

FORM 1

SPRUSON & FERGUSON

APPLICATION ACCEPTED AND AMENDMENTS
7-1-91

600376

COMMONWEALTH OF AUSTRALIA
PATENTS ACT 1952
APPLICATION FOR A STANDARD PATENT

Siemens Aktiengesellschaft, incorporated in the Federal Republic of Germany,
of Wittelsbacher Platz 2, 8000 Muenchen, FEDERAL REPUBLIC OF GERMANY, hereby
apply for the grant of a standard patent for an invention entitled:

Circuit Arrangement with a Preamplifier Connected to an
Opto-electric Transducer

which is described in the accompanying complete specification.

Details of basic application(s):-

<u>Basic Applc. No:</u>	<u>Country:</u>	<u>Application Date:</u>
P37 36 181.3	DE	26 October 1987

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DATED this TWENTY FOURTH day of OCTOBER 1988

Siemens Aktiengesellschaft

By:

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Registered Patent Attorney

TO: THE COMMISSIONER OF PATENTS
OUR REF: 74330
S&F CODE: 61890

5845/4

COMMONWEALTH OF AUSTRALIA

THE PATENTS ACT 1952

DECLARATION IN SUPPORT OF A
CONVENTION APPLICATION FOR A PATENTIn support of the Convention Application made for a
patent for an invention entitled:AUSTRALIA
CONVENTION
STANDARD
& PETTY PATENT
DECLARATION

Title of Invention

Circuit Arrangement with a Preamplifier Connected to an
Opto-electric TransducerFull name(s) and
address(es) of
Declarant(s)

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do solemnly and sincerely declare as follows:

Full name(s) of
Applicant(s)

1. I am/We are the applicant(s) for the patent

(or, in the case of an application by a body corporate)

1. I am/We are authorised by

Siemens Aktiengesellschaft

the applicant(s) for the patent to make this declaration on
its/their behalf.2. The basic application(s) as defined by Section 141 of the
Act was/were made

Basic Country(ies)

in Federal Republic of Germany

Priority Date(s)

on 26 October 1987

Basic Applicant(s)

by Siemens Aktiengesellschaft

Full name(s) and
address(es) of
Inventor(s)3. I am/We are the actual inventor(s) of the invention referred
to in the basic application(s)

(or where a person other than the inventor is the applicant)

3. Peter Bartenstein and Karl-Heinz Prasche

of Ramsauerstr. 19, 8000 Muenchen 70 and
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both in Federal Republic of Germany

(respectively)

are the actual inventor(s) of the invention and the facts upon
which the applicant(s) is/are entitled to make the application are
as follows:Set out how Applicant(s)
derive title from actual
inventor(s) e.g. The
Applicant(s) is/are the
assignee(s) of the
invention from the
inventor(s)The said applicant is the assignee of the
actual inventors4. The basic application(s) referred to in paragraph 2 of this
Declaration was/were the first application(s) made in a Convention
country in respect of the invention(s) the subject of the application.

Declared at Sydney this 20th day of October 1988

Signature of Declarant(s)

(12) PATENT ABRIDGMENT (11) Document No. AU-B-24328/88
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 608376

- (54) Title
CIRCUIT ARRANGEMENT WITH A PREAMPLIFIER CONNECTED TO AN
OPTO-ELECTRIC TRANSDUCER
- International Patent Classification(s)
(51)⁴ H03G 003/30
- (21) Application No. : 24328/88 (22) Application Date : 25.10.88
- (30) Priority Data
- (31) Number (32) Date (33) Country
3736181 26.10.87 DE FEDERAL REPUBLIC OF GERMANY
- (43) Publication Date : 27.04.89
- (44) Publication Date of Accepted Application : 28.03.91
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- (56) Prior Art Documents
US 4459475
US 4053847
EP 54571
- (57) Claim

1. A circuit arrangement comprising:

a preamplifier having a signal input connected to an opto-electric transducer, the preamplifier having a gain adapted to be controlled with the aid of an actuator formed by a field effect transistor having two controlling terminals; and

a controllable amplifier arrangement, containing at least one amplifier adapted to be controlled with respect to its gain, said controllable amplifier arrangement being arranged in series with the preamplifier and being controlled by means of a regulator having a first input connected to a sampled output of said circuit arrangement and a second input connected via a differentiating section to the output circuit of the preamplifier; wherein

said preamplifier contains a series circuit of two resistors in a feedback branch in which said field effect transistor has its drain-source path connected in parallel with one of the resistors of the series circuit, the gate of said field effect transistor being controlled by means of a

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on/off control circuit exhibiting hysteresis such that the field effect transistor is cut off in a first switching state of the control circuit and is rendered conductive in a second switching state of the control circuit wherein the on/off control circuit is controlled by said regulator in such a manner that it changes from the first into the second switching state when the controllable amplifier arrangement at least approximately reaches the state of minimum gain with a rising input level of the circuit arrangement.

608376

S & F Ref: 74330

FORM 10

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952

COMPLETE SPECIFICATION

(ORIGINAL)

This document contains the
amendments made under
Section 49 and is correct for
printing

FOR OFFICE USE:

Class Int Class

Complete Specification Lodged:

Accepted:

Published:

Priority:

Related Art:

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Complete Specification for the invention entitled:

Circuit Arrangement with a Preamplifier Connected to an
Opto-electric Transducer

The following statement is a full description of this invention, including the
best method of performing it known to me/us

Abstract

Circuit arrangement with a preamplifier connected to an opto-electric transducer.

Circuit arrangement with a preamplifier (2),
5 which is connected with its input (E) to an opto-electric transducer (1), the gain of which can be controlled with the aid of an actuator formed by a field effect transistor (23). To achieve a particularly wide dynamic range, the preamplifier (2) contains, in parallel with a resistor
10 (22) arranged in a feedback branch, the drain-source path of a field effect transistor (23) which is controlled to conduct or is cut off by a regulator (3). The control range of a controllable amplifier arrangement (6, 7) following the preamplifier (2) is utilised twice in this
15 manner. The circuit arrangement can be advantageously used in optical transmission devices of the PCM technology.

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Circuit arrangement with a preamplifier connected to an opto-electric transducer.

5 The invention relates to a circuit arrangement with a preamplifier connected to an opto-electric transducer, as specified in the precharacterizing clause of Claim 1.

Such a circuit arrangement is already known from
10 German Patent Specification 32 04 839.

The known circuit arrangement has a photodiode at the input and contains a chain circuit of a common emitter stage and a common collector stage. Between the output of the common collector stage and the input of the common
15 emitter stage, a resistor is arranged in a feedback branch. This circuit arrangement consisting of two stages forms a so-called transimpedance amplifier which has a comparatively small input impedance and a comparatively very low output impedance. In parallel with the
20 collector resistor of the common emitter stage, the drain-source path of a field effect transistor is connected, the impedance of which is continuously controllable with the aid of a control voltage. This makes it possible to change the effective collector impedance within wide
25 limits. This provides a possibility of externally setting the gain of the first amplifier stage within a relatively large dynamic range.

In addition, the known circuit arrangement should exhibit the usual requirements with regard to optimum
30 coupling out of the electric signals emitted by the photo-receiver with respect to noise, high gain and low current consumption together with the lowest possible inherent noise.

The invention has the object of developing a circuit arrangement of the type initially mentioned, in such
35 a manner that a particularly wide dynamic range of the gain is obtained and that at the same time the change in the frequency response of the circuit arrangement remains as small as possible. In particular, proper operation

should be ensured even with jumps in the light level which lead to the preamplifier being overdriven.

In accordance with the present invention there is disclosed a circuit arrangement comprising:

5 a preamplifier having a signal input connected to an opto-electric transducer, the preamplifier having a gain adapted to be controlled with the aid of an actuator formed by a field effect transistor having two controlling terminals; and

10 a controllable amplifier arrangement, containing at least one amplifier adapted to be controlled with respect to its gain, said controllable amplifier arrangement being arranged in series with the preamplifier and being controlled by means of a regulator having a first input connected to a sampled output of said circuit arrangement and a second input connected via a differentiating section to the output circuit
15 of the preamplifier; wherein

said preamplifier contains a series circuit of two resistors in a feedback branch in which said field effect transistor has its drain-source path connected in parallel with one of the resistors of the series circuit, the gate of said field effect transistor being controlled by means of a
20 on/off control circuit exhibiting hysteresis such that the field effect transistor is cut off in a first switching state of the control circuit and is rendered conductive in a second switching state of the control circuit wherein the on/off control circuit is controlled by said regulator in such a manner that it changes from the first into the second switching state
25 when the controllable amplifier arrangement at least approximately reaches the state of minimum gain with a rising input level of the circuit arrangement.

In this arrangement, the gain of the preamplifier is automatically switched over, unnecessary switching processes being avoided. This switch-
30 over, in conjunction with the control of the controllable amplifier arrangement by the regulator, has the advantage that the full dynamic range of the circuit arrangement is achieved by dual utilization of the control range of the controllable amplifier arrangement. In this arrangement, both slow level changes and jumps in level are compensated with the aid of the
35 regulator contained in the circuit arrangement. The increased dynamic range can be advantageously easily dimensioned in such a manner that short-circuit operation by means of a laser transmitter is also possible.



The preamplifier, the feedback branch of which can be switched over with the aid of the field effect transistor used as actuator, can be constructed in the manner specified in Claim 2. This construction as transimpedance amplifier is already known as such from German Patent Specification 3,204,839. In conjunction with the measures specified in Claim 1, the particular advantage is obtained that the field effect transistor used as actuator is operated as a switch and thus ensures particularly reliable switching states for the switch-over.

A particularly advantageous development with respect to the transimpedance amplifier is obtained from Claim 3. A field effect transistor is preferably used as a further transistor. The small input capacitance of the field effect transistor allows the feedback branch to be advantageously constructed to have a particularly high impedance. In addition, the field effect transistor provides the possibility of low noise with high gain.

The measures according to Claim 4 have the advantage that the direct current operating point can be adjusted independently of the alternating voltage.



characteristics of the amplifier with the aid of a voltage divider and that the differentiating section is here fed from a low-impedance voltage source.

In the further development according to Claim 5, the high-pass filter suitably cancels the low-pass-shaped frequency response of the preamplifier. The required frequency response of the circuit arrangement is determined with the aid of the low-pass filter following the controllable amplifier arrangement.

10 The further development of the invention according to Claim 6 advantageously allows particularly great tolerances to be allowed for the two potentials to which the controlled section of the field effect transistor forming the actuator is connected.

15 The further development of the invention according to Claim 7 allows inherent oscillations of the preamplifier to be reliably suppressed in advantageous manner and at the same time to ensure that the frequency response of the preamplifier is virtually the same in both
20 switching states of the field effect transistor used as actuator.

The measures according to Claim 8 have the advantage that the insertion of the diode does not have any influence on the stability of the preamplifier.

25 In the embodiment of the amplifier arrangement specified in Claim 9, the opto-electric transducer, the preamplifier and the controllable amplifier arrangement are advantageously included in the dynamic control system.

The measures according to Claim 10 result in the
30 advantage that a differential amplifier provided for driving a controllable amplifier is at the same time used for driving the hysteresis-affected on/off control circuit in an accelerated manner. The resultant fast switch-over has the advantage of limiting bit errors in the trans-
35 mitted signals.

The invention will be explained in greater detail with reference to the illustrative embodiment shown in the Figure.

The Figure shows a circuit arrangement with a

preamplifier connected to an opto-electric transducer and with a controllable amplifier arrangement chain-connected to the preamplifier.

The circuit arrangement shown in the Figure contains a preamplifier 2 which is connected to the photodiode 1 and in particular an avalanche diode. The preamplifier 2, in turn, contains the first bipolar transistor 11, the second bipolar transistor 12 and the field effect transistor 14. In the first transistor 11, the base is connected via the capacitor 13 to reference potential, the collector is connected via resistor 10 to the supply voltage $+U_g$ and the emitter is connected to the drain electrode of the field effect transistor 14. In the case of the field effect transistor 14, the source electrode is connected to earth via the capacitor 15, that is to say with respect to alternating voltage. The control electrode of the field effect transistor 14 is connected to the anode of the photodiode 1.

The second transistor 12 is connected with its base to the collector of the first transistor 11 and with its collector to the supply voltage $+U_g$. The transistor 12, which is connected as an emitter follower, is connected with its emitter via the RC parallel circuit consisting of the resistor 17 and the capacitor 16 and via the resistor 25, which is connected in series with it, to the supply voltage $-U_g$. The junction between the resistors 17 and 25 forms the output of the preamplifier 2 which is connected with the input of the high-pass filter 5 and is connected via the feedback branch consisting of the resistors 21 and 22 to the control electrode of the field effect transistor 14.

The source-drain path of the field effect transistor 23 used as actuator is connected in parallel with the resistor 22. The drain electrode of the field effect transistor 23 is here connected to the control electrode of the field effect transistor 14. Between the control electrode and the source electrode of the field effect transistor 23, the serial circuit consisting of the diode 26 and the resistor 24 is located. This series circuit

is thus located in parallel with the controlled section of the field effect transistor 23. The diode 26 is polarised in such a manner that it is operated in the direction of conduction for control voltages which control the field effect transistor 23 to conduct. The junction of diode 26 and resistor 24 is connected to earth via the capacitor 27. The capacitor 20 is located in parallel with the resistor 21.

The high-pass filter 5 connected to the output of the preamplifier 2 is followed by a chain circuit consisting of the controlled amplifier 6, the controlled amplifier 7, the low-pass filter 8 and the output amplifier 9.

The control input of the controllable amplifier 6 is preceded by the differential amplifier 35, the control input of the controllable amplifier 7 is preceded by the differential amplifier 36. The differential amplifiers 35 and 36 are connected with their reference voltage inputs to taps of the voltage divider consisting of resistors 32, 33 and 34. In this voltage divider, the resistor 32 is connected to the supply voltage $+U_g$ and the resistor 34 is connected to reference potential. The reference voltage input of the differential amplifier 35 is connected to the junction of resistor 32 and 33, the reference voltage input of the differential amplifier 36 is connected to the junction of resistors 33 and 34. The reference voltage of the differential amplifier 35 is therefore greater than that of the differential amplifier 36.

The actual value input of the differential amplifier 35 is connected to the output of the regulator 4 via the resistor 37 and the actual value input of the differential amplifier 36 is connected to the output of the regulator 4 via the resistor 38. In addition, the input of the direct current static converter 3, the output of which is connected to the cathode of the photodiode 1, is also connected to the output of regulator 4. Finally, the control input of the on/off control circuit 43 is connected to the output of the regulator 4 via the resis-

tor 39.

In addition, the output of the differential amplifier 36 is connected to the control input of the on/off control circuit 43 via the series circuit consisting of the resistor 41 and the diode 42. The diode 42 is polarised in such a manner that it is cut off at output voltages of the differential amplifier 36 such as are provided for the control range of the controllable amplifier 7.

The on/off control circuit 43 is formed by a differential amplifier with feedback. In the case of this differential amplifier, another input is connected via the resistor 48 to reference potential or earth. The output of the on/off control circuit 43 is connected to the $-U_g$ supply voltage via the series circuit consisting of resistors 45, 46 and 47. The junction of the resistors 45 and 46 is connected via resistor 44 to the further input of the differential amplifier 43, the junction of the resistors 46 and 47 is connected via the resistor 28 to the control electrode of the field effect transistor 23 used as actuator.

The reference voltage input of the regulator 4 is connected to a reference voltage U_{ref} . The actual-value input of the regulator 4 is connected via the diode 31 to the output of the circuit arrangement and via the capacitor 30 to reference potential and via the resistor 29 to the $+U_g$ supply voltage.

The optical signal arriving at input E is converted into another electric signal in the avalanche photodiode 1 and supplied to the low-noise transimpedance amplifier 2.

The direct current static converter 3, which is controlled by the regulator 4 used for automatic gain control, supplies the supply voltage for the photodiode 1.

The gain-determining feedback of the transimpedance amplifier essentially consists of the two resistors 21 and 22, the resistor 22 of which can be short-circuited by the control system via the source-drain path of the field effect transistor 23 with appropriate gate control, as a result of which the gain is lowered by, for example,

approximately 40 dB.

The subsequent high-pass equalising filter 5 cancels the frequency response of the preamplifier 2. It is followed by the two controllable amplifiers 6 and 7, the frequency-independent gain control range of which is in each case, for example, about 20 dB. The controllable amplifiers 6 and 7 are in each case constructed, particularly, as two-stage wideband amplifiers.

Before the signal is amplified again in the output stage or in the output amplifier 9, it is band limited in the low-pass filter 8. This low-pass filter is preferably a gaussian low-pass filter free of phase distortion.

The signal amplitude at the output A of the amplifier arrangement or of the optical receiver, respectively, is kept constant via the gain control system.

Starting with the maximum total gain with a corresponding low input signal, initially only the gain factor M of the photodiode 1 is controlled down by reducing the bias voltage when the input level rises. At the end of the control range of the photodiode 1, in particular as soon as the gain factor M of the photodiode 1 approximately reaches the value 1, the first controllable amplifier 6 begins with the gain reduction. This is done, in particular, by reducing the PIN diode current to which PIN diode used as actuator is controlled by the differential amplifier 35. At the lower end of the control range the gain of the second amplifier 7 is reduced. At its end, the preamplifier 2 is switched over by short circuit of the feedback resistor 22 via the switching field effect transistor 23 if the level continues to rise. The resultant drop in gain is compensated again by increasing the gain of the two controlled amplifiers 6 and 7. A further increase in level up to the maximum permissible input level leads to the same gain reduction process as described above.

In the circuit arrangement in the Figure, the feedback resistor of the preamplifier 2, which is constructed as a transimpedance amplifier, is divided into

the two resistors 21 and 22. One of these resistors, the resistor 22, can be short-circuited via the source-drain path of the field effect transistor 23. The field effect transistor is controlled to have a high impedance or low impedance via the on/off control circuit 43. The gain of the amplifier 2 can thus be lowered by, for example, 40 dB.

This switch-over advantageously leads to a considerable widening of the control range of the circuit arrangement without needing additional control circuits. This is the result of the fact that the existing control circuits of the two subsequent amplifiers 6 and 7 are utilised twice. If the widening of the dynamic range by, for example, 20 dB referred to the light level were implemented by means of a continuous control in the preamplifier 2, an increase in the control range of the gain by 40 dB would be required because of the proportionality between light power and photoelectric current. Two additional control circuits would be required for this, for example.

In a preferred application of the circuit arrangement, the optical signals received by the photodiode are light pulses of PCM signals which are transmitted, for example, at a transmission rate of 34 Mbit/s. In this case, a decision circuit is located at the output A. In this arrangement, approximately the same eye pattern should be available at the decision circuit in both switching states of the field effect transistor 23. This means that the frequency responses, which the preamplifier 2 has in both switching states of the field effect transistor 23 should be identical.

If the cut-off frequencies of the high-impedance and low-impedance two-terminal feedback network were to be equally dimensioned without capacitor 27, the cut-off frequency of the high-impedance two-terminal feedback network only being formed by the parasitic capacitance, the frequency responses of both switching states would be theoretically identical. However, natural oscillations could occur because of the comparatively high gain in the

feedback loop. The cut-off frequency of the low-impedance two-terminal network is therefore suitably selected to be higher and the capacitor 27 is connected transversely for adapting the frequency response when the high-impedance two-terminal network is switched in.

This capacitor 27 has no influence on the frequency response of the preamplifier 2 when the feedback resistor 22 is short-circuited because it is in parallel with a very low-impedance circuit point. The series-connected low-impedance resistor 24 damps out the excessive gain in the case of series resonance.

The "conducting" and "non-conducting" operating states of the field effect transistor 23 are set by appropriate gate-source voltages. The relatively narrow available gate-source voltage range for the "conducting" state could not be easily set with the required reliability by means of a fixed gate voltage since the source voltage is subject to fluctuations as a function of light level. These problems are avoided by the fact that the required gate-source voltage, which is within a range from +0.5 V to -0.8 V, is generated by the forward voltage of the Schottky diode 26. The diode 26 is controlled to conduct current by the high-tolerance switching voltage of the on/off control circuit 43 via the series resistor 28. The gate-source voltage of the field effect transistor 23 is thereby always adjusted to approximately 0.3 V independently of the fluctuations in the source voltage of the field effect transistor or of the voltage of the on/off control circuit 43. The "non-conducting" switching state is implemented by means of a fixed gate voltage which is derived from the $-U_g$ supply voltage by means of the voltage divider which consists of the transistors 45, 46 and 47. This is possible since the available gate-source voltage range is sufficiently wide. The diode 26 is here cut off.

Special demands are made on the circuit arrangement when large light levels are rapidly switched on after the preamplifier has been previously set to a high gain due to low or lacking light power. In this case, the preamplifier is overdriven so that the control would

not obtain the correct information for reducing the gain of the subsequent amplifiers 6 and 7 and for the subsequent switch-over of the preamplifier 2 to low gain without special measures. This would result in a failure of the data signal transmission.

This problem does not occur when the input level changes slowly in comparison with the control time constant since the preamplifier 2 is switched over by the on/off control circuit before overdriving starts.

10 Since the emitter voltage of the transistor 12 is changed by approximately 1... 3V in the direction of the supply voltage $-U_B$, depending on the overdriving of the preamplifier 2, this criterion is supplied as a second controlling variable to the input of the regulator 4. If
15 the emitter voltage of the transistor 12 were to be connected to the input of the regulator 4 only via the decoupling resistor 18, manufacturing tolerances of the operating point of the transistor 12 would have effects on the signal amplitude, which should be kept constant at the
20 decision circuit if this is not prevented by means of a special calibration. In contrast, changes in the signal amplitude due to small displacements of the operating point of the transistor 12 in the entire light level range could not be compensated.

25 However, the capacitor 19 interrupts the direct current link between the emitter of the transistor 12 and the input of the regulator 4. Thus, only abrupt increases in light level, which overdrive the preamplifier 2, lead to the control circuit being influenced. The capacitance of the capacitor 19 of, for example, 6.8 μF is
30 suitably selected to be such that the time constant of the RC series circuit 19, 29 is greater than the control time constant of the control circuit.

In general, the preamplifier 2 is only switched
35 over in the exceptional case during operation. Nevertheless, it is desirable to keep bit errors as low as possible during the switch-over time. If the light level, at which the second controlled amplifier 7 has just reached its lower end of the control range, is slowly

increased further, the output voltage at the operational amplifier 36 rapidly drops towards negative potential or the direction of $-U_B$ supply voltage. The diode 42 becomes conductive and controls the on/off control circuit for a positive output voltage. The field effect transistor 23 is controlled into the "conducting" state via the voltage divider, consisting of the resistors 46 and 47, and the series resistor 28 and the Schottky diode 102. The switch-over is also ensured without resistor 41 or without the diode 42. However, the switch-over process is advantageously rapidly accelerated with the aid of the resistor 41 and the diode 42 by utilisation of the gain of the operational amplifier 36.

If the optical receiver or the amplifier arrangement is operated with a light level which is in the range of a switch-over of the preamplifier, the usual level fluctuations do not cause any switch-over operations. This is achieved by virtue of the fact that the on/off control circuit is provided with a hysteresis. In the two switching states of the on/off control circuit 43, a correspondingly different reference voltage is set with the aid of resistors 40, 44 and 45. The hysteresis is set to the design value by a suitable choice of resistors 40 and 44.

25 10 Patent Claims

1 Figure

The claims defining the invention are as follows:

1. A circuit arrangement comprising:

a preamplifier having a signal input connected to an opto-electric transducer, the preamplifier having a gain adapted to be controlled with the aid of an actuator formed by a field effect transistor having two controlling terminals; and

a controllable amplifier arrangement, containing at least one amplifier adapted to be controlled with respect to its gain, said controllable amplifier arrangement being arranged in series with the preamplifier and being controlled by means of a regulator having a first input connected to a sampled output of said circuit arrangement and a second input connected via a differentiating section to the output circuit of the preamplifier; wherein

said preamplifier contains a series circuit of two resistors in a feedback branch in which said field effect transistor has its drain-source path connected in parallel with one of the resistors of the series circuit, the gate of said field effect transistor being controlled by means of a on/off control circuit exhibiting hysteresis such that the field effect transistor is cut off in a first switching state of the control circuit and is rendered conductive in a second switching state of the control circuit wherein the on/off control circuit is controlled by said regulator in such a manner that it changes from the first into the second switching state when the controllable amplifier arrangement at least approximately reaches the state of minimum gain with a rising input level of the circuit arrangement.

2. A circuit arrangement according to claim 1, wherein said preamplifier comprises a first transistor, the collector of which being connected via a resistor to a first supply voltage, and a second transistor in an emitter follower circuit, wherein the base of the second transistor is connected to the collector of the first transistor and that the feedback branch is connected to the emitter circuit of the second transistor.

3. A circuit arrangement according to claim 2, wherein said preamplifier comprises a further transistor operatively coupled between the emitter of the first transistor and a reference potential, wherein the feedback branch and the opto-electric transducer are connected to a control electrode of said further transistor.



4. A circuit arrangement according to claim 2 or 3, wherein the second input of the regulator is connected to the emitter of the second transistor via a (first) RC series circuit, the output of said preamplifier being formed by the series junction of two resistors, the series circuit of which forms the emitter circuit, and wherein a capacitor is arranged in parallel with the resistor of the series circuit located between the emitter of the second transistor and the output of the preamplifier.

5. A circuit arrangement according to any one of claims 1 to 4, further comprising:

a high-pass filter arranged between the preamplifier and the controllable amplifier arrangement; and

a low-pass filter arranged between the controllable amplifier arrangement and the output of the circuit arrangement.

6. A circuit arrangement according to any one of claims 1 to 5, further comprising, a diode located in parallel with the controlling terminals of the field effect transistor forming the actuator, said diode being polarised for conduction of control voltages which enable conduction of said field effect transistor.

7. A circuit arrangement according to any one of claims 1 to 6, wherein the junction of the resistors of said feedback branch is connected via a (second) RC-series circuit to a reference potential and that a capacitor is arranged in parallel with the resistor of the feedback branch which remains effective when the actuator field effect transistor conducts.

8. A circuit arrangement according to claim 7 when dependent upon claim 6, wherein the diode is arranged between the control electrode of the actuator field effect transistor and the junction between the resistor and the capacitor of the (second) RC series circuit.

9. A circuit arrangement according to any one of claims 1 to 8, wherein the opto-electric transducer is connected to a direct voltage static converter, said converter being connected to the output of the regulator.

10. A circuit arrangement according to any one of the preceding claims, wherein said controllable amplifier arrangement further including a controllable amplifier controlled by means of a differential amplifier connected to the regulator, the control input of the on/off control circuit being connected both to the output of the regulator via a resistor and to



the output of the differential amplifier via a current branch containing a second diode and a resistor which is connected in series therewith, wherein said second diode is polarised in such a manner that it is cut off at output voltages of the differential amplifier which are within the control range of the controllable amplifier.

11. A circuit arrangement as claimed in any one of the preceding claims wherein said opto-electric transducer is a photodiode.

12. A circuit arrangement as claimed in any one of the preceding claims where said reference potential is an earth potential.

13. A circuit arrangement as claimed in any one of the preceding claims wherein the sampled output of said circuit arrangement that supplies said regulator is derived from a rectifier including a diode and a capacitor.

14. A circuit arrangement substantially as described herein with reference to the drawings.

DATED this EIGHTEENTH day of DECEMBER 1990
Siemens Aktiengesellschaft

Patent Attorneys for the Applicant
SPRUSON & FERGUSON

