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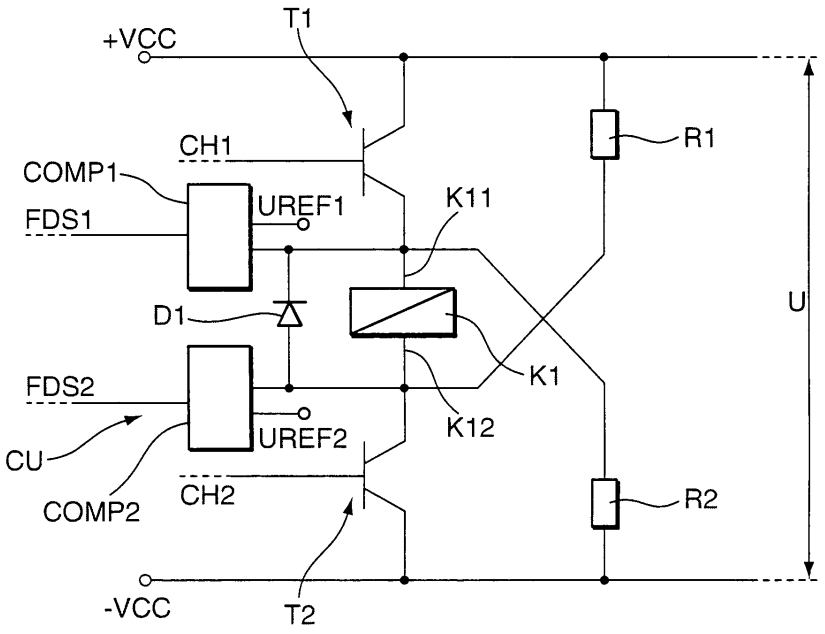
(54) Relay switching-on circuit

(57) Disclosed is a relay switching-on circuit, comprising: a relay (K1) having a first terminal (K11) and a second terminal (K12); a first switching element (T1) connected between the first terminal and a first operating voltage (+VCC); a second switching element (T2) connected between the second terminal and a second operating voltage (-VCC), wherein said first and second switching elements are operatively connected with a respective control channel (CH1, CH2) for controlling a respective switching action of said switching elements. The proposed circuit further comprises: a first resistor (R1) connected between said first operating voltage and one of said first and second terminals; a second resistor (R2) connected between said second operating voltage and the other one of said first and second terminals; and a comparator unit (CU) connected with said first and second terminals for comparing a potential at said first and second terminals with a respective reference potential (UREF1, UREF2) in a switched-off state of the relay, wherein said comparator unit is configured to issue at least one fault disclosure signal (FDS1, FDS2) in response to a relation between the potential at said first and/or second terminal and the corresponding reference potential.



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Description

Background of the invention

[0001] The present invention relates to a relay switching-on circuit, comprising: a relay having a first terminal and a second terminal; a first switching element connected between the first terminal and a first operating voltage; a second switching element connected between the second terminal and a second operating voltage, wherein said first and second switching elements are operatively connected with a respective control channel for controlling a respective switching action of said switching elements.

[0002] The above-described dual channel switching-on circuit for a relay has the disadvantage that faulty conditions of the switching elements, e.g., a short circuit, cannot be detected in a switched-off state of the relay. However, if such faults go unnoticed, e.g., if one switching element is defective, this may lead to a situation, in which the relay becomes switched on although only one of the switching elements is activated or in case the other switching element becomes defective, too.

[0003] In order to overcome this problem, use of two relays instead of only one has been disclosed. However, this leads to an increase in costs and requires more space than a single-relay circuit.

Object of the invention

[0004] It is the object of the present invention to improve a circuit of the above-described type so that a secure relay switching-on circuit can be realised with only one relay.

Summary of the invention

[0005] The object is achieved in accordance with the present invention by providing a relay switching-on circuit with the features of appended patent claim 1.

[0006] In accordance with the present invention a relay switching-on circuit, comprising: a relay having a first terminal and a second terminal; a first switching element connected between the first terminal and a first operating voltage; a second switching element connected between the second terminal and a second operating voltage; wherein said first and second switching elements are operatively connected with a respective control channel for controlling a respective switching action of said switching elements, is characterised by a first resistor connected between said first operating voltage and one of said first and second terminals; a second resistor connected between said second operating voltage and the other one of said first and second terminals; and a comparator unit connected with said first and second terminals for comparing a potential at said first and second terminals with a respective reference potential in a switched-off state of the relay, wherein said comparator unit is configured to issue at least one fault disclosure signal in response to a relation between the potential at said first and/or second terminal and the corresponding reference potential.

[0007] In this way, in a switched-off state of the relay the potential or a voltage at both terminals of the relay is monitored by means of the comparator unit, which may comprise two separate comparators, one for each terminal of the relay. If any one of the switching elements displays a faulty condition, the monitored voltage (or voltages) will differ from a state in which the switching elements do not display said faulty condition. If said difference or differences exceed a certain predetermined amount, this can be interpreted as a fault, and a corresponding fault disclosure signal can be issued to initiate a suitable security reaction.

[0008] As will be appreciated by a person skilled in the art, the above-mentioned voltage difference or differences will only occur if any one of said switching elements displays said faulty condition, e.g. a short circuit.

[0009] In an embodiment of the circuit in accordance with the present invention at least one of said switching elements can be devised as a transistor, e.g. a bipolar transistor. However, the present invention is not limited to such a configuration of the relay switching-on circuit. As will be appreciated by person skilled in the art, any other suitable switching element for controlling relay operation could be used instead.

[0010] In yet another embodiment of the circuit in accordance with the present invention said first resistor is connected between said first operating voltage and said second terminal, and said second resistor is connected between said second operating voltage and said first terminal.

[0011] In this way, in a switched-off state of the relay a small negative current (negative with respect to the usual direction of current flow during operation of the relay) will flow through the relay, thus ensuring a secure switching-off behaviour of the relay.

[0012] The first and second resistances may have the same resistance value. However, the present invention is not limited to such an embodiment, provided that the reference potentials of the comparator unit are adapted accordingly.

[0013] Advantageously, a respective resistance of the first and second resistors is chosen so that a respective operating current through said first and second resistors is lower than a relay operating current through the relay in a switched-on state of the relay in order to ensure secure switching-off of the relay. For example, the resistances of first and second resistors may be chosen so that said operating current through said first and second resistors is lower than said relay operating current by a factor of 50 to 200, preferably 100.

[0014] Further advantages and characteristics of the present invention can be gathered from the following description of preferred embodiments given by way of example only with reference to the enclosed drawings. Fea-

tures mentioned above as well as below can be used in accordance with the present invention either individually or in conjunction. The following description is not to be regarded as an exhaustive enumeration but rather as examples with respect to a general concept underlying the present invention.

Short description of the drawing

[0015] The only figure shows a circuit diagram of a relay switching-on circuit in accordance with an embodiment of the present invention.

Detailed description

[0016] The figure shows a circuit diagram of a relay switching-on circuit in accordance with an embodiment of the present invention. The relay switching-on circuit comprises a relay K1 having a first terminal K11 and a second terminal K12. A first switching element in form of but not limited to a bipolar transistor T1 is connected between the first terminal K11 of the relay K1 and a first operating voltage +VCC. Similarly, a second switching element in the form of a bipolar transistor T2 is connected between the second terminal K12 of the relay K1 and a second operating voltage -VCC which - in the present exemplary embodiment - has the same absolute-valued magnitude as the first operating voltage +VCC. The transistors T1, T2 are operatively connected with a respective control channel CH1, CH2 by means of their respective gate terminals. In this way, a respective switching action of the transistors T1, T2 can be controlled by means of control signals on said control channels CH 1, CH2.

[0017] As known to a person skilled in the art, simultaneously switching on the transistors T1, T2 by means of corresponding control signals on control channels CH1, CH2 will result in an activation of relay K1. In order to limit a voltage peak when switching off relay K1 the relay switching-on circuit further comprises a diode D1 connected in parallel with relay K1.

[0018] With the relay switching-on circuit described so far, it is not possible to detect a fault of any one of transistors T1, T2 in a switched-off state of relay K1. In order to enable fault disclosure even in the switched-off state of relay K1, the exemplary embodiment of the relay switching-on circuit in accordance with the present invention further comprises a first resistor R1 connected between the first operating voltage +VCC and one of said first and second terminals K11, K12 of relay K1, i.e., said second terminal K12 in the context of the embodiment shown. Furthermore, the exemplary relay switching-on circuit comprises a second resistor R2 connected between the second operating voltage -VCC and the other one of said first and second terminals K11, K12 of relay K1, i.e., the first terminal K11 in the context of the shown embodiment. Additionally, the exemplary relay switching-on circuit comprises a comparator unit CU including two comparators COMP1, COMP2. One input of the first comparator COMP1 is connected with the first terminal K11 of relay K1. One input of the second comparator COMP2 is connected with the second terminal K12 of relay K1. Other inputs of the first and second comparators COMP1, COMP2 are connected with corresponding reference potentials UREF1, UREF2.

[0019] In the present example, resistors R1 and R2 have identical resistance values. Said resistance values are relatively high compared with a resistance of a relay coil, preferably by a factor of approximately 100. Assuming faultless or non-defective transistors T1, T2, said resistance values are chosen so that in a switched-off state of relay K1 both first and second terminals K11, K12 "see" a voltage of approximately U/2, wherein U = +VCC - (-VCC), taking into account the relatively low resistance value of the relay coil. Said voltages or potentials at the terminals K11, K12 of relay K1 are monitored by means of the first and second comparators COMP1, COMP2. Assuming a suitably chosen reference potential UREF1, UREF2, respectively, a faulty condition of any one of transistors T1, T2 can thus be detected in a switched-off state of relay K1 by means of the corresponding comparator COMP1, COMP2. Said comparator COMP1, COMP2 then produces a corresponding fault detection signal or fault disclosure signal FDS1, FDS2, which can be used for signalling a corresponding faulty condition of any one of transistors T1. T2.

[0020] As will be appreciated by a person skilled in the art, a fault disclosure is thus achievable in a switched-off state of relay K1.

[0021] If, for example, transistor T1 is defective and experiences a short circuit, then terminal K11 will not be at U/2 in a switched-off state of relay K1. This faulty condition will be indicated by means of fault detection signal FDS1 from comparator COMP1. In this way, the faulty condition can be detected and transistor T1 can be replaced prior to complete operational failure of the relay switching-on circuit, i.e., failure of second transistor T2.

[0022] Owing to the fact that the first resistor R1, which is connected with operating voltage +VCC, is connected with the second terminal K12, i.e., the "-"-terminal of relay K1 and that the second resistor R2, which is connected with potential -VCC, is connected with the first terminal K11 of relay K1, i.e., the "+"-terminal, a small negative current flows across relay K1 in its switched-off state. This small negative current achieves a secure switching-off action of relay K1.

[0023] Otherwise, i.e., with first resistor R1 connected with first terminal K11 and second resistor R2 connected with second terminal K12 (alternative configuration; not depicted in the figure), a small positive current would flow in the same direction as for switching on relay K1, so that relay K1 could switch off in a delayed fashion, or may not switch off at all. However, as will be appreciated by a person skilled in the art, in the alternative configuration resistances R1 and R2 would still enable detecting a faulty condition of any one of switching elements T1, T2.

[0024] As will further be appreciated by a person skilled

in the art, first and second resistors R1, R2 can be neglected when turning on transistors T1, T2. In other words: They have no negative effect on the operation of the relay switching-on circuit.

[0025] As will also be appreciated by a person skilled in the art, the relay switching-on circuit described herein is not only adapted to detect short circuits of transistors T1, T2 but can be configured to detect any kind of faulty condition of switching elements used for switching on and off relay K1.

[0026] As will be appreciated by a person skilled in the art, resistance values of the first and second resistors may be chosen so that in a switched-off state of relay K1 the first and second terminals K11, K12 see different voltages U1, U2, wherein U = U1 + U2, taking into account the relatively low resistance value of the relay coil. Said voltages or potentials at terminals K11, K12 of relay K1 should then be monitored by means of the first and second comparators COMP1, COMP2 having respective suitably chosen reference potentials UREF1, UREF2 which will differ from each other in accordance with a difference in resistance between the first and second resistors.

Claims

1. A relay switching-on circuit, comprising:

a relay (K1) having a first terminal (K11) and a second terminal (K12);
a first switching element (T1) connected between the first terminal and a first operating voltage (+VCC);
a second switching element (T2) connected between the second terminal and a second operating voltage (-VCC);
wherein said first and second switching elements are operatively connected with a respective control channel (CH1, CH2) for controlling a respective switching action of said switching elements;

characterised by

a first resistor (R1) connected between said first operating voltage and one of said first and second terminals;
a second resistor (R2) connected between said second operating voltage and the other one of said first and second terminals; and
a comparator unit (CU) connected with said first and second terminals for comparing a potential at said first and second terminals with a respective reference potential (UREF1, UREF2) in a switched-off state of the relay, wherein said comparator unit is configured to issue at least one fault disclosure signal (FDS1, FDS2) in response to a relation between the potential at said first and/or second terminal and the corresponding reference potential.

2. The circuit of claim 1, **characterised in that** said comparator unit (CU) is configured to issue the at least one fault disclosure signal (FDS1, FDS2) when the potential at said first and/or second terminal (K11, K12) differs from the corresponding reference potential (UREF1, UREF2) by at least a predetermined amount.

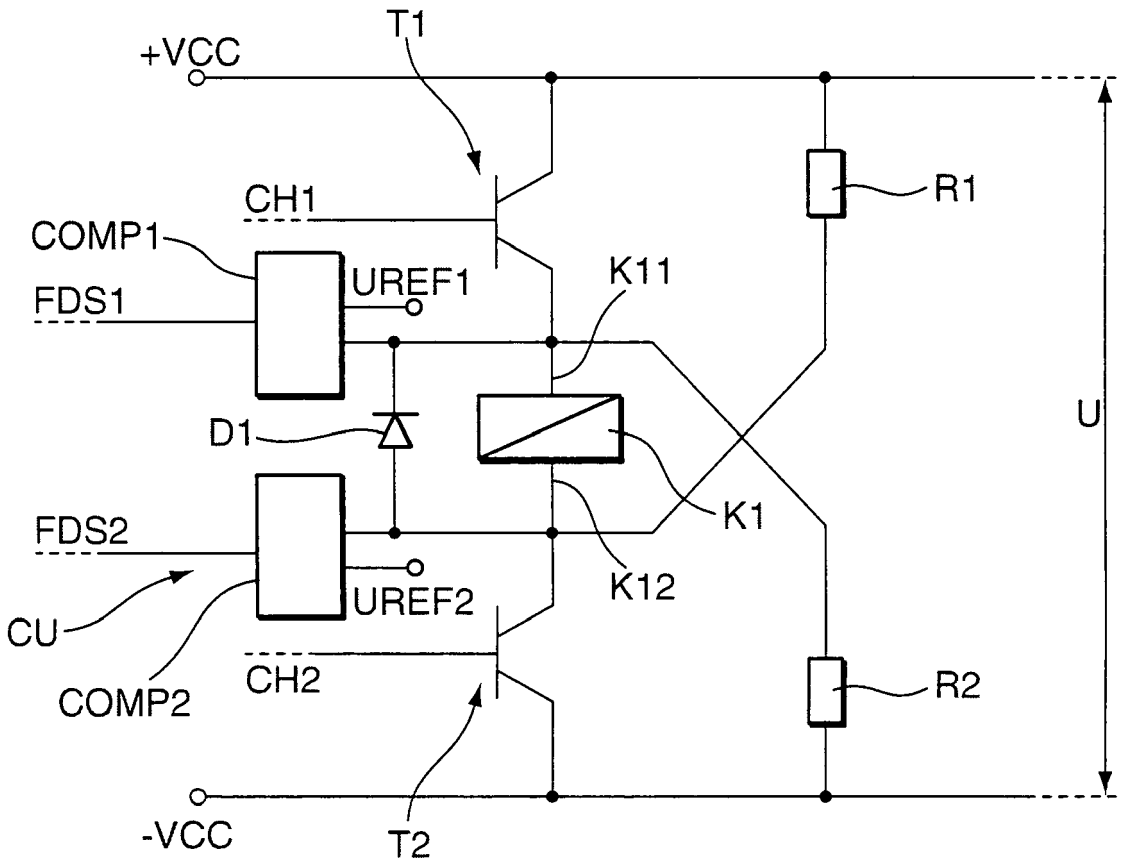
3. The circuit of claim 1, **characterised in that** said first and/or second switching element (T1, T2) is devised as a transistor.

4. The circuit of claim 1, **characterised in that** said comparator unit (CU) comprises a first comparator (COMP1) and a second comparator (COMP2), said first comparator for comparing the potential at said first terminal (K11) with the corresponding reference potential (UREF1) and for issuing a first fault disclosure signal (FDS1), and said second comparator (COMP2) for cQmpa.ring the potential at said second terminal (K12) with the corresponding reference potential (UREF2) and for issuing a second fault disclosure signal (FDS2).

5. The circuit of claim 1, **characterised in that** a respective resistance of said first and second resistors (R1, R2) is chosen so that a respective operating current through said first and second resistors is lower than a lowest relay operating current through the relay (K1) in a switched-on state of the relay to ensure secure switching-off of the relay.

6. The circuit of claim 1, **characterised in that** said first resistor (R1) is connected between said first operating voltage (+VCC) and said second terminal (K12), and **in that** said second resistor (R2) is connected between said second operating voltage (-VCC) and said first terminal (K11).

7. The circuit of claim 6, **characterised in that** a respective resistance of said first and second resistors (R1, R2) is chosen so that a small inverse current with respect to a relay operating current flows through the relay (K1) in a switched-off state of the relay.


+VCC
T1
CH1
COMP1
FDS1
UREF1
K11
R1
D1
K1
U
FDS2
K12
UREF2
CU
COMP2
CH2
R2
-VCC
T2

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EUROPEAN SEARCH REPORT

Application Number
EP 07 29 0182

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 0 478 289 A2 (HONEYWELL INC [US]) 1 April 1992 (1992-04-01) * column 6, line 9 - column 7, line 3; figure 4 *	1-7	INV. H01H47/00
A	JP 08 250000 A (MITSUBISHI ELECTRIC CORP) 27 September 1996 (1996-09-27) * abstract *	1-7	
A	GB 957 803 A (PHILIPS ELECTRICAL IND LTD) 13 May 1964 (1964-05-13) * page 1, line 74 - page 3, line 7; figure 1 *	1-7	
A	RU 2 191 467 C2 (RAJNIN VALERIJ EFIMOVICH) 20 October 2002 (2002-10-20) * page 3 *	1-7	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	27 June 2007	Drabko, Jacek

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27-06-2007

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0478289 A2	01-04-1992	CA 2052257 A1	27-03-1992
		DE 69119523 D1	20-06-1996
		DE 69119523 T2	28-11-1996
		HK 1008102 A1	30-04-1999
		JP 2683970 B2	03-12-1997
		JP 4306702 A	29-10-1992
		US 5210756 A	11-05-1993
JP 8250000 A	27-09-1996	NONE	
GB 957803 A	13-05-1964	DE 1128465 B	26-04-1962
		NL 109531 C	
		NL 241067 A	
RU 2191467 C2	20-10-2002	NONE	

EPO FORM P0459

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