-modulator PM, the output of which is connected to the inputs of the controllable switches 12 and 13.

It is also possible, as Figure 3 shows, to provide a respective pulse-width-modulator PM1 and PM2 for both the focus- and for the tracking-control circuit. The microprocessor MP generates a first control signal for the first pulse-width-modulator PM1, the output of which is connected to the control input of the controllable switch 12, and independently thereof a second control signal for the other pulse-width-modulator PM2, the

output of which is connected to the control input of the controllable switch 13.

Because the sum signal PS = AS + BS + CS + DS represents a direct measure for the entire light energy radiated onto the four-quadrant-detector, it is reasonable to produce from the sum signal PS in the microprocessor MP the control signal for controlling the gain.

The invention is however in no way limited to the application shown in Figure 2 and 3. It is suitable for automatic gain control generally.

Claims

1. A circuit arrangement for automatic gain control with an analog-to-digital converter (AD), the output of which is connected to a microprocessor (MP), which generates a control signal, characterised in that the input signal (S) to be amplified is supplied via a controllable switch (SC) and a first low-pass filter (TP1) to an amplifier (V) and via a second low-pass filter (TP2) and the analog-to-digital converter (AD) to the microprocessor (MP), in that the output of the microprocessor (MP) is connected to the input of a pulse-width-modulator (PM), the output of which is connected to the control input of the controllable switch (SC), and in that the microprocessor (MP) generates a control signal for the pulse-width-modulator (PM) in dependence upon the digital values at the output of the analog-to-digital converter (AD).

2. A circuit arrangement for automatic gain control according to claim 1, characterised in that for the controllable switch (SC) there is provided an analog switch.

3. A circuit arrangement for automatic gain control according to claim 1 or 2, characterised in that the microprocessor (MP) generates the control signal for the pulse-width-modulator (PM) by means of an algorithm from the output signal of the analog-to-digital converter (AD).

4. A circuit arrangement for automatic gain control according to claim 1 or 2, characterised in that to each digital value at the output of the analog-to-digital converter (AD) there is assigned a value stored in a memory, in that the microprocessor (MP) monitors the respective value in the memory related to the digital

* C L M S *

value at the output of the analog-to-digital converter (AD) and delivers it at its output as a control signal to the pulse-width-modulator (PM).

5. A circuit arrangement for automatic gain control according to claim 1,2,3 or 4, characterised in that, in an optical or a magneto-optical reproduction device, the sum signal (PS) formed from the output signals of a plurality of photodiodes (A,B,C,D) is supplied via the second low-pass filter (TP2) and the analog-to-digital converter (AD) to the microprocessor (MP) and in that the output of the pulse-width-modulator (PM) is connected to the control input of the controllable switch (12,13), which is located in the focus- and/or tracking-control circuit ahead of the first low-pass filter (TP1) and the control amplifier (VF,VS).

6. A circuit arrangement for automatic gain control according to claim 1,2,3 or 4, characterised in that, in an optical or a magneto-optical reproduction device, the sum signal (PS) formed from the output signals of a plurality of photodiodes (A,B,C,D) is supplied via the second low-pass filter (TP2) and the analog-to-digital converter (AD) to the microprocessor (MP), the first output of which is connected to the input of a first pulse-width-modulator (PM1) and the second output of which is connected to the input of a second pulse-width-modulator (PM2), in that the output of the first pulse-width-modulator (PM1) is connected to the control input of the controllable switch (12), which is located ahead of the control amplifier (VF) of the focus control circuit, and in that the output of the second pulse-width-modulator (PM2) is connected to the control input of the controllable switch (13), which is located ahead of the control amplifier (VS) of the tracking control circuit.

* C L M S *