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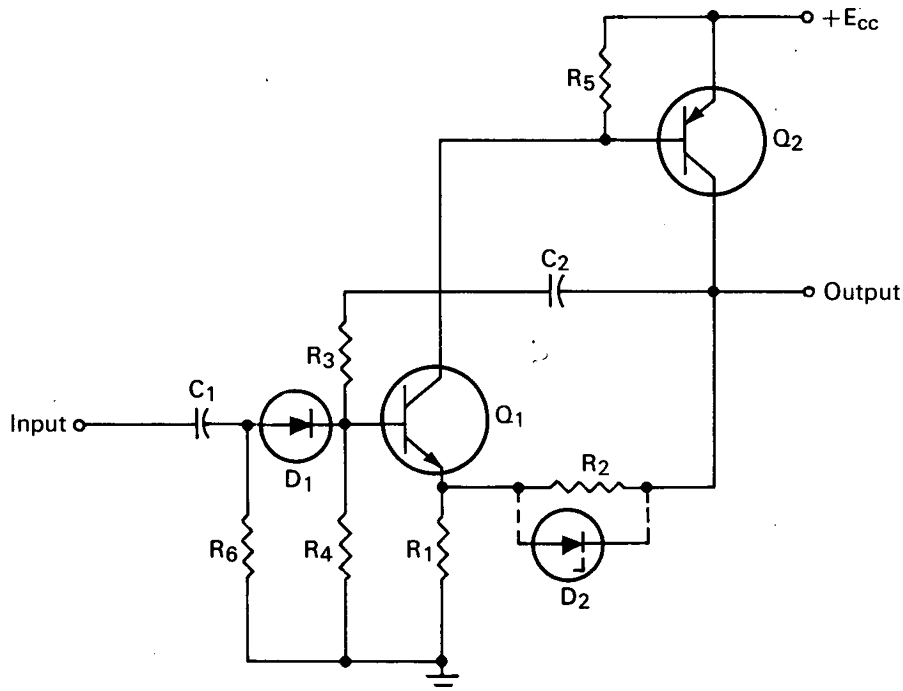
NASA TECH BRIEF

Complementary Monostable Circuits Achieve Low Power Drain and High Reliability



The problem:

To design a complementary monostable multivibrator having minimum power dissipation and maximum reliability.

The solution:

A two-transistor multivibrator that minimizes the use of components that are subject to environmental change or other unpredictable behavior. The circuit has virtually no power drain in standby operation.

How it's done:

The two transistors are normally off in the absence of a biasing network to turn them on. When a positive trigger pulse is applied to the input coupling network (C_1, R_6, D_1), both transistors turn on. Positive regeneration occurs because the input trigger pulse is amplified by the forward voltage gain $[1 + R_2/R_1]$ of the circuit and fed back through C_2 to the base of Q_1 in phase with the input trigger pulse. If the attenuation of the amplified trigger pulse, approximately equal to $[R_4/R_3 + R_4]$, is small, regeneration is rapid. Q_2 is driven to saturation by Q_1. Regeneration will take place if $[1 + (R_2/R_1)]\ [R_4(R_3 + R_4)] > 1$.

As C_2 begins to charge, the base voltage of Q_1 decreases exponentially until Q_2 comes out of saturation. Negative regeneration then occurs and the circuit

(continued overleaf)

turns off. The base voltage required to remove Q_2 from saturation is approximately the supply voltage divided by the forward gain $[E_{cc}/(1 + R_2/R_1)]$. In effect, a negative resistance of magnitude $[-R_1R_3/R_2]$ appears in parallel with the input impedance seen at the base of Q_1. If the resultant impedance is negative, switching takes place.

The output pulse width may be varied by changing the forward gain $[1 + R_2/R_1]$. The width may be changed by a factor of ten or more by varying R_2. Temperature compensation is obtained by inserting the proper thermistor in series with R_1.

Notes:

1. By placing a zener diode across R_2, the effects of power supply and beta variations are made negligible. The operation is the same as described above until the voltage across R_2 reaches the zener voltage, E_Z. At this time the forward gain is unity and regeneration ceases. Both Q_1 and Q_2 are then operating on the linear portion of their characteristic curves, provided the supply voltage is greater than $E_z (1 + R_4/R_3)$. The input impedance is now $\beta^2 R_1$. When the zener diode conducts, the voltage across R_3 and C_2 remains constant. The current through R_4 is essentially the current through R_3 and C_2, and is decreasing exponentially. When the current through R_1 decreases to where the zener can no longer conduct, negative regeneration takes place and the circuit turns off.
2. This circuit exhibits high rejection of spurious triggers, is easy to design, is capable of pulse widths of 0.5 microsecond, is easily temperature compensated, and has an easily controlled output width. It is, however, limited to low duty cycles. The addition of the zener diode makes the output pulse width independent of beta.
3. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland, 20771
   Reference: B66-10179

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C., 20546.

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