Symmetrical square wave

Patrick Knöbel

Just about anyone must be familiar with the NE555 by now. It is one of the most common components in do-it-yourself circuits. This IC, however, was not designed specifically to generate a clock signal, and certainly not one with a duty-cycle of 50%, although it is frequently used for that.

There are of course a number of circuit possibilities that could realise a duty ratio of 50%. **Figure 1** shows a solution that uses two diodes. Capacitor C is, via the diodes, always charged and discharged with the same resistor value, so there is no asymmetry and the duty-cycle stays at 50%. We can calculate the (clock) frequency as follows:

$$f = 1.44 / (2RC)$$

where $R_1 = R_2 = R$.
It is however not possible to calculate the frequency exactly because the forward voltage drops of the diodes are not known.

This and the fact that six parts are required make it worthwhile to think about another solution. The engineers that STMicroelectronics [1] thought the same.

Their data sheet for the NE555 contains a circuit that, for a clock generator with 50% duty-cycle, requires only three external components (see **Figure 2**).

The amount of time that the output is high (t_1), is calculated as follows:

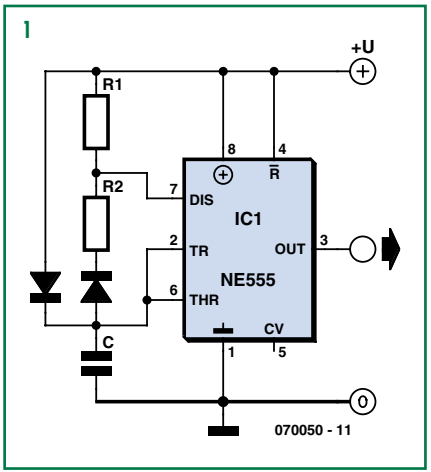
$$t_1 = 0.693 R_1 C$$

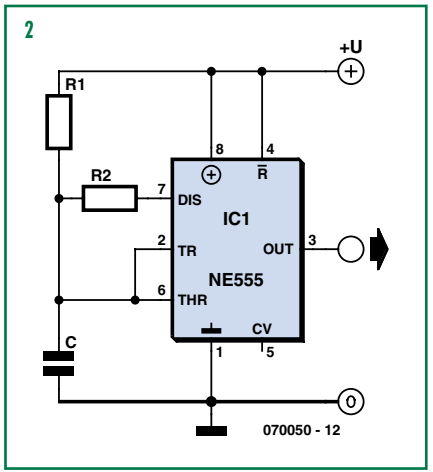
The time that the output is low (t_2), is a little more complicated:
$t_2 = (R_1 \times R_2) / (R_1 + R_2) \times C \times \ln((R_2 - 2R_1) / (2R_2 - R_1))$

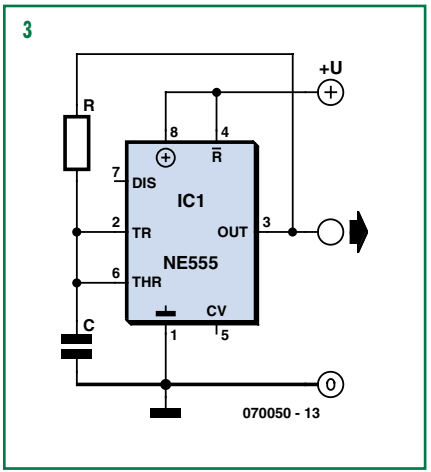
For a duty cycle of 50% it is true that $t_1 = t_2 = t$. The clock frequency is then:

$f = 1/2t$.

The disadvantage of this circuit is that it is not easy to select the values for the components. For example, R_2 may not be greater than $\frac{1}{2}R_1$.







So there is an opportunity to do better still. And this is shown in **Figure 3**. This extremely simple schematic shows a clock generator using an NE555 with a 50% duty ratio in its minimal form. It requires only three components in total, including the timer IC itself.

The frequency can be calculated with this formula:

$f = 0.72 / RC$

Where most people would normally use a D-flipflop, we solve that with this circuit using only a capacitor and a resistor. It is not likely to get much simpler than this.

(070050-I)

Links:

[1] www.st.com