

### Formulas

The following formulas for resistor values in the astable configuration of a 555 timer are derived from one of many on-line 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 ( $> \frac{1}{2}$ ).

$$T_H = \ln(2) \times (R_1 + R_2) \times C_1 \quad (1)$$

$$T_L = \ln(2) \times (R_2) \times C_1 \quad (2)$$

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

$$= T_H + T_L \quad (4)$$

$$= \ln(2) \times (R_1 + 2R_2) \times C_1 \quad (5)$$

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

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

$$d(R_1 + 2R_2) = (R_1 + R_2) \quad (8)$$

$$dR_1 + 2dR_2 = R_1 + R_2 \quad (9)$$

$$2dR_2 - R_2 = R_1 - dR_1 \quad (10)$$

$$(2d - 1)R_2 = (1 - d)R_1 \quad (11)$$

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

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

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

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

$$\therefore R_1 = (2d - 1)(R_1 + 2R_2) \quad (16)$$

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