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(58) Field of search
H3T

(54) Trigger circuit

(57) A monostable trigger circuit comprises transistors (TR2 and TR3) arranged with their collectors and bases interconnected. The collector of the transistor TR2 is connected to the base of transistor TR3 via a capacitor (C2), the main current path of a grounded base transistor (TR1) and resistive means (R_2, R_3). The collector of transistor TR3 is connected to the base of transistor TR2 via resistive means R6, R7).

In the stable state all the transistors are OFF, the capacitor C2 is charged, and the output (13) is LOW. A positive pulse input to the base of TR2 switches it ON, which in turn lowers the voltage at points A and B and so switches TR1 ON so that C2 can discharge via R2 R3, which in turn switches TR3 ON making the output (13) high. Thus all three transistors are latched ON. When C2 has discharged sufficiently TR1 switches OFF, followed by TR3 (making the output 13 low again) and TR2.

The components C1 C3 and R4 serve to reduce noise, and the diode D1 is optional.

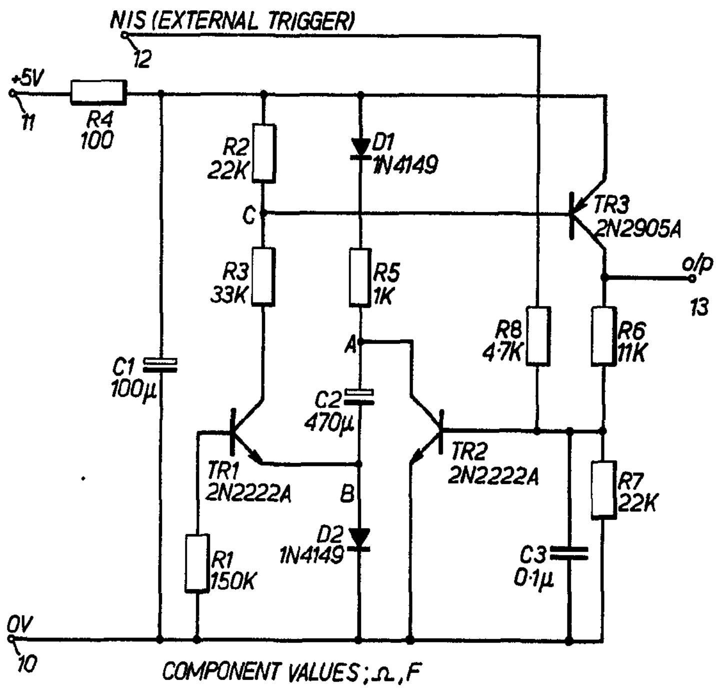

FIG. 1.

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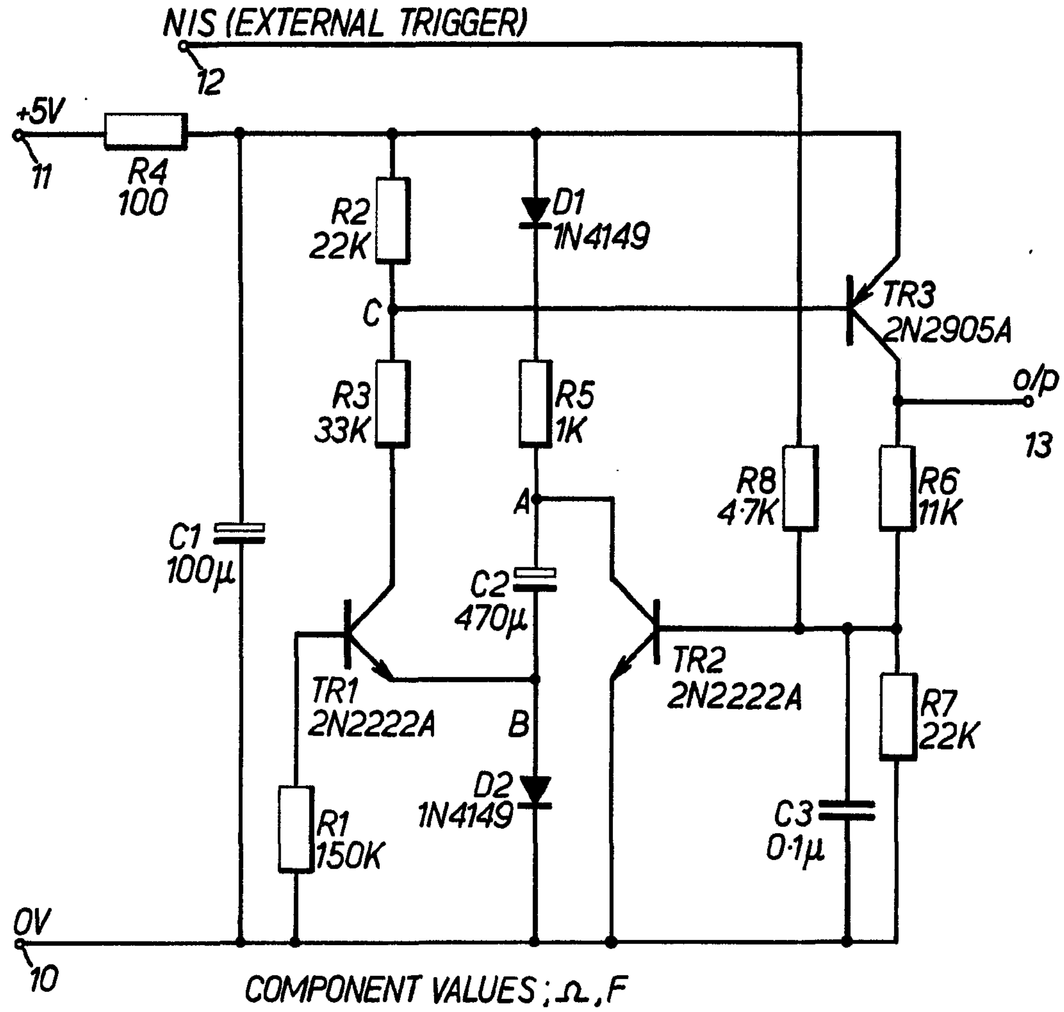

N/S (EXTERNAL TRIGGER)
12
+5V
11
R4
100
R2
22K
D1
1N4149
C
TR3
2N2905A
R3
33K
R5
1K
o/p
13
A
R8
4·7K
R6
11K
C1
100µ
C2
470µ
TR1
2N2222A
TR2
2N2222A
B
R7
22K
D2
1N4149
R1
150K
C3
0·1µ
0V
10
COMPONENT VALUES; Ω, F

FIG. 1.

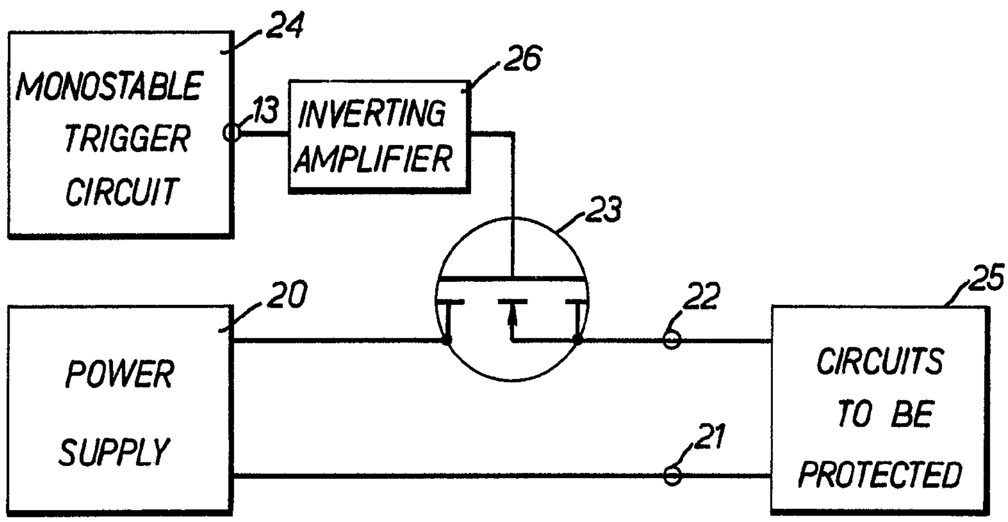
24
MONOSTABLE
TRIGGER
CIRCUIT
13
INVERTING
AMPLIFIER
26
23
20
POWER
SUPPLY
22
21
25
CIRCUITS
TO BE
PROTECTED

FIG.2.

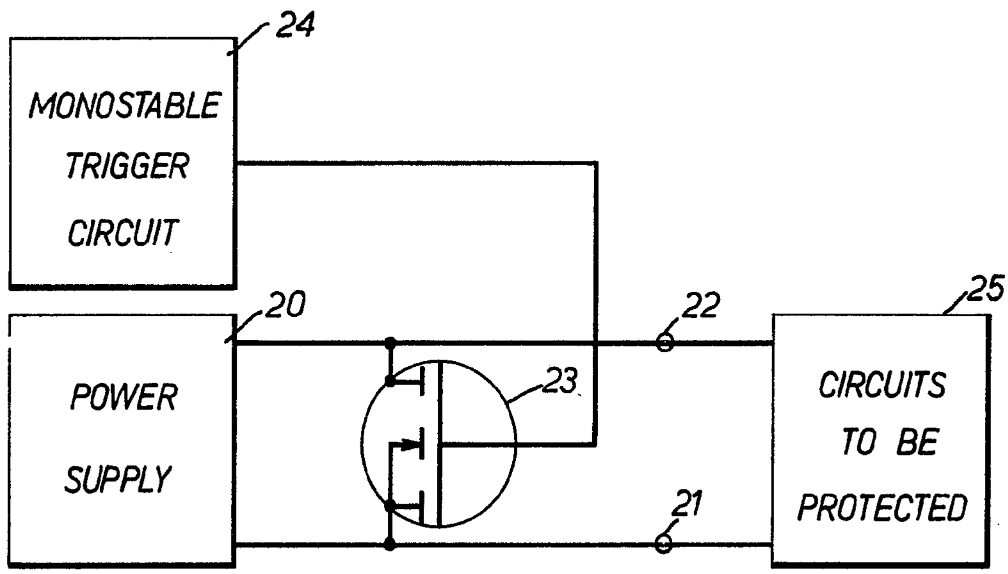
24
MONOSTABLE
TRIGGER
CIRCUIT
20
POWER
SUPPLY
23
22
21
25
CIRCUITS
TO BE
PROTECTED

FIG.3.

SPECIFICATION

Trigger circuit

This invention relates to trigger circuits and more particularly to a monostable trigger circuit which is triggered by gamma radiation and which is suitable for switching off a power supply.

Transistor circuitry, particularly NMOS circuitry, is easily destroyed by the effects of radiation resulting from a nuclear explosion. The major damage to NMOS devices is in the form of ionisation, which changes the device threshold level to such an extent that the device will not function properly. The degree of ionisation occuring in these devices is a factor of the total accumulated gamma dose received. Such circuitry is less susceptible to damage if the supply of power is removed. Therefore by switching off the power a few microseconds after the initial leading edge of a gamma pulse, ionisation will be appreciably reduced (since the accumulated gamma dose is absorbed over a period of several seconds).

The invention seeks to provide a trigger circuit capable of detecting the onset if gamma radiation, which is suitable for switching off a power supply for a predetermined time interval until the radiation has passed.

According to the invention there is provided a monostable trigger circuit comprising first and second voltage supply lines, a biasing circuit connected between the supply lines and comprising a series arrangement of a first resistor, a capacitor and a diode connected in that order between the first and second supply lines with the diode arranged to be forward biased, a first transistor of one polarity type having its base electrode coupled with the second supply line via a second resistor and its emitter electrode coupled with the junction between the diode and the capacitor, a second transistor of said one polarity type having its collector electrode coupled with the junction between the capacitor and the first resistor and its emitter electrode coupled with the second supply line, a third transistor of opposite polarity type having its base electrode coupled with the collector electrode of the first transistor via a first resistive means, its emitter electrode coupled with the first supply line and its collector electrode coupled with the base electrode of the second transistor via a second resistive means.

The first resistive means may comprise a voltage divider connected between the collector electrode of the first transistor and the first supply line, the base electrode of the third transistor being coupled with a tapping point of the voltage divider.

The second resistive means may comprise a voltage divider connected between the collector of the third transistor and the second supply line, the base electrode of the second transistor being coupled with a tapping point of the voltage divider.

The circuit may include a second diode connected in the biasing circuit between the first supply line and the first resistor and arranged to be forward biased.

A capacitor may be coupled between the base electrode of the second transistor and the second supply line.

The transistors are preferably bipolar transistors.

According to another aspect of the invention a power supply circuit is provided with a switching device which is coupled with a circuit as previously defined and which is responsive thereto to disable the supply of power for a predetermined interval in response to exposure to gamma radiation.

The switching device may be connected in series with one of the output supply lines of the power supply and be switched to its non conductive state by the monostable trigger circuit in response to exposure to gamma radiation. Alternatively, if the power supply has an overload protection circuit, the switching device may be connected in parallel with the output supply lines of the power supply and be switched to its conductive state by the monostable trigger circuit in response to gamma radiation.

In a particularly advantageous form of the invention the switching device is a HEXFET.

In order that the invention and its various other preferred features may be understood more easily, embodiments thereof will now be described, by way of example only, with reference to the drawings, in which:-

Figure 1 is a circuit diagram of a trigger circuit constructed in accordance with the invention;

Figure 2 is a schematic diagram of a power supply circuit constructed in accordance with the invention and employing a series switching element, and

Figure 3 is a schematic diagram of an alternative configuration of power supply circuit constructed in accordance with the invention and employing a parallel switching element.

Referring now to Figure 1 the monostable trigger circuit comprises three bipolar transistors TR1, TR2 and TR3. The first transistor TR1 has its base electrode connected to a zero volt d.c. supply line 10 via a resistor R1 and its collector electrode connected to a 5 volt positive supply line 11 via a potential divider circuit formed by resistors R2 and R3. The 5V supply line is smoothed by means of a resistor R4 and shunt capacitor C1 which together form a low pass filter.

A timing circuit is provided by a series arrangement between lines 11 and 10 comprising a diode D1, a resistor R5, a capacitor C2 and another diode D2 connected in that order with the diodes being arranged to be forward biased so that a current flows through the series arrangement between lines 11 and 10. The emitter electrode of TR1 is coupled to the junction between capacitor C2 and diode D2 (point B).

The second transistor T2 has its collector electrode connected to the junction between resistor R5 and capacitor C2 (point A) and its emitter electrode connected to line 10.

The third transistor has its emitter electrode connected to supply line 11, its collector electrode connected to line 10 via a voltage divider formed by resistors R6 and R7, the junction of which is coupled to the base electrode of transistor TR2, and its base electrode coupled to the junction between resistors R2 and R3 (point C). The base of transistor TR2 is decoupled to the line 10 via a capacitor C3 and is connected to a test terminal 12 via a resistor R8. An output 13 from the circuit is coupled to the emitter of TR3. The following components may be omitted in certain circumstances as they are not essential to the working of the circuit:- C1, C3, R4, R8, D1. C1, C3 & R4 serve to reduce noise. The operation of the circuit is as follows:-

In the untriggered state, point A is at +5V, B is at 0V, C is at +5V and all of the transistors TR1, TR2 and TR3 are non conductive or "off" and the output at terminal 13 is low. When a positive test pulse is applied to the base of TR2 it becomes conductive i.e. it is turned "on". This pulls the voltage of point A down towards 0V, which in turn causes the voltage at point B to approach −5V. The base-emitter junction of TR1 is now forward biased and so turned on which causes the voltage at point C to drop. Due to the Vbe of TR3, point C drops by 0.7V to +4.3V. TR3 is therefore turned on which in turn causes the voltage on the base of TR2 to become high and also produces a positive edge/level on the output 13. This regenerative action latches all the transistors on.

The voltage at point B begins to rise slowly as the charge on capacitor C2 discharges through resistors R3 and R2. After about 10 seconds the voltage at point B rises sufficiently to turn off TR1. The point C therefore rises to +5V causing TR3 to turn off. This in turn causes TR2 to turn off and the output on terminal 13 to go low. The capacitor C2 is then charged via the rsistor R5 until point A is at +5V again.

The input 12 is for test purposes and the test pulse purely simulates the effect of gamma radiation incident on the circuit. The circuit is a discrete monostable which is triggered by induced photocurrents in response to the leading edge of a gamma radiation pulse resulting from a nuclear explosion. The monostable stays in the switched state for 10 seconds with the component values indicated and this is sufficient to stop any appreciable total dose of gamma radiation building up whilst the circuitry is powered.

The output from the monostable can be used to shut down a power supply feeding electronic circuitry which might otherwise be damaged by the gamma radiation and this utilisation is illustrated in Figures 2 and 3.

The drawing of Figure 2 shows a power supply 20 having a pair of output lines one of which is connected directly to an output terminal 21 and the other of which is connected to an output terminal 22 via a HEXFET 23. The gate electrode of the HEXFET is connected via an inverting amplifier 26 to output terminal 13 of a monostable circuit as shown in Figure 1. The output of the monostable circuit in its normal state is normally low. This low output is converted to a high output by the inverting amplifier 26 which high output serves to trigger the HEXFET on and permit the supply of output current to load circuits 25 to be protected. When a gamma wave is received the monostable output voltage goes high, the output of the inverting amplifier 26 goes low and the HEXFET is switched off so that current supply to the circuits 25 is prevented for a period of 10 seconds thereby protecting the circuit until the gamma radiation has passed.

The circuit of Figure 3 employs a power supply 20 having current overload protection e.g. fold back current limiting, and employs a HEXFET in parallel with the output from the power supply to provide the so called "crow bar" effect. The gate electrode is coupled with the output 13 of the monostable 24. In the normal state the output of the inverting amplifier is low and the HEXFET is off so that an output from the power supply 20 is provided to load circuits 25 to be protected. Upon receipt of gamma radiation, the output of the monostable 24 becomes high and triggers the HEXFET into the on state thereby short circuiting the power supply such that its output voltage falls to zero.

With the component values shown in the circuit diagram a response time with a test trigger pulse has been measured as 7 microseconds. This reduces to 5 microseconds when triggered by gamma radiation at a dose rate of 8×10^6 Rads/sec. The reduction is because photocurrents caused by the radiation cause all transistors to switch simultaneously.

The circuit and power supply is susceptible of various modifications and changes within the scope of the claims e.g.

1. The circuit of Figure 1 could be produced employing P.N.P. transistors for TR1 and TR2 and NPN transistors for TR3 with appropriate polarity supply lines.
2. Although HEXFETS are preferred for the switching devices, in view of their stable operating parameters in the presence of nuclear radiation, alternative switching devices can be employed in the arrangement of Figure 3 e.g. thyristors or transistors.
3. A single monostable circuit can be employed to protect systems having many circuits with a variety of supplies. Protection could be accomplished by having an appropriate HEXFET in each supply line controlled from the same monostable circuit.
4. The arrangement is particularly valuable in the protection of total dose sensitive NMOS devices, "latch up" prone CMOS and Schottky TTL circuitry.

CLAIMS

1. A monostable trigger circuit comprising first and second voltage supply lines, a biasing circuit connected between the supply lines and comprising a series arrangement of a first resistor, a capacitor and a diode connected in that order between the first and second supply lines with the diode arranged to be forward biased, a first transistor of one polarity type having its base electrode coupled with the second supply line via a second resistor and its emitter electrode coupled with the junction between the diode and the capacitor, a second transistor of said one polarity type having its collector electrode coupled with the junction between the capacitor and the first resistor and its emitter electrode coupled with the second supply line, a third transistor of opposite polarity type having its base electrode coupled with the collector electrode of the first transistor via a first resistive means, its emitter

electrode coupled with the first supply line and its collector electrode coupled with the base electrode of the second transistor via a second resistive means.

2. A circuit as claimed in claim 1, wherein the first resistive means comprises a voltage divider connected between the collector electrode of the first transistor and the first supply line and the base electrode of the third transistor is coupled with a tapping point of the voltage divider.

3. A circuit as claimed in claim 1 or 2, wherein the second resistive means comprises a voltage divider connected between the collector of the third transistor and the second supply line and the base electrode of the second transistor is coupled with a tapping point of the voltage divider.

4. A circuit as claimed in any one of the preceding claims, including a second diode connected in the biasing circuit between the first supply line and the first resistor and arranged to be forward biased.

5. A circuit as claimed in any one of the preceding claims, including a capacitor coupled between the base electrode of the second transistor and the second supply line.

6. A circuit as claimed in any one of the preceding claims wherein the transistors are bipolar transistors.

7. A monostable trigger circuit substantially as described herein with reference to Figure 1 of the drawings.

8. A power supply circuit provided with a switching device coupled with a circuit as claimed in any one of claims 1 to 7 and responsive thereto to disable the supply of power for a predetermined interval in response to exposure to gamma radiation.

9. A power supply circuit as claimed in claim 8, wherein the switching device is connected in series with one of the output supply lines of the power supply and is switched to its non conductive state by the monostable trigger circuit in response to exposure to gamma radiation.

10. A power supply circuit as claimed in claim 8 having an overload protection circuit and wherein the switching device is connected in parallel with the output supply lines of the power supply and is switched to its conductive state by the monostable trigger circuit in response to gamma radiation.

11. A power supply circuit as claimed in claim 8, 9 or 10 wherein the switching device is a HEXFET.

12. A power supply circuit substantially as described herein with reference to Figure 2 of the drawings.

13. A power supply circuit substantially as described herein with reference to Figure 3 of the drawings.

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