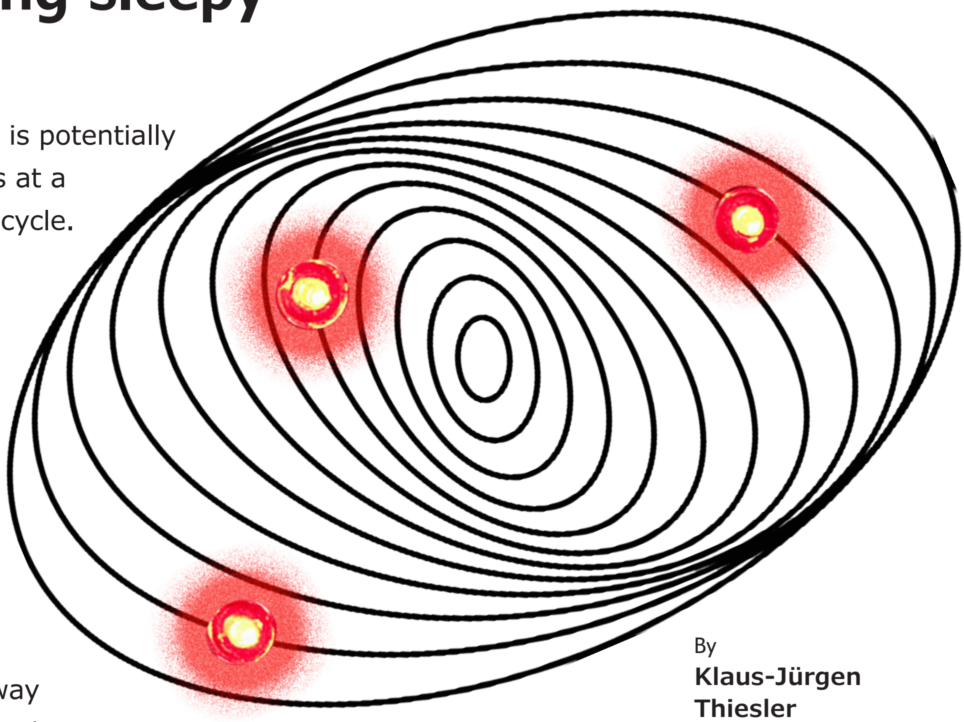
The Hypnotizer

Look into my LEDs… you are getting sleepy



Watching a single LED blink is potentially hypnotizing, even if it blinks at a fixed rate with a fixed duty cycle. That's promising for a set of three LEDs flashing in quasi random order with a constantly varying duty cycle. An out-of-body experience? Nirvana? Kobain? Maybe you just fall asleep. Anyway, the simple circuit presented in this **.**POST article will flash three LEDs in such a way that you can look at them for hours without ever getting bored.

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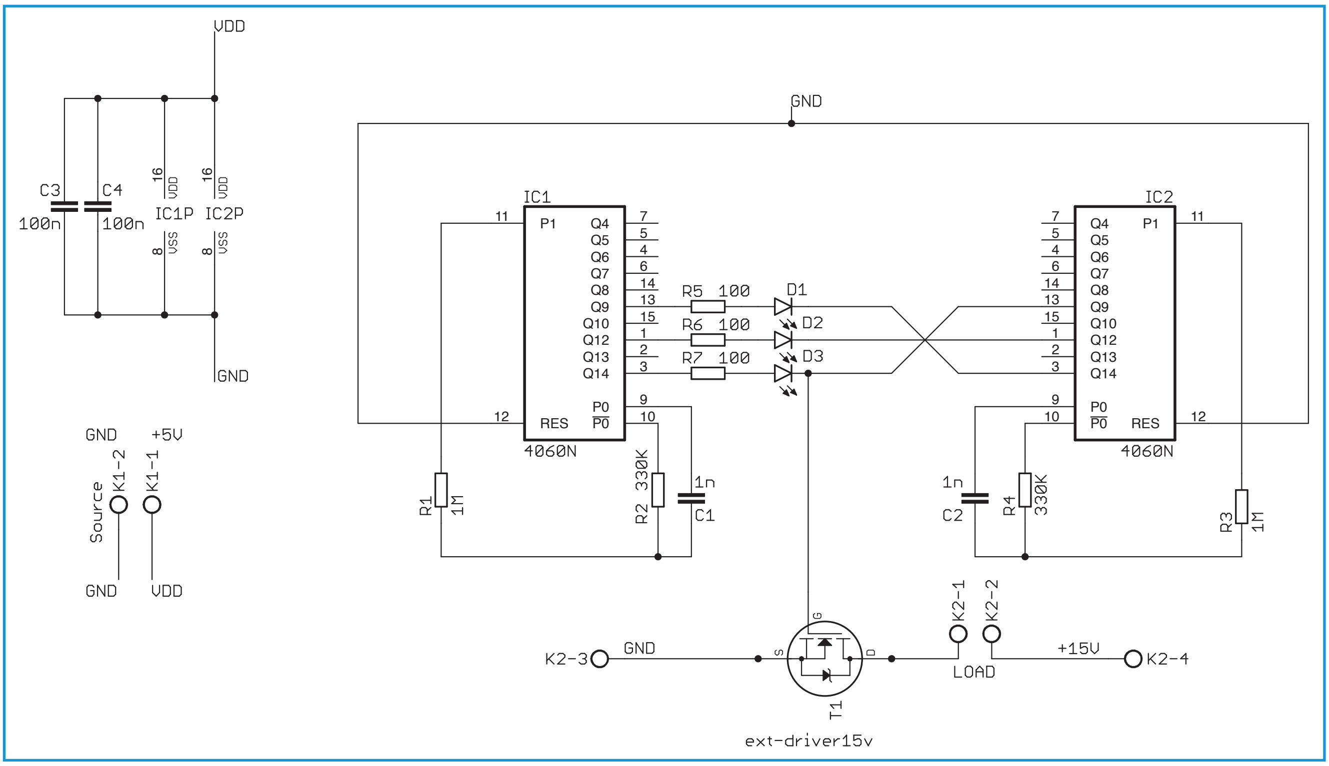
Theory vs. practice

The sun always shines on TV, and circuits always work on paper! Unfortunately, in reality that's not always the case. Knowledge and experience help when it comes to solve problems in the real world, and sometimes, as we will see, we can even exploit such issues to our advantage. For example, the circuit presented here doesn't really behave as it should in (naive) theory.

Before delving into the details, let's first have a look at the circuit diagram in **Figure 1**. IC1 and IC2 are type 4060 [1] binary counters/dividers/oscillators, configured as two identical pulse generators. Since both chips are connected to separate but identical RC networks, their output signals should be identical. Three outputs of one pulse generator are connected through LEDs to three outputs from the other generator. The LEDs will only light up when they are correctly polarized, which is the case when one generator output is logic Low and the other, logic High. The way the 4060s' counters outputs are interconnected here show just one example of the concept—other configurations are possible for sure.
MOSFET T1 is optional and may be used to power an external load.

Unexpected behavior is good behavior

As you may have guessed already, wiring the two oscillators this way will not result in a periodic LED sequence due to tolerances in the values of the parts used for the RC networks R1/R2/C1 and R3/R4/C2. As a result, the three LEDs will blink in a



seemingly random fashion, never repeating any apparent pattern.

After switching on the power supply, the LEDs will start blinking. An LED will only light up when one counter (IC1) has changed its output to a High level, while the output of the other (IC2) has a Low level. Even with well-matched values for the RC networks, it will only take a short time for the LEDs to start flashing in a seemingly random way.

When you mix two sine waves with two slightly different frequencies, an interference signal can be heard: a third sine wave with a frequency equal to the difference of the two input sine waves. The closer the two input frequencies, the lower the difference frequency will be. In acoustics, this difference frequency is called a *beat signal* [2]. A low beat frequency has a long period.

Here the situation is a bit more complicated because we are not mixing two sine waves but three times two square waves.

Since these square waves are almost synchronized to multiples of each other, three low-frequency beat signals at different but related frequencies will be created. We can use these signals to make LEDs flash in an apparently random manner.

When you restart the circuit, the LED sequence should be predictable. However, due to temperature variations and component tolerances, the pattern will divert quickly from the previous run. This makes it impossible to guess which LED will blink next, as is the time it will be on, and the time until another LED will light up next. When you stare at the LEDs too long there's a good chance you become hypnotized.

With the given values for R2/C1 (R4/C2) the oscillators IC1 and IC2 should run at about 1 kHz, but the exact value also depends on the brand of the type 4060 ICs. Make sure to use two chips from the same manufacturer for the highest precision. The ratio R1:R2 (R3:R4) determines the oscillator's duty cycle.

Figure 1.
Schematic of the Hypnotizer.

Sooo easy to build

This circuit can be easily built on a common breadboard. **Figure 2** depicts a simple wiring diagram which may be used as a guide. Furthermore, a compact circuit board has been designed to make building the Hypnotizer even easier. The Eagle PCB design files, as well as the .pdf artwork files, are available from the project page at Elektor.LABS [3].

We encourage you to give this circuit a try, as it's really fun to play around changing the values of the components and staring at the perpetually changing lights. But be careful! Never use this circuit in the company of other people or you risk becoming the victim of a YouTube loving prankster making you do weird things and act strangely in general while you are under hypnosis.

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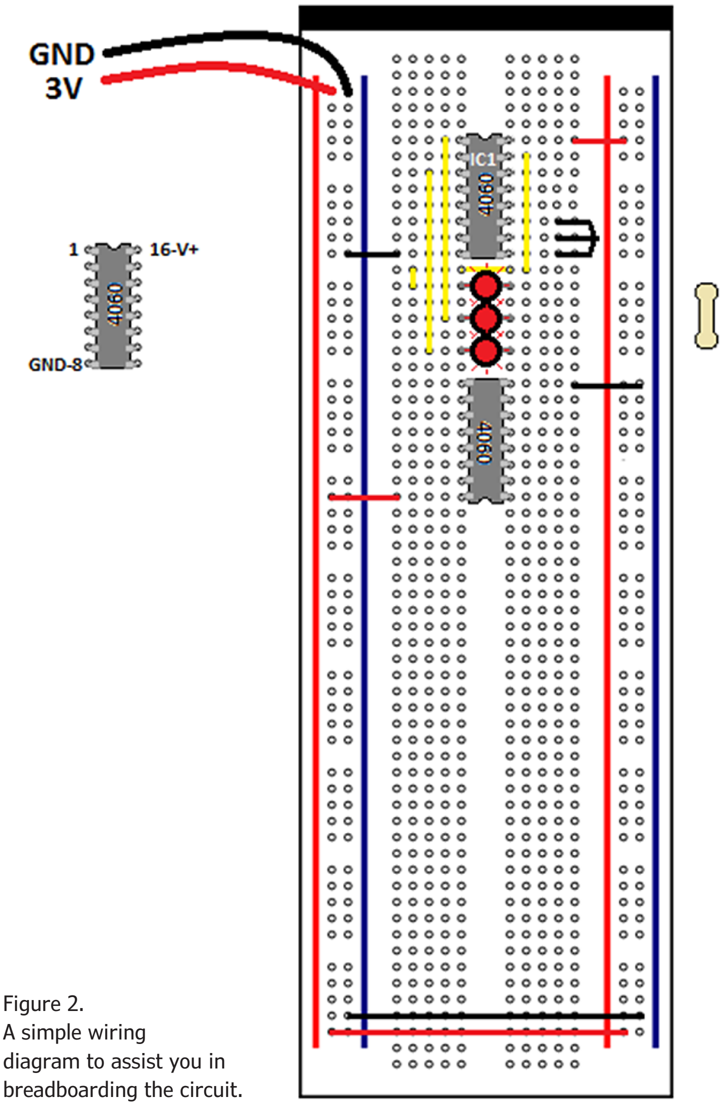

Figure 2.
A simple wiring diagram to assist you in breadboarding the circuit.

Internet Links

[1] http://bit.ly/16fL2JC

[2] http://en.wikipedia.org/wiki/Beat_%28acoustics%29

[3] http://www.elektor-labs.com/120470

COMPONENT LIST

Resistors

R1,R3 = 1MΩ, 0.25W, 1%
R2,R4 = 330kΩ, 0.25W, 1%
R5,R6,R7 = 100Ω, 0.25W, 1%

Capacitors

C1,C2 = 1nF, 63V, film dielectric
C3,C4 = 100nF, 63V, film dielectric

Semiconductors

T1 = MOSFET, N-channel, 200mA, 60V, TO-92
D1,D2,D3 = LED, 5mm, red
IC1,IC2 = 74HC4060, 5V, CMOS, DIP16