(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 854 697 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
14.11.2007 Bulletin 2007/46

(51) Int Cl.:
B61L 21/04 *(2006.01)* ***B61L 27/00*** *(2006.01)*

(21) Application number: **06290777.9**

(22) Date of filing: **10.05.2006**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

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(54) **Electric assembly for monitoring the dynamic of a micro controller with a relay interface**

(57) An electrical assembly, wherein, in a first operating condition, the electrical assembly switches an input voltage (Vin) at a working input (1) onto a working output (2) if an alternating voltage is applied at a monitoring input (3), and wherein, in a second operating condition, the electrical assembly switches off the working output if no voltage or a direct voltage is applied to the monitoring input, is characterized in that the electronic assembly comprises a dynamic circuit (4), a measurement circuit (6) with a readout output (7), and a buffer circuit (5), that the dynamic circuit comprises a switching capacity (C2), which is connected to the monitoring input or an amplifier circuit (9) of the monitoring input via a serial connection of a loading diode (V2) and a loading capacity (C1), wherein a resistive component (R5, V4) is connected in parallel to the switching capacity, that the dynamic circuit further comprises a switching transistor (V7) with a first contact (11), a second contact (12) and a control contact (10), wherein the first contact is connected to the working input, and wherein the control contact is connected to the switching capacity or an amplifier circuit (13) of the switching capacity, that the measurement circuit is connected to the second contact of the switching transistor, and that the buffer circuit comprises a separating diode (V8) and a buffer capacity (C3), wherein the separating diode connects the second contact of the switching transistor with the working output, and wherein the buffer capacity is connected to the working output. The inventive electric assembly allows its testing at arbitrary points of time, and is inexpensive and simple in construction.

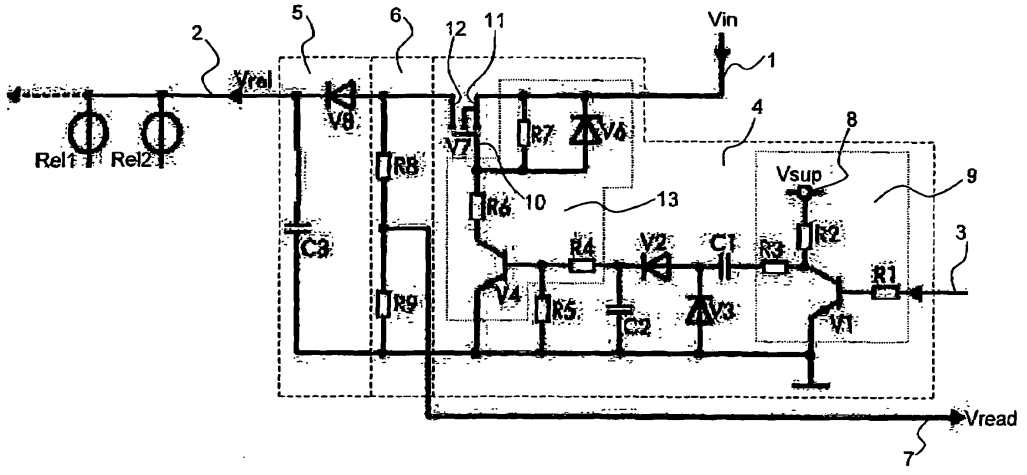

Fig. 1

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Description

Background of the invention

[0001] The invention relates to an electrical assembly, in particular for an interface between an electronic interlocking system and an relay interlocking system,
wherein, in a first operating condition, the electrical assembly switches an input voltage at a working input onto a working output if an alternating voltage is applied at a monitoring input,
and wherein, in a second operating condition, the electrical assembly switches off the working output if no voltage or a direct voltage is applied to the monitoring input.

[0002] Railway control centers, i.e, interlocking systems in the railway technology, are used to control railway field devices, in particular railway signals and railway switches of railway tracks and railway stations. Since most of the controlled field devices are of safety relevance, the components of a railway control center must be verified regularly.

[0003] In electronic railway control centers, the function of its components is checked in a cyclic manner by a test software. The checking frequency may be chosen freely, typically taking into account the technology of the components. The checking frequency is independent of the frequency of regular use of the components.

[0004] In a relay railway control center, its relays are only checked during regular use upon engergizing and de-energizing, i.e. the checking frequency depends on the data flow.

[0005] In the state of the art, there are also electronic interlocking systems which are attached to relay interlocking systems; this is often the result of a cost-effective partial upgrading of railway equipment. At the interface of the electronic interlocking system and the relay interlocking system, there are some electrical components which forward a switching voltage to output relays. The output relays control the railway field devices such as the railway signals or railway switches by means of the control computer. The electronic components can, in the state of the art, only be checked depending on the data flow of regular use. This may be too rare for an acceptance by common safety standards.

[0006] More specifically, in the state of the art, there are dynamic relays connected upstream to the output relays. The control computer (belonging to the electronic interlocking system) provides electronic pulses periodically (a so called dynamic signal) when the control computer is executing its programming regularly, By means of an electronic pulse analysis, the dynamic relays are energized by the dynamic signal, and the dynamic relays can forward a switching current to the output relays. If the programming of the control computer is not executed properly and the dynamic signal ceases, the dynamic relay is supposed to de-energize, thus ending the switching current to the output relays, and putting the field devices (such as railway signals) into a safe condition.

[0007] The electronic pulse analysis and the dynamic relays are checked periodically by a de-energizing test. However, this de-energizing for testing could be interpreted as a regular operation (such as switching a signal to red despite of a free track). This misinterpretation is prevented, in the state of the art, by doubling the pulse analysis circuit and the dynamic relays, and connecting the two sets in parallel. When one of the sets is tested, the other set can output the switching current. Such a doubling of sets is necessary for each channel of the control computer, increasing the construction costs in particular for multichannel control computers.

Object of the invention

[0008] It is the object of the invention to provide an electrical assembly at the interface of an electronic interlocking system and a relay interlocking system as introduced in the beginning, which allows its testing at arbitrary points of time, and at the same time is inexpensive and simple in construction.

Short description of the invention

[0009] This object is achieved, in accordance with the invention, by an electrical assembly as introduced in the beginning, characterized in
that the electronic assembly comprises a dynamic circuit, a measurement circuit with a readout output, and a buffer circuit,
that the dynamic circuit comprises a switching capacity, which is connected to the monitoring input or an amplifier circuit of the monitoring input via a serial connection of a loading diode and a loading capacity,
wherein a resistive component is connected in parallel to the switching capacity, that the dynamic circuit further comprises a switching transistor with a first contact, a second contact and a control contact,
wherein the first contact is connected to the working input,
and wherein the control contact is connected to the switching capacity or an amplifier circuit of the switching capacity,
that the measurement circuit is connected to the second contact of the switching transistor,
and that the buffer circuit comprises a separating diode and a buffer capacity,
wherein the separating diode connects the second contact of the switching transistor with the working output,
and wherein the buffer capacity is connected to the working output.

[0010] In brief, the switching capacitor (C2) collects charges upon any recharging of the loading capacitor (C1) when the dynamic signal is present.. When enough charge is accumulated at the switching capacitor, the switching transistor (V7) becomes conductive, and forwards the input voltage to the working output. When the dynamic signal is not present, the switching capacity is no further charged, but is discharged via the resistive

components (R5, V4). The switching transistor blocks. The voltage at the second contact of the switching transistor measurement circuit drops, what can be read at the readout output, indicating proper de-energizing. However, the voltage at the working output is maintained by the buffer capacity for some time, long enough to make the switching transistor conductive again (by resuming the dynamic signal) before the voltage at the working output has dropped significantly.

[0011] The inventive electrical assembly is a completely electronic surveillance tool for the dynamic of the control computer, in particular doing without any space-consuming relays such as dynamic relays. This minimizes the risk of mechanical malfunctions. Note that dynamic relays may have malfunctions that are difficult to detect with regular testing. The switching transistor and the electronic assembly as a whole, in contrast, are much more reliable than a dynamic relay, and very easy to test.

[0012] Further, the switching transistor is voltage controlled (and not current-controlled as a relay), and thus can be operated with less power consumption.

[0013] Within the electrical assembly, there are no components that need to be provided in double and connected in parallel. The inventive electronic assembly itself can maintain a switching current at the interface relays during testing by means of the buffer circuit. This makes the inventive electronic assembly very cost-effective and keeps its design simple and small.

Preferred variants of the invention

[0014] In a preferred embodiment of the inventive electric assembly, the measurement circuit comprises a series connection of two resistors, and the readout output is attached between the two resistors. The two resistors act as potential dividers, so a typical voltage at the readout output can be set. Further, via the resistors a relic voltage at the second contact of the switching transistor is quickly eliminated during testing.

[0015] In another preferred embodiment of the invention, the the switching transistor is a field effect transistor, in particular a VMOS transistor, and the control contact of the switching transistor is the gate of the field effect transistor. The field effect transistor is voltage controlled, and only little electric power at the control contact is sufficient for controlling the forwarding of voltage.

[0016] Further preferred is an embodiment of the inventive electrical assembly wherein the control contact of the switching transistor is connected to the working input via a resistor, or a limiting diode, or a resistor and a limiting diode connected in parallel. By these means, in particular with the limiting diode, the voltage at the control input of the switching transistor can be limited to a maximum value appropriate for the switching transistor.

[0017] Further preferred is an embodiment wherein the switching capacity is connected to the basis of a DC amplification transistor via a resistor, and the collector of the DC amplification transistor is connected to the control contact of the switching transistor via a resistor. By this means, the current resulting from the charge at the switching capacity through the resistive component, here the DC amplification transistor, can be amplified in order to switch the state of the switching transistor.

[0018] In a preferred further development of this embodiment, the basis of the DC amplification transistor is connected to a grounded resistor. With the grounded resistor, a relic voltage at the switching capacity can be eliminated more quickly. It further helps setting the amplification factor at the DC amplification transistor.

[0019] In a preferred embodiment, the electrical assembly is characterized in
that the monitoring input is connected to the basis of an AC amplification transistor via a resistor,
that the collector of the AC amplification transistor is connected to a supply voltage input via a resistor,
and that the collector of the AC amplification transistor is connected to the loading capacitor, in particular via a resistor. By this means, the signal at the monitoring input is amplified in order to allow or accelerate the loading of the switching capacity. A typical voltage at the supply voltage input is 5 V DC. The resistor (R3) upstream of the loading capacitor helps to avoid current peaks.

[0020] Another advantageous embodiment provides that a grounded discharging diode is attached between the loading diode and the loading capacity. The discharging diode helps to discharge the loading capacity during testing.

[0021] Also within the scope of the invention is a railway control center device, comprising at least one output relay for a railway field device such as a railway signal or a track switch, and a control computer for controlling the at least one relay, wherein the control computer has a monitoring output for providing an alternating voltage signal in order to indicate its proper working condition, characterized in that the railway control center device further comprises an inventive electric assembly (or one of its embodiments mentioned above),
wherein the at least one output relay has a control input which is connected to the working output of the electric assembly, and wherein the monitoring output of the control computer is connected to the monitoring input of the electric assembly. The inventive railway control center device can secure the at least one output relay, and it can be tested whenever desired, in particular periodically and independent from regular use, without interfering into the regular use when testing.

[0022] Further within the scope of the invention is a method for operating a railway control center device as described above, characterized in that the control computer periodically runs a testing program, with the following steps:

a) a direct current signal or no signal is applied to the monitoring output of the control computer;
b) if the signal at the readout output of the measurement circuit drops to low level within a predefined

time interval, indicating a proper functioning of the dynamic circuit, an alternating voltage signal is provided at the monitoring output of the control computer again until the next cycle of the testing program; c) if the signal at the readout output does not drop to low level within a predefined time interval, indicating a malfunction of the dynamic circuit, an error message is delivered and/or an emergency shutdown of the voltage at the control input of the at least one output relay is done. With this procedure, the railway control center device can be tested in a to the satisfaction of any safety standard, in particular as often as necessary.

[0023] Further advantages can be extracted from the description and the enclosed drawing. The features mentioned above and below can be used in accordance with the invention either individually or collectively in any combination. The embodiments mentioned are not to be understood as exhaustive enumeration but rather have exemplary character for the description of the invention.

Drawing

[0024] The invention is shown in the drawing.

Fig. 1 shows a circuit diagram of an inventive electric assembly;

Fig. 2 shows a flow diagram of an inventive method for operating a railroad control center device comprising an inventive electric assembly.

[0025] **Fig. 1** shows a circuit diagram of an inventive electric assembly. The electric assembly is connected between a control computer (which is part of an electric interlocking system) and a set of output relays Rel1, Rel2. The output relays Rel1, Rel2 control railway field devices such as railway signals according to the orders of the control computer (the details of this controlling are not shown here). The electric assembly is adapted to forward a constant input voltage Vin at a working input 1 to a working output 2, which is connected to the control inputs of the output relays Rel1, Rel2, as long as the control computer works properly.

[0026] As long as the control computer works properly, it provides an AC dynamic signal (such as a sinusoidal or saw tooth voltage) to a monitoring input 3 of the electric assembly. When the dynamic signal ceases (by staying at a constant level which may be zero or a higher voltage), the electric assembly stops the forwarding of the input voltage Vin to the working output 2 by means of a dynamic circuit 4. Nonetheless, the voltage Vrel at the working output 2 stays for some time at its level by means of a buffer circuit 5.

[0027] The ending of the forwarding of the input voltage Vin can be noticed with the aid of a measuring circuit 6 providing a readout signal Vread to a readout output 7 before Vrel drops significantly. If the dynamic signal is reestablished quickly enough (i.e, within a "buffer time" of the buffer circuit), the input voltage Vin is forwarded again before Vrel has dropped significantly. This characteristic is used to test the electric assembly. In this case, there is no interruption of the voltage supply of the output relays Rel1, Rel2. If the dynamic signal is not reestablished quickly enough, what is in particular the case at a malfunction of the control computer, the voltage at the working output 2 finally drops. Then the output relays Rel1, Rel2 get no more (or not enough) relay voltage Vrel and switch into a safe state.

[0028] In the following, the function of the inventive electric assembly is explained in detail.

Regular operation

[0029] During regular operation, a dynamic signal (such as a rectangular alternating voltage of e.g. 5 volts peak to peak and 10 Hz) is present at the monitoring input 3. The dynamic signal is provided via resistor R1 to the basis of the AC amplification transistor V1.

[0030] When the dynamic signal is in a low voltage half wave, V1 blocks, and the loading capacitor C1 and the switching capacitor C2 are loaded by the supply voltage Vsup of supply voltage input 8 via resistors R2, R3, and loading diode V2.

[0031] When the dynamic signal is in a high voltage half wave, then the AC amplification transistor V1 is conducting, and loading capacitor C1 is discharged via discharging diode V3 as well as resistors R3 and V1.

[0032] When V1 blocks again, C1 is recharged, and C2 is charged further. After a few cycles of the dynamic signal, a saturation voltage of e.g. 2V is present at the switching capacitor C2. In this sense, C1 loads C2, therefore C1 is called loading capacitor. Note that the supply voltage input 8, the resistors R1, R2, R3, and AC amplification transistor V1 form an amplifier circuit 9 for the monitoring input 3.

[0033] The switching capacitor C2 provides (via resistor R4) the basis of a DC amplification transistor V4 with a voltage, so V4 becomes conductive. Via the potential divider of the two resistors R6, R7 connected to the working input 1, the switching transistor V7 (here a field effect transistor) gets a voltage onto its control contact 10 (here its gate). The voltage at the control contact 10 is limited by the limiting diode V6. V4, R4, R6, R7 and V6 form an amplification circuit 13 of the switching capacity C2.

[0034] As a consequence of the voltage at the control contact 10, the switching transistor V7 becomes conductive, and the input voltage Vin at the first contact 11 is transmitted to the second contact 12 as well as to the working output 2 via the separating diode V8, so a voltage Vrel equaling Vin is present at the working output 2. In the end, it is the voltage at C2 that causes the switching transistor V7 to change its state. Therefore, C2 is called switching capacitor.

[0035] The buffer capacity C3, which is connected to

the working output 2, is loaded. Moreover, the potential divider of the resistors R8, R9 connected to the second contact 12 of V7 provides a high voltage level to the readout output 7.

[0036] Typically, and in accordance with the invention, the regular operation is maintained for a predefined time, such as one hour or one day, and then a test procedure is launched, independent of the use of the output relays Rel1, Rel2.

Test procedure

[0037] For testing the dynamic circuit 4, at the monitoring input 3 a constant high level signal is set instead of the dynamic signal. As a result, the AC amplification transistor V1 is conductive, and loading capacitor C1 is discharged via the discharging diode V3 and resistor R3 and V1. The switching capacitor C2 is not reloaded periodically any more, but discharged via the resistive components V4 and R5, and R4. The DC amplification transistor V4 blocks, and the control contact 10 of switching transistor V7 looses its voltage.

[0038] As a result of the lacking voltage at the control input 10, the V7 blocks. At the anode of V8 (or at the second contact 12 of V7), there is no more voltage either. Note that any relic voltage there would be discharged via R8, R9. As a result, the readout signal Vread at readout output 7 drops to low level (here even zero level).

[0039] As soon as there is a low level at the readout output 7, the proper de-energizing function of the dynamic circuit 4 is proved, and the control computer immediately reestablishes the regular dynamic signal. Quickly afterwards, V7 is conductive again.

[0040] For the duration of a successful testing, i.e. from the beginning of the constant high level signal at monitoring input 3 until the V7 becomes conductive again, the buffer capacity C3 provides the energy for the output relays Rel1, Rel2. During the testing, separating diode V8 blocks and prevents the buffer capacity C3 from discharging via the resistors R8, R9.

[0041] The testing can also be done with a constant low level signal at the monitoring input 3. At C1, there is a constant voltage. Since C2 requires changing charges at C1 for further loading, C2 is discharges via R4, R5, V4 again, with the further function of the electric assembly as described above.

[0042] Figure 2 describes an inventive method for operating a railway control center device, comprising an inventive electric assembly as described above, connected to a control computer and at least one output relay.

[0043] The railway control center device is, at the beginning, in regular operation 21. During regular operation, the dynamic signal is provided to the monitoring input of the electric assembly by the monitoring output of the control computer.

[0044] After a time interval Tver, the control computer starts automatically a test procedure 22. The signal at the monitoring input is put to a constant high level. Then it is waited for a time interval Tdis, long enough for the switching capacitor C2 to discharge, and the switching transistor V7 to block, but short enough so buffer capacity C3 is not yet discharged. Immediately after Tdis has elapsed, the readout signal Vout at the readout output is read out in step 23.

[0045] If Vout is at low level, indicating proper de-energizing of the dynamic circuit, regular operation 21 is resumed for another time interval Tver.

[0046] If Vout is at high level, indicating that the dynamic circuit does not de-energize as required for safety reasons, an emergency shutdown 24 of the input voltage Vin is undertaken. The voltage Vrel at the working output drops to zero, putting the output relays into a safe condition. The defective dynamic circuit can be repaired or exchanged afterwards,

[0047] In summary, the invention describes a safety tool guaranteeing a turning off of a switching voltage of at least one output relay in case a control computer (or micro controller), which operates or controls the output relays, has a defect. Such a defect is indicated by the cessation of a dynamic signal which is provided to the electronic assembly. The electronic assembly can be tested for de-energizing independent of the use of the output relays by the control computer, and in particular as often as desired, without interfering into the regular operation of the output relays.

Claims

1. Electrical assembly,
in particular for an interface between an electronic interlocking system and a relay interlocking system,
wherein, in a first operating condition, the electrical assembly switches an input voltage (Vin) at a working input (1) onto a working output (2) if an alternating voltage is applied at a monitoring input (3),
and wherein, in a second operating condition, the electrical assembly switches off the working output (2) if no voltage or a direct voltage is applied to the monitoring input (3),
characterized in
that the electronic assembly comprises a dynamic circuit (4), a measurement circuit (6) with a readout output (7), and a buffer circuit (5), that the dynamic circuit (4) comprises a switching capacity (C2), which is connected to the monitoring input (3) or an amplifier circuit (9) of the monitoring input (3) via a serial connection of a loading diode (V2) and a loading capacity (C1),
wherein a resistive component (R5, V4) is connected in parallel to the switching capacity (C2),
that the dynamic circuit (4) further comprises a switching transistor (V7) with a first contact(11), a second contact (12) and a control contact (10),
wherein the first contact (11) is connected to the working input (1),

and wherein the control contact (10) is connected to the switching capacity (C2) or an amplifier circuit (13) of the switching capacity (C2), that the measurement circuit (6) is connected to the second contact (12) of the switching transistor (V7),
and **that** the buffer circuit (5) comprises a separating diode (V8) and a buffer capacity (C3),
wherein the separating diode (V8) connects the second contact (12) of the switching transistor (V7) with the working output (2),
and wherein the buffer capacity (C3) is connected to the working output (2).

2. Electric assembly according to claim 1, **characterized in that** the measurement circuit (6) comprises a series connection of two resistors (R8, R9), and the readout output (7) is attached between the two resistors (R8, R9).

3. Electric assembly according to claim 1, **characterized in that** the switching transistor (V7) is a field effect transistor, in particular a VMOS transistor, and the control contact (10) of the switching transistor (V7) is the gate of the field effect transistor.

4. Electrical assembly according to claim 1, **characterized in that** the control contact (10) of the switching transistor (V7) is connected to the working input (1) via a resistor (R7), or a limiting diode (V6), or a resistor (R7) and a limiting diode (V6) connected in parallel.

5. Electrical assembly according to claim 1, **characterized in that** the switching capacity (C2) is connected to the basis of a DC amplification transistor (V4) via a resistor (R4), and the collector of the DC amplification transistor (V4) is connected to the control contact (10) of the switching transistor (V7) via a resistor (R6).

6. Electrical assembly according to claim 5, **characterized in that** the basis of the DC amplification transistor (V4) is connected to a grounded resistor (R5).

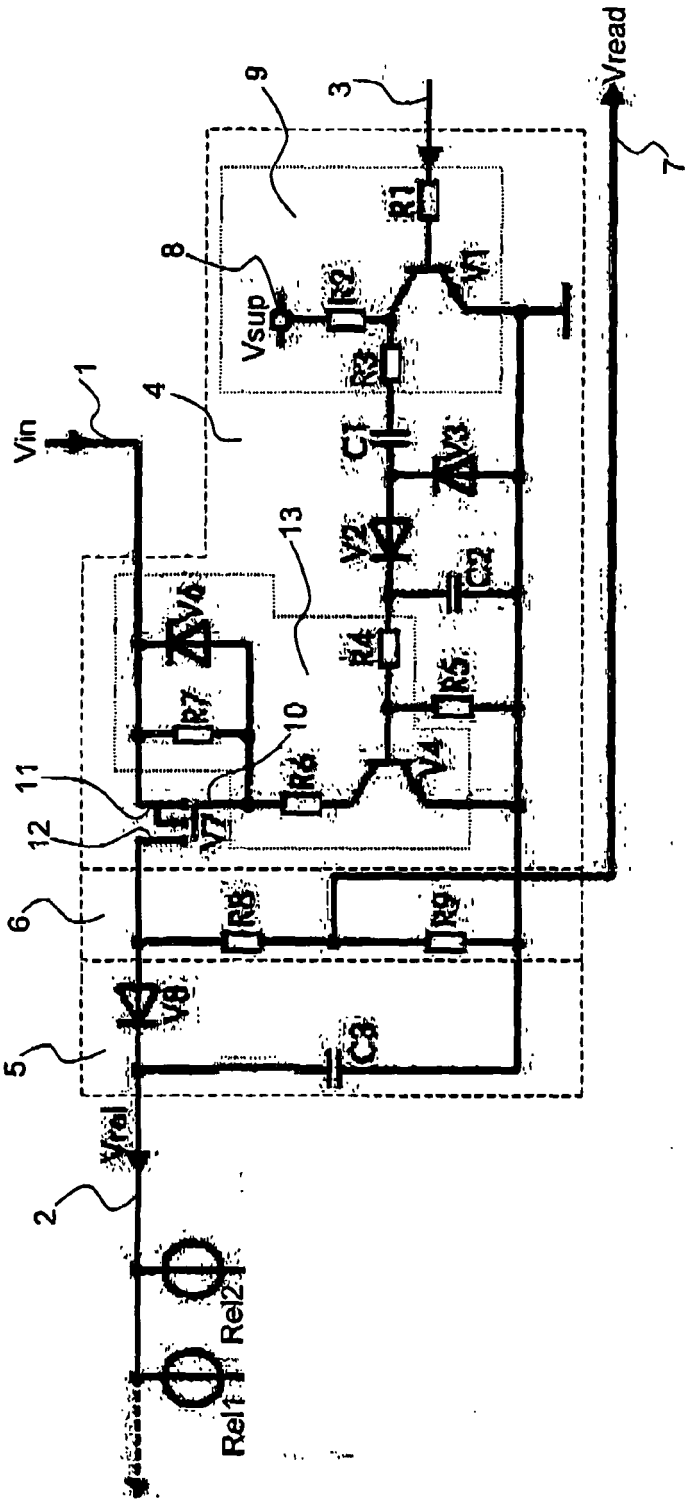
7. Electrical assembly according to claim 1, **characterized in**
that the monitoring input (3) is connected to the basis of an AC amplification transistor (V1) via a resistor (R1),
that the collector of the AC amplification transistor (V1) is connected to a supply voltage input (8) via a resistor (R2),
and **that** the collector of the AC amplification transistor (V1) is connected to the loading capacitor (C1), in particular via a resistor (R3).

8. Electrical assembly according to claim 1, **characterized in that** a grounded discharging diode (V3) is attached between the loading diode (V2) and the loading capacity (C1).

9. Railway control center device, comprising
at least one output relay (Rel1, Rel2) for a railway field device such as a railway signal or a track switch, and a control computer for controlling the at least one output relay (Rel1, Rel2),
wherein the control computer has a monitoring output for providing an alternating voltage signal in order to indicate its proper working condition,
characterized in
that the railway control center device further comprises an electric assembly according to claim 1,
wherein the at least one output relay (Rel1, Rel2) has a control input which is connected to the working output (2) of the electric assembly, and wherein the monitoring output of the control computer is connected to the monitoring input (3) of the electric assembly.

10. Method for operating a railway control center device according to claim 9,
characterized in that the control computer periodically runs a testing program, with the following steps:

a) a direct current signal or no signal is applied to the monitoring output of the control computer (22);
b) if the signal at the readout output of the measurement circuit drops to low level within a predefined time interval (Tdis), indicating a proper functioning of the dynamic circuit (4), an alternating voltage signal is provided at the monitoring output of the control computer again until the next cycle of the testing program (21);
c) if the signal at the readout output (7) does not drop to low level within a predefined time interval (Tdis), indicating a malfunction of the dynamic circuit (4), an error message is delivered and/or an emergency shutdown (24) of the voltage at the control input of the at least one output relay (Rel1, Rel2) is done.


Vread
7
3
9
R1
8
Vsup
R2
V1
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4
C1
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V6
R4
R5
R7
10
R6
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5
C3
Vrel
2
Rel2
Rel1

Fig. 1

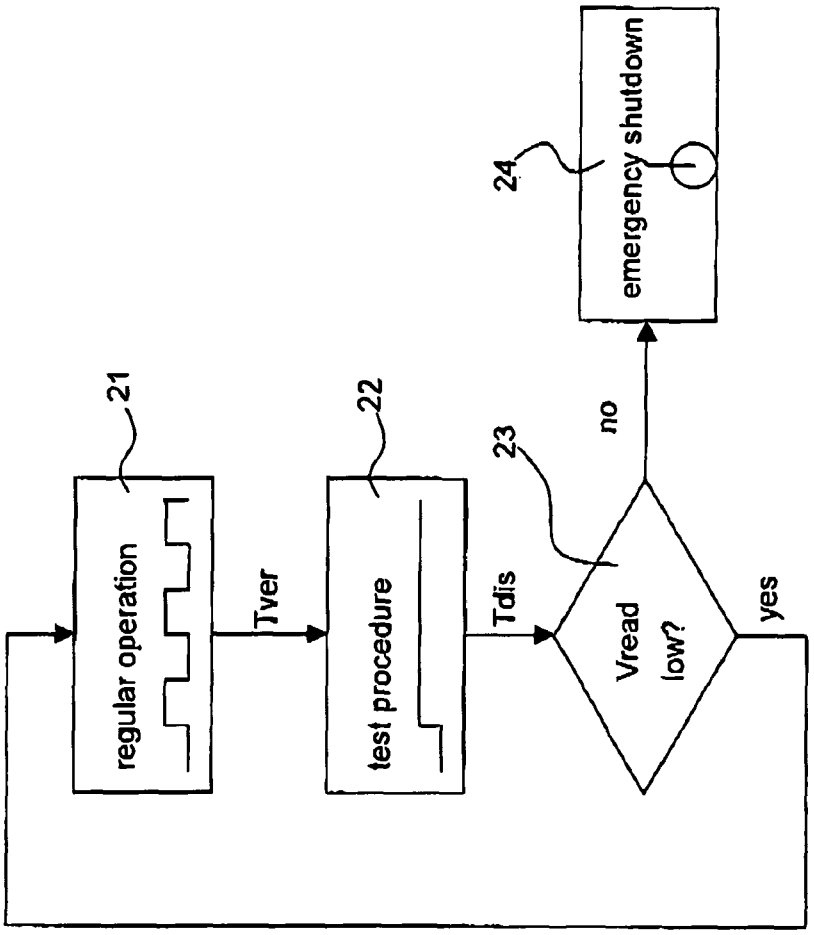
regular operation
21
Tver
test procedure
22
Tdis
Vread
low?
23
yes
no
emergency shutdown
24

Fig. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 29 0777

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	5 October 2006	Massalski, Matthias

CATEGORY OF CITED DOCUMENTS

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