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DESIGNING TUNNEL DIODE MONOSTABLE CIRCUITS. -

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A NOMOGRAM FOR DESIGNING TUNNEL DIODE MONOSTABLE CIRCUITS†

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In this letter a simple nomogram is described useful for a straight design of tunnel diode monostable circuits (tdmc) with linear biasing (lb) and non linear biasing (nlb).

The nomogram is straight derived from theoretical calculations that will be published later. It refers to the two monostable circuits shown in fig. 1.

The monostable circuits are assumed to feed a non linear load.

The nomogram parameters are defined as follows:

$$K = L/(R_p^2 C); \quad R_p = V_p/I_p;$$

$$A = (V_{max}/V_p)S_f; \quad S_f = 5.88(V_p/V_{pp})$$

F_0 = frequency of operation = $1/T_0$,

where:

V_{pp} = the projected peak voltage;

V_p = the td peak voltage;

I_p = the td peak current;

C = the td capacitance (assumed constant and equal to the valley point value);

n = R_1/R_p ;

V_{max} = maximum output voltage;

j_0 = biasing current normalised to I_p ;

j_{in} = input pulse current normalised to I_p ;

T_0 = resolving time or duration time of the complete dynamic cycle.

The nomogram can solve the general problems of designing a tdmc. They can be stated in this way:

1. One wishes to run the tdmc up to a fixed operation frequency allowing for some variations of the typical parameters of the waveforms at the output. In the nomogram, fig. 2, it is taken into consideration only the maximum amplitude value of the output pulse.

By use of the nomogram, the problem can be solved choosing the circuit parameters between the set of values shown; that is, one can either first decide what maximum output amplitude one wants and then read the td constant $R_p C$ for such an operation; or, first choose the td (that is the constant $R_p C$) and then read the maximum output voltage obtainable from the circuit.

2. One possesses tunnel diodes with fixed $R_p C$; a set of allowable operation rates and output maximum amplitudes is attainable. Therefore one can first choose the operation rate and then obtain the maximum output amplitude; or, first choose the maximum output amplitude and then obtain the maximum operation rate.

Let us now give an example of the nomogram application:

Suppose we want to operate a nlb circuit up to 100 MHz. A straight line running parallel to the abscissa axis at 10 nsec marks off between the $K = \text{const.}$ and $A = \text{const.}$ lines the intervals:

$$10 < K < 10^4 \quad 3/S_f < A < 5.7/S_f.$$

Commercially available tunnel diodes have $R_p C$ constants ranging between 10^{-11} and 5×10^{-10} sec.

We chose a 1N3858 RCA td ($R_p C = 6.4 \times 10^{-11}$ sec). It allowed at the maximum frequency operation, a maximum output pulse amplitude of 5.3 which corresponds to $K = 120$.

This completely defines the circuit; in fact, being:

$$V_p = 7.5 \times 10^{-2} \text{ V}; \quad I_p = 10^{-2} \text{ A}; \quad S_f = 0.8;$$

we obtain:

$$A = 6.6 V_p; \quad L = 57 \text{ nH.}$$

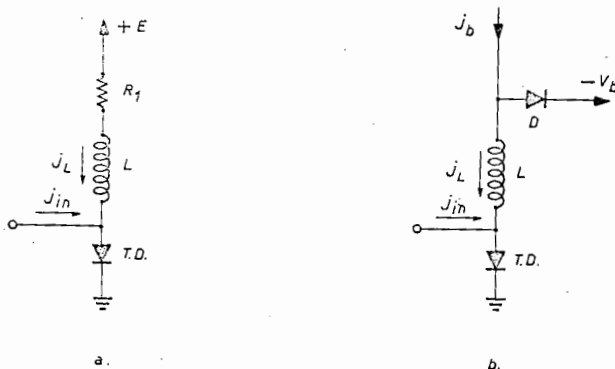


Fig. 1. Tunnel diode monostable in: a. linear biasing configuration; b. non linear biasing configuration.

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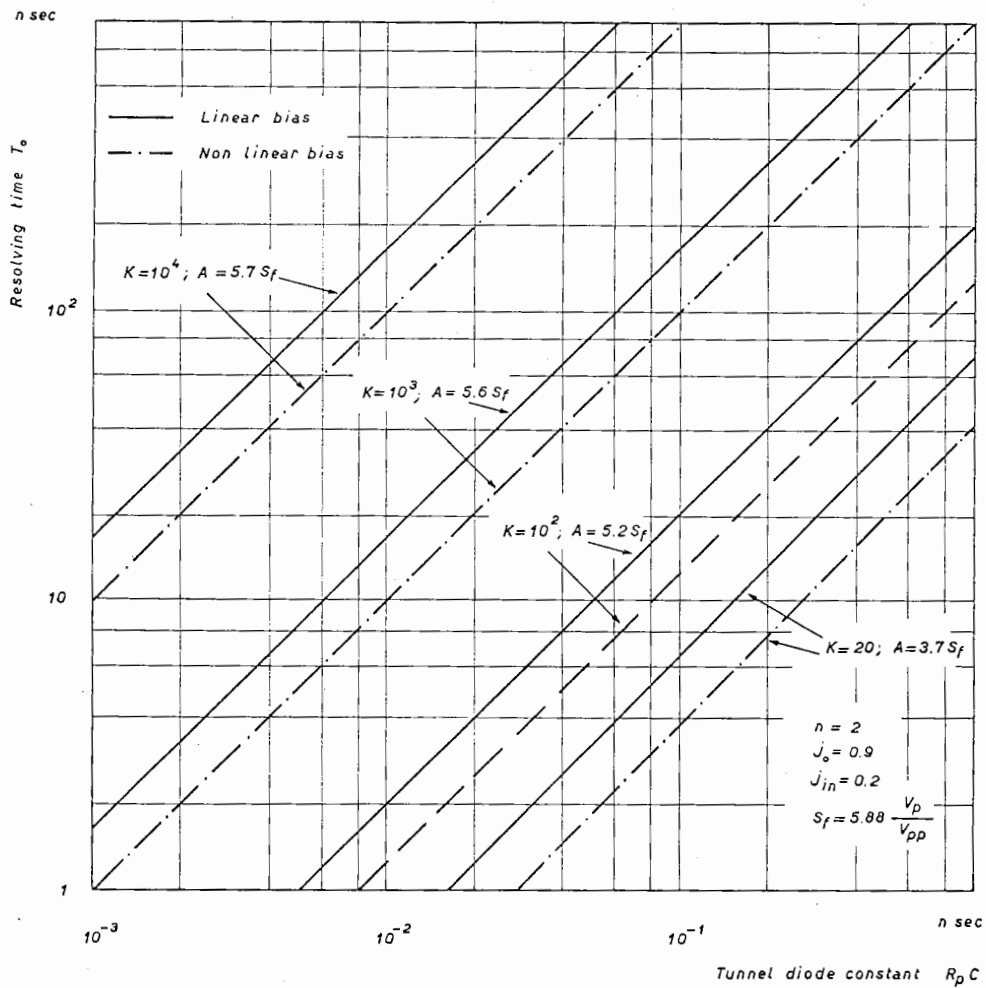


Fig. 2. Nomogram to design tunnel diode monostable circuits.

The biasing resistance must be chosen as $R_1 < 15 \Omega$.

For the unloaded circuit the duty cycle (the ratio W_0/T_0 where W_0 is the output pulse width; or $W_0 F_0$) is 40% for the condition of nlb and 20% for lb.

From the rule of thumb cited above the output pulse width may be expected to be 4 nsec.

If a load is present, W_0 and A will decrease, but the frequency of operation will be a little higher.