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(54) MONOLITHIC MAGNETIC SENSOR HAVING EXTERNALLY ADJUSTABLE TEMPERATURE COMPENSATION

MONOLITHISCHER MAGNETISCHER SENSOR MIT EXTERN EINSTELLBARER TEMPERATURKOMPENSATION

CAPTEUR MAGNETIQUE MONOLITHIQUE A COMPENSATION DE TEMPERATURE REGLABLE DE L'EXTERIEUR

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Description

Background of The Invention

1. Field of the Invention

[0001] The present invention relates to magnetic sensors and, more particularly, to a Hall-effect sensor arrangement having temperature compensation circuitry that is user-adjustable.

2. Discussion of Related Art

[0002] Hall-effect elements are used to sense magnetic fields. In its simplest form, a monolithically fabricated Hall-effect element employs a square plate formed, for example, of an epitaxial (epi) pocket formed in a bipolar (BP) or bipolar complementary metal oxide semiconductor (BiCMOS) process. The square plate has two pairs of contacts oriented such that each pair of contacts straddles the plate from a different pair of its diametrically opposing corners. When a current I_H is caused to flow between one of the two pairs of contacts, a voltage V_H will appear across the other pair of contacts. The voltage V_H is a function of: (a) the amplitude of the current I_H, (b) the strength of a magnetic field **B**, if any, intercepting the Hall plate, and (c) the sensitivity S_H of the Hall plate to the magnetic field **B** (i.e., $V_H = I_H{*}B{*}S_H$, where * denotes the multiplication operator). Thus, when properly calibrated, a Hall plate may be used to measure the strength of a magnetic field **B** by applying a known current I_H between one pair of contacts of a Hall plate and measuring the voltage V_H across the other pair of contacts.

[0003] There are two major difficulties encountered when using Hall plates to sense magnetic fields. One difficulty arises because a Hall plate includes unavoidable imperfections, such as geometrical asymmetries, that cause the Hall plate to produce a non-zero output voltage V_H in the absence of any applied magnetic field **B**. This voltage V_H generated when B=0 commonly is referred to as the offset voltage V_{OH} of the Hall plate. A discussion of the Hall effect, the operation of Hall-effect elements, circuits in which Hall-effect elements may be used, and various techniques for addressing the problem of Hall plate offset voltage are discussed in the following patents and publications, each of which is incorporated herein by reference: Bilotti et al., U.S. Patent 5,621,319; Mehrgardt et al., U.S. Patent 5,406,202; Bilotti, Albert, "Monolithic Magnetic Hall Sensor Using Dynamic Quadrature Offset Cancellation," IEEE Journal of Solid-State Circuits, Vol. 32, No. 6, June 1997; Bellekom, A.A., and Munter, P.J.A., AOffset Reduction in Spinning-Current Hall Plates,≅ Sensors and Materials, 5, 5 (1994) 253-263, MYU Tokyo; Baltes, H.P., and Popovic, R.S., AIntegrated Semiconductor Magnetic Field Sensors,≅ Proc. IEEE, vol. 74, pp. 1107-1132, Aug. 1986.

[0004] A second difficulty arises due to the fact that the sensitivity S_H of a Hall-effect element changes as the temperature of the element changes. Therefore, for a given current I_H and magnetic field **B**, the voltage V_H produced by a Hall-effect element will vary depending on the temperature of the element. Because of this temperature-dependency, the actual magnitude of the magnetic field **B** is difficult to ascertain when a Hall-effect element is used in an environment wherein its temperature is not held constant.

[0005] In addition, Hall-effect elements often are used to sense the permanent magnetic fields of components. For example, a Hall-effect element may be used to sense the position of a magnetic component while it is rotating or otherwise in motion relative to the Hall-effect element. Because the magnitude of a magnetic field emanating from a magnetic component changes as the temperature of the component changes, for any given position of the component with respect to the Hall-effect element, the magnitude of the output voltage V_H of the Hall-effect element when the component is at a first temperature will not be the same as the output voltage V_H when the component is at a second temperature. Therefore, the magnitude of the output voltage V_H of a Hall-effect element does not provide a reliable indication of the position of a magnetic component when the component is subjected to a variable-temperature environment.

[0006] It therefore is a general object of the present invention to provide a Hall effect device having improved immunity to the effects of a variable-temperature environment.

Summary of the Invention

[0007] According to one aspect of the present invention, a Hall-effect device comprises a Hall-effect element having at least one input for receiving a bias signal and at least one output for providing an output signal dependent on the bias signal and on a magnetic field intercepting the Hall-effect element; at least one output lead to provide an output signal responsive to the output signal of the Hall-effect element and dependent on an overall gain of the Hall-effect device; and a temperature-variable gain control circuit coupled to the Hall-effect element to adjust the sensitivity of the overall gain of the Hall-effect device to temperature changes, wherein the temperature-variable gain control circuit includes a pair of nodes such that, when a first component is coupled between the pair of nodes, changing a characteristic of only the first component alters the sensitivity of the overall gain of the Hall-effect device to temperature changes without substantially altering the overall gain of the Hall-effect device when the Hall-effect device is maintained at a reference temperature.

[0008] According to another aspect of the present invention, a Hall effect device includes a substrate mounted within an integrated circuit package, a Hall-effect element integrated on the substrate, and a pair of terminals adapted to interface with a component external to the package. The pair of terminals is arranged with respect to the Hall-effect element such that, when the component is coupled to the pair of terminals, a characteristic of the component may be changed to adjust the sensitivity of the gain of the Hall effect device to temperature changes in the device.

[0009] According to another aspect, the Hall effect device includes a temperature-variable signal source arranged to provide the bias signal such that a value of the bias signal changes in response to temperature changes in the Hall-effect element. Additionally, the pair of terminals is arranged with respect to the signal source such that, when the component is coupled to the pair of terminals, the characteristic of the component may be changed to adjust the sensitivity of the signal source to temperature changes in the Hall-effect element.

[0010] According to another aspect of the invention, a Hall-effect device includes an integrated circuit package having a Hall-effect element mounted within it, and a user-accessible component arranged with respect to the Hall-effect element such that a characteristic of the component may be changed to adjust the sensitivity of the gain of the Hall-effect device to temperature changes in the device.

[0011] According to another aspect a Hall-effect device includes a Hall effect device mounted in an integrated circuit package and means for adjusting the sensitivity of the gain of the Hall-effect device to changing temperature conditions from a point external to the package.

[0012] According to yet another aspect of the present invention, a method for compensating for the effects of temperature variations on a Hall-effect element comprises steps of (a) providing a Hall-effect device including a Hall-effect element and a temperature-variable gain control circuit coupled to the Hall-effect element to adjust the sensitivity of the gain of the Hall-effect device to temperature changes; the method further comprising (b) coupling a first component between a pair of nodes of the temperature-variable gain control circuit to set the sensitivity of the gain of the Hall-effect device to temperature variations; and (c) altering a characteristic of only the first component to adjust the sensitivity of the gain of the Hall-effect device to temperature variations without substantially altering the gain of the Hall-effect device when the Hall-effect device is maintained at a reference temperature.

[0013] According to another aspect of the invention, a method for compensating for the effects of temperature variations on a Hall-effect element includes coupling a component to a pair of external terminals of an integrated circuit to adjust the sensitivity of the gain of a Hall-effect device included in the integrated circuit.

Brief Description of the Drawings

[0014]

Figure 1 is a top-view of a quad-cell Hall-effect element used in one embodiment of the invention.

Figure 2 is a side cross-sectional view of the substrate portion of the quad-cell Hall cell shown in Figure 1.

Figure 3 is a block diagram of one embodiment of a Hall-effect device according to the invention.

Figure 4 is a partial schematic/partial block diagram showing in more detail a commutation switch portion of the device shown in Figure 3.

Figure 5 is a partial schematic/partial block diagram showing in more detail a demodulation portion of the device shown in Figure 3.

Figure 6 is a timing diagram showing control and output signals of the portions of the device shown in Figures 4 and 5.

Figure 7 is a schematic diagram showing in more detail the ratiometric temperature reference portion of the circuit shown in Figure 3.

Figure 8 is a graph showing how voltages produced by the temperature reference portion shown in Figure 7, which are presented on external pins of the device, vary with temperature.

Figure 9 is partial block/partial schematic diagram showing a possible configuration of circuit elements external to the device.

Figure 10 is a side-view of an embodiment of the device according to the invention showing how the device senses a magnetic field applied thereto.

Figure 11 is partial block/partial schematic diagram showing a possible configuration of circuit elements external to the device.

Detailed Description of the Invention

[0015] Figure 1 is a top-view of a quad-cell Hall-effect element 20 used in one embodiment of the invention. As shown, quad-cell Hall-effect element 20 includes four Hall cells 20A-20D. Hall cells 20A, 20B, 20C and 20D are made of n-type epitaxial (n-epi) regions (e.g., 200 micrometers in diameter) formed within p-type wells or hubs (p-wells/p-tubs) 30A, 30B, 30C and 30D, respectively. P-wells/p-tubs 30A, 30B, 30C and 30D, in turn, are formed on an n-type substrate 32.

[0016] Each of Hall cells 20A, 20B, 20C and 20D includes two pairs of orthogonally oriented contacts. Specifically, Hall cells 20A, 20B, 20C and 20D, include, respectively, first pairs of contacts 20A1 and 20A3, 20B1 and 20B3, 20C1 and 20C3, and 20D1 and 20D3, and second pairs of contacts 20A2 and 20A4, 20B2 and 20B4, 20C2 and 20C4, and 20D2 and 20D4. Conductor 34 interconnects contacts 20A1, 20B2, 20C3 and 20D4, conductor 36 interconnects contacts 20A2, 20B3, 20C4 and 20D1, conductor 38 interconnects contacts 20A4, 20B1, 20C2 and 20D3, and conductor 40 interconnects contacts 20A3, 20B4, 20C1 and 20D2, thereby wiring cells 20A-20D in parallel such that each of cells 20A-20D is oriented orthogonally with respect to the other cells in quad-cell Hall-effect element 20. This orientation of cells 20A-20D reduces the adverse effects of imperfections, such as processing gradients, in the cells.

[0017] Figure 1 also shows how each of cells 20A-20D may be intercepted by a magnetic field **B**, which is shown as entering the surface of the cells in a direction normal and into the page. If a current I_H were applied between conductors 34 and 40, for example, then the magnitude of magnetic field **B** and the sensitivity S_H of the Hall-effect element would determine a magnitude of a voltage V_H created between conductors 36 and 38 according to the equation $V_H = I_H{*}B{*}S_H$, discussed above.

[0018] Figure 2 is a side cross-sectional view of the substrate portion of the quad-cell Hall-effect element 20 shown in Figure 1. As shown, p-wells/p-tubs 30D and 30C are formed within an n-type substrate 32, and n-EPI Hall cells 20C and 20D are formed within p-wells/p-tubs 30C and 30D, respectively. The letters "p" and "n" in Figures 1 and 2 are intended only to illustrate the doping types of the various regions, and are not intended to signify the amounts by which the regions are doped or the process by which the regions were formed.

[0019] Figure 3 is a block diagram of one embodiment of a Hall-effect device 80 according to the invention. As shown, Hall-effect device 80 includes quad-cell Hall-effect element 20, commutation switches 50, a differential pre-amplifier 52, a demodulator 54, an output amplifier 56, an output terminal P7, a reference terminal P5, a temperature-variable current source 22 (which includes a ratiometric temperature reference block 42 and a voltage-to-current converter 46), and a clock and logic stage 48.

[0020] The operation of circuit 80 is discussed in more detail below in connection with a description of its various portions, but Figure 3 is useful to understand the basic operation of Hall-effect device 80. As shown, temperature-variable current source 22 supplies a Hall bias current I_H which varies according to the temperature of the device to commutation switches 50. Commutation switches 50 are controlled by clock and logic stage 48 to commutate the current I_H alternately (1) between conductors 34 and 40, and (2) between conductors 36 and 38. When the current I_H is presented between conductors 34 and 40, commutation switches 50 concurrently apply the voltage generated between conductors 36 and 38 (responsive to the magnetic field **B**) to inputs 26 and 28, respectively, of differential pre-amplifier 52; and when the current I_H is presented between conductors 36 and 38, commutation switches 50 concurrently apply the voltage generated between conductors 34 and 40 (responsive to the magnetic field **B**) to inputs 26 and 28, respectively, of differential pre-amplifier 52. This commutation of signals to and from quad-cell Hall-effect element 20 is performed to eliminate the inherent voltage offset V_{OH} of the Hall cells, and is discussed in detail in several of the documents referred to and incorporated by reference above. Suffice it to note, however, that the flowing of current in a first direction across a Hall cell generates a first voltage V_1 including a first Hall voltage V_{H1} and a first Hall offset voltage V_{OH2} (V_1=V_{H1}+V_{OH1}), and the flowing of current across a Hall cell in a second direction, which is oriented orthogonally to the first direction, generates a second voltage V_2 including a second Hall voltage V_{H2} and a second Hall offset voltage V_{OH2} (V_2=-V_{H2}+V_{OH2}).

[0021] Because the second hall voltage V_{H2} is approximately equal to and of an opposite sign as the first Hall voltage V_{H1} (i.e., $V_{H2} \cong V_{H1} = V_H$) and the second Hall offset voltage V_{OH2} is approximately equal to and the same sign as the first Hall offset voltage V_{OH1} (i.e., $V_{OH2} \cong V_{OH1} = V_{OH}$), a subtraction of the voltage V_2 generated by the current flowing in the second direction from the voltage V_1 generated by the current flowing in the first direction (i.e., $(V_{H1} + V_{OH1}) - (-V_{H2} + V_{OH2})$) effectively cancels the offset voltage so that only a voltage equal to $2V_H$ results. As explained below, this subtraction is performed by a combination of pre-amplifier 52 and demodulator 54. The offset-free output of demodulator 54 then is provided to the input of rail-to-rail output amplifier 56, and the output of amplifier 56 feeds external terminal P7 (e.g., a pin) of the device. As described below, the gain of amplifier 56 is adjusted using resistors external to device 80.

[0022] The effect of temperature on the sensitivity of quad-cell Hall-effect element 20 is compensated by adjusting the magnitude of the Hall bias current I_H supplied to commutation switches 50. That is, because the voltage V_H produced at the output of Hall-effect element 20 is proportional to the magnitude of the current flowing through the element as well as to the sensitivity constant S_H (i.e.,$V_H = I_H{*}B{*}S_H$), an increase or decrease in sensitivity S_H due to a temperature change may be countered by a corresponding decrease or increase, respectively, in Hall current I_H. The output voltage V_H therefore always will be the same for a given magnitude of magnetic field **B,** regardless of the temperature of the Hall-effect device 80.

[0023] Similarly, an increase or decrease in the magnetic field strength **B** of a magnetic component being sensed by device 80 due to a temperature change may be countered by a corresponding decrease or increase, respectively, in the Hall current I_H. This is useful when the magnetic field is produced by a moving permanent magnet. Thus, regardless of the temperature of the environment in which the magnetic component and Hall-effect device 80 are disposed, the output voltage V_H of Hall-effect device 80 always will be the same when the moving (e.g., rotating) component being sensed is a given distance from device 80.

[0024] Figure 4 is a partial schematic/partial block diagram showing commutation switches 50 and their surrounding circuitry in more detail. As shown, commutation switches 50 include switches S1-S8. Switches S1 and S2 are connected between a first polarity output of temperature-variable current source 22 and conductors 36 and 34, respectively, of quad-cell Hall-effect element 20, and switches S3 and S4 are connected between a second polarity output of temperature-variable current source 22 and conductors 38 and 40, respectively, of Hall-effect element 20. Similarly, switches S5 and S6 are connected, respectively, between conductors 34 and 36 of Hall-effect element 20 and non-inverting input 26 of pre-amplifier 52, and switches S7 and S8 are connected, respectively, between conductors 40 and 38 of Hall-effect element 20 and inverting input 28 of pre-amplifier 52. As explained below, the symbol "P1" or "P2" next to switches S1-S8 indicates which of two phases of a control signal from clock and logic stage 48 (shown in Figure 3) causes each of the switches to close. In addition to receiving signals at non-non-inverting input 26 and inverting input 28, pre-amplifier 52 receives a reference voltage V_{REF} from reference conductor 58. The reference voltage V_{REF} is created within Hall-effect device 80 and is set to be one-half of the high-supply voltage VCC of device 80 (i.e., V_{REF}=VCC/2). The high-supply voltage VCC is approximately 5 volts, so the reference voltage V_{REF} is set to approximately 2.5 volts. The operation of the circuitry shown in Figure 4 is described below in connection with the description of the timing diagram shown in Figure 6.

[0025] Figure 5 is a partial schematic/partial block diagram showing demodulation block 54 in more detail. As shown, demodulation block 54 includes capacitors C1 and C2 and switches S9 and S10. Capacitor C1 is connected between a single-ended output of differential pre-amplifier 52 and one terminal of each of switches S9 and S10. The other terminal of switch S9 is connected to reference conductor 58 (which is maintained at V_{REF}), and the other terminal of switch S10 is connected to a non-inverting input of output amplifier 56. Capacitor C2 is connected between the non-inverting input of amplifier 56 and conductor 58.

[0026] Figure 6 is a timing diagram showing control signals for switches S1-S10 and output signals of pre-amplifier 52 and demodulator 54 shown in Figures 4 and 5. Specifically, the timing diagram of Figure 6 illustrates: (1) commutation clock signal 60, (2) pre-amplifier output signal 62, (3) switch S10 control signal 64, (4) switch S9 control signal 66, and (5) demodulator output signal 68. The vertical axis of each of these signals represents an amplitude attained by the signal and the horizontal axis represents time. While all of the signals shown in Figure 6 share a common time axis, the placement of one signal above another is not intended to indicate that the signal attains a higher amplitude than do the others.

[0027] Referring now to Figure 4 in conjunction with Figure 6, the operation of the portion of Hall-effect device 80 shown in Figure 4 will be explained. As shown, commutation clock 60 has two phases, P1 and P2. Specifically, when clock 60 is low, it is in phase P1, and when clock 60 is high, it is in phase P2. Each of switches S1-S8 is arranged to be closed during only one of these two phases. That is, switches S2, S4, S6 and S8 are closed during phase P1 (when clock 60 is low) and switches S1, S3, S5 and S7 are closed during phase P2 (when clock 60 is high). The phase during which each of the switches is closed is indicated next to the switch by the symbol "P1" or "P2."

[0028] During phase P1 of clock 60, temperature-variable current source 22 is connected between conductors 34 and 40 of Hall-effect element 20 and conductors 36 and 38 of Hall-effect element 20 are connected, respectively, to non-inverting input 26 and inverting input 28 of differential pre-amplifier 52. Pre-amplifier 52 amplifies the differential voltage between its non-inverting input 26 and its inverting input 28, and effectively adds the amplified input voltage (which is positive during phase P1) to the reference voltage V_{REF} on conductor 58. Pre-amplifier 52 then provides this sum of voltages as a single-ended output signal (shown as pre-amplifier output signal 62 in Figure 6). As shown, pre-amplifier output signal 62 is greater than V_{REF} during phase P1 (e.g., as indicated by portion 62A of curve 62).

[0029] During phase P2 of clock 60, temperature-variable current source 22 is connected between conductors 36 and 38 of Hall-effect element 20 and conductors 34 and 40 of Hall-effect element 20 are connected, respectively, to non-inverting input 26 and inverting input 28 of differential pre-amplifier 52. Pre-amplifier 52 amplifies the differential voltage between its non-inverting input 26 and its inverting input 28, and effectively adds the amplified input voltage (which is negative during phase P2) to the reference voltage V_{REF} on conductor 58. Pre-amplifier 52 then provides this sum of voltages as a single-ended output signal (shown as pre-amplifier output signal 62 in Figure 6). As shown, pre-amplifier output signal 62 is less than V_{REF} during phase P2 (e. g., as indicated by portion 62B of curve 62).

[0030] Generally, due to the offset voltage V_{OH} of Hall-effect element 20, portions 62A and 62B, respectively, of curve 62 will not be the same voltage greater than (V_H) and less than ($-V_H$) the voltage V_{REF} during phases P1 and P2. Demodulator 54 deals with this difference by effectively subtracting the voltage $-V_H$ at the output of pre-amplifier 52 during phase P2 from the voltage V_H at the output of pre-amplifier 52 during phase P1, thereby removing the effects of the Hall offset voltage V_{OH}, as described above.

[0031] Referring now to Figure 5 in conjunction with Figure 6, the operation of demodulator 54 will be described. Clock and logic stage 48 (shown in Figure 3) produces switch S9 control signal 66 and switch S10 control signal 64 as shown in Figure 6. Switches S9 and S10 are arranged such that they are closed, respectively, during phase P4 of switch S9 control signal 66 and during phase P3 of switch S10 control signal 64 (i.e., when switch S9 control signal 66 and switch S10 control signal 64, respectively, are high). The phase during which each of switches S9 and S10 is closed is indicated next to the switch by the symbol "P4" or "P3."

[0032] During phase P4, switch S9 is closed during a brief time interval while the output of pre-amplifier 52 is negative with respect to V_{REF} so that capacitor C1 will charge to the current voltage at the output of pre-amplifier 52 with respect to the voltage V_{REF}. During phase P3, after switch S9 has opened, switch S10 is closed during a brief time interval while the output of pre-amplifier 52 is positive with respect to V_{REF}. Because capacitors C1 and C2 are connected in series during this interval, some of the charge on capacitor C1 will be transferred to capacitor C2. After several P4/P3 cycles, the charge on capacitor C2 will be equal to the peak-to-peak voltage of curve 62.

[0033] In this manner, demodulator circuit 54 effectively subtracts (a) the negative difference between the amplitude of the voltage at the output of pre-amplifier 52 and reference voltage V_{REF} during phase P2 from (b) the positive difference between the amplitude of pre-amplifier 52 and reference voltage V_{REF} during phase P1. The output of demodulator circuit 54, i.e., the pole of capacitor C2 that is connected to the non-inverting input of output amplifier 56, therefore remains at a positive voltage equal to the peak-to-peak voltage of curve 62. As discussed above, this peak-to-peak voltage has the Hall offset voltage V_{OH} removed from it.

[0034] Figure 7 is a schematic diagram showing ratiometric temperature reference block 42 in more detail. As shown, ratiometric temperature reference stage 42 includes operational amplifiers 74 and 86, temperature-sensitive n+ diffusion resistor DR1, temperature-sensitive p-well diffusion resistors DR2 and DR3, and thin film resistors TF1-TF7, which are not particularly sensitive to temperature changes.

[0035] A resistive bridge including diffusion resistor DR1 and thin-film resistors TF1 and TF2 is connected between high-supply rail 70 (which has a voltage VCC thereon) and an analog ground 84. specifically, thin film resistor TF1 is connected between high-supply rail 70 and a non-inverting input of operational amplifier 74, and resistors DR1 and TF2 are connected in series between the non-inverting input of operational amplifier 74 and analog ground 84. The non-inverting input of operational amplifier 74 therefore is maintained at a voltage that changes in proportion to changes in the supply voltage (i.e., it is a ratiometric differential reference voltage).

[0036] Resistors TF3 and TF4 are connected in series between high-supply rail 70 and analog ground 84, and the connection point of these resistors is connected to the inverting input of operational amplifier 74. Resistor TF5 is connected in feedback between the output and the inverting input of operational amplifier 74. The values of resistors TF3-TF5 therefore control the gain of operational amplifier 74.

[0037] The output of operational amplifier 74 feeds node 88. Node 88, in turn, is connected to: (1) an external terminal P1, (2) one terminal of a first divider resistor R1 (including series-connected resistors DR2 and TF6), the other terminal of which is connected to an external terminal P2, and (3) one input of unity-gain inverting operational amplifier 86, the other input of which is connected to conductor 58 (which has the voltage V_{REF} applied on it). Thus, operational amplifier 86 will produce an output that is equal to the inverted difference between: (a) the voltage at node 88, and (b) the reference voltage VCC/2. As used herein, an "external terminal" refers to a terminal extending outwardly from an integrated circuit package such the terminal may interface with circuitry external to the package.

[0038] The output of operational amplifier 86 is connected to one terminal of a second divider resistor R2 (including series-connected resistors DR3 and TF7), the other terminal of which is connected to: (a) an external terminal P3, and (b) conductor 72, which drives a control input of voltage-to-current converter 46 (shown in Figure 3). Voltage-to-current converter 46 is configured so that a one millivolt change in the voltage applied to its control input results in a 0.04% change in Hall bias current I_H provided to quad-cell Hall-effect element 20 (shown in Figure 3).

[0039] Additionally, a trimmable resistor R3 is selectively connected between external terminal P3 and one of external terminals P1 and P2. Resistor R3 preferably is external to the integrated circuit package in which Hall-effect device 80 is disposed so that its value is user-selectable. Resistor R3 may comprise a simple potentiometer, a thick-film laser trimmable resistor, or any other device having a user-adjustable resistance known to those skilled in the art. It should be noted, however, that resistor R3 also may be included within the same package as Hall-effect device 80 so long as it is readily accessible to an end user of the integrated circuit.

[0040] As noted above, the resistance of diffusion resistors DR1, DR2 and DR3 changes responsive to temperature changes. Thus, as the temperature of Hall-effect device 80 increases, the resistance of resistor DR1 will change and the voltage at the output of operational amplifier 74 (node 88) will change accordingly. Assuming initially that resistor R3 is not present, when the voltage at node 88 is equal to VCC/2 (i.e., the voltage on conductor 58), the voltage at each of external terminals P1, P2 and P3 also will be equal to VCC/2. As the voltage at node 88 diverges from VCC/2, however, the voltage at external terminals P1 and P2 will follow the divergence of the voltage at node 88, and the presence of polarity-inverting operational amplifier 86 will cause the voltage at external terminal P3 to diverge in a voltage direction opposite-the direction in which the voltage at node 88 diverges from VCC/2. Specifically, the voltage at external terminal P3 will diverge in a positive voltage direction when the voltage at node 88 decreases below VCC/2 and will diverge in a negative voltage direction when the voltage at node 88 increases above VCC/2.

[0041] After fabrication of the device, bridge resistors TF1 and TF2, or gain-setting resistors TF3-TF5, may be trimmed using any conventional wafer probing apparatus so that the voltage at node 88 is equal to VCC/2 when the temperature of the Hall-effect device is at an ambient temperature (e.g., approximately 27° Celsius).

[0042] Figure 8 is a graph showing how the voltages on external terminals P1, P2 and P3 vary with temperature, both with and without resistor R3 being connected between terminal P3 and one of terminals P1 and P2. As shown, curve 76 represents the voltage on both of external terminals P1 and P2 when resistor R3 is not connected to either of them, curve 78 represents the voltage on external terminal P3 when resistor R3 is not connected to it, and curve 82 represents the voltage on external terminal P3 when resistor R3 is connected between terminal P3 and one of terminals P1 and P2. Curves 76, 78 and 80 are shown as they would appear after bridge resistors TF1 and TF2, or gain-setting resistors TF3-TF5, have been trimmed properly. That is, after selected ones of resistors TF1-TF5 have been trimmed properly, curves 76, 78 and 80 will converge at a point 80, which corresponds to an ambient temperature of 27° Celsius.

[0043] When resistor R3 is connected between terminal P3 and one of terminals P1 and P2, external terminal P3 will form a node of a voltage divider including at least two resistors that divide the voltage between node 88 and the output of operational amplifier 86. Specifically, when resistor R3 is connected between terminal P3 and terminal P1, terminal P3 will form a node of a voltage divider including resistor R2 (which includes resistors DR3 and TF7) and resistor R3, and when resistor R3 is connected between terminal P3 and terminal P2, terminal P3 will form a node of a voltage divider including resistor R1 (which includes resistors DR2 and TF6), resistor R2 (which includes resistors DR3 and TF7), and resistor R3. The voltage at terminal P3 resulting from the voltage division performed by these resistors is represented by curve 82 in Figure 8. The ability to connect resistor R3 to either of two separate terminals is provided to permit temperature compensation of the device for different types of magnets. For example, the connection of resistor R3 between terminals P1 and P3 may permit the compensation of a -2000 parts-per-million (ppm) magnet and the connection of resistor R3 between terminals P2 and P3 may permit the compensation of a -200 ppm magnet.

[0044] After resistor R3 is connected between external terminal P3 and one of external terminals P1 and P2, its value may be trimmed to optimize the slope of curve 82 for the particular application. That is, by adjusting the slope of curve 82, the amount that the voltage at external terminal P3 changes in response to temperature changes will be adjusted. Because the voltage at external terminal P3 controls the magnitude of the Hall current I_H generated by voltage-to-current converter 42 (shown in Figure 3), optimizing the slope of curve 82 (by trimming resistor R3) will permit compensation of the temperature dependency of the sensitivity S_H of Hall-effect element 20 with a high degree of accuracy.

[0045] As mentioned above, each of resistors R1 and R2 includes a series combination of a thin film and a temperature-sensitive diffusion resistor. Diffusion resistors are used in resistors R1 and R2 to add curvature to curve 82 to provide correction for the second-order temperature coefficient of the quad-cell Hall-effect element sensitivity S_H.

[0046] Figure 9 is partial block/partial schematic diagram showing a possible embodiment of Hall-effect device 80 and a possible configuration of circuit elements external thereto. In the embodiment shown, Hall-effect device 80 is an 8-pin dual-in-line package (DIP) including terminals (i.e., external connectors) P1-P8, several of which are the same terminals shown in previously-described Figures. Terminal P8 receives power from high-supply conductor 70 and terminal P4 is connected to an analog ground conductor 84. Trimmable resistor R3 is connected between terminals P2 and P3 (or optionally could be connected between terminals P1 and P3). Resistors R4-R6 are configured to set the gain of output amplifier 56. Specifically, resistor R4 is connected between terminals P8 and P6 (which is the inverting input of output amplifier 56), resistor R6 is connected between terminals P6 and P5 (which has a voltage equal to VCC/2 on it), and resistor R5 is connected between terminals P6 and P7 (which is the output of amplifier 56).

[0047] Figure 10 is a side-view of an embodiment of Hall-effect device 80 showing how device 80 senses a magnetic field. As shown, the device is configured to sense a magnetic field B oriented transverse to the plane of the device.

[0048] Figure 11 is partial block/partial schematic diagram showing another possible configuration of circuit elements external to device 80, wherein an additional potential divider (including resistors R7 and R10) is connected across the supply to further adjust the offset of the device. Specifically, resistor R7 is connected between terminal P5 and a first terminal of resistor R9 (the second terminal of which is connected to terminal P7), resistor R8 is connected between terminal P6 and terminal P7, and resistor R10 is connected between the first terminal of resistor R9 and terminal P3.

[0049] While the embodiment of Hall-effect device 80 has been described herein as using, temperature sensitive resistors, any devices capable of producing an output that varies with temperature could equivalently be used without departing from the intended scope of the invention. Additionally, while the temperature-variable current source 22 includes a first device that generates a voltage dependent on temperature and a second device that converts the generated voltage into a current to be supplied to Hall-effect element 20, a single device that produces a temperature-dependent current could equivalently be used, or, alternatively, a temperature-dependent voltage source could be used directly as the source of current across terminal pairs of Hall-effect element 20. Further, while the external device used to adjust the sensitivity of the temperature compensation circuitry has been described herein as a resistor, any other external device capable of adjusting the sensitivity of the device equivalently could be employed. In addition, while the semiconductor components have been described herein as being of particular doping types, opposite doping types equivalently may be used.

[0050] Having thus described at least one illustrative embodiment of the invention, various alterations, modifications and improvements will readily occur to those skilled in the art. Such alterations, modifications and improvements are intended to be within the scope of the invention. Accordingly, the foregoing description is by way of example only and is not intended as limiting. The invention is limited only as defined in the following claims.

Claims

1. A Hall-effect device (80), comprising:

a Hall-effect element (20) having at least one input (34, 36, 38, 40) for receiving a bias signal and at least one output (34, 36, 38, 40) for providing an output signal dependent on the bias signal and on a magnetic field intercepting the Hall-effect element (20);
at least one output lead (P7) to provide an output signal responsive to the output signal of the Hall-effect element (20) and dependent on an overall gain of the Hall-effect device (80); and
a temperature-variable gain control circuit (22) coupled to the Hall-effect element (20) to adjust the sensitivity of the overall gain of the Hall-effect device (80) to temperature changes, **characterized in that** the temperature-variable gain control circuit (22) includes a pair of nodes (P2, P3) such that, when a first component (R3) is coupled between the pair of nodes (P2, P3), changing a characteristic of only the first component (R3) alters the sensitivity of the overall gain of the Hall-effect device (80) to temperature changes without substantially altering the overall gain of the Hall-effect device (80) when the Hall-effect device (80) is maintained at a reference temperature, wherein the temperature-variable gain control circuit (22) includes a temperature-variable signal source (42, 46) coupled to the Hall-effect element to provide the bias signal thereto such that an amplitude of the bias signal changes in response to temperature changes.

2. The Hall-effect device (80) as claimed in claim 1, wherein the temperature-variable signal source (42, 46) is configured such that, when the first component (R3) is coupled between the pair of nodes (P2, P3), changing the characteristic of only the first component (R3) alters an amount that the amplitude of the bias signal changes in response to a given temperature change without substantially altering the amplitude of the bias signal when the Hall-effect device (80) is maintained at the reference temperature.

3. The Hall-effect device (80) as claimed in claim 2, wherein the temperature-variable signal source (42, 46) includes:

a controllable current source (46), having a control input (72), that provides a bias current as the bias signal to the Hall-effect element (20), and
a temperature-sensitive signal source (42) coupled to the control input (72) of the controllable current source (46) to provide a temperature dependent control signal thereto.

4. The Hall-effect device (80) as claimed in claim 3, wherein:

the controllable current source (46) includes a voltage-controlled current source, and
the temperature-sensitive signal source (42) includes a temperature-sensitive voltage source.

5. The Hall-effect device (80) as claimed in any of claims 1-4, wherein:

at least one of the pair of nodes (P2, P3) forms a node of a potential divider (R1, R2, R3) when the first component (R3) is coupled therebetween.

6. The Hall-effect device (80) as claimed in any of claims 1-5, wherein the first component (R3) includes a resistor having an adjustable resistance.

7. The Hall-effect device (80) as claimed in any of claims 1-6, further comprising means (22) for compensating for offset of the Hall-effect element (20).

8. The Hall-effect device (80) as claimed in any of claims 1-7, wherein:

the Hall-effect element (20) is configured such that the output signal thereof represents a product of a strength of a magnetic field (B) intercepting the Hall-effect element, an amplitude of the bias signal (I), and a sensitivity constant (S) of the Hall-effect element (20), wherein the sensitivity constant (S) of the Hall-effect element (20) changes with temperature changes of the Hall-effect element (20) such that, if the ampli-

tude of the bias signal (I) and the strength of the magnetic field (B) were held constant, a magnitude of the output signal would change in a particular polarity direction as a temperature of the Hall-effect element (20) increased; and
the temperature-variable gain control circuit (22) is configured such that, when the first component (R3) is coupled between the pair of nodes (P2, P3) and the characteristic of the first component (R3) has a first value, an amount that the overall gain of the Hall-effect device (80) changes in the particular polarity direction in response to a given increase in temperature is greater than an amount that the overall gain of the Hall-effect device (80) would change in the particular polarity direction in response to the given increase in temperature if the temperature-variable gain control circuit (22) did not alter the overall gain of the Hall-effect device (80) in response to changing temperature conditions.

9. The Hall-effect device (80) as claimed in claim 8, wherein the temperature-variable gain control circuit (22) is configured such that, when the first component (R3) is coupled between the pair of nodes (P2, P3) and the characteristic of the first component (R3) has a second value, the amount that the overall gain of the Hall-effect device (80) changes in the particular polarity direction in response to the given increase in temperature is less than the amount that the overall gain of the Hall-effect device (80) would change in the particular polarity direction in response to the given increase in temperature if the temperature-variable gain control circuit (22) did not alter the overall gain of the Hall-effect device (80) in response to changing temperature conditions.

10. The Hall-effect device (80) as claimed in any of claims 1-9, wherein:

the Hall-effect element (20) is mounted in an integrated circuit package; and
the pair of nodes (P2, P3) includes a pair of terminals extending from the integrated circuit package so that the first component (R3) can be coupled between the pair of terminals at a location external to the package.

11. The Hall-effect device (80) as claimed in any of claims 1-10, further including at least one second component (TF1, TF2) coupled to the temperature-variable gain control circuit (22), a characteristic of the at least one second component (TF1, TF2) being adjustable to select the reference temperature at which changing the characteristic of only the first component (R3) does not substantially alter the overall gain of the Hall-effect device.

12. The Hall-effect device (80) as claimed in claim 2, wherein the temperature-variable signal source (42, 46) is configured such that, when the first component (R3) is coupled between the pair of nodes (P2, P3) and the characteristic of the first component (R3) has a first value, an amplitude of the bias signal increases as the temperature increases, and when the first component (R3) is coupled between the pair of nodes (P2, P3) and the characteristic of the first component (R3) has a second value, the bias signal decreases as the temperature increases.

13. The Hall-effect device (80) as claimed in claim 2, wherein the temperature-variable signal source (42, 46) includes a current source 46 that provides a bias current as the bias signal to the Hall-effect element (20).

14. The Hall-effect device (80) as claimed in claim 5, wherein:

the temperature-variable gain control circuit (22) includes an inverting amplifier (86) that inverts a non-inverted temperature-dependent voltage to create an inverted temperature-dependent voltage; and
the potential divider (R1, R2, R3) is coupled between a first node (88) having the non-inverted temperature-dependent voltage thereon and a second node having the inverted temperature-dependent voltage thereon.

15. The Hall-effect device (80) as claimed in any of claims 1-14, in combination with the first component (R3).

16. The Hall-effect device (80) as claimed in any of claims 1-15, wherein the temperature variable gain control circuit (22) includes a temperature-dependent voltage source (74), a voltage-controlled gain adjustment circuit (46), and a voltage divider (R1, R2, R3) having at least a first node (88) coupled to the voltage source (74) to receive a temperature dependent voltage therefrom and a second node (72) coupled to the gain adjustment circuit (46) to provide a control voltage thereto, the voltage divider (R1, R2, R3) including the first component (R3) and being configured such that adjusting the characteristic of only the first component (R3) alters a ratio of component values in the voltage divider (R1, R2, R3) so as to alter the voltage at the second node (72).

17. A method for compensating for the effects of temperature variations on a Hall-effect element (20), comprising steps of:

(a) providing a Hall-effect device (80) including a Hall-effect element (20) and a temperature-variable gain control circuit (22) coupled to the Hall-effect element (20) to adjust the sensitivity of the gain of the Hall-effect device (80) to temperature changes;

characterized in that it further comprises

(b) coupling a first component (R3) between a pair of nodes (P2, P3) of the temperature-variable gain control circuit (22) to set the sensitivity of the gain of the Hall-effect device (80) to temperature variations; and

(c) altering a characteristic of only the first component (R3) to adjust the sensitivity of the gain of the Hall-effect device (80) to temperature variations without substantially altering the gain of the Hall-effect device (80) when the Hall-effect device (80) is maintained at a reference temperature.

18. The method of claim 17, wherein:

the step (a) includes a step of providing a temperature-variable signal source (42, 46) as the temperature-variable gain control circuit (22), the temperature-variable signal source (42, 46) being coupled to the Hall-effect element (20) to provide a bias signal to at least one input (34, 36, 38, 40) of the Hall-effect element such that an amplitude of the bias signal changes responsive to temperature changes; and

the step (b) includes a step of (b1) coupling the first component (R3) between the pair of nodes (P2, P3) to set a sensitivity of the temperature-variable signal source (42, 46) to temperature variations; and

the step (c) includes a step of altering the characteristic of only the first component (R3) to adjust an amount that the amplitude of the bias signal changes responsive to a given temperature change without substantially altering the amplitude of the bias signal when the Hall-effect device (80) is maintained at the reference temperature.

19. The method of claim 17 or 18, wherein the Hall-effect device (80) is included in an integrated circuit, and wherein the step (b) includes a step of coupling the first component (R3) between a pair of external terminals (P2, P3) of the integrated circuit to set the sensitivity of the gain of the Hall-effect device (80) to temperature variations.

20. The method of any of claims 17-19, further including a step of:

adjusting the reference temperature.

21. The Hall-effect device (80) as claimed in claims 8-10, wherein the temperature-variable signal source (42, 46) includes:

a controllable current source (46), having a control input (72), that provides a bias current as the bias signal to the Hall-effect element (20), and

a temperature-sensitive signal source (42) coupled to the current source (46) to provide a temperature-dependent control signal to the control input (72) of the controllable current source (46), the temperature-sensitive signal source (42) being configured such that, when the first component (R3) is coupled between the pair of nodes (P2, P3), an amplitude of the temperature-dependent control signal is caused to change as the temperature of the Hall-effect device (80) changes, thereby causing the amplitude of the bias current to change as the temperature of the Hall-effect device (80) changes.

22. The Hall-effect device (80) as claimed in claim 21, wherein:

the controllable current source (46) includes a voltage-controlled current source, and

the temperature-sensitive signal source (42) includes a temperature-sensitive voltage source.

23. The Hall-effect device (80) as claimed in claim 21, wherein:

the temperature-variable signal source (22) includes a current source (46) that provides a bias current as the bias signal (I) to the Hall-effect element (20); and

the temperature-variable signal source (42) is configured such that, when the first component (R3) is coupled between the pair of nodes (P2, P3), an amplitude the bias current is caused to change as the temperature changes.

24. The Hall-effect device (80) as claimed in any of claims 21-23, wherein:

the temperature-variable gain control circuit (22) includes an inverting amplifier (86) that inverts a non-inverted temperature-dependent voltage to create an inverted temperature-dependent voltage;

the first component (R3) includes a resistor; and

the temperature-variable gain control circuit (22) is configured such that, when the resistor (R3) is coupled between the pair of nodes (P2, P3), the resistor (R3) is included in a voltage divider (R1, R2, R3) coupled between a first node (88) having the non-inverted temperature-dependent voltage thereon and a second node having the inverted temperature-dependent voltage thereon, the sensitivity of the overall gain of the Hall-effect device (80) being adjusted in response to a voltage at a node (72) of the voltage divider.

25. The Hall-effect device (80) as claimed in any of claims 21-24, wherein the temperature variable gain control circuit (22) includes a temperature-dependent voltage source (74), a voltage-controlled gain adjustment circuit (46), and a voltage divider (R1, R2, R3) having at least a first node (88) coupled to the voltage source (74) to receive a temperature dependent voltage therefrom and a second node (72) coupled to the gain adjustment circuit (46) to provide a control voltage thereto, the voltage divider (R1, R2, R3) including the first component (R3) and being configured such that adjusting the characteristic of only the first component (R3) alters a ratio of component values in the voltage divider (R1, R2, R3) so as to alter the voltage at the second node (72).

Patentansprüche

1. Eine Hall-Effekt Vorrichtung (80) die Folgendes aufweist:

ein Hall-Effekt Element (20) mit mindestens einem Eingang (34, 36, 38, 40) zum Empfang eines Vorspannsignals und mit mindestens einem Ausgang(34, 36, 38, 40) zum Liefern eines Ausgangssignals, abhängig von dem Vorspannsignal und von einem Magnetfeld, welches das Hall-Effekt Element (20) unterbricht (intercepts);
mindestens ein Ausgangsleiter (P7) um ein Ausgangssignal, ansprechend auf das Ausgangssignal des Hall-Effekt Elements (20) und abhängig von einer Gesamtverstärkung der Hall-Effekt Vorrichtung (80) zu liefern; und
eine temperaturveränderbare Verstärkungssteuerschaltung (22), gekoppelt an das Hall-Effekt Element (20) zum Einstellen der Empfindlichkeit der Gesamtverstärkung der Hall-Effekt Vorrichtung (80) gegenüber Temperaturänderungen;

dadurch gekennzeichnet, dass
die temperaturveränderbare Verstärkungssteuerschaltung (22) ein Paar von Knoten (P2, P3) derart aufweist, dass dann, wenn eine erste Komponente (R3) zwischen dem Paar von Knoten (P2, P3) gekoppelt ist, eine Charakteristik von nur der ersten Komponente (R3) die Empfindlichkeit der Gesamtverstärkung der Hall-Effekt Vorrichtung (80) gegenüber Temperaturänderungen ändert, ohne im Wesentlichen die Gesamtverstärkung der Hall-Effekt Vorrichtung (80) zu ändern, wenn die Hall-Effekt Vorrichtung (80) auf einer Bezugstemperatur gehalten ist, wobei die temperaturveränderbare Verstärkungssteuerschaltung (22) eine temperaturveränderbare Signalquelle (42, 46) aufweist, und zwar gekoppelt an das Hall-Effekt Element, um das Vorspannsignal dafür derart vorzusehen, dass eine Amplitude des Vorspannsignals sich ansprechend auf die Temperaturänderungen ändert.

2. Hall-Effekt Vorrichtung (80) nach Anspruch 1, wobei die temperaturveränderbare Signalquelle (42, 46) derart konfiguriert ist, dass dann, wenn die erste Komponente (R3) zwischen das Paar von Knoten (P2, P3) gekoppelt ist, das Ändern der Charakteristik von nur der ersten Komponente (R3) eine Größe ändert, die die Amplitude des Vorspannsignals ändert, und zwar ansprechend auf eine gegebene Temperaturänderung ohne im Wesentlichen die Amplitude des Vorspannsignals dann zu ändern, wenn die Hall-Effekt Vorrichtung (80) auf der Bezugstemperatur gehalten wird.

3. Hall-Effekt Vorrichtung (80) nach Anspruch 2, wobei die temperaturveränderbare Signalquelle (42, 46) Folgendes aufweist:

eine steuerbare Stromquelle (46) mit einem Steuereingang (72), der einen Vorspannstrom als das Vorspannsignal an das Hall-Effekt Element (20) liefert, und
ein temperaturempfindliches Signal (42), gekoppelt an den Steuereingang (72) der steuerbaren Stromquelle (46), um ein temperaturabhängiges Steuersignal dafür vorzusehen.

4. Hall-Effekt Vorrichtung (80) nach Anspruch 3, wobei die steuerbare Stromquelle (46) eine spannungsgesteuerte Stromquelle aufweist oder ist, und wobei ferner die temperaturempfindliche Signalquelle (42) eine temperaturempfindliche Spannungsquelle aufweist.

5. Hall-Effekt Vorrichtung (80) nach einem der Ansprüche 1 bis 4, wobei mindestens einer des Paares von Knoten (P2, P3) einen Knoten eines Potentialteilers (R1, R2, R3) bildet, wenn die erste Komponente (R3) dazwischen gekoppelt ist.

6. Hall-Effekt Vorrichtung (80) nach einem der Ansprüche 1 bis 5, wobei die erste Komponente (R3) einen Widerstand mit einem einstellbaren Widerstandswert besitzt.

7. Hall-Effekt Vorrichtung (80) nach einem der Ansprüche 1 bis 6, wobei ferner Mittel (22) vorgesehen sind zum Kompensieren der Versetzung (offset) des Hall-Effekt Elements (20).

8. Hall-Effekt Vorrichtung (80) nach einem der Ansprüche 1 bis 7, wobei Folgendes vorgesehen ist:

das Hall-Effekt Element (20) ist derart konfiguriert, dass das Ausgangssignal desselben ein Produkt einer Stärke des Magnetfeldes (B) repräsentiert, welches das Hall-Effekt Element unterbricht oder durchschneidet,
eine Amplitude des Vorspannsignals (I) und eine Empfindlichkeitskonstante (S) des Hall-Effekt Elements (20),

wobei die Empfindlichkeitskonstante (S) des Hall-Effekt Elements (20) sich mit Temperaturänderungen des Hall-Effekt Element (20) derart ändert, dass dann, wenn die Amplitude des Vorspannsignals (I) und die Stärke des Magnetfeldes (B) konstant gehalten würden, eine Größe des Ausgangssignals sich in einer bestimmten Polaritätsrichtung ändern würde, wenn eine Temperatur des Hall-Effekt Elements (20) erhöht würde; und
wobei die Temperatur veränderbare Verstärkungssteuerschaltung (22) derart konfiguriert ist, dass dann, wenn die erste Komponente (R3) zwischen das Paar von Knoten (P2, P3) gekoppelt ist, und die Charakteristik der ersten Komponente (R3) einen ersten Wert besitzt, eine Größe, die die gesamte Verstärkung der Hall-Effekt Vorrichtung (80) in der bestimmten Polaritätsrichtung ändert, und zwar ansprechend auf einen gegebenen Temperaturanstieg, größer ist als eine Größe, mit der sich die Gesamtverstärkung der Hall-Effekt Vorrichtung (80) in der bestimmten Polaritätsrichtung ändern würde, ansprechend auf einen gegebenen Temperaturanstieg, wenn die temperaturveränderbare Verstärkungssteuerschaltung (22) nicht die Gesamtverstärkung der Hall-Effekt Vorrichtung (80), ansprechend auf die Änderung der Temperaturbedingungen ändern würde.

9. Hall-Effekt Vorrichtung (80) nach Anspruch 8, wobei die temperaturveränderbare Verstärkungssteuerschaltung (22) derart konfiguriert ist, dass dann, wenn die erste Komponente (R3) zwischen das Paar von Knoten (P2, P3) gekoppelt ist und die Charakteristik der ersten Komponente (R3) einen zweiten Wert besitzt, die Größe die die Gesamtverstärkung der Hall-Effekt Vorrichtung (80) ändert und zwar in der speziellen Polaritätsrichtung, ansprechend auf den gegebenen Temperaturanstieg kleiner ist als die Größe mit der sich die Gesamtverstärkung der Hall-Effekt Vorrichtung (80) ändern würde in der speziellen Polaritätsrichtung, ansprechend auf den gegebenen Temperaturanstieg, wenn die temperaturveränderbare Verstärkungssteuerschaltung (22) nicht die Gesamtverstärkung der Hall-Effekt Vorrichtung (80) ändern würde, und zwar ansprechend auf die Änderung der Temperaturbedingungen.

10. Hall-Effekt Vorrichtung (80) nach einem der Ansprüche 1 bis 9, wobei Folgendes vorgesehen ist:

das Hall-Effekt Element (20) ist in einer integrierten Schaltungspackung angebracht; und
das Paar von Knoten (P2, P3) weist ein Paar von Anschlüssen auf, die sich von der integrierten Schaltungspackung derart erstrecken, dass die erste Komponente (R3) zwischen das Paar von Anschlüssen an einer Stelle außerhalb der Packung gekoppelt werden können.

11. Hall-Effekt Vorrichtung (80) nach einem der Ansprüche 1 bis 10, wobei ferner mindestens eine zweite Komponente (TF1, TF2) vorgesehen ist, und zwar gekoppelt an die temperaturveränderbare Verstärkungssteuerschaltung (22), wobei eine Charakteristik von der mindestens einen zweiten Komponente (TF1, TF2) einstellbar ist, um die Bezugstemperatur auszuwählen, bei der die Änderung der Charakteristik von nur der ersten Komponente (R3) nicht im Wesentlichen die Gesamtverstärkung der Hall-Effekt Vorrichtung ändert.

12. Hall-Effekt Vorrichtung (80) nach Anspruch 2, wobei die temperaturveränderbare Signalquelle (42, 46) derart konfiguriert ist, dass dann, wenn die erste Komponente (R3)zwischen das Paar von Knoten (P2, P3) gekoppelt ist und die Charakteristik der ersten Komponente (R3) einen ersten Wert besitzt, eine Amplitude des Vorspannsignals dann ansteigt, wenn die Temperatur ansteigt, und wobei dann, wenn die erste Komponente (R3) zwischen das Paar von Knoten (P2, P3) gekoppelt ist und die Charakteristik der ersten Komponente (R3) einen zweiten Wert besitzt, das Vorspannsignal abnimmt, wenn die Temperatur ansteigt.

13. Hall-Effekt Vorrichtung (80) nach Anspruch 2, wobei die temperaturveränderbare Signalquelle (42, 46) eine Stromquelle (46) aufweist, die einen Vorspannstrom als das Vorspannsignal für das Hall-Effekt Element (20) vorsieht.

14. Hall-Effekt Vorrichtung (80) nach Anspruch 5, wobei:

die temperaturveränderbare Verstärkungssteuerschaltung (22) einen invertierenden Verstärker (86) aufweist, der die nicht invertierte temperaturabhängige Spannung invertiert, um

eine invertierte temperaturabhängige Spannung zu erzeugen; und
der Potentialteiler (R1, R2, R3) zwischen einen ersten Knoten (88) und einen zweiten Knoten gekoppelt ist, wobei der erste Knoten daran anliegend die nicht invertierte temperaturabhängige Spannung aufweist, und

wobei der zweite Knoten die invertierte temperaturabhängige Spannung daran anliegend aufweist.

15. Hall-Effekt Vorrichtung (80) nach einem der Ansprüche 1 bis 14, und zwar in Kombination mit der ersten Komponente (R3).

16. Hall-Effekt Vorrichtung (80) nach einem der Ansprüche 1 bis 15, wobei die temperaturveränderbare Verstärkungssteuerschaltung (22) eine temperaturabhängige Spannungsquelle (74), eine spannungsgesteuerte Verstärkungseinstellschaltung (46) und einen Spannungsteiler (R1, R2, R3) aufweist, und zwar mit mindestens einem Knoten (88), gekoppelt an die Spannungsquelle (74), und zwar zum Empfang einer temperaturabhängigen Spannung davon, und ferner mit einem zweiten Knoten (72), gekoppelt mit der Verstärkungseinstellschaltung (46) um eine Steuerspannung daran zu liefern, wobei der Spannungsteil (R1, R2, R3) die erste Komponente (R3) aufweist, und derart konfiguriert ist, dass die Einstellung der Charakteristik von nur der ersten Komponente (R3) ein Verhältnis der Komponentenwerte im Spannungsteil (R1, R2, R3) derart ändert, dass die Spannung an dem zweiten Knoten (72) geändert wird.

17. Verfahren zum Kompensieren der Effekt von Temperaturveränderungen an einem Hall-Effekt Element (20), wobei die folgenden Schritte vorgesehen sind:

(a) Vorsehen einer Hall-Effekt Vorrichtung (80) einschließlich eines Hall-Effekt Elements (20) und einer temperaturveränderbaren Verstärkungssteuerschaltung (22), gekoppelt an das Hall-Effekt Element (20), um die Empfindlichkeit der Verstärkung der Hall-Effekt Vorrichtung (80) gegenüber Temperaturänderungen einzustellen, **dadurch gekennzeichnet, dass** das Verfahren ferner Folgendes aufweist:
(b) Koppeln einer ersten Komponente (R3) zwischen ein Paar von Knoten (P2, P3) der temperaturveränderbaren Verstärkungssteuerschaltung (22), um die Empfindlichkeit der Verstärkung der Hall-Effekt Vorrichtung (80) auf die Temperaturveränderungen einzustellen; und
(c) Ändern einer Charakteristik von nur der ersten Komponente (R3) zur Einstellung der Empfindlichkeit der Verstärkung der Hall-Effekt Vorrichtung (80) auf Temperaturveränderungen, ohne im Wesentlichen die Verstärkung der Hall-Effekt Vorrichtung (80) zu ändern, wenn die Hall-Effekt Vorrichtung (80) auf einer Bezugstemperatur gehalten ist.

18. Verfahren nach Anspruch 17, wobei Folgendes vorgesehen ist:

der Schritt (a) weist einen Schritt auf zum Vorsehen einer temperaturveränderbaren Signalquelle (42, 46) als der temperaturveränderbaren Verstärkungssteuerschaltung (22), wobei die temperaturveränderbare Signalquelle (42, 46) mit dem Hall-Effekt Element (20) gekoppelt ist, um ein Vorspannsignal für mindestens einen Eingang (34, 36, 38, 40) des Hall-Effekt Elements derart vorzusehen, dass eine Amplitude des Vorspannsignals sich ansprechend auf die Temperaturänderungen ändert; und
der Schritt (b) weist einen Schritt (b1) auf und war zum Koppeln der ersten Komponente (R3) zwischen das Paar von Knoten (P2, P3), um eine Empfindlichkeit der temperaturveränderbaren Signalquelle (42, 46) auf Temperaturveränderungen einzustellen; und
der Schritt (c) weist einen Schritt des Ändern der Charakteristik von nur der ersten Komponente (R3) auf, um eine Größe einzustellen, die die Größe der Amplitude des Vorspannsignals ändert, und zwar ansprechend auf eine gegebene Temperaturänderung, ohne im Wesentlichen die Amplitude des Vorspannsignals dann zu ändern, wenn die Hall-Effekt Vorrichtung (80) auf der Bezugstemperatur gehalten wird.

19. Verfahren nach Anspruch 17 oder 18, wobei die Hall-Effekt Vorrichtung (80) in einer integrierten Schaltung enthalten ist, und wobei der Schritt (b) einen Schritt des Koppelns der ersten Komponente (R3) zwischen einem Paar von externen Anschlüssen (P2, P3) der integrierten Schaltung aufweist, um die Empfindlichkeit der Verstärkung der Hall-Effekt Vorrichtung (80) gegenüber Temperaturänderungen einzustellen.

20. Verfahren nach einem der Ansprüche 17 bis 19, wobei ferner ein Schritt des Einstellens der Bezugstemperatur vorgesehen ist.

21. Hall-Effekt Vorrichtung (80) nach Anspruch 8 bis 10, wobei die temperaturveränderbare Signalquelle (42, 46) Folgendes aufweist:

eine steuerbare Stromquelle (46) mit einem Steuereingang (72), der ein Vorspannstrom als das Vorspannsignal an das Hall-Effekt Element

(20) liefert, und
eine temperaturempfindliche Signalquelle (42), gekoppelt mit der Stromquelle (46), um ein temperaturabhängiges Steuersignal für den Steuereingang (72) der steuerbaren Stromquelle (46) zu liefern, wobei die temperaturempfindliche Signalquelle (42) derart konfiguriert ist, dass dann, wenn die erste Komponente (R3) zwischen das Paar von Knoten (P2, P3) gekoppelt ist, eine Amplitude des temperaturabhängigen Steuersignals veranlasst wird sich zu ändern, wenn die Temperatur der Hall-Effekt Vorrichtung (80) ändert, wodurch bewirkt wird, dass die Amplitude des Vorspannstromes sich ändert, wenn die Temperatur der Hall-Effekt Vorrichtung (80) sich ändert.

22. Hall-Effekt Vorrichtung (80) nach Anspruch 21, wobei die steuerbare Stromquelle (46) eine spannungsgesteuerte Stromquelle aufweist, und wobei die temperaturempfindliche Signalquelle (42) eine temperaturempfindliche Spannungsquelle aufweist.

23. Hall-Effekt Vorrichtung (80) nach Anspruch 21, wobei Folgendes vorgesehen ist:

die temperaturveränderbare Signalquelle (22) weist eine Stromquelle (46) auf, die einen Vorspannstrom als das Vorspannsignal (I) für das Hall-Effekt Element (20) vorsieht; und
die temperaturveränderbare Signalquelle (42) ist derart konfiguriert, dass dann, wenn die erste Komponente (R3) zwischen das Paar von Knoten (P2, P3) gekoppelt ist, eine Amplitude des Vorspannstromes veranlasst wird sich zu ändern, wenn die Temperatur sich ändert.

24. Hall-Effekt Vorrichtung (80) nach einem der Ansprüche 21 bis 23, wobei Folgendes vorgesehen ist:

die temperaturveränderbare Verstärkungssteuerschaltung (22) weist einen invertierten Verstärker (86) auf, der eine nicht invertierte temperaturabhängige Spannung invertiert, um eine invertierte temperaturabhängige Spannung zu erzeugen;
die erste Komponente (R3) weist einen Widerstand auf; und
die temperaturveränderbare Verstärkungssteuerschaltung (22) ist derart konfiguriert, dass dann, wenn der Widerstand (R3) zwischen das Paar von Knoten (P2, P3) gekoppelt ist, der Widerstand (R3) in einem Spannungsteiler (R1, R2, R3) eingeschlossen ist, und zwar gekoppelt zwischen einen ersten Knoten (88) mit der nicht invertierten temperaturabhängigen Spannung daran anliegend, und einen zweiten Knoten mit der invertierten temperaturabhängigen Spannung daran anliegend, wobei die Empfindlichkeit der Gesamtverstärkung der Hall-Effekt Vorrichtung (80) ansprechend auf eine Spannung am Knoten (72) des Spannungsteiles eingestellt wird.

25. Hall-Effekt Vorrichtung (80) nach einem der Ansprüche 21 bis 24, wobei die temperaturveränderbare Verstärkungssteuerschaltung (22) eine temperaturabhängige Spannungsquelle (74), eine spannungsgesteuerte Verstärkungseinstellschaltung (46) und einen Spannungsteiler (R1, R2, R3) mit mindestens einen ersten Knoten (88), gekoppelt an die Spannungsquelle (74) zum Empfang einer temperaturabhängigen Spannung davon, und ferner einen zweiten Knoten (72) aufweist, und zwar gekoppelt mit der Verstärkungseinstellschaltung (46) um eine Steuerspannung daran vorzusehen, wobei der Spannungsteiler (R1, R2, R3) eine erste Komponente (R3) aufweist und derart konfiguriert ist, dass die Einstellung der Charakteristik von nur einer Komponente (R3) ein Verhältnis der Komponentenwerte in dem Spannungsteiler (R1, R2, R3) derart ändert, dass die Spannung am zweiten Knoten (72) geändert wird.

Revendications

1. Dispositif à effet Hall (80), comprenant :

un élément à effet Hall (20) comportant au moins une entrée (34, 36, 38, 40) pour recevoir un signal de polarisation et au moins une sortie (34, 36, 38, 40) pour fournir un signal de sortie dépendant du signal de polarisation et d'un champ magnétique interceptant l'élément à effet Hall (20) ;
au moins un conducteur de sortie (P7) pour fournir un signal de sortie en réponse au signal de sortie de l'élément à effet Hall (20) et dépendant du gain total du dispositif à effet Hall (80) ; et
un circuit de commande de gain variable avec la température (22) couplé à l'élément à effet Hall (20) pour ajuster la sensibilité du gain total du dispositif à effet Hall (80) aux variations de température, **caractérisé en ce que** le circuit de commande de gain variable avec la température (22) comprend deux noeuds (P2, P3) tels que, lorsqu'un premier composant (R3) est couplé entre les deux noeuds (P2, P3), le fait de changer une caractéristique du seul premier composant (R3) modifie la sensibilité du gain total du dispositif à effet Hall (80) aux variations de température sans modifier sensiblement le gain total du dispositif à effet Hall (80) lorsque

le dispositif à effet Hall (80) est maintenu à une température de référence, le circuit de commande de gain variable avec la température (22) comprenant une source de signal variable avec la température (42, 46) couplée à l'élément à effet Hall pour lui fournir un signal de polarisation tel que l'amplitude du signal de polarisation varie en fonction des variations de température.

2. Dispositif à effet Hall (80) selon la revendication 1, dans lequel la source de signal variable avec la température (42, 46) est agencée de sorte que, lorsque le premier composant (R3) est couplé entre les deux noeuds (P2, P3), le fait de changer la caractéristique du seul premier composant (R3) modifie la quantité dont l'amplitude du signal de polarisation varie en fonction d'une variation de température donnée sans modifier sensiblement l'amplitude du signal de polarisation lorsque le dispositif à effet Hall (80) est maintenu à une température de référence.

3. Dispositif à effet Hall (80) selon la revendication 2, dans lequel la source de signal variable avec la température (42, 46) comprend :

une source de courant commandable (46), ayant une entrée de commande (72), qui fournit un courant de polarisation en tant que signal de polarisation à l'élément à effet Hall (20), et
une source de signal sensible à la température (42) reliée à l'entrée de commande (72) de la source de courant commandable (46) pour lui fournir un signal de commande dépendant de la température.

4. Dispositif à effet Hall (80) selon la revendication 3, dans lequel :

la source de courant commandable (46) comprend une source de courant commandée en tension, et
la source de signal sensible à la température (42) comprend une source de tension sensible à la température.

5. Dispositif à effet Hall (80) selon l'une quelconque des revendications 1 à 4, dans lequel :

au moins un des deux noeuds (P2, P3) constitue un noeud d'un diviseur de potentiel (R1, R2, R3) quand le premier composant (R3) est relié entre eux.

6. Dispositif à effet Hall (80) selon l'une quelconque des revendications 1 à 5, dans lequel le premier composant (R3) comprend une résistance de valeur réglable.

7. Dispositif à effet Hall (80) selon l'une quelconque des revendications 1 à 6, comprenant en outre un moyen (22) pour compenser le décalage de l'élément à effet Hall (20).

8. Dispositif à effet Hall (80) selon l'une quelconque des revendications 1 à 7, dans lequel :

l'élément à effet Hall (20) est agencé de sorte que son signal de sortie représente le produit de l'intensité d'un champ magnétique (B) interceptant l'élément à effet Hall, par l'amplitude du signal de polarisation (I), et par une constante de sensibilité (S) de l'élément à effet Hall (20), dans lequel la constante de sensibilité (S) de l'élément à effet Hall (20) varie avec les variations de température de l'élément à effet Hall (20) de sorte que, si l'amplitude du signal de polarisation (I) et l'intensité du champ magnétique (B) étaient maintenues constantes, l'amplitude du signal de sortie varierait dans un sens de polarité particulier lorsque la température de l'élément à effet Hall (20) augmente ; et
le circuit de commande de gain variable avec la température (22) est agencé de sorte que, lorsque le premier composant (R3) est relié entre les deux noeuds (P2, P3) et que la caractéristique du premier composant (R3) a une première valeur, la quantité dont le gain total du dispositif à effet Hall (80) varie dans le sens de polarité particulier en fonction d'une augmentation donnée de température est supérieure à la quantité dont le gain total du dispositif à effet Hall (80) changerait dans le sens de polarité particulier en fonction de l'augmentation donnée de température si le circuit de commande de gain variable avec la température (22) ne modifiait pas le gain total du dispositif à effet Hall (80) en fonction de conditions de température variables.

9. Dispositif à effet Hall (80) selon la revendication 8, dans lequel le circuit de commande de gain variable avec la température (22) est agencé de sorte que, lorsque le premier composant (R3) est couplé entre les deux noeuds (P2, P3) et que la caractéristique du premier composant (R3) a une seconde valeur, la quantité dont le gain total du dispositif à effet Hall (80) varie dans le sens de polarité particulier en fonction de l'augmentation donnée de température est inférieure à la quantité dont le gain total du dispositif à effet Hall (80) changerait dans le sens de polarité particulier en fonction de l'augmentation donnée de température si le circuit de commande de gain variable avec la température (22) ne modifiait pas le gain total du dispositif à effet Hall (80) en fonction de conditions de température variables.

10. Dispositif à effet Hall (80) selon l'une quelconque des revendications 1 à 9, dans lequel :

l'élément à effet Hall (20) est monté dans un boîtier de circuit intégré ; et
les deux noeuds (P2, P3) comprennent deux bornes sortant du boîtier de circuit intégré de sorte que le premier composant (R3) puisse être relié entre les deux bornes à un emplacement extérieur au boîtier.

11. Dispositif à effet Hall (80) selon l'une quelconque des revendications 1 à 10, comprenant en outre au moins un second composant (TF1, TF2) couplé au circuit de commande de gain variable avec la température (22), une caractéristique dudit au moins un second composant (TF1, TF2) étant ajustable pour sélectionner la température de référence à laquelle un changement de la caractéristique du seul premier composant (R3) ne modifie pas sensiblement le gain total du dispositif à effet Hall.

12. Dispositif à effet Hall (80) selon la revendication 2, dans lequel la source de signal variable avec la température (42, 46) est agencée de sorte que, lorsque le premier composant (R3) est relié entre les deux noeuds (P2, P3) et que la caractéristique du premier composant (R3) a une première valeur, l'amplitude du signal de polarisation augmente quand la température augmente, et lorsque le premier composant (R3) est relié entre les deux noeuds (P2, P3) et que la caractéristique du premier composant (R3) a une seconde valeur, le signal de polarisation diminue lorsque la température augmente.

13. Dispositif à effet Hall (80) selon la revendication 2, dans lequel la source de signal variable avec la température (42, 46) comprend une source de courant (46) qui fournit un courant de polarisation en tant que signal de polarisation à l'élément à effet Hall (20).

14. Dispositif à effet Hall (80) selon la revendication 5, dans lequel :

le circuit de commande de gain variable avec la température (22) comprend un amplificateur inverseur (86) qui inverse une tension dépendant de la température non inversée pour créer une tension dépendant de la température inversée ; et
le diviseur de potentiel (R1, R2, R3) est couplé entre un premier noeud (88) qui est porté à la tension dépendant de la température non inversée et un second noeud qui est porté à la tension dépendant de la température inversée.

15. Dispositif à effet Hall (80) selon l'une quelconque des revendications 1 à 14, en combinaison avec le premier composant (R3).

16. Dispositif à effet Hall (80) selon l'une quelconque des revendications 1 à 15, dans lequel le circuit de commande de gain variable avec la température (22) comprend une source de tension dépendant de la température (74), un circuit de réglage de gain commandé en tension (46), et un diviseur de tension (R1, R2, R3) ayant au moins un premier noeud (88) couplé à la source de tension (74) pour en recevoir une tension dépendant de la température et un second noeud (72) relié au circuit de réglage de gain (46) pour lui fournir une tension de commande, le diviseur de tension (R1, R2, R3) comprenant le premier composant (R3) et étant agencé de sorte que le fait d'ajuster la caractéristique du seul premier composant (R3) modifie un rapport de valeurs de composants du diviseur de tension (R1, R2, R3) afin de modifier la tension sur le second noeud (72).

17. Procédé de compensation des effets de variations de température sur un élément à effet Hall (20), comprenant les étapes suivantes :

(a) prévoir un dispositif à effet Hall (80) comprenant un élément à effet Hall (20) et un circuit de commande de gain variable avec la température (22) relié à l'élément à effet Hall (20) pour ajuster la sensibilité du gain du dispositif à effet Hall (80) aux variations de température ;
caractérisé en ce qu'il comprend en outre :
(b) coupler un premier composant (R3) entre deux noeuds (P2, P3) du circuit de commande de gain variable avec la température (22) pour régler la sensibilité du gain du dispositif à effet Hall (80) aux variations de température ; et
(c) modifier une caractéristique du seul premier composant (R3) pour ajuster la sensibilité du gain du dispositif à effet Hall (80) aux variations de température sans modifier sensiblement le gain du dispositif à effet Hall (80) lorsque le dispositif à effet Hall (80) est maintenu à une température de référence.

18. Procédé selon la revendication 17, dans lequel :

l'étape (a) comprend une étape consistant à prévoir une source de signal variable avec la température (42, 46) en tant que circuit de commande de gain variable avec la température (22), la source de signal variable avec la température (42, 46) étant couplée à l'élément à effet Hall (20) pour fournir un signal de polarisation à au moins une entrée (34, 36, 38, 40) de l'élément à effet Hall de sorte que l'amplitude du signal de polarisation varie en fonction des variations de température ; et

l'étape (b) comprend une étape (b1) consistant à coupler le premier composant (R3) entre les deux noeuds (P2, P3) pour régler la sensibilité de la source de signal variable avec la température (42, 46) aux variations de température ; et

l'étape (c) comprend une étape consistant à modifier la caractéristique du seul premier composant (R3) pour ajuster la quantité dont l'amplitude du signal de polarisation varie en fonction d'une variation donnée de température sans modifier sensiblement l'amplitude du signal de polarisation lorsque le dispositif à effet Hall (80) est maintenu à la température de référence.

19. Procédé selon la revendication 17 ou 18, dans lequel le dispositif à effet Hall (80) est inclus dans un circuit intégré, et dans lequel l'étape (b) comprend une étape consistant à coupler le premier composant (R3) entre deux bornes externes (P2, P3) du circuit intégré pour régler la sensibilité du gain du dispositif à effet Hall (80) aux variations de température.

20. Procédé selon l'une quelconque des revendications 17 à 19, comprenant en outre une étape consistant à ajuster la température de référence.

21. Dispositif à effet Hall (80) selon les revendications 8 à 10, dans lequel la source de signal variable avec la température (42, 46) comprend :

une source de courant commandable (46), comportant une entrée de commande (72), qui fournit un courant de polarisation en tant que signal de polarisation à l'élément à effet Hall (20), et

une source de signal sensible à la température (42) reliée à la source de courant (46) pour fournir à l'entrée de commande (72) de la source de courant commandable (46) un signal de commande dépendant de la température, la source de signal sensible à la température (42) étant agencée de sorte que, lorsque le premier composant (R3) est relié entre les deux noeuds (P2, P3), l'amplitude du signal de commande dépendant de la température est amenée à varier quand la température du dispositif à effet Hall (80) varie, amenant ainsi l'amplitude du courant de polarisation à varier lorsque la température du dispositif à effet Hall (80) varie.

22. Dispositif à effet Hall (80) selon la revendication 21, dans lequel :

la source de courant commandable (46) comprend une source de courant commandée en tension, et

la source de signal sensible à la température (42) comprend une source de tension sensible à la température.

23. Dispositif à effet Hall (80) selon la revendication 21, dans lequel :

la source de signal variable avec la température (22) comprend une source de courant (46) qui fournit un courant de polarisation en tant que signal de polarisation (I) à l'élément à effet Hall (20) ; et

la source de signal variable avec la température (42) est agencée de sorte que, lorsque le premier composant (R3) est relié entre les deux noeuds (P2, P3), l'amplitude du courant de polarisation est amenée à varier lorsque la température varie.

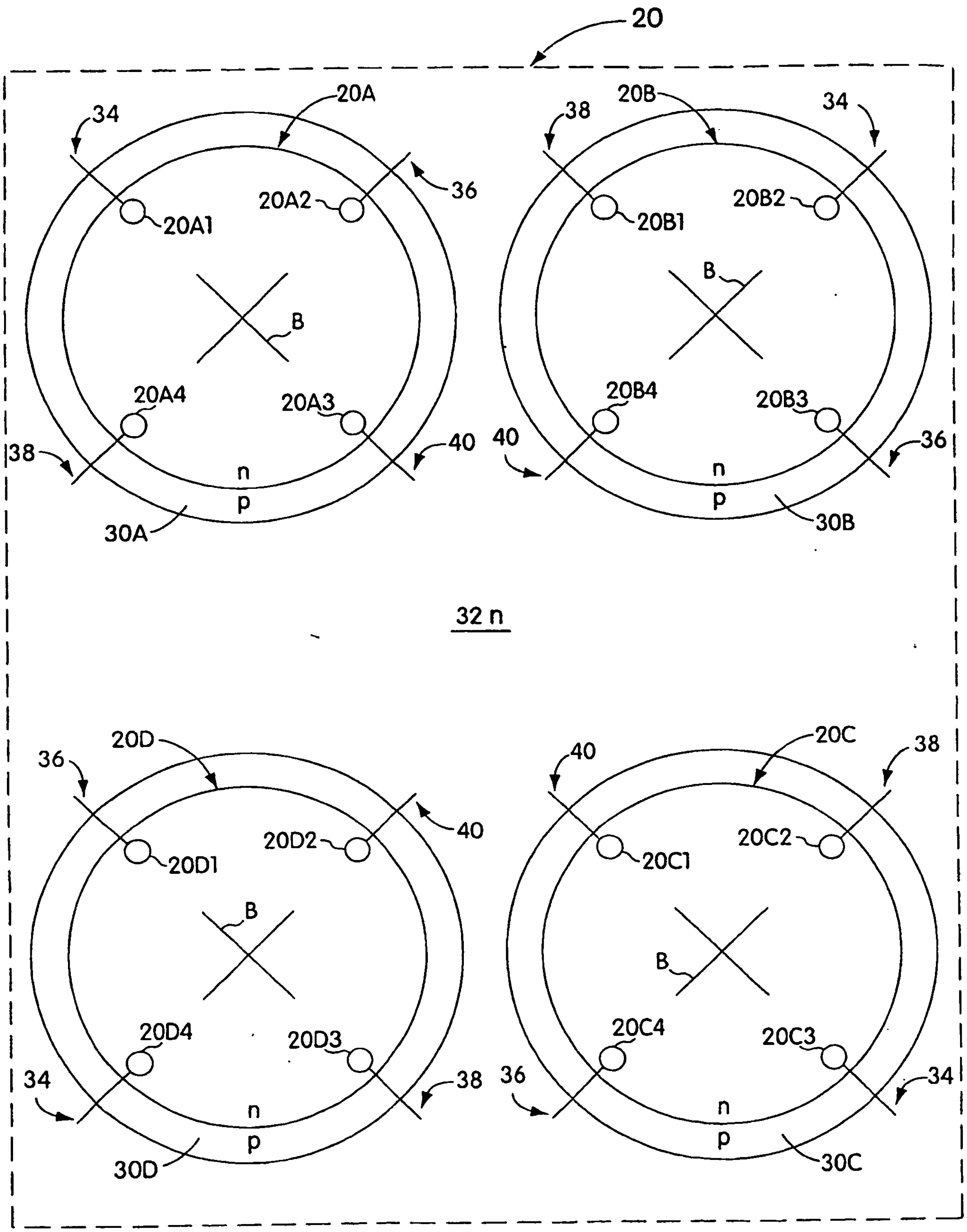
24. Dispositif à effet Hall (80) selon l'une quelconque des revendications 21 à 23, dans lequel :

le circuit de commande de gain variable avec la température (22) comprend un amplificateur inverseur (86) qui inverse une tension dépendant de la température non inversée pour créer une tension dépendant de la température inversée ;

le premier composant (R3) comprend une résistance ; et

le circuit de commande de gain variable avec la température (22) est agencé de sorte que, lorsque la résistance (R3) est reliée entre les deux noeuds (P2, P3), la résistance (R3) est incluse dans un diviseur de tension (R1, R2, R3) couplé entre un premier noeud (88) porté à la tension dépendant de la température non inversée et un second noeud porté à la tension dépendant de la température inversée, la sensibilité du gain total du dispositif à effet Hall (80) étant ajustée en fonction d'une tension à un noeud (72) du diviseur de tension.

25. Dispositif à effet Hall (80) selon l'une quelconque des revendications 21 à 24, dans lequel le circuit de commande de gain variable avec la température (22) comprend une source de tension dépendant de la température (74), un circuit de réglage de gain commandé en tension (46), et un diviseur de tension (R1, R2, R3) ayant au moins un premier noeud (88) relié à la source de tension (74) pour en recevoir une tension dépendant de la température et un second noeud (72) relié au circuit de réglage de gain (46) pour lui fournir une tension de commande, le diviseur de tension (R1, R2, R3) comprenant le premier composant (R3) et étant agencé de sorte que le fait d'ajuster la caractéristique du seul premier composant (R3) modifie un rapport de valeurs de composant du diviseur de tension (R1, R2, R3) afin de modifier la tension sur le second noeud (72).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20B2
B
20B4
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40
20D1
20D2
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20D4
20D3
34
38
n
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n
p
30C

Fig. 1

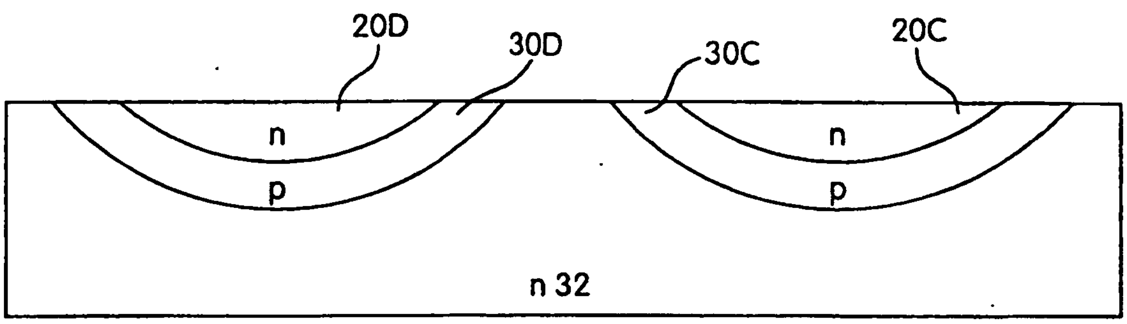
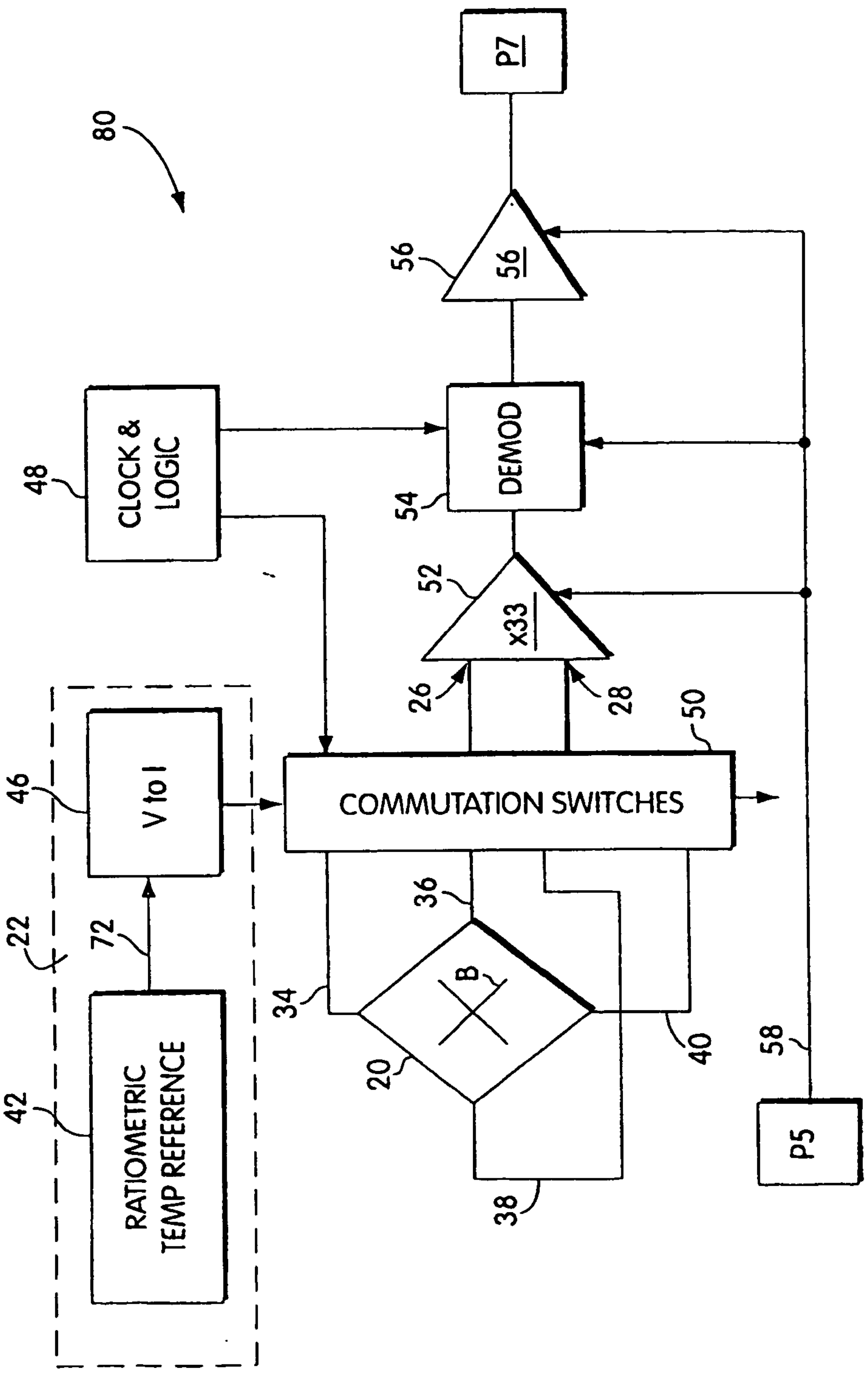


Fig. 2


80
P7
56
56
CLOCK & LOGIC
48
DEMOD
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52
x33
26
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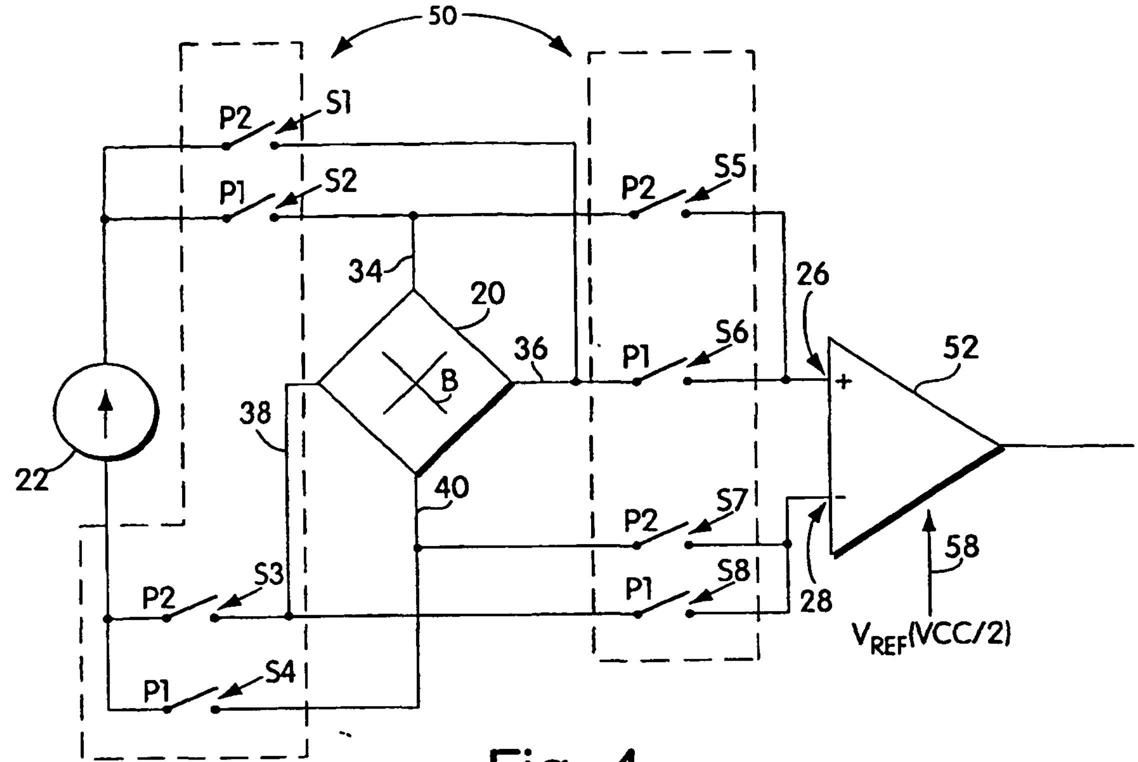
46
V to I
COMMUTATION SWITCHES
22
72
36
B
34
42
RATIOMETRIC TEMP REFERENCE
20
40
58
P5
38

Fig.3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P2
S1
P1
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P2
S5
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20
26
36
P1
S6
52
B
38
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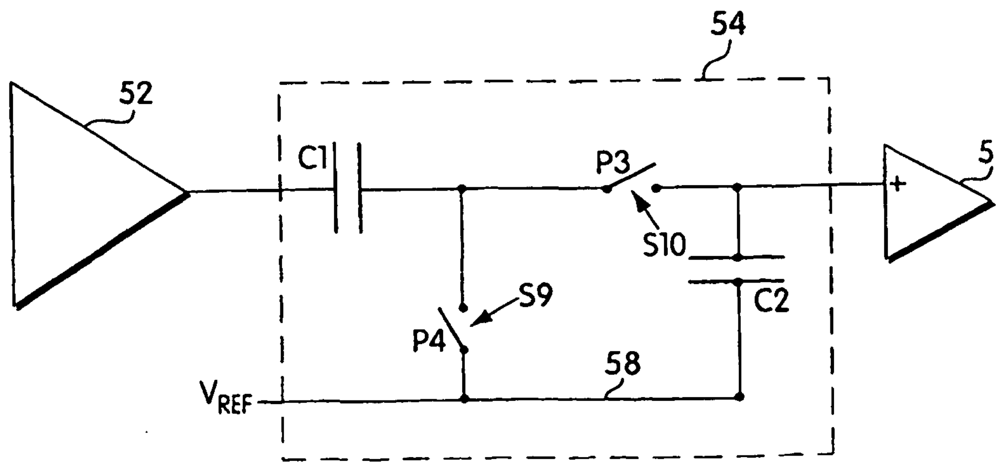
40
P2
S7
58
P2
S3
P1
S8
28
V_{REF}(VCC/2)
P1
S4

Fig. 4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C2
P4
V_{REF}
58

Fig. 5

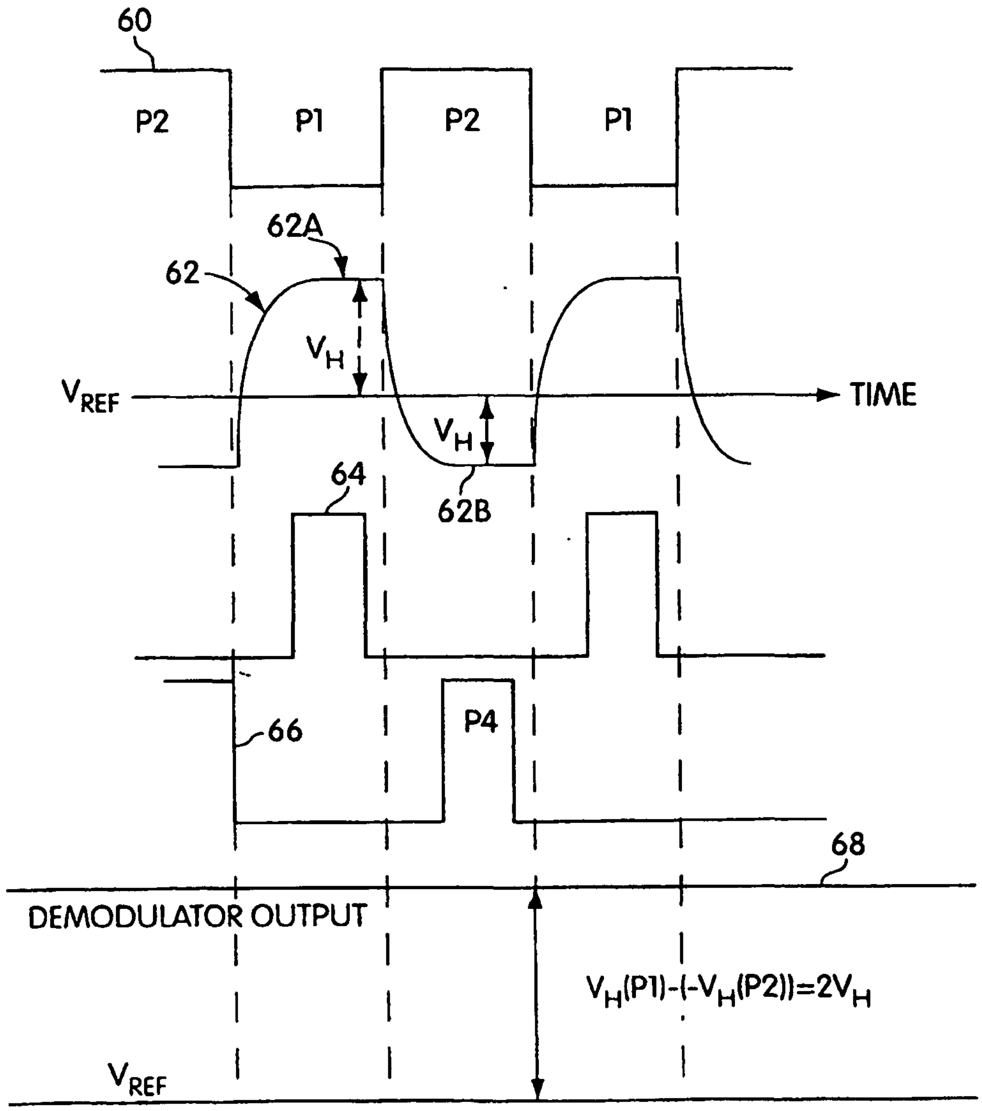
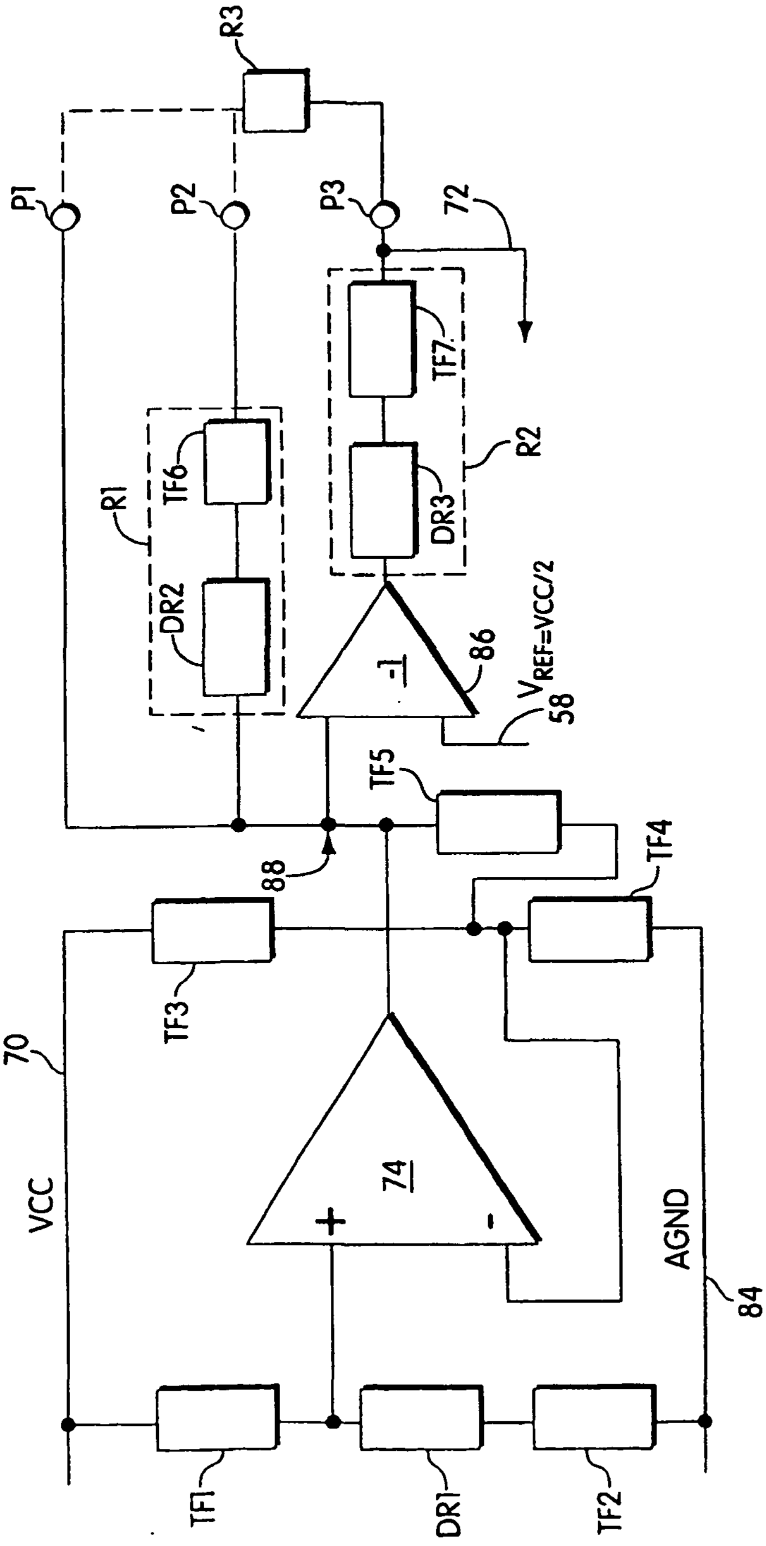

60
P2
P1
P2
P1
62A
62
V_H
V_{REF}
TIME
V_H
64
62B
P4
66
68
DEMODULATOR OUTPUT
$V_H(P1)-(-V_H(P2))=2V_H$
V_{REF}

Fig. 6



R3
P1
P2
P3
72
R1
TF6
DR2
TF7
DR3
R2
-1
86
VREF=VCC/2
58
TF5
88
TF4
TF3
70
VCC
74
+
-
AGND
84
TF1
DR1
TF2

Fig. 7

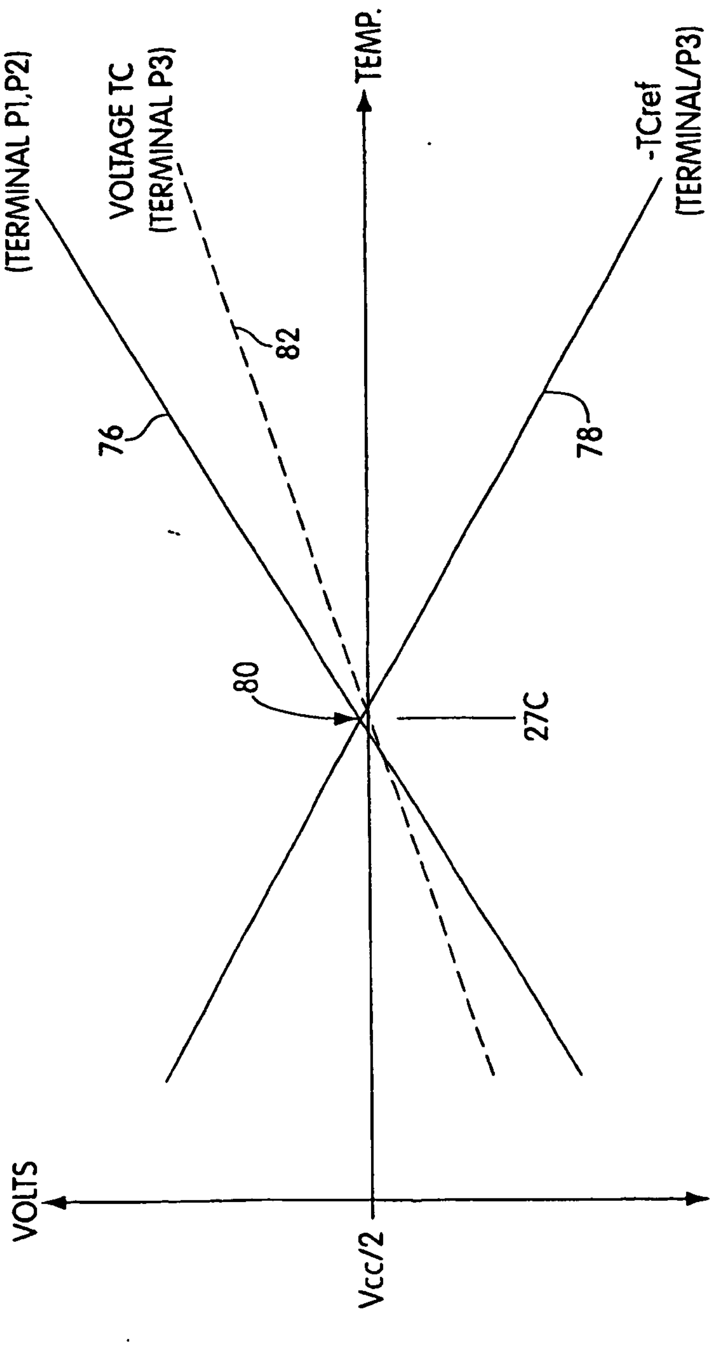

+ TCref
(TERMINAL P1,P2)
VOLTAGE TC
(TERMINAL P3)
TEMP.
-TCref
(TERMINAL/P3)
82
76
78
80
27C
VOLTS
Vcc/2

Fig. 8

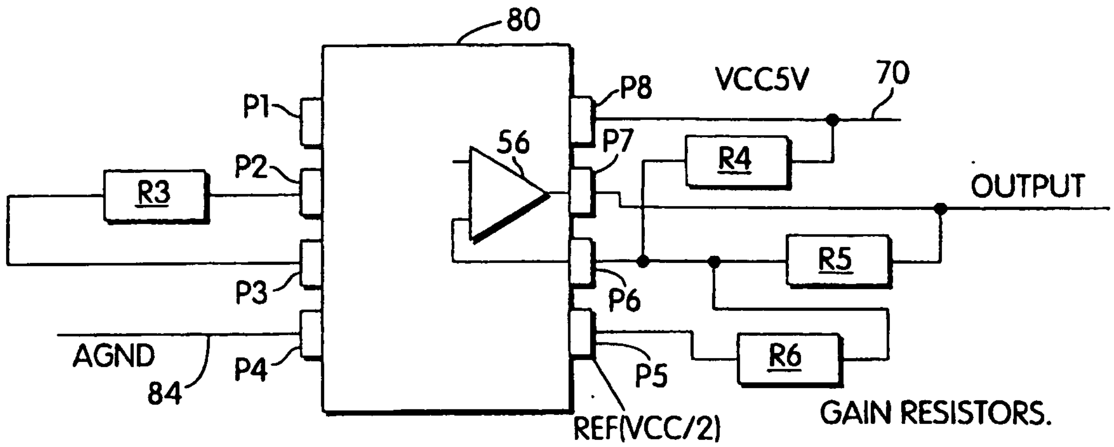


Fig. 9

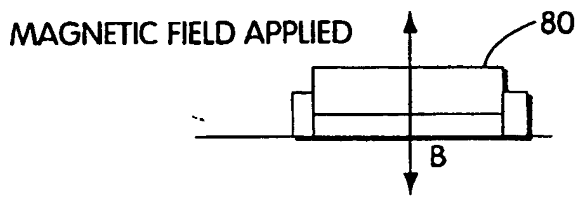


Fig. 10

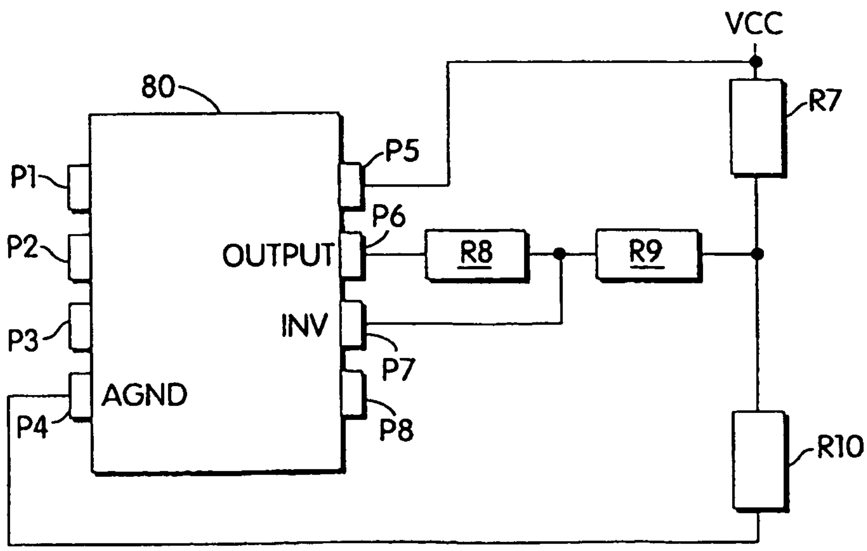


Fig. 11