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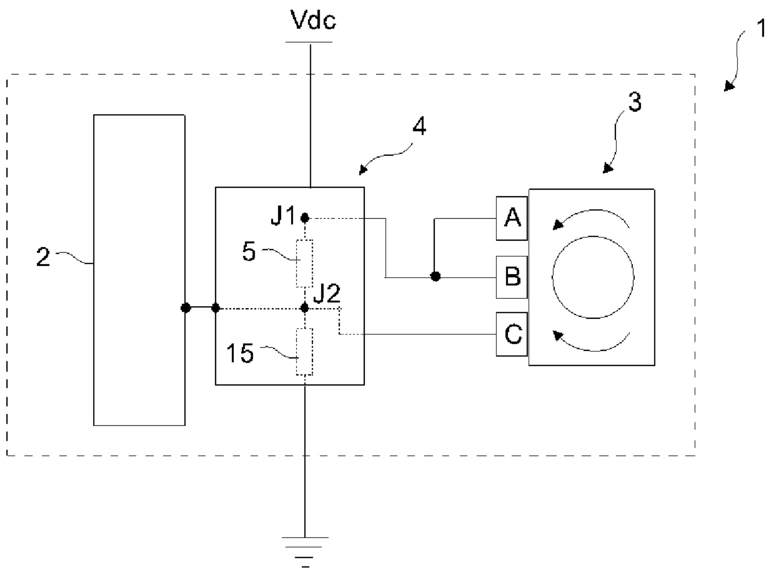
(54) **Title:** A ROTARY ENCODER CONTROL CIRCUIT



(57) **Abstract:** The control circuit (1) of the present invention comprises a microprocessor (2), a rotary encoder (3) and a readout circuit (4).

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Description

A ROTARY ENCODER CONTROL CIRCUIT

[001] The present invention relates to a rotary encoder control circuit in which faulty reading is prevented.

[002] The rotary encoders produce output signals in form of pulsing waves and are used in measuring position, speed and distance. The rotary encoders are preferred in electronic systems such as radio/tapes, music sets especially because of their soft rotating feel and low cost.

[003] In state of the art, the rotary encoders (3) have three output terminals named A, B and C. Of these, A and B output terminals are connected to the microprocessor (2) and are utilized as data transmittal terminals for the microprocessor (2), and the C terminal is utilized as a common terminal (Figure 1). The rotary encoder (3) is connected to the microprocessor (2) so that one of its terminals is used as an interrupt terminal. There is a definite phase difference between the output signals received from the data transmission terminals (A and B) of the rotary encoder (3). Generally the signal received from the other data transmission terminal B is evaluated at the rising edge or the falling edge of the output signal received form preferably the output terminal A for detecting the direction of the rotation. When the rotary encoder (3) rotates in one direction, the falling edge of the signal received from A output terminal is at the front, and when it rotates in the opposite direction, the falling edge of the signal received from B output terminal is at the front. If the signal received from B output terminal is “1”, it means that the rotary encoder (3) is rotating in one direction, if it is “0” then it is rotating in the opposite direction (Figure 2).

[004] When the rotary encoder (3) is utilized in this manner, both of the data transmission terminals (A and B) are connected to the microprocessor (2), two terminals are used from the microprocessor (2) and the rotating direction of the rotary encoder (2) can be detected inaccurately as a result of the delays in the operation of the microprocessor (2). If this delay is less than the time difference between the falling edge of the signal received from output terminal A and the falling edge of the signal received simultaneously from output terminal B, then the rotation direction of the rotary encoder (3) can be detected accurately. When this time difference is greater, then the rotation direction of the rotary encoder (3) is detected erroneously and can result in doing just the opposite of the process that should be carried out. The interrupt terminal of the microprocessor (2) is especially utilized to prevent this delay. When the interrupt terminal of the microprocessor (2) is utilized, the microprocessor (2) slows down each time the rotary encoder (3) rotates since the interrupt terminal is active and the inaccurate detection of the rotation direction is encountered depending on the duration of the

other interrupting routines.

[005] In the state-of-the-art United States of America Patent no. US5276722, an absolute multi-revolution encoder having precision and high resolution is described .

[006] The object of the present invention is to design a rotary encoder control circuit in which inaccurate reading is prevented.

[007] The rotary encoder control circuit designed to fulfill the object of the present invention is shown in the attached figures, where:

[008] Figure 1 – is the schematic view of a state-of-the-art rotary encoder control circuit.

[009] Figure 2 – is the variation / time graph of the output signals derived from A and B output terminals of the state-of-the-art rotary encoder when the rotary encoder rotates clockwise and counterclockwise.

[010] Figure 3 – is the schematic view of a rotary encoder control circuit.

[011] Figure 4 – is the variation / time graph of the output signal derived at the readout circuit when the control circuit and the rotary encoder is rotated in one direction, clockwise for example

[012] Figure 5 – is the variation / time graph of the output signal derived at the readout circuit when the control circuit and the rotary encoder is rotated in one direction, counterclockwise for example

[013] Figure 6 – is the variation / time graph of the output signal derived at the readout circuit when the control circuit and the rotary encoder is rotated in one direction, clockwise for example in an alternative embodiment of the present invention.

[014] Figure 7 – is the variation / time graph of the output signal derived at the readout circuit when the control circuit and the rotary encoder is rotated in one direction, counterclockwise for example in an alternative embodiment of the present invention.

[015] Elements shown in the figures are numbered as follows:

1. Control circuit
2. Microprocessor
3. Rotary encoder
4. Readout circuit
5. , 15. Impedance circuit

[016] The control circuit (1) of the present invention comprises a microprocessor (2), a rotary encoder (3) and a readout circuit (4) which converts the signals received from the rotary encoder (3) into analog signals, converting the clockwise and counterclockwise rotation movements into completely different output signals and prevents the rotary encoder (3) from making inaccurate reading.

[017] The rotary encoder (3) comprises an outer case, a shaft connected to this case, rotating in its own axis and at least three terminals (A, B, C) composing the output terminals. Preferably two of these terminals are used as data transmission terminals (A

and B), and one (C) is used as the common terminal.

[018] In the control circuit (1) of the present invention, the output terminals (A, B, C) of the rotary encoder (3) act as two switching circuits where one terminal is jointly connected and there is a certain phase difference in between their opening / closing periods.

[019] The readout circuit (4) comprises two impedance circuits (5 and 15), chosen with compatible values and connected in series to each other, one of which is earthed. The single terminal made by connecting two data transmission terminals (A and B) of the rotary encoder (3) is connected to the first impedance circuit (5) which is not earthed at point J1, and the common terminal C is connected at point J2 where two impedance circuits (5 and 15) are connected to each other. Consequently two terminals enter the readout circuit (4) from the rotary encoder (3) to be connected at points J1 and J2, one terminal leaves from point J2 by way of the readout circuit (4) to the microprocessor (2). Consequently since one of the two terminals reserved previously for the rotary encoder (3) in the microprocessor (2) is left idle, the microprocessor (2) is allowed to use this idle terminal for carrying out another process (Figure 3).

[020] The output signal received from the two data transmission terminals (A and B) is in minimum voltage level (V_{min}) since there isn't any generation of signals when the rotary encoder (3) is not rotated. The output signal received from the data transmission terminals (A and B) reaches a maximum voltage level (V_{max}) when the rotary encoder (3) is rotated by the user. The output signal received from data transmission terminals (A and B) with a certain phase difference, reaches an intermediate voltage value (V_{int}) which is lower than the maximum voltage value (V_{max}) with the effect of the impedance circuit (5) between points J1 and J2. The output signal produced from the data transmission terminals (A and B) falls back to the initial minimum voltage level (V_{min}) since no signal is produced when the rotation of the rotary encoder (3) is completed. The clockwise and the counterclockwise rotation movement of the rotary encoder (3) is converted into analog signals as different sequences of three different voltage levels by utilizing the readout circuit (4). If intermediate voltage value (V_{int}) is followed by the maximum voltage value (V_{max}) then it is detected that the rotary encoder (3) is rotating in one direction, if maximum voltage value (V_{max}) is followed by the intermediate voltage value (V_{int}) then rotation is in the opposite direction (Figure 4 and Figure 5).

[021] The analog input port of the microprocessor (2) can function both in analog and digital modes. Analog reading always takes longer than the numerical readings and delays the operation of the microprocessor (2). The (V_{max}) (V_{int}) voltage values, the values of the impedance circuits (5, 15) are chosen in accordance where each is defined by one voltage value and the numerical signals (0 and 1) produced at two

different positions are aligned with corresponding voltage values logic low V_{l-l} and V_{l-h} logic high. Until the "1" level is read numerically at the microprocessor (2) input, that is, the rotary encoder (3) is rotated and the analog input signals (V_{max}) or (V_{int}) voltage values are read, numerical signal reading is done instead of analog reading and therefore the analog signal reading duration of the microprocessor (2) is reduced resulting in a faster operation.

[022] Each of these three different voltage levels (V_{max}, $V_{int\ and}$ V_{min}) can easily be discriminated if the sampling rate of the microprocessor (2) is adequate. When sampling is delayed, since either the V_{max} - V_{min} or the V_{int} - V_{min} crossings or the Vmax, Vint voltage values where voltage values do not change will be read depending on the rotation direction of the rotary encoder (3), inaccurate detection of the rotation direction of the rotary encoder (3) will be out of the question and the ongoing process will continue. In an alternative embodiment of the present invention, feeding is made in opposite direction, that is, power source and the grounding is inverted (Figure 6 and Figure 7).

[023] Numerical signals are converted into analog signals by using the readout circuit (4), clockwise and counterclockwise rotation movements are converted into completely independent wave forms and the analog signal readout duration of the microprocessor is reduced enabling faster operation.

Claims

[001] A control circuit (1) comprising a microprocessor (2) and a rotary encoder (3) having at least three output terminals (A, B, C) and characterized by a readout circuit (4) situated between the rotary encoder (3) and the microprocessor (2) , which prevents the rotary encoder (3) from taking inaccurate reading by converting the numerical signals received from the rotary encoder (3) into analog signals, and the clockwise and counterclockwise rotations into entirely independent output signals.

[002] A control circuit (1) characterized by a readout circuit (4) comprising two impedance circuits (5 and 15) connected in series to each other, one of which is earthed.

[003] A control circuit (1) characterized by a readout circuit (4) where the terminal obtained by connecting two data transmission terminals (A and B) of the rotary encoder (3) is connected to the first impedance circuit (5) which is not earthed at point J1, and the common terminal C is connected at point J2 where two impedance circuits (5 and 15) are connected to each other.

[004] A control circuit (1) characterized by a readout circuit (4) comprising a single terminal that enters into the microprocessor (2).from point J2.

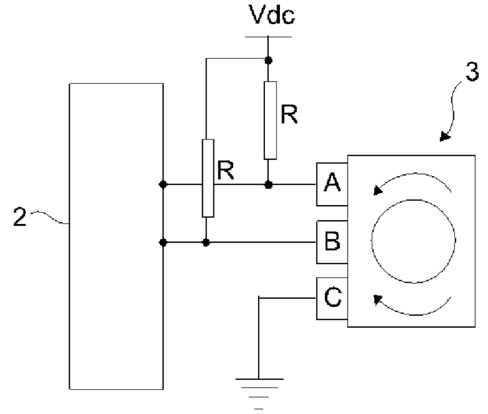
[005] A control circuit (1) as in Claim 2, characterized by a readout circuit (4) which provides the output signal received from the data transmission terminals (A and B) to reach maximum voltage level (V_{max}) when the rotary encoder (3) is rotated, to reach an intermediate voltage value (V_{int}) which is lower than the maximum voltage value (V_{max}) with the effect of the impedance circuit (5) between points J1 and J2 and provides the output signal received from the data transmission terminals (A and B) to fall back to the initial minimum voltage level (V_{min}) when the rotation of the rotary encoder (3) is completed and converts the clockwise and the counterclockwise rotation movement of the rotary encoder (3) into analog signals as different sequences of three different voltage levels.

[006] A control circuit (1) as in Claim 3, characterized by a readout circuit (4) which determines that the rotary encoder (3) is rotating in one direction if intermediate voltage value (V_{int}) is reached following the maximum voltage value (V_{max}) and that the rotary encoder (3) is rotating in the opposite direction if maximum voltage value (V_{max}) is reached following the intermediate voltage value (V_{int}) .

[007] A control circuit (1) as in Claim 3 or 4, characterized by a readout circuit (4) which provides the analog signal reading duration of the microprocessor (2) to be reduced by choosing the (V_{max}) (V_{int}) voltage values, the values of the impedance circuits (5, 15) in accordance where each is defined by one voltage value and the

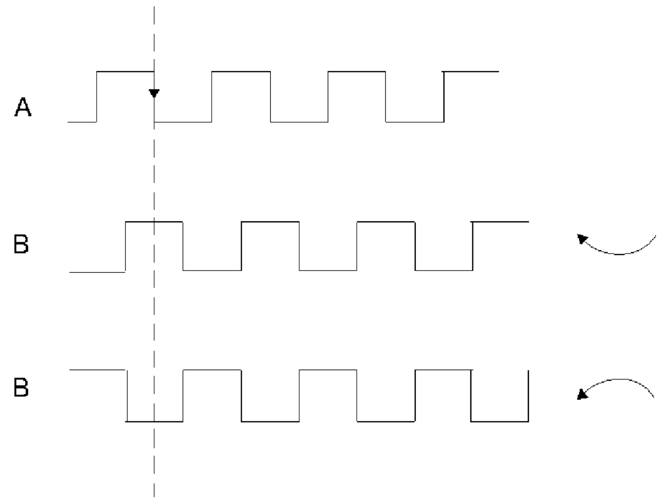
numerical signals (0 and 1) produced at two different positions are aligned with corresponding voltage values logic low V_{l-l} and V_{l-h} logic high, numerical signal reading is done instead of analog until the rotary encoder (3) is rotated and the analog input signals (V_{max}) or (V_{int}) voltage values are read.

[Fig. 001]



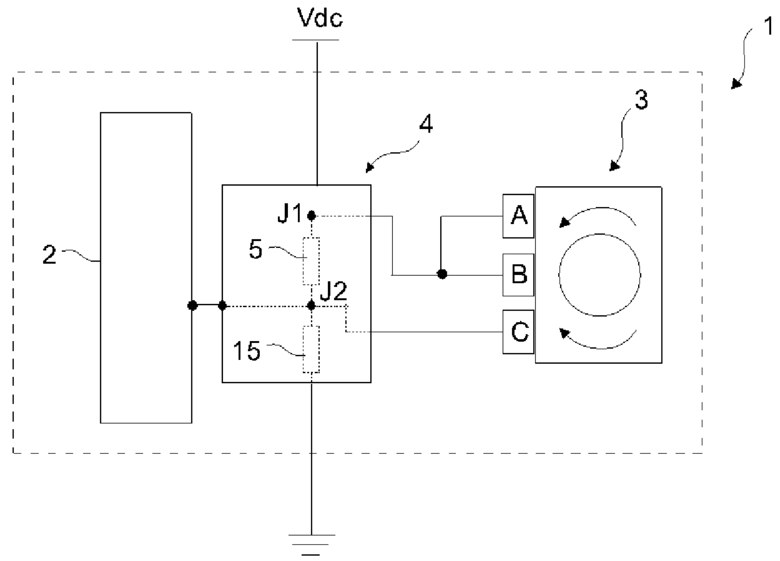
PRIOR ART

[Fig. 002]

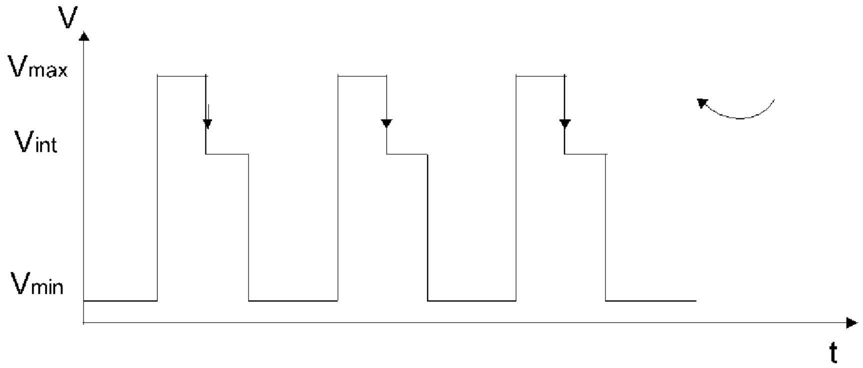


PRIOR ART

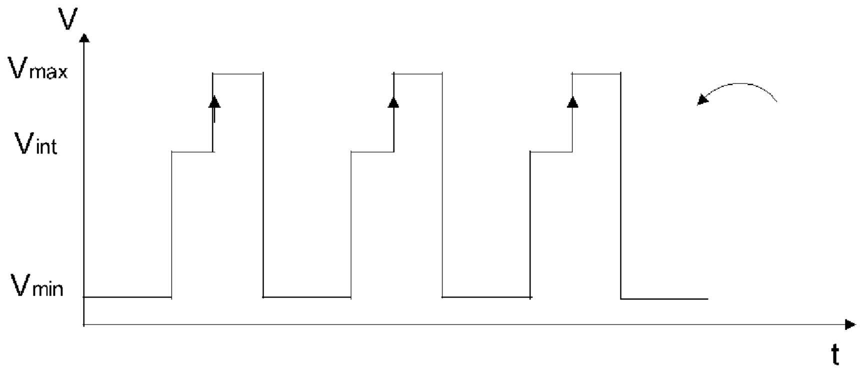
[Fig. 003]



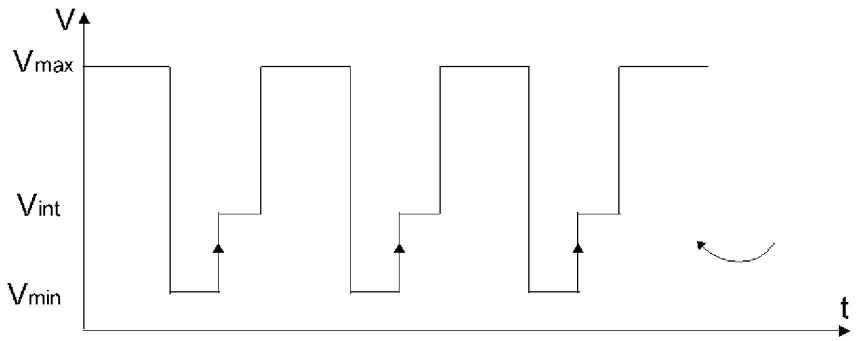
[Fig. 004]



[Fig. 005]



[Fig. 006]



[Fig. 007]