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(54) **Relay terminal array with malfunction detection and transmission functions**

Endstufenrelaismatrix mit Fehlererkennungs- und Übertragungsfunktionen

Ensemble de relais de sortie avec des fonctions de détection d'erreur et de transmission

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Description

FIELD OF THE INVENTION

This invention concerns a relay terminal which is capable of transmitting detection signals when malfunctions are detected in the relay load circuits.

BACKGROUND OF THE INVENTION

A conventional relay terminal array consists of a number of relays whose contacts are connected to load circuits. Each load circuit is switched on or off in accordance with the contact state of the relay coil. Some conventional relay terminals are not able to transmit signals whether or not there is contact while other conventional relay terminals can. Conventional relay terminals of the type described above, however, cannot detect malfunctions. When such a relay becomes fused or a contact becomes intermittent, the malfunction cannot be immediately detected in the control center. The delay in detecting the malfunctioning relay causes down time and other problems.

From EP-A-0 616 346, which is a document according to Art. 54 (3) EPC for all designated countries, a relay terminal array is known having a plurality of relays, each of said plurality of relays having a relay coil such that excitation of said relay coil causes a relay contact, said relay terminal array comprising: a current detection circuit for detecting the presence or absence of a current in a load circuit of said relays and outputting detection signals, and a transmission control circuit for comparing said detection signals from said current detection circuit with a state signal from each of said relay coils, to determine if a malfunction has occurred in said relays, said transmission control circuit outputting a malfunction detection signal when a malfunction has occurred.

FR-A-2 565 430 discloses a relay terminal having a relay coil such that excitation of said relay coil causes a relay contact, said relay terminal comprising: a current detection circuit for detecting the presence or absence of a current in a load circuit of said relay and outputting detection signals, and a transmission control circuit for comparing said detection signals from said current detection circuit with a state signal from said relay coil, to determine if a malfunction has occurred in said relay, said transmission control circuit outputting a malfunction detection signal when a malfunction has occurred.

SUMMARY OF THE INVENTION

This invention considers the problem described above. One advantage of this invention that the relay terminal array is capable of detecting malfunctions and transmitting the status of the relay terminal to the main control unit.

This invention in an embodiment, provides a number of other advantages. This invention uses a magneto-electric converter element to detect the presence or absence of current in a load circuit. Thus, an advantage is that a determination whether or not a malfunction has occurred is made based on the logic state of a current detection circuit and the result of processing performed on an output indicating the state of a relay coil.

Other advantages are that a wide range of currents can be detected and that signal indicating that a relay has malfunctioned can be transmitted to a programmable controller or other device. Another advantage is that a malfunction of a relay can be reported on site without increasing the number of components required.

According to the invention the malfunction detection function can be disabled. Thus, a further advantage of this invention is that the user can enable or disable the detection function, as needed, in response to the load being used.

The relay terminal array according to the invention is defined in claim 1.

The relay terminal array of this invention comprises a number of relays in which the excitation of the relay coil of each relay causes the relay contact, which is connected to a load circuit, to be made or broken. Each of the relays has a current detection unit comprising, in an embodiment, a detection coil serially connected to its associated load circuit; a magneto-electric converter element to detect the presence of magnetic flux which is generated by an electric current flowing through the detection coil; and a current detection circuit which outputs a signal representing a logic state. By performing logic processing on the output of the magneto-electric converter element and the excitation of the relay coil, the current detection unit can detect a malfunction in any of the relays. If a malfunction is detected, the current detection unit outputs a signal indicating that a malfunction has occurred. The relay terminal array also has a transmitting unit to transmit the state of the relay whether a malfunction has occurred. The transmitting unit receives the output of the current detection unit and outputs an output signal to, for example, a monitoring center for the system.

When current is flowing in the load circuit for any relay, a magnetic flux is generated in the detection coil serially connected to that load circuit. When no current is flowing, no flux is generated. The presence or absence of this magnetic flux is detected by the magneto-electric converter element in the current detection circuit, and the result is output as a signal representing a logic state. The signal output by the current detection circuit and the state of the relay coil are processed by the logic processing device. If, for example, the state of the relay coil is "1", indicating that the relay is on, and the output of the current circuit is "0", indicating that the load circuit is open, the processor will conclude that a malfunction has occurred. If the state of the relay coil is "1" and the output of the current detection circuit is also "1", meaning that current is flowing in the load circuit, the processor will conclude that the load circuit is nor-

mal. A signal indicating that a malfunction has or has not occurred is transmitted to the exterior, for example, to a programmable controller. An open relay detection switch for preventing said transmission control circuit from outputting said malfunction signal is provided.

BRIEF DESCRIPTION OF THE FIGURES

Fig. 1 is a block diagram showing a relay terminal array of this invention;
Fig. 2 is a circuit diagram showing a circuit used as the current detection unit in the relay terminal array;
Figs. 3a-3d are a timing chart illustrating the operation of the smoothing circuit of the current detection unit;
Fig. 4 is a timing chart illustrating the operation of the relay terminal array in its normal ON state;
Fig. 5 is a timing chart illustrating the operation of the relay terminal array in its normal OFF state;
Fig. 6 is a timing chart illustrating the operation of the relay terminal array when the circuits are open and the open circuit detection switches are on;
Fig. 7 is a timing chart illustrating the operation of the relay terminal array when the circuits are open and the open circuit detection switches are off;
Figs. 8a-8d show various waveforms illustrating the operation of the relay terminal array when the circuits are open and the open circuit detection switches are switched on while detection is occurring;
Figs. 9a-9c show various waveforms illustrating the operation of the relay terminal array when the load circuit is shorted; and
Fig. 10 is a chart showing the state of the display for normal operation and malfunction for every relay coil state and load current in the relay terminal array.

DETAILED DESCRIPTION OF THE INVENTION

The invention will be described with references to the accompanying drawings, Figs. 1-10. Fig. 1 is a block diagram showing a relay terminal array of this invention. This relay terminal array comprises power supply circuit 1; reset circuit 2; driver/receiver circuit 3, which sends data to and receives data from a programmable controller; transmission control circuit 4; output circuit 6, which receives relay coil outputs D_{16}, D_{17}, D_{18} and D_{19} from transmission control circuit 4 and transmits them to relay coils 5_1, 5_2, 5_3, and 5_4, respectively; current detection coils 9_1, 9_2, 9_3, and 9_4, which are connected in series with relay contacts 7_1, 7_2, 7_3, and 7_4 and connected to load circuits 8_1, 8_2, 8_3, and 8_4, respectively; current detection circuit 10, which detects the magnetic flux generated in detection coils 9_1, 9_2, 9_3, and 9_4 and outputs signals D_0, D_1, D_2, and D_3 to indicate the presence or absence of a current in load circuits 8_1, 8_2, 8_3, and 8_4; LEDs (LED3, LED4, LED5, and LED6) which display the states of the four relays; and switches 11_1, 11_2, 11_3, and 11_4, which can be switched to a mode in which an "Open" state is not to be detected. Current detection circuit 10 comprises four independent circuits corresponding to detection coils 9_1, 9_2, 9_3, and 9_4, which are connected in series with their corresponding load circuits. Transmission control circuit 4 receives the signals representing the presence or absence of current in the load circuits which are output by current detection circuit 10. It processes these signals together with the state of the relay coils to determine whether or not a malfunction has occurred. When a malfunctioning relay is detected, its corresponding display means, one of LED3, LED4, LED5, and LED6, will flash on and off, and a signal indicating that the relay is malfunctioning (its corresponding flag) will be transmitted to the programmable controller via driver/receiver 3.

Fig. 2 is a circuit diagram of an example of a circuit for the current detection circuit 10. This circuit comprises magnetic flux detection circuit 21, which contains Hall element HE to detect magnetic flux in detection coil 9; constant voltage circuit 22, which provides drive voltage to Hall element HE at a constant level of 1V; amplifier circuit 23, which amplifies the output of Hall element HE; comparator circuit 24, which compares the amplified signal with a reference voltage and whose output is "HIGH" in the presence of a current and is "LOW" in the absence of a circuit; and smoothing circuit 25, which smooths the output signal when an AC load is being used.

Detection coil 9, which is connected to load circuit 8 serially, is wound on a ring core with a gap. When a current is flowing in detection coil 9, Hall element HE in magnetic flux detection circuit 21 measures the magnetic flux generated by the current outputs the voltage generated by the load current.

Constant-voltage circuit 22 comprises transistor Q_1, whose emitter is connected to Hall element HE and whose collector is connected to the +5V power supply; resistor R_1, one of whose terminals is connected to the +5V power supply; and resistor R_2, one of whose terminals is connected to the other terminal of resistor R_1 at the connection point for the base of transistor Q_1, and the other of whose terminals is connected to the power supply at the 0V level. The ratio for resistors R_1 and R_2 is set so that a voltage of 1V is applied to Hall element HE.

Amplifier circuit 23 has a differential amplifier unit 27 comprising resistors R_3, R_4, R_5, and R_6, operational amplifier 26; and operational amplifier 28. The output terminal of operational amplifier 28 and the inverting input terminal are connected to form a voltage follower, which is connected to one of the terminals of resistor R_6. The output voltage V_{OP} of amplifier circuit 23 can be obtained by solving $V_{OP} = AV_H + V_C$, where the output of Hall element HE is V_H, the differential amplification factor is A, and the constant voltage output by voltage follower 29 is V_C.

Comparator circuit 24 comprises the series circuit comprising resistors R_7, R_8, R_9, and R_{10}, connected to

the power supply between the +5V and 0V levels, which supply reference voltages VR_1, and VR_2; operational amplifier 30, whose non-inverting input terminal is connected the output of amplifier circuit 23 and whose inverting input terminal is connected the common connection point of resistors R_7 and R_8, the reference voltage VR_1; operational amplifier 31, whose non-inverting input terminal is connected the connection points of resistors R_9 and R_{10}, the reference voltage VR_2 ($VR_1 > VR_2$) and whose inverting input terminal is connected the output of amplifier circuit 23; and OR circuit 32, which receives as input the outputs of operational amplifiers 31 and 32.

When the output V_{OP} of amplifier circuit 23 is greater than VR_1 ($V_{OP} > VR_1$), the output of operational amplifier 30 is "HIGH" and the output of operational amplifier 31 is "LOW". In this case, the output of OR circuit 32 is "HIGH", indicating that a current has been detected.

When the output V_{OP} of amplifier circuit 23 is greater than VR_1, but less than VR_2 ($VR_2 > V_{OP} > VR_1$), the output of both operational amplifiers 30 and 31 are "LOW". In this case, the output of OR circuit 32 is "LOW", indicating the absence of a current.

When the output V_{OP} of amplifier circuit 23 is less than VR_2 ($V_{OP} < VR_2$), the output of operational amplifier 30 is "LOW" and the output of operational amplifier 31 is "HIGH". In this case, the output of OR circuit 32 is "HIGH", indicating the presence of a current.

Smoothing circuit 25 comprises resistor R_{12} connected in series with a parallel circuit of diode d and resistor R_{11} between the input terminal which receives the output V_I of comparator circuit 24 and output terminal D_i (i = 0, 1, 2, 3). Resistor R_{13} is connected between the input terminal and 0V. Capacitor C_1 is connected between the output terminal and 0V.

Let us assume that the load current in smoothing circuit 25 is AC and the output of Hall element HE is the signal pictured in Fig. 3a. This signal is amplified by amplifier circuit 23, superposed on the 2.5V DC reference voltage, and output. The result is that the output V_{OP} of amplifier circuit 23 has a waveform like that shown in Fig. 3b. Comparator circuit 24 compares output V_{OP} to reference voltages VR_1 and VR_2. If $V_{OP} > VR_1$ or $V_{OP} < VR_2$, the output of comparator circuit 24 is "HIGH". In this case, the output V_I of comparator circuit 24 assumes the waveform shown in Fig. 3c. This pulse-type output waveform V_I is smoothed by smoothing circuit 25 and output as signal D_o shown in Fig. 3d to indicate that a current has been detected.

When the output V_I of comparator circuit 24 is "HIGH", capacitor C_1 is charged via diode d and resistor R_{12}. Since the time constants of R_{12} and C_1 are small, the charging will occur rapidly. When the output V_I of comparator circuit 24 is "LOW", the voltage charged in capacitor C_1 is discharged through resistors R_{12}, R_{11}, and R_{13}. In this case, the time constant ($R_{11} + R_{12} + R_{13}$) with capacitor C_1 is large, resulting in a smoothing effect. The smoothing circuit does not operative when a DC current flows in the load circuit, since it is not needed.

The output of current detection circuit 10, achieved as described above, comprises signals D_0, D_1, D_2, and D_3, which indicate the presence or absence of a current in load circuits 8_1, 8_2, 8_3, and 8_4. These signals are input into transmission control circuit 4. In transmission control circuit 4, logic processing is performed on signals D_0, D_1, D_2, and D_3 received from circuit detection circuit 10 and on relay coil outputs D_{16}, D_{17}, D_{18}, and D_{19}, which are output to the various relays via output circuit 6. This processing determines whether a malfunction has occurred.

A brief explanation of determination of a malfunction follows. If a relay is ON, that is, if the output signal from the relay coil is "LOW", and the current detection signal (the load current) is positive (i.e., greater than 0.5A), the relay is in its normal ON state, and its LED will stay lit continuously. Waveforms for this case are shown in Fig. 4.

In the normal OFF state, the output signals D_{16}, D_{17}, D_{18}, and D_{19} from the relay coils are "HIGH". The current detection signal is negative (i.e., less than 0.5A), and LED3, LED4, LED5, and LED6 will be off. The waveforms for this case are shown in Fig. 5.

When the relays are in the normal OFF state, all malfunction flags will be set to "0", and a malfunction flag "0" will be transmitted to the programmable controller.

When any of the load circuits of the relays are open, and detection switches 11_1, 11_2, 11_3, and 11_4 are on, the output signals from the relay coils are "LOW", indicating that the relays are on, but the current detection signals will be negative. In this case, the LED drive signal will pulse, and LED3, LED4, LED5, and LED6 will flash on and off to indicate a malfunction. The malfunction flag will be set to "1". Fig. 6 shows the waveforms for this case.

Normally, the current flowing in the load circuit which is made or broken by the relays is relatively large. However, conditions set by the user, such as having a load which is only the display means, may cause the current to be very small. If this happens, the current detection circuit may output a "negative" signal, even though the load current is normal. An open relay malfunction is then detected when conditions are in fact normal. This circuit has a feature which allows the user to prevent such false positives. When open relay detection switches 11_1, 11_2, 11_3, and 11_4 are on, the detection of open relay malfunctions will be prevented. When the load circuits of the relays are open and switches 11_1, 11_2, 11_3, and 11_4 are off, the output signals from the relay coils will be "LOW" (to indicate that the relays are on). Because switches 11_1, 11_2, 11_3, and 11_4 are off, the LEDs will remain lit even if the current detection signal is negative, and the malfunction flag will be "0". Waveforms for this case are shown in Fig. 7.

When the relays are open and switches 11_1, 11_2,

11_3, and 11_4 are switched on, while detection is occurring, LED3, LED4, LED5, and LED6 will enter detection phase and light up. The LEDs will begin flashing when the switches are activated. Figs. 8a-8d shown the waveforms for this case.

When the load circuit is shorted, the output signal from the relay coils are "HIGH", indicating that the relays are off. Since the current detection signal is positive, the LED drive signal will pulse, as shown in Fig. 9c. The LEDs (LED3, LED4, LED5, and LED6) will flash to indicate a malfunction, and the malfunction flag will be "1". Fig. 9 shows the waveforms for the case in which the circuit is shorted.

A summary of the relationship of the relays, the load current, the open relay detection switches, the LEDs, and the malfunction flags is shown in Fig. 10 for each condition discussed above.

Claims

1. A relay terminal array having a plurality of relays, each of said plurality of relays having a relay coil such that excitation of said relay coil causes a relay contact, said relay terminal array comprising:

   a current detection circuit (10) for detecting the presence or absence of a current in a load circuit of said relays and outputting detection signals,
   a transmission control circuit (4) for comparing said detection signals from said current detection circuit with a state signal from each of said relay coils, to determine if a malfunction has occurred in said relays, said transmission control circuit outputting a malfunction detection signal when a malfunction has occurred, and
   a switch (11_1, 11_2, 11_3, 11_4) for preventing said transmission control circuit from outputting said malfunction signal.

2. A relay terminal array as claimed in claim 1, wherein said current detection circuit (10) comprises:

   a magnetic flux detection circuit (21) for detecting magnetic flux generated by said current in said load circuit and to output a magnetic flux detection signal;
   a constant-voltage circuit (22) for providing a constant drive voltage to said magnetic flux detection circuit;
   an amplifier circuit (23) for amplifying said magnetic flux detection signal from said magnetic flux detection circuit and outputting an amplified detection signal; and
   a comparator circuit (24) for comparing said amplified detection signal from said amplifier circuit with a reference voltage to determine the presence or absence of said current in said load circuit and outputting a current detection signal, wherein said detection signals comprise said magnetic flux detection signal, said amplified detection signal, and said current detection signal.

3. A relay terminal array as claimed in claim 2, wherein said magnetic flux detection circuit (21) comprises:

   a detection coil (9) connected serially to said load circuit of said relay; and
   a magneto-electric converter element (HE) for detecting magnetic flux generated by said current in said load circuit.

4. A relay terminal array as claimed in claim 2, said relay terminal array further comprising a smoothing circuit (25) for smoothing said current detection signal outputted by said comparator circuit (24).

5. A relay terminal array as claimed in any of the preceding claims, said relay terminal array further comprising a plurality of display means (LED3, LED4, LEDS, LED6) corresponding to said plurality of relays for displaying whether a malfunction has occurred in each of said relays, said display means being activated by said malfunction detection signal from said transmission control circuit (4).

6. A relay terminal array as claimed in any of the preceding claims, said relay terminal array further comprising a driver-receiver circuit (3) for transmitting said malfunction detection signal to a monitoring center.

Patentansprüche

1. Relaisanschlußfeld mit einer Anzahl von Relais, wobei jedes der Anzahl von Relais eine Relaiswicklung derart aufweist, daß eine Erregung der Relaiswicklung einen Relaiskontakt bewirkt, wobei das Relaisanschlußfeld

   eine Stromnachweisschaltung (10) zum Nachweisen des Vorhandenseins oder Fehlens eines Stroms in einer Lastschaltung der Relais und Ausgeben von Nachweissignalen,
   eine Datenübertragungssteuerschaltung (4) zum Vergleichen der Nachweissignale der Stromnachweisschaltung mit einem Zustandssignal einer jeden der Relaiswicklungen, um festzustellen, ob eine Fehlfunktion in den Relais aufgetreten ist, wobei die Datenübertragungssteuerschaltung ein Fehlfunktionsnachweissignal ausgibt, wenn eine Fehlfunktion aufgetreten ist, und

einen Schalter (11_1, 11_2, 11_3, 11_4) zur Verhinderung, daß die Datenübertragungssteuerschaltung ein Fehlfunktionssignal ausgibt, aufweist.

2. Relaisanschlußfeld nach Anspruch 1, wobei die Stromnachweisschaltung (10)

eine Magnetflußnachweisschaltung (21) zum Nachweisen von durch den Strom in der Lastschaltung erzeugtem magnetischen Fluß und zum Ausgeben eines Magnetflußnachweissignals,
eine Konstantspannungsschaltung (22) zur Lieferung einer konstanten Ansteuerspannung an die Magnetflußnachweisschaltung,
eine Verstärkerschaltung (23) zum Verstärken des Magnetflußnachweissignals der Magnetflußnachweisschaltung und Ausgeben eines verstärkten Nachweissignals, und
eine Komparatorschaltung (24) zum Vergleichen des verstärkten Nachweissignals der Verstärkerschaltung zur Feststellung des Vorhandenseins oder Fehlens des Stroms in der Lastschaltung und Ausgeben eines Stromnachweissignals aufweist,
wobei die Nachweissignale das Magnetflußnachweissignal, das verstärkte Nachweissignal und das Stromnachweissignal umfassen.

3. Relaisanschlußfeld nach Anspruch 2, wobei die Magnetflußnachweisschaltung

eine in Reihe an die Lastschaltung des Relais angeschlossene Nachweisspule (9) und
ein magnetoelektrisches Umwandlungselement (HE) zum Nachweisen von durch den Strom in der Lastschaltung erzeugtem magnetischem Fluß aufweist.

4. Relaisanschlußfeld nach Anspruch 2, wobei das Relaisanschlußfeld ferner eine Glättungsschaltung (25) zum Glätten des von der Komparatorschaltung (24) ausgegebenen Stromnachweissignals aufweist.

5. Relaisanschlußfeld nach irgendeinem der vorstehenden Ansprüche, wobei das Relaisanschlußfeld ferner eine Anzahl von der Anzahl von Relais entsprechenden Anzeigemitteln (LED3, LED4, LED5, LED6), ob eine Fehlfunktion in den einzelnen Relais aufgetreten ist, aufweist, wobei die Anzeigemittel durch das Fehlfunktionnachweissignal der Datenübertragungssteuerschaltung (4) aktiviert werden.

6. Relaisanschlußfeld nach irgendeinem der vorstehenden Ansprüche, wobei das Relaisanschlußfeld ferner eine Treiber-Empfängerschaltung (3) zum Übertragen des Fehlfunktionnachweissignals an ein Überwachungszentrum aufweist.

Revendications

1. Réseau de bornes de relais comportant une pluralité de relais, chacun parmi ladite pluralité de relais ayant une bobine de relais telle que l'excitation de ladite bobine de relais provoque un contact de relais, ledit réseau de bornes de relais comprenant :

- un circuit de détection de courant (10), pour détecter la présence ou l'absence d'un courant dans un circuit de charge desdits relais, et délivrer en sortie des signaux de détection,
- un circuit de commande de transmission (4) pour comparer lesdits signaux de détection dudit circuit de détection de courant à un signal d'état provenant de chacune desdites bobines de relais, pour déterminer si un dysfonctionnement s'est produit dans lesdits relais, ledit circuit de commande de transmission délivrant en sortie un signal de détection de dysfonctionnement lorsqu'un dysfonctionnement s'est produit, et
- un commutateur (11_1, 11_2, 11_3, 11_4), pour empêcher ledit circuit de commande de transmission de délivrer en sortie ledit signal de dysfonctionnement.

2. Réseau de bornes à relais selon la revendication 1, dans lequel ledit circuit de détection de courant (10) comprend :

- un circuit de détection de flux magnétique (21), pour détecter le flux magnétique généré par ledit courant dans ledit circuit de charge, et pour délivrer en sortie un signal de détection de flux magnétique ;
- un circuit à tension constante (22), pour fournir une tension de commande constante audit circuit de détection de flux magnétique ;
- un circuit amplificateur (23), pour amplifier ledit signal de détection de flux magnétique provenant dudit circuit de détection de flux magnétique, et délivrer en sortie un signal de détection amplifié ; et
- un circuit comparateur (24), pour comparer ledit signal de détection amplifié provenant dudit circuit amplificateur à une tension de référence, pour déterminer la présence ou l'absence dudit courant dans ledit circuit de charge, et délivrer

en sortie un signal de détection de courant,

dans laquelle lesdits signaux de détection comprennent ledit signal de détection de flux magnétique, ledit signal de détection amplifié et ledit signal de détection de courant.

3. Réseau de bornes de relais selon la revendication 2, dans laquelle ledit circuit de détection de flux magnétique (21) comprend :

- une bobine de détection (9), connectée en série audit circuit de charge dudit relais ; et
- un élément convertisseur magnétoélectrique (HE), pour détecter le flux magnétique généré par ledit courant dans ledit circuit de charge.

4. Réseau de bornes de relais selon la revendication 2, ledit réseau de bornes de relais comprenant en outre un circuit de lissage (25), pour lisser ledit signal de détection de courant délivré en sortie par ledit circuit comparateur (24).

5. Réseau de bornes de relais selon l'une quelconque des revendications précédentes, ledit réseau de bornes de relais comprenant en outre une pluralité de moyens d'affichage (LED3, LED4, LED5, LED6), correspondant à ladite pluralité de relais, pour afficher le fait qu'un dysfonctionnement a eu lieu dans chacun desdits relais, lesdits moyens d'affichage étant activés par ledit signal de détection de dysfonctionnement provenant dudit circuit de commande de transmission (4).

6. Réseau de bornes de relais selon l'une quelconque des revendications précédentes, ledit réseau de bornes de relais comprenant en outre un circuit de commande-récepteur (3), pour transmettre ledit signal de détection de dysfonctionnement à un centre de surveillance.

FIG. 1

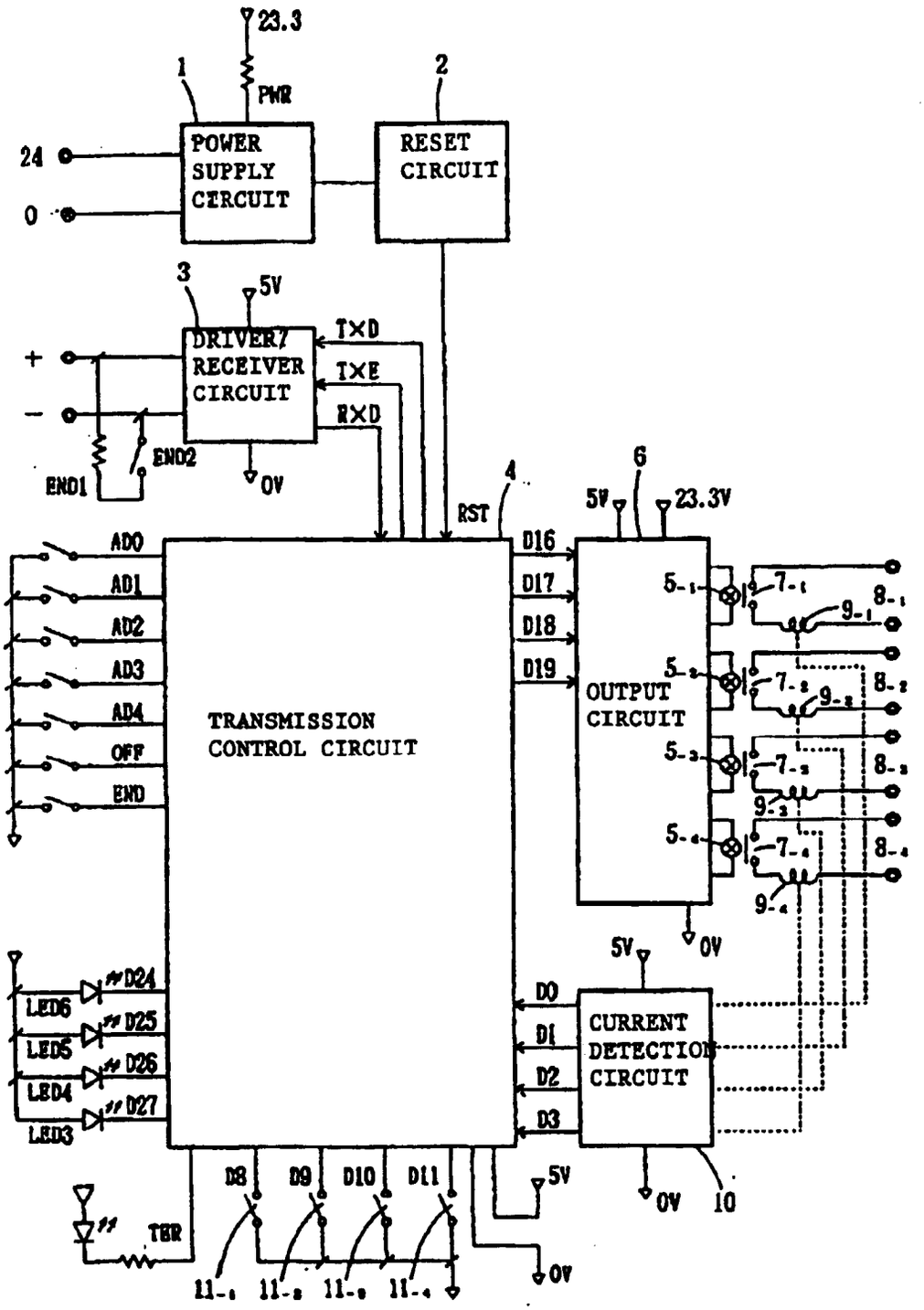

23.3
1
PWR
2
24
0
POWER SUPPLY CIRCUIT
RESET CIRCUIT
3
5V
DRIVER/ RECEIVER CIRCUIT
TXD
TXE
RXD
+
−
END1
END2
0V
4
RST
6
5V
23.3V
AD0
AD1
AD2
AD3
AD4
OFF
END
TRANSMISSION CONTROL CIRCUIT
D16
D17
D18
D19
OUTPUT CIRCUIT
5-1
5-2
5-3
5-4
7-1
7-2
7-3
7-4
8-1
8-2
8-3
8-4
9-1
9-2
9-3
9-4
5V
0V
D0
D1
D2
D3
CURRENT DETECTION CIRCUIT
LED6
LED5
LED4
LED3
D24
D25
D26
D27
THR
D8
D9
D10
D11
11-1
11-2
11-3
11-4
5V
0V
10

FIG. 2

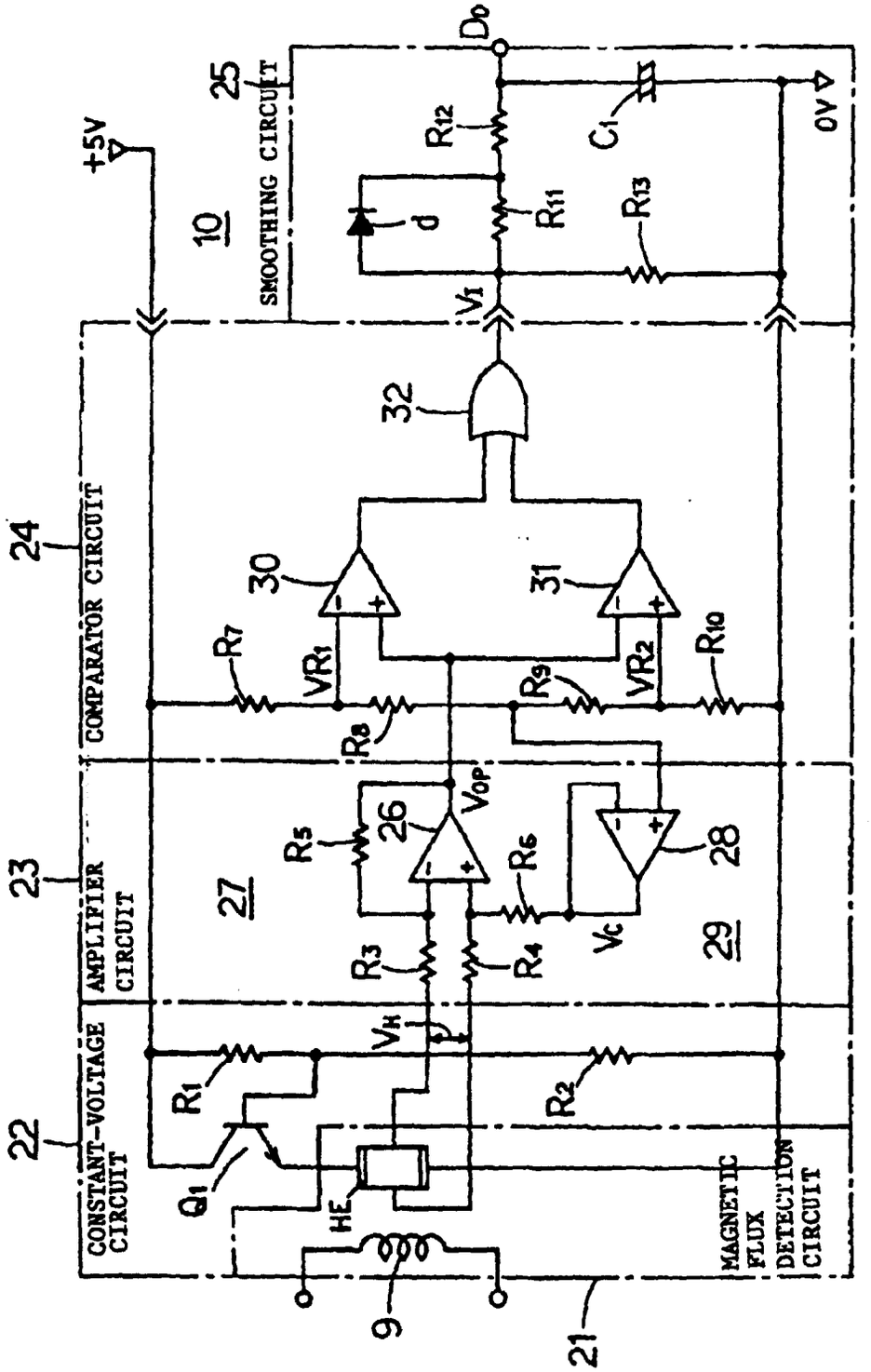

+5V
0V
Do
25
SMOOTHING CIRCUIT
10
R12
R11
R13
C1
d
V1
32
24
COMPARATOR CIRCUIT
30
31
R7
VR1
R8
R9
VR2
R10
23
AMPLIFIER CIRCUIT
27
29
VOP
26
28
R5
R6
R3
R4
Vc
22
CONSTANT-VOLTAGE CIRCUIT
VH
R1
R2
Q1
HE
9
21
MAGNETIC FLUX DETECTION CIRCUIT

FIG. 3a

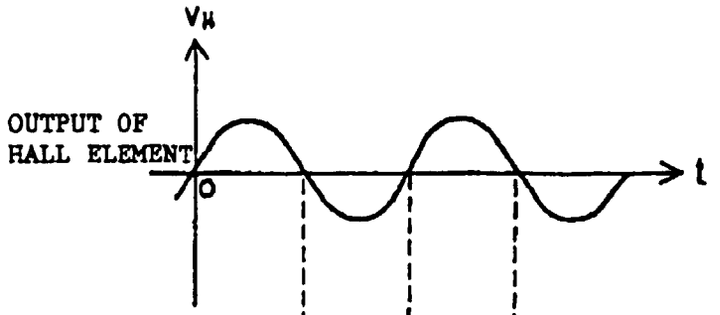


FIG. 3b

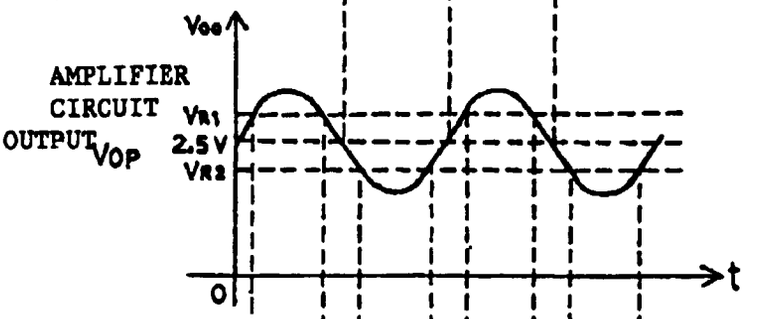


FIG. 3c

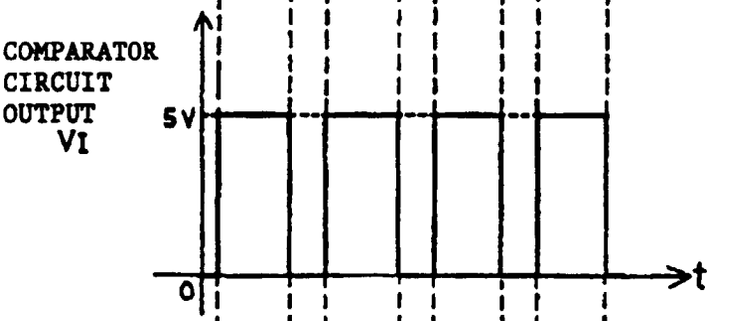


FIG. 3d

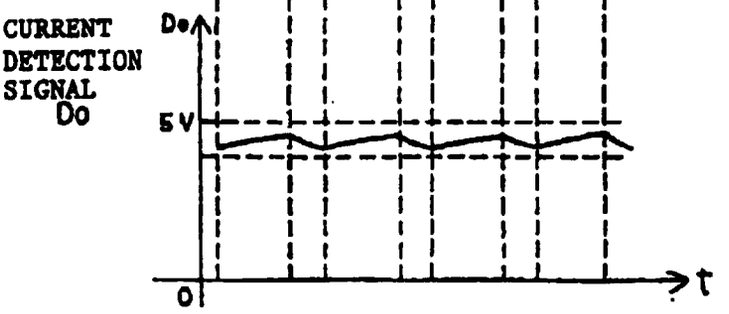


FIG. 4

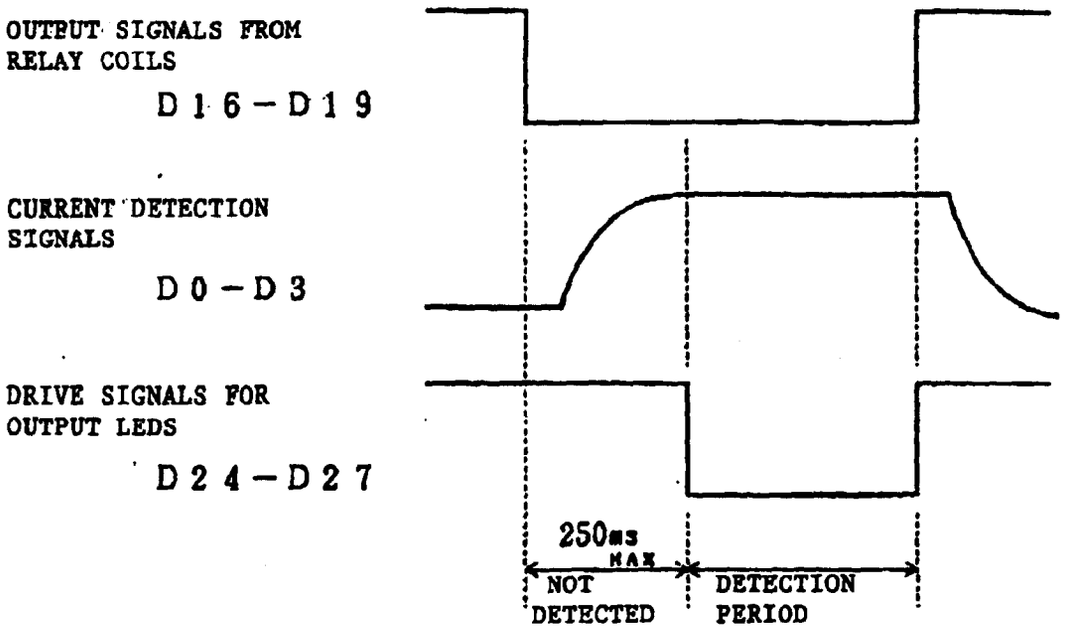

NORMAL ON STATE
OUTPUT SIGNALS FROM RELAY COILS
D16-D19
CURRENT DETECTION SIGNALS
D0-D3
DRIVE SIGNALS FOR OUTPUT LEDS
D24-D27
250ms MAX
NOT DETECTED
DETECTION PERIOD

FIG. 5

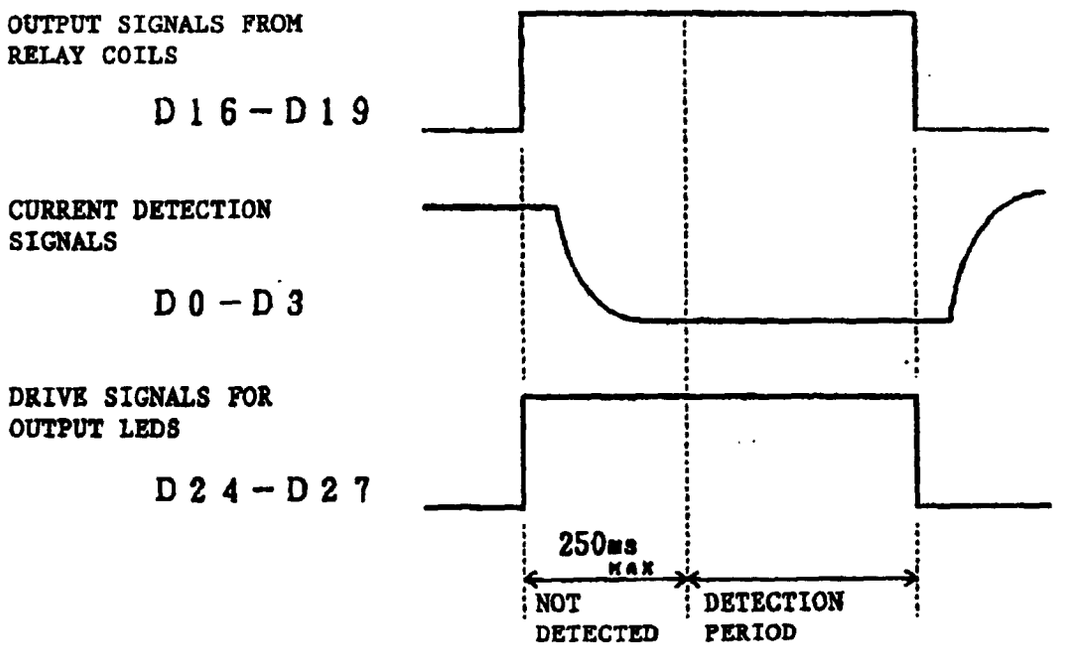

NROMAL OFF STATE
OUTPUT SIGNALS FROM RELAY COILS
D16-D19
CURRENT DETECTION SIGNALS
D0-D3
DRIVE SIGNALS FOR OUTPUT LEDS
D24-D27
250ms MAX
NOT DETECTED
DETECTION PERIOD

FIG. 6

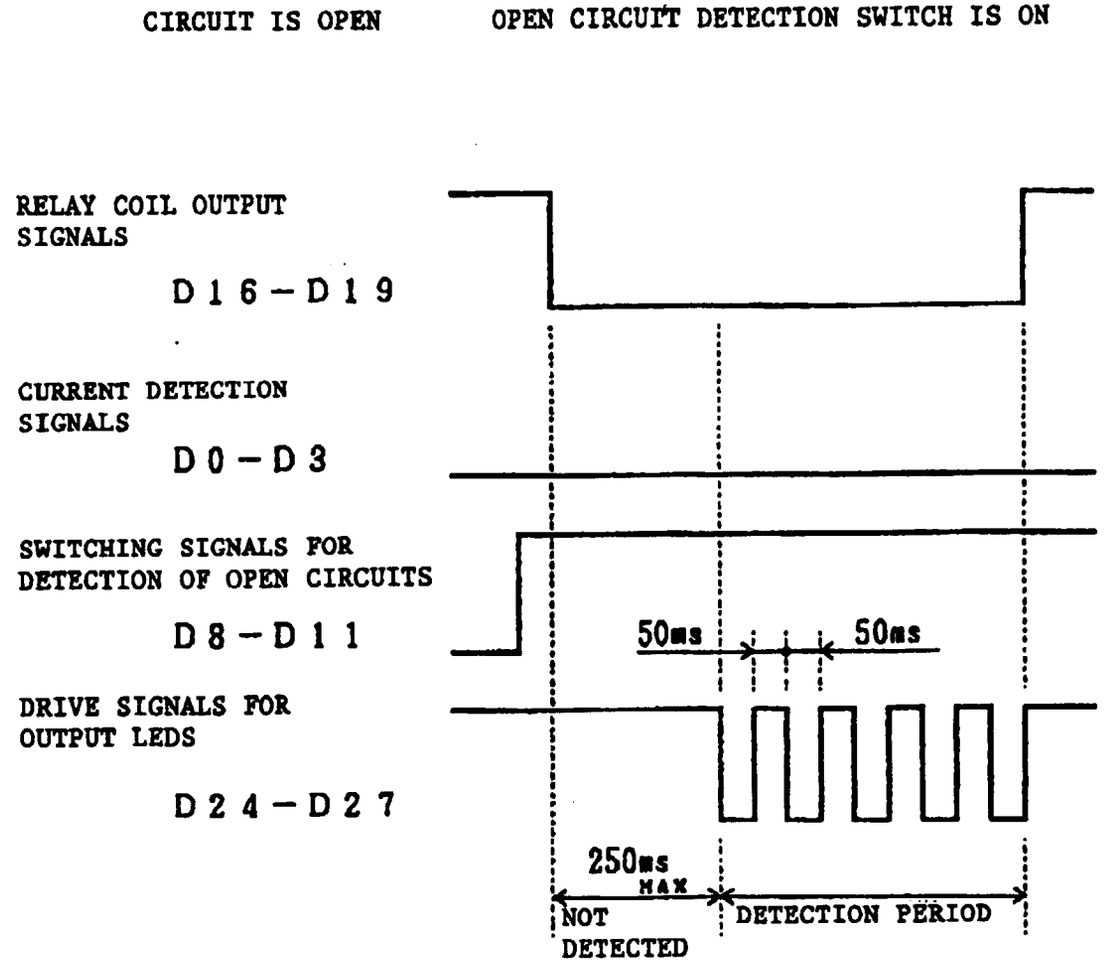
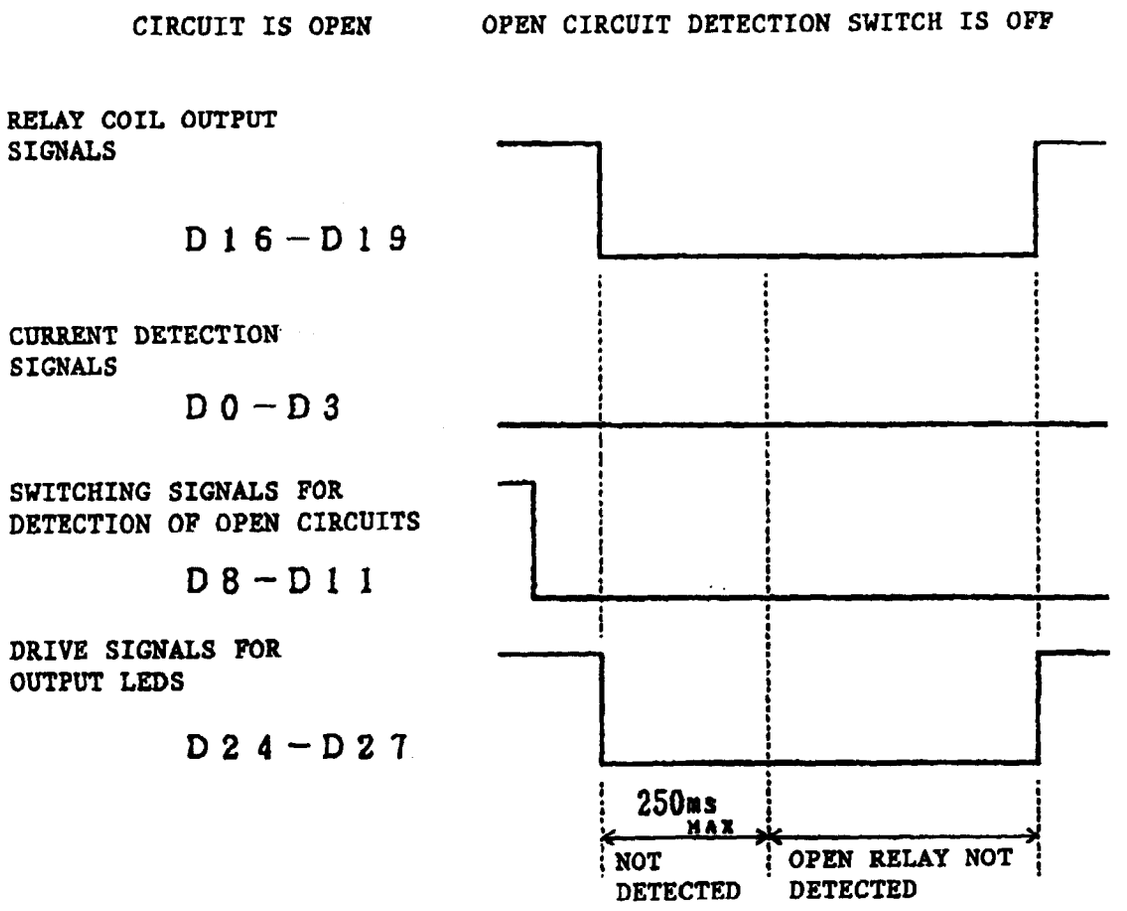

CIRCUIT IS OPEN
OPEN CIRCUIT DETECTION SWITCH IS ON
RELAY COIL OUTPUT SIGNALS
D16 – D19
CURRENT DETECTION SIGNALS
D0 – D3
SWITCHING SIGNALS FOR DETECTION OF OPEN CIRCUITS
D8 – D11
50ms
50ms
DRIVE SIGNALS FOR OUTPUT LEDS
D24 – D27
250ms MAX
NOT DETECTED
DETECTION PERIOD

FIG. 7


CIRCUIT IS OPEN
OPEN CIRCUIT DETECTION SWITCH IS OFF
RELAY COIL OUTPUT SIGNALS
D16 – D19
CURRENT DETECTION SIGNALS
D0 – D3
SWITCHING SIGNALS FOR DETECTION OF OPEN CIRCUITS
D8 – D11
DRIVE SIGNALS FOR OUTPUT LEDS
D24 – D27
250ms MAX
NOT DETECTED
OPEN RELAY NOT DETECTED

CIRCUIT IS OPEN, DETECTION SWITCH THROWN
DURING DETECTION PERIOD

FIG. 8a
RELAY COIL OUTPUT
SIGNALS

D16 – D19

FIG. 8b
CURRENT DETECTION
SIGNALS

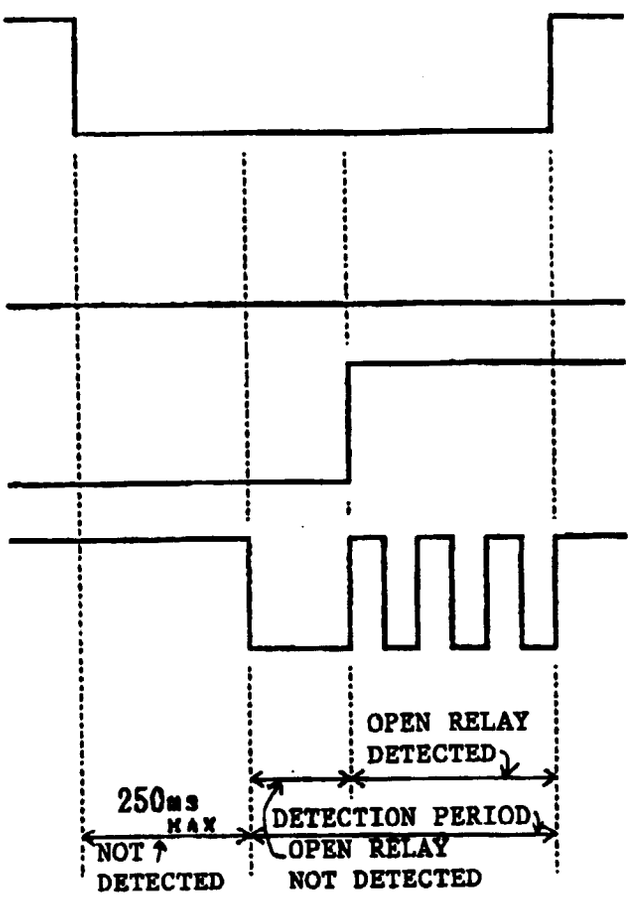
D0 – D3

FIG. 8c
SWITCHING SIGNALS FOR
OPEN CIRCUIT DETECTION

D8 – D11

FIG.8d
DRIVE SIGNALS FOR OUTPUT
LEDS

D24 – D27



CIRCUIT IS SHORTED

FIG. 9a
RELAY COIL OUTPUT SIGNALS
D16 – D19

FIG. 9b
CURRENT DETECTION SIGNALS
D0 – D3

FIG. 9c
DRIVE SIGNALS FOR OUTPUT LEDS
D24 – D27

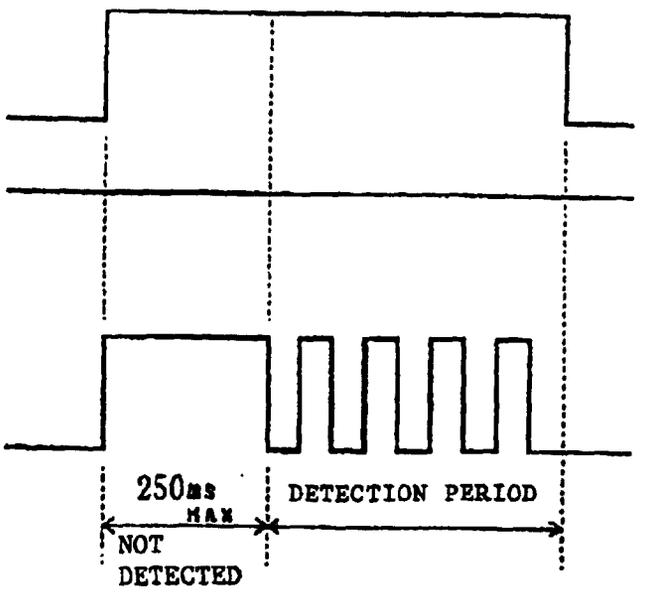


FIG. 10

RELAY	LOAD CURRENT	DETECTION SWITCH FOR OPENING CIRCUIT	LED DISPLAY	MALFUNCTION FLAG
ON	> 0.5A	※	ON	0
OFF	< 0.5A	※	OFF	0
ON	< 0.5A	ON	FLASHING	1
ON	< 0.5A	OFF	ON	0
OFF	> 0.5A	※	FLASHING	1

※ DON'T CARE