Formulas

The following formulas for resistor values in the astable configuration of a 555 timer are derived from one of many online calculators and are based on four parameters:

- *N, the base note of the scale $[Hz]$;*
- *D, the degree of the scale on $[0, 12]$;*
- *C_1, the capacitance $[F]$; and*
- *d, the duty cycle of the square wave ($> \frac{1}{2}$).*

$$T_H = \ln(2) \times (R_1 + R_2) \times C_1 \tag{1}$$

$$T_L = \ln(2) \times (R_2) \times C_1 \tag{2}$$

$$T = \frac{1}{\left(N \times 2^{\frac{D}{12}}\right)} \tag{3}$$

$$= T_H + T_L \tag{4}$$

$$= \ln(2) \times (R_1 + 2R_2) \times C_1 \tag{5}$$

$$\therefore (R_1 + 2R_2) = \boxed{\frac{1}{\left(\ln(2) \times \left(N \times 2^{\frac{D}{12}}\right) \times C_1\right)}} \tag{6}$$

$$d = \frac{T_H}{T_H + T_L} = \frac{(R_1 + R_2)}{(R_1 + 2R_2)} > \frac{1}{2} \tag{7}$$

$$d\,(R_1 + 2R_2) = (R_1 + R_2) \tag{8}$$

$$dR_1 + 2dR_2 = R_1 + R_2 \tag{9}$$

$$2dR_2 - R_2 = R_1 - dR_1 \tag{10}$$

$$(2d - 1)R_2 = (1 - d)R_1 \tag{11}$$

$$\therefore R_2 = \boxed{\frac{(1-d)}{(2d-1)}R_1} \tag{12}$$

$$(R_1 + 2R_2) = R_1 + 2\frac{(1-d)}{(2d-1)}R_1 \tag{13}$$

$$= \frac{(2d-1)}{(2d-1)}R_1 + \frac{(2-2d)}{(2d-1)}R_1 \tag{14}$$

$$= \frac{1}{(2d-1)}R_1 \tag{15}$$

$$\therefore R_1 = (2d-1)(R_1 + 2R_2) \tag{16}$$

$$= \boxed{\frac{(2d-1)}{\left(\ln(2) \times \left(N \times 2^{\frac{D}{12}}\right) \times C_1\right)}}\,\Omega \tag{17}$$

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