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(54) MICROPHONE PRE-AMPLIFIER WITH POLARIZATION VOLTAGE SUPPLY

MIKROFONVORVERSTÄRKER MIT POLARISATIONSSPANNUNGSVERSORGUNG

PRÉAMPLIFICATEUR DE MICROPHONE AYANT UNE ALIMENTATION EN TENSION DE
POLARISATION

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(56) References cited:
**CN-A- 105 072 241 US-A- 5 377 273
US-A1- 2005 220 314 US-A1- 2015 181 335**

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Description

FIELD OF THE INVENTION

[0001] The invention relates to a system of at least one microphone and a remote signal analyzer connected to the microphone with two wires to transmit an audio signal back to the analyzer and to receive a constant input current on one of the wires from the analyzer, which microphone comprises an acoustic sensor and a pre-amplifier powered with the constant input current to amplify the audio signal from the acoustic sensor.

BACKGROUND OF THE INVENTION

[0002] Prior art systems often comprise a large number of sensors like microphones mounted in different locations of an area to measure analogue sensor signals, which signals are analyzed in the analyzer to which all sensors are connected. Measurement microphones are known with two different microphone versions: one pre-polarized and one that requires external polarization. The pre-polarized is more complicated and expensive to make in a measurement quality. Furthermore measurement microphones are known in two different interface versions:

The first version is a multi-wire interface with separate wires for power, which includes polarization voltage which enables use of both microphone versions.

[0003] In a second interface version used for accelerometers and microphones a two wire interface is used, here the power is sourced to the transducer on the same two wires as a constant current and the transducer signal is being overlaid as a voltage on the same two wires. A pre-amplifier of the microphone is powered by the constant current of typically 2 to 4mA applied between the wires and the acoustic sensor signal is transmitted back to the analyzer as a voltage on the two wires. The applied current is required to drive the preamplifier and capacitive load from the cable; any use of the available current for other purposes will degrade the capability to drive the cable. As it requires about 200V polarization voltage with high stability to polarize an un-polarized microphone, only pre-polarized microphone capsules may be used in state of the arte microphones with this second interface version. Known power supplies used in these microphones are not able to generate the stabile and high voltage needed from this small input current, which voltage in addition varies with the audio signal of the acoustic sensor. This is a problem as microphones with pre-polarized microphone capsules are more complicated and expensive to make in a measurement quality.

[0004] Further relevant prior art teaching may be found in: US 5 377 273 A, US 2005/220314 A1 and US 2015/181335 A1.

SUMMARY OF THE INVENTION

[0005] It is an object of the invention to provide a system of at least one microphone and a remote analyzer that enables to use un-polarized microphones and a two wire interface between the analyzer and the microphone. This object is achieved with a system with a microphone that comprises a polarization voltage supply connected to the two wires to polarize the microphone, which polarization voltage supply comprises:

a transformation stage to transform a partial part of the constant input current on the one wire from the remote signal analyzer into an output voltage with a first voltage level and a voltage increaser stage to increase the voltage level of the output voltage into an increased output voltage with a second voltage level and a noise reduction stage to provide a polarization voltage to the acoustic sensor.

[0006] The polarization voltage supply of the claimed system is able to generate the polarization voltage of about 200V from the very limited input current available to power the microphone, by taking only approx. 0.25mA from the available input current. The power source for this polarization voltage supply is from a voltage between the two wires varying with the audio signal and the very limited current available primary reserved for the analog pre-amplifier and the driving of the capacity load of the two wires. This provides the advantage that un-polarized microphones may be used in combination with a two wire interface. This reduces the technical complexity and costs for larger systems with a substantial number of microphones connected to the analyzer and increases the reliability and quality of the audio signals. Although the stages of the claimed polarization voltage supply may be known as such and even may be used in combination in other technical fields to generate a stabilized power, this never has been done for constant current power supplied microphones due to limited space and available power, where precision and low noise is a core specification and in particular for microphones connected to an analyzer. There was a long felt need to solve above identified problem of the state of the art systems, but no technical solution has been found by the man skilled in the art until the invention was made.

[0007] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter. The person skilled in the art will understand that various embodiments may be combined.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Figure 1 shows a system of several microphones connected to a remote analyzer to analyze the audio signals of the microphones.

Figure 2 shows the polarization voltage supply of the system shown in Figure 1.

Figure 3 shows part of the signal analyzer of the system shown in Figure 1.

DETAILED DESCRIPTION OF EMBODIMENTS

[0009] Figure 1 shows a system 1 of four sensors realized as microphones 2 and a remote signal analyzer 3, wherein one of the microphones 2 is shown in detail. All four microphones 2 are connected with a coax-cable 4 that comprises two wires, a signal wire 5 and a shield wire 6. Other two wire cables could be used as well as interface between the microphones 2 and the analyzer 3. Each of the microphones 2 comprises an acoustic sensor 7, that is built as acoustic transducer with a membrane to measure the physical parameter of noise or sound.

[0010] Microphones 2 of system 1 may for instance be attached on the surface of a wing of a test airplane to sense turbulences and to improve the surface of the wing.

[0011] Analyzer 3 is built to transfer a constant input current I_{in} over signal wire 5 to the microphones 2. Figure 3 shows that part of analyzer 3 that generates the constant input current I_{in} and amplifies the audio signal U_{aud} received from microphone 2. Microphones 2 comprise a polarization voltage supply 8 connected to signal wire 5 to generate a polarization voltage U_{pol} at a capacity 10 of an acoustic sensor 7 and a pre-amplifier 9 of the microphones 2. The pre-amplifier 9 is used to amplify an audio signal generated by the acoustic sensor 7, which is built with a membrane that forms the capacity 10 that changes with the amount of noise or sound at the membrane. Microphone 2 is capsuled with a housing and needs to be polarized by the high precision low noise polarization voltage U_{pol} of about 200V, which thereby transforms the change in capacity 10 direct proportional into a high impedance voltage signal to be fed to the pre-amplifier 9.

[0012] Polarization voltage supply 8 comprises a transformation stage 11 to transform a partial part of the constant input current I_{in} on signal wire 5, shown in figures 1 and 2 as transformation current I_T , from the remote signal analyzer 3 into a stabilized output voltage U_{stab} with a first voltage level, which could be in the range of e.g. 5V to 15V. Transformation stage 11 could be realized by an integrated precision power supply circuit available on the market as shown in figure 2.

[0013] Polarization voltage supply 8 furthermore comprises a voltage increaser stage 12 to increase the voltage level of the high precision stabilized output voltage U_{stab} into an increased output voltage U_{high} with a second voltage level, which could be in the range of e.g. 20V to 300V and typically is about 200V. Voltage increaser stage 12 is realized as charge pump circuit known to a man skilled in the art that consists of a row of capacitors and diodes driven by a switching circuit and could be integrated in C-MOS technology. Such a charge pump

circuit with an oscillator 13 is shown in figure 2.

[0014] Polarization voltage supply 8 furthermore comprises a noise reduction stage 14, as shown in figure 2, to provide a polarization voltage sourced through resistance R to the microphone 7, which could be in the range of e.g. 10 to 50 G Ω and typically is 20 G Ω . The polarization voltage U_{pol} is used to polarize the un-polarized microphone 2, thereby transforming the change in capacity direct proportional into a voltage signal. This provides that advantage that although only a two wire interface is used between microphones 2 and analyzer 3 an un-polarized microphones 2 may be used.

[0015] In another embodiment of the invention, the sequence of the transformation stage 11 and the voltage increaser stage 12 could be exchanged. This means that a voltage generated from the partial part of the constant input current I_{in} would first be stabilized and then increased and afterwards processed in the noise reduction stage 14. In another embodiment both stages would be combined and processed in one stage. This sequence of generating the polarization voltage U_{pol} would lead to the same advantages as for the embodiment shown in figures 1 to 3.

Claims

1. System (1) of at least one microphone (2) and a remote signal analyzer (3) connected to the microphone (2) with only two wires (5, 6) to transmit an audio signal (U_{aud}) back to the analyzer (3) and to receive a constant input current (I_{in}) on one of the wires (5) from the analyzer (3), which microphone (2) comprises an acoustic sensor (7) and a pre-amplifier (9) powered with the constant input current (I_{in}) to amplify the audio signal (U_{aud}) from the acoustic sensor (7) transmitted back to the analyzer (3) over the two wires (5, 6), **characterized in, that** the microphone (2) comprises a polarization voltage supply (8) connected to the two wires (5, 6) to polarize the microphone (10), which polarization voltage supply (8) comprises:

a transformation stage (11) to transform part of the constant input current (I_{in}) on the one wire (5) from the remote signal analyzer (3) into an output voltage (U_{stab}) with a first voltage level and

a voltage increaser stage (12) to increase the voltage level of the output voltage (U_{stab}) into an increased output voltage (U_{high}) with a second voltage level and

a noise reduction stage (13) to provide a polarization voltage (U_{pol}) to the acoustic sensor (7).

2. System (1) according to claim 1, wherein the polarization voltage (U_{pol}) is sourced through a resistor (R) to a microphone capsule used as acoustic sen-

sor.

3. System (1) according to claim 1 or 2, wherein the transformation stage (11) is realized as integrated circuit.
4. System (1) according to one of the claims 1 to 3, wherein the voltage increaser stage (12) is realized as charge pump circuit consisting of a row of capacitors and diodes driven by a switching circuit.
5. System (1) according to one of the claims 1 to 4, wherein the noise reduction stage (13) is realized as RC filter.

Patentansprüche

1. System (1) aus mindestens einem Mikrofon (2) und einem Femsignalanalysator (3), der mit nur zwei Drähten (5, 6) mit dem Mikrofon (2) verbunden ist, um ein Audiosignal (U_{aud}) zurück zum Analysator zu übertragen und um einen konstanten Eingangsstrom (I_{in}) auf einem der Drähte (5) vom Analysator (3) zu empfangen, wobei das Mikrofon (2) einen akustischen Sensor (7) und einen Vorverstärker (9), der mit dem konstanten Eingangsstrom (I_{in}) angetrieben wird, umfasst, um das Audiosignal (U_{aud}) von dem akustischen Sensor (7), das zum Analysator (3) über die zwei Drähte (5, 6) zurück übertragen wird, zu verstärken, **dadurch gekennzeichnet, dass** das Mikrofon (2) eine Polarisierungsspannungsversorgung (8) umfasst, die mit den zwei Drähten (5, 6) verbunden ist, um das Mikrofon (10) zu polarisieren, wobei die Polarisierungsspannungsversorgung (8) umfasst:
 - eine Transformationsstufe (11), um einen Teil des konstanten Eingangsstroms (I_{in}) auf dem einen Draht (5) von dem Femsignalanalysator (3) in eine Ausgangsspannung (U_{stab}) mit einem ersten Spannungspegel zu transformieren, und eine Spannungsübersetzungsstufe (12), um den Spannungspegel der Ausgangsspannung (U_{stab}) in eine übersetzte Ausgangsspannung (U_{high}) mit einem zweiten Spannungspegel zu übersetzen, und
 - eine Rauschunterdrückungsstufe (13), um dem akustischen Sensor (7) eine Polarisierungsspannung (U_{pol}) bereitzustellen.
2. System (1) gemäß Anspruch 1, wobei die Polarisierungsspannung (U_{pol}) durch einen Widerstand (R) zu einer als akustischer Sensor verwendeten Mikrofonkapsel gelagert wird.
3. System gemäß Anspruch 1 oder 2, wobei die Transformationsstufe (11) als eine integrierte Schaltung

ausgeführt ist.

4. System (1) gemäß einem der Ansprüche 1 bis 3, wobei die Spannungsübersetzungsstufe (12) als eine Ladepumpschaltung ausgeführt ist, die aus einer Reihe von Kondensatoren und Dioden besteht, die durch einen Schaltkreis angetrieben werden.
5. System (1) gemäß einem der Ansprüche 1 bis 4, wobei die Rauschunterdrückungsstufe (13) als ein RC-Filter ausgeführt ist.

Revendications

1. Système (1) constitué d'au moins un microphone (2) et d'un analyseur de signal à distance (3) connecté au microphone (2) avec seulement deux fils (5, 6) pour transmettre en retour un signal audio (U_{aud}) à l'analyseur (3) et pour recevoir un courant d'entrée constant (I_{in}) sur un premier des fils (5) à partir de l'analyseur (3), lequel microphone (2) comprend un capteur acoustique (7) et un préamplificateur (9) alimenté par le courant d'entrée constant (I_{in}) pour amplifier le signal audio (U_{aud}) provenant du capteur acoustique (7) transmis en retour à l'analyseur (3) sur les deux fils (5, 6), **caractérisé en ce que** le microphone (2) comprend une alimentation en tension de polarisation (8) connectée aux deux fils (5, 6) pour polariser le microphone (10), laquelle alimentation en tension de polarisation (8) comprend :
 - un étage de transformation (11) pour transformer une partie du courant d'entrée constant (I_{in}) sur le premier des fils (5) à partir de l'analyseur de signal à distance (3) en une tension de sortie (U_{stab}) avec un premier niveau de tension, et
 - un étage d'augmentation de tension (12) pour augmenter le niveau de tension de la tension de sortie (U_{stab}) en une tension de sortie accrue (U_{high}) avec un second niveau de tension, et
 - un étage de réduction de bruit (13) pour fournir une tension de polarisation (U_{pol}) au capteur acoustique (7).
2. Système (1) selon la revendication 1, dans lequel la tension de polarisation (U_{pol}) est fournie par une résistance (R) à une capsule de microphone utilisée comme capteur acoustique.
3. Système (1) selon la revendication 1 ou 2, dans lequel l'étage de transformation (11) est réalisé sous la forme d'un circuit intégré.
4. Système (1) selon l'une des revendications 1 à 3, dans lequel l'étage d'augmentation de tension (12) est réalisé sous la forme d'un circuit de pompe de charge constitué d'une rangée de condensateurs et

de diodes pilotés par un circuit de commutation.

5. Système (1) selon l'une des revendications 1 à 4, dans lequel l'étage de réduction de bruit (13) est réalisé sous la forme d'un filtre RC.

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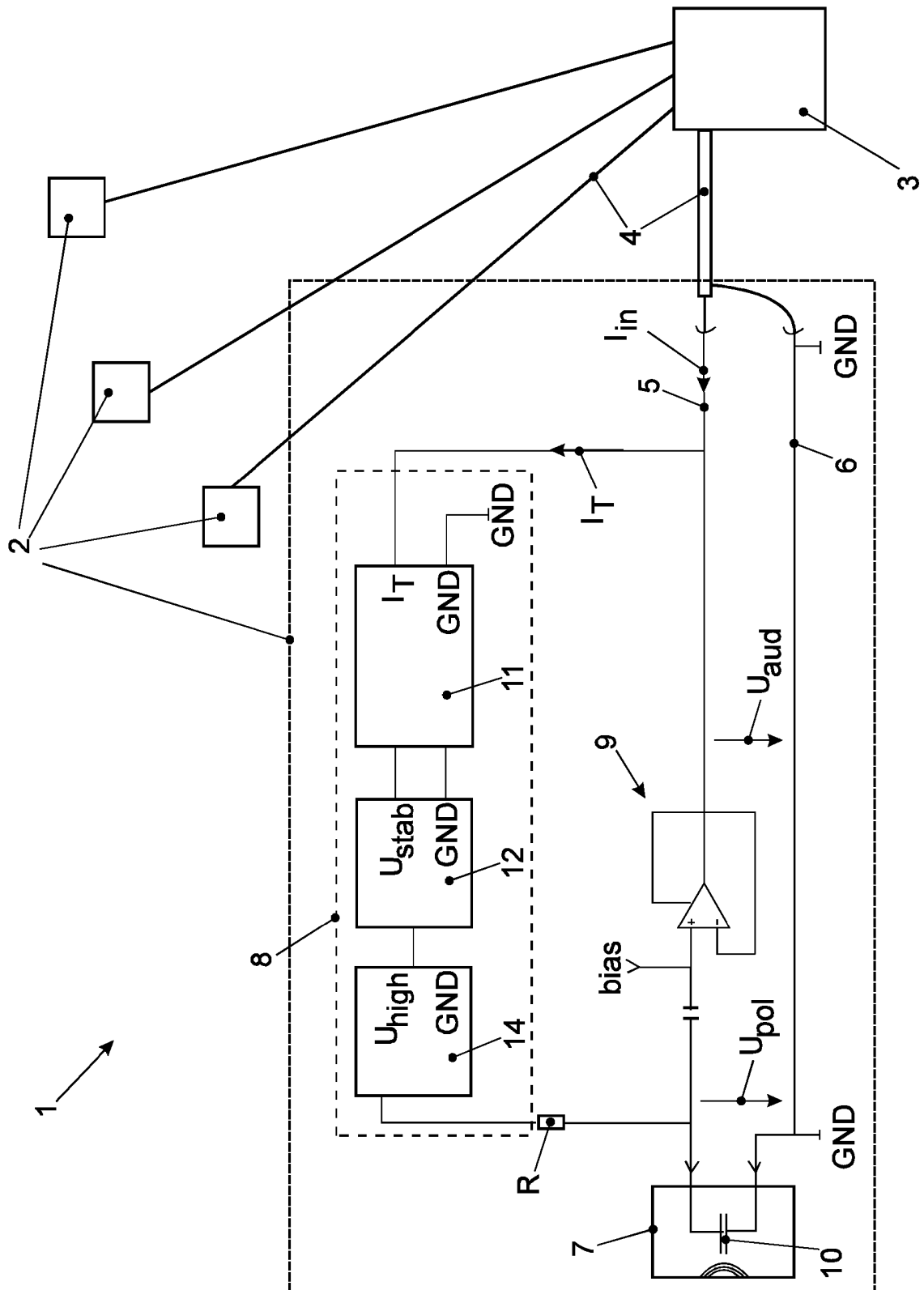


FIG. 1

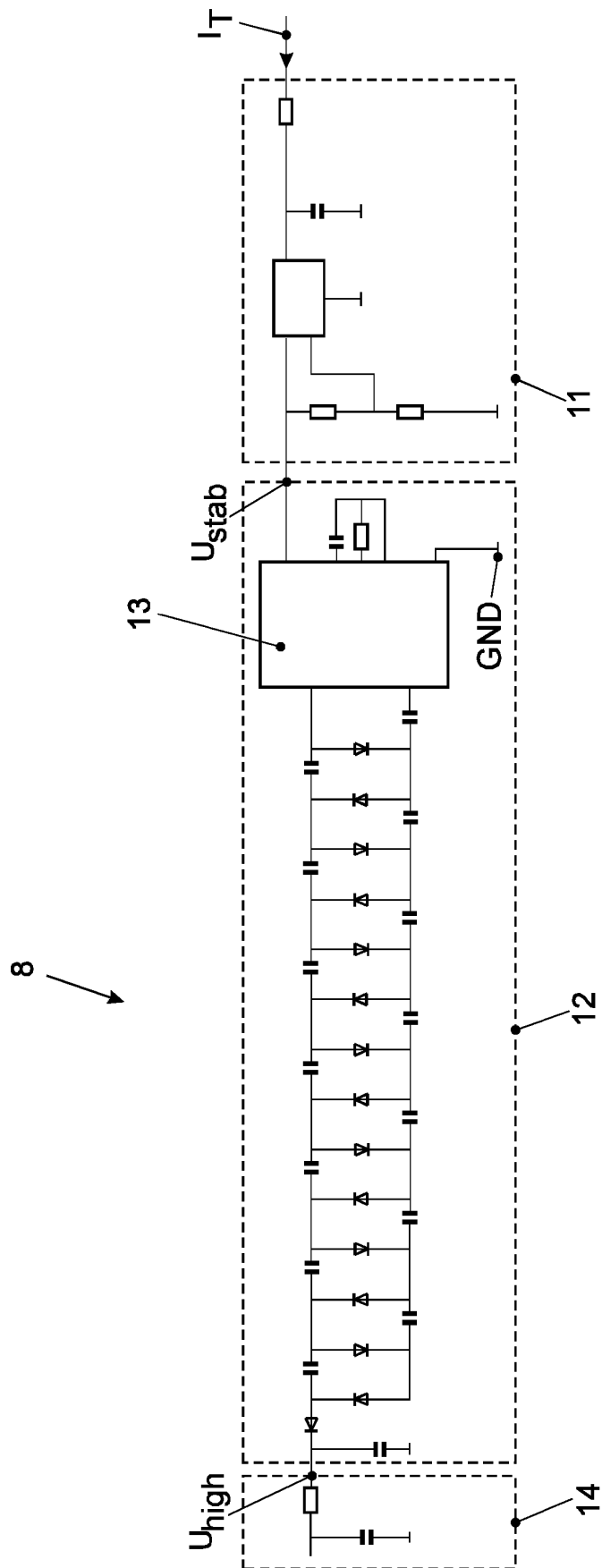


FIG.2

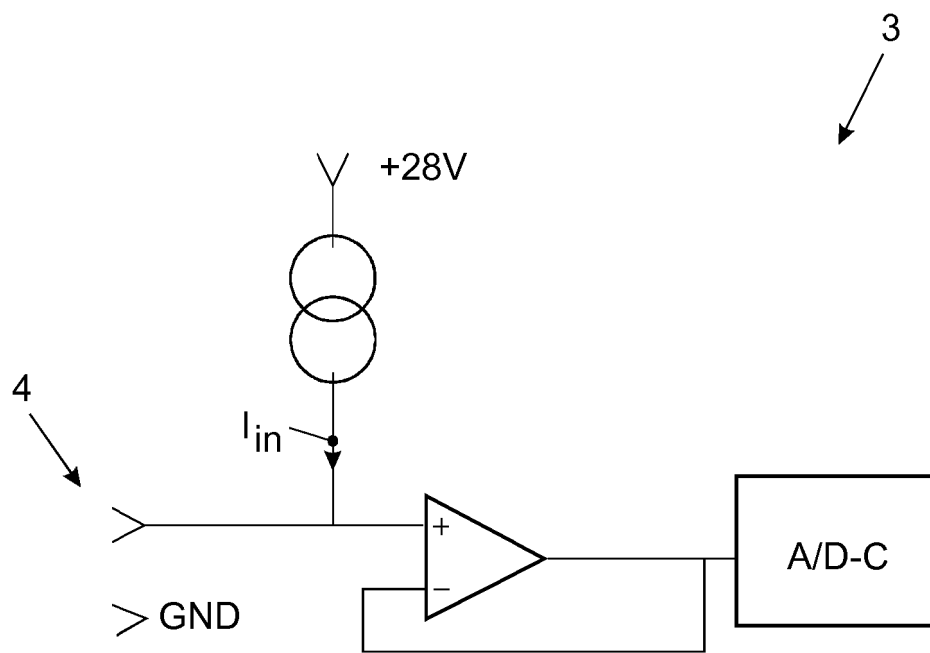


FIG.3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 5377273 A [0004]
- US 2005220314 A1 [0004]
- US 2015181335 A1 [0004]