Low-power inverter using LM555 Timer IC

For Electroluminescent (EL) backlights and Fluorescent tubes

By Joshua D. Wyatt
Last updated 29 January 2007

Overview

This document describes a basic circuit that can be used to power high impedance, high voltage, low current devices such as EL backlights and fluorescent tubes.

This project got its genesis when I needed a simple, yet flexible inverter circuit for an EL backlight, using a 12 volt input. My specific need was to power the backlight for the wildly popular LCD-107 (specs) from All Electronics Corporation. However, this circuit is versatile enough that it should be able to power any EL strip or small (up to a few watts) fluorescent tube.

Why build instead of buy an inverter? Well, I actually bought one from one of the several surplus resale houses out there. It was apparently very poorly designed. I connected it to the backlight contacts, then to the +5V recommended, only to get a brief buzzing noise and some smoke for my trouble. I decided I could build a much more reliable, versatile inverter for just a few dollars (Total cost is only about $6 for the semiconductors and transformer at your local Radio Shack), and set out to do it.


Figure 1: The el-cheapo inverter

Approach

The data sheet for this display gave me an idea of the design goals for the EL backlight:

Parameter	Condition	Min	Typical	Max	Units
Voltage	f=400Hz	--	100	--	V RMS
Current	V=100V RMS, f=400Hz	--	2.9	--	mA RMS
Voltage	f=1kHz, 60 sec max	--	--	200	V RMS

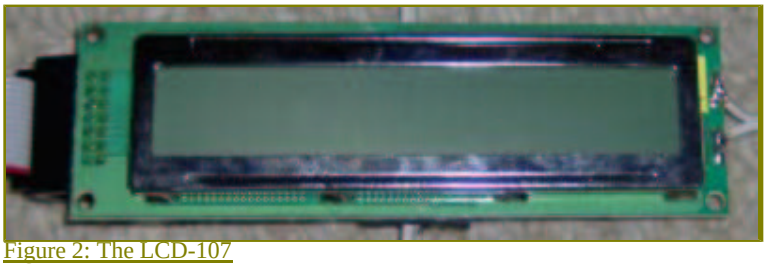
Figure 2: The LCD-107

It occurred to me that a simple 555 timer with a small step-up transformer should work well. The 555 timer is now ubiquitous, available on nearly any street corner via Radio Shack. For the transformer, many circuits use a filament transformer or other step-down transformer generally designed for use in a utility power supply. This wouldn't do - it would be too large and cumbersome for my needs, and besides, I didn't have a need for Big Power.

I'd had good luck in the past using 8 ohm to 1k ohm audio output transformers in "tickle stick" inverter-type applications, so I thought this might work if driven with a good oscillator.

Results

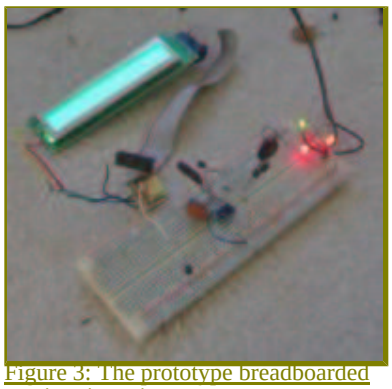
Figure 3: The prototype breadboarded version, in action

I initially setup the circuit for 400Hz operation, with the timer driving the transformer directly through a 47uF capacitor. This worked, although the display was fairly dim. After experimenting with various frequencies, I decided to add a medium-power transistor driver stage. This worked wonders! The base current and drive frequency were then tweaked to make the transistor run nice and cool, while maintaining optimum brightness on the backlight.

The final circuit parameters generate about 127 AC volts RMS, at about 2.5kHz. With these specifications, the transistor barely warms at all, and current consumption is about 110 mA at 12 volts input. The EL backlight is VERY bright!

Notice in the image to the left, the soft green-blue glow of the display. There are three LEDs (two Reds and a Green) attached to the power supply input to give an idea of relevant brightness.

Be aware that I used an old RF power transistor (a 2sc2078) I had in my junk box for Q1. However, the TIP31 should be a suitable, common replacement.

The 2sc2078 did not even require a heat sink with this design. The TIP31 is a slightly more rugged design, and might have slightly different electrical characteristics - notably, you might need to experiment a little with R3 by increasing value by a few K if the transistor gets too warm, or decrease the value by a few K if the transistor is cool but the display's too dim. See the circuit notes for more info.

Final Version

For the final version, I wanted to go from breadboard to perfboard, and make a few other changes. Because this was destined for a Media PC, I wanted to be able to power it from a standard ATX power supply. The power cord from a failed 80mm fan solved that problem; it has the requisite "in-line" Molex-style power connectors, with a tap from the 12 volt line.

I also wanted to make sure the power supply for the EL backlight could be placed with little consideration for the display location itself. A length of 18 gauge zip cord solved that.

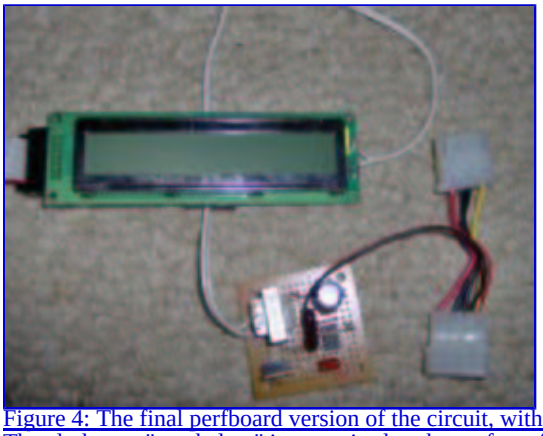

Figure 4: The final perfboard version of the circuit, with the LCD. The el-cheapo "smokeless" inverter is also shown for reference.

Figure 5: The el-cheapo side-by-side with the 555 inverter

The completed version is comparable in size, and quite superior in performance to the original el-cheapo. Best of all, this design is easy and fun to build, using readily available components. And look ma, no smoke!

Circuit Details

Schematic diagram (click for larger version):

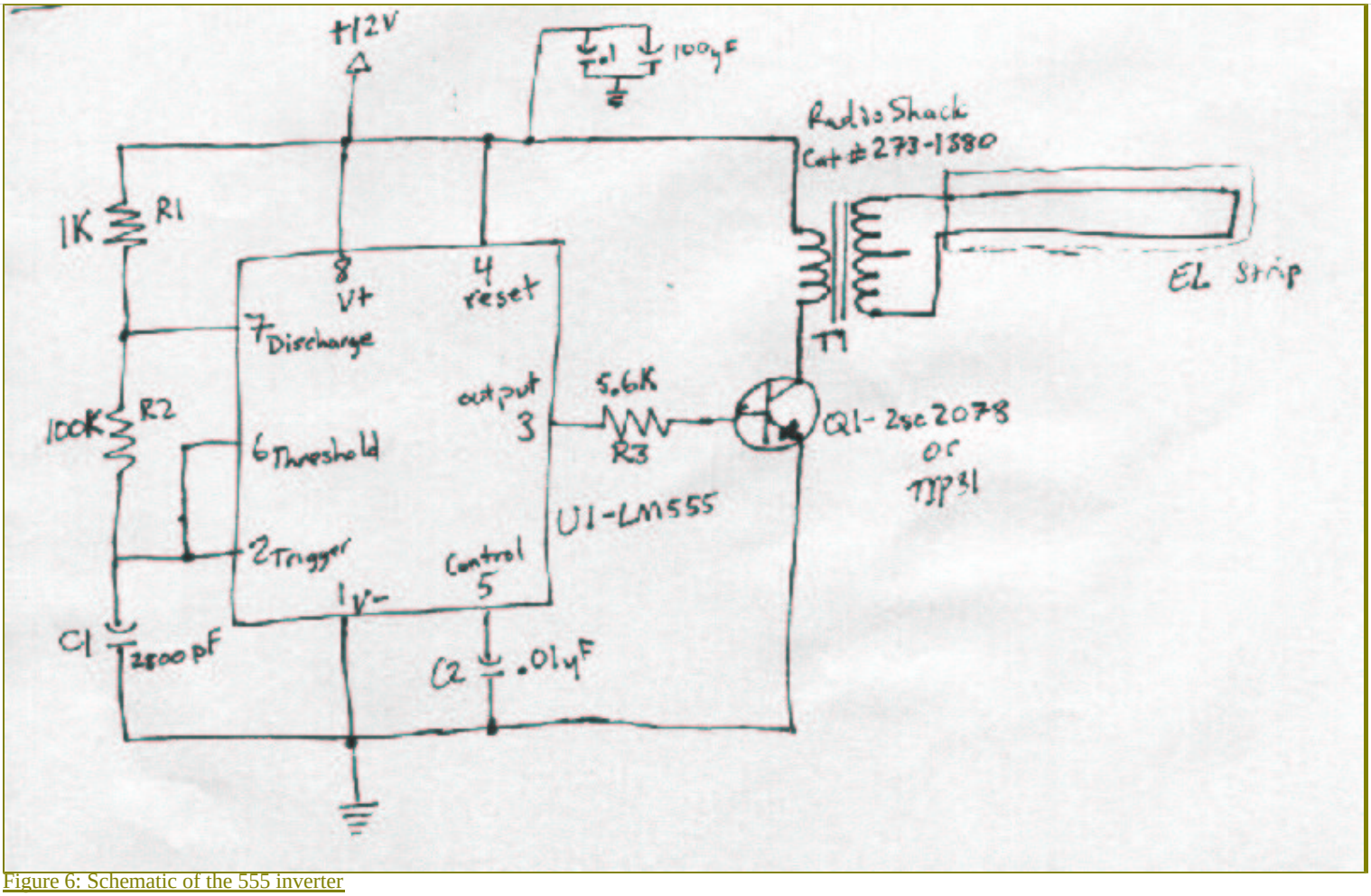

Figure 6: Schematic of the 555 inverter

Parts list	
Component	Description
U1	LM555 timer IC. Do not use CMOS. Radio Shack 276-1723 or equiv.
T1	8 ohm to 1k ohm audio output transformer. Radio Shack 273-1380 or equiv.
Q1	Medium-power NPN transistor; 2sc2078 or equiv (perhaps TIP31, Radio Shack 276-2017 or equiv.)
R1	1K ohm resistor
R2	100K ohm resistor
R3	5.6K ohm resistor
C1	2800pF capacitor (.002uF in parallel with .001uF will do)
C2	.01uF capacitor
C(bypass)	.1uF capacitor, in parallel with 100uF capacitor (top of schematic)
All resistors are 1/4 watt	

Circuit notes:

- It’s a good idea to include the bypass capacitors. This circuit can be noisy.
- Do not touch the output leads of the transformer. You have been warned.
- The transformer will very quietly "sing" at 2.5 to 3.0 kHz. This is normal.
- Experiment with the value of R3 to get the best tradeoff between brightness and transistor cool temperature.
- A PDF of this document can be found here.