

# Lecture 9. Flash Camera

## FLASH BULB

The flash bulb in throwaway cameras work by supplying a very high voltage (1-10 KV) across a bulb containing Xenon gas. The Xenon gas in the bulb is at a low pressure. In the at rest state the gas acts as an insulator. When a large voltage is applied to the bulb the gas becomes a conductor. A large current is passed through the gas causing the bright light.

## 1.5 VOLTS DC TO 2,000 VOLTS AC

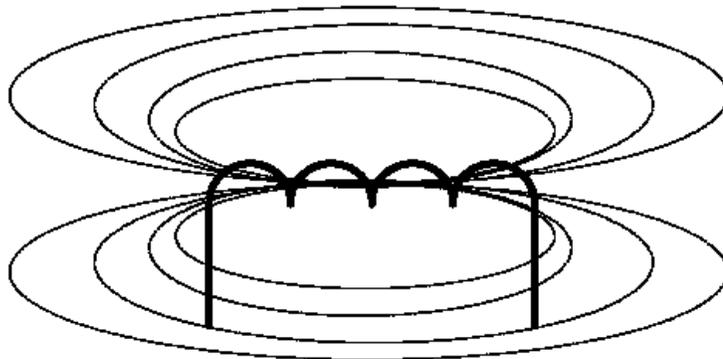
The battery that supplies power in the camera is a 1.5-volt AA battery. In order to get a large enough voltage to fire the flash bulb the battery voltage must be increased. The camera does this by first converting the DC voltage to AC by means of an internal oscillator. Once a sine wave is produced an electrical device called a transformer is used to increase the 1.5 VAC to  $\approx 320$ VAC.

## TRANSFORMER ACTION

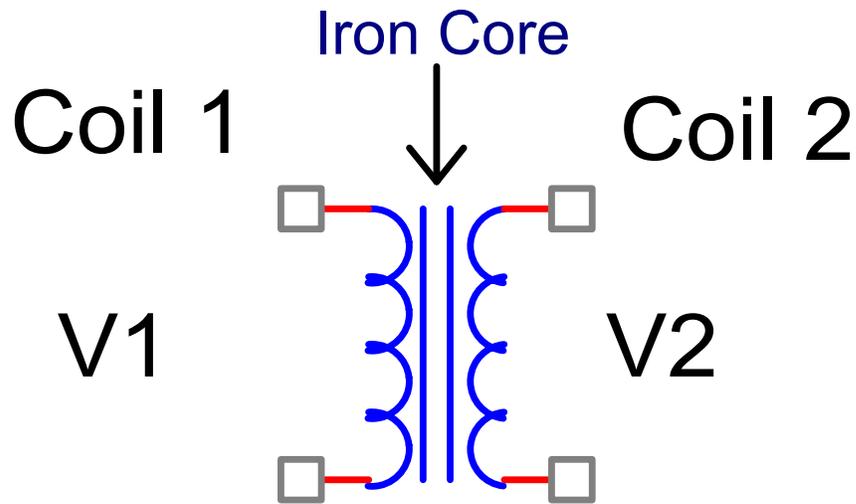
A transformer is an iron core wound with two coils of wire. It takes advantage of the fact that a magnetic field is created around a wire that is carrying current. If another wire is placed within a changing magnetic field a current is induced in the second wire. When the wire is wrapped to form a coil the magnetic field strength is increased.

A coiled wire is called an inductor. A constant voltage (DC) will create a constant magnetic field. A changing magnetic field will induce a current (AC) in another conductor.

## *A Coil of Wire*



MAGNETIC FIELDS IN A COIL



## TRANSFORMER

### TRANSFORMER BASICS

The AC voltage at V2 is related to the AC voltage at V1 by the ratio of coil windings, also called turns.

$$V_2 = NV_1 \therefore N \text{ is the coil ratio}$$

$$N = \frac{N_2, \text{ number of turns of coil \#2}}{N_1, \text{ number of turns of coil \#1}}$$

Since power is constant

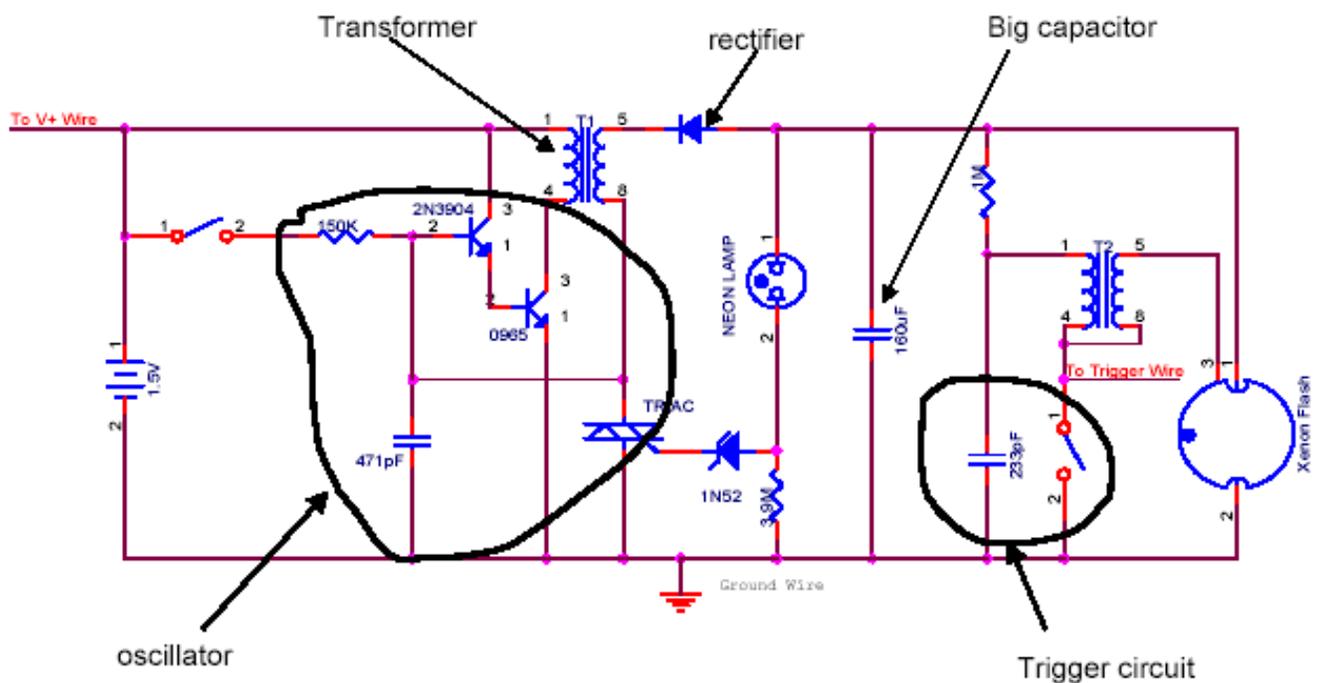
$$P = EI, \quad \text{if } E \uparrow, \text{ in a transformer } I \downarrow$$

For this application the 1.5 VDC is changed to 1.5 VAC by means of an oscillator circuit in the camera body. The transformer boosts that voltage to  $\approx 320$  VAC. As seen by the above equation, as the voltage increases at the output of a transformer the current decreases. Therefore, the transformer cannot provide the current needed to fire the Xenon bulb. The solution is to take the output of the transformer and charge a capacitor that can provide the current needed when it discharges. The output of the capacitor discharges to another transformer, which is connected to the flash bulb.

## FLASH CIRCUIT

The flash circuit has six major components:

- Oscillator – changes batter DC to AC
- Transformer – changes 1.5 VAC to 320 VAC
- Rectifier – converts AC to DC (positive)
- Capacitor – charges to 300+ volts DC
- Trigger – single pulse to flash the camera
- Flash – makes a bright light



### THE FLASH CAMERA CIRCUIT

#### HOW THE CIRCUIT WORKS

1. The switch is closed that applies the battery voltage to the oscillator.
2. The output of the oscillator is sent to the transformer converting 1.5VAC to 320VAC.
3. The rectifier converts 320VAC to 300+VDC.
4. The 160µf capacitor charges and the neon bulb lights. At the same time the 23,000pf capacitor charges.

5. When the trigger circuit fires, the high DC voltage on the 23,000pf capacitor discharges through the output transformer. Even though the signal to the output transformer is DC, the rate of change of voltage to the transformer is so fast that the transformer treats it as a dynamic signal and converts 300+VDC to >2,000 VAC. If you were to look at the signal sent to the flash bulb it would look like a damped sine wave. The bulb flashes within one or two half cycles of the output from the transformer.
6. The bulb flashes.

### LABORATORY CIRCUIT

The circuit you will build in the lab will have several features:

Create a trigger pulse every 7 seconds.

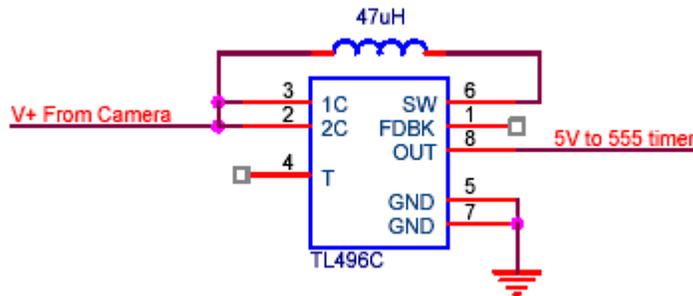
Change 1.5 VDC into 5 VDC for a 555 timer.

Use a special switch (Triac) so the 555 timer can trigger the flash circuit.

### DC – DC CONVERTER

A DC-to-DC converter is used to change the 1.5 volt battery voltage to 5 VDC that the 555 timer needs in order to operate.

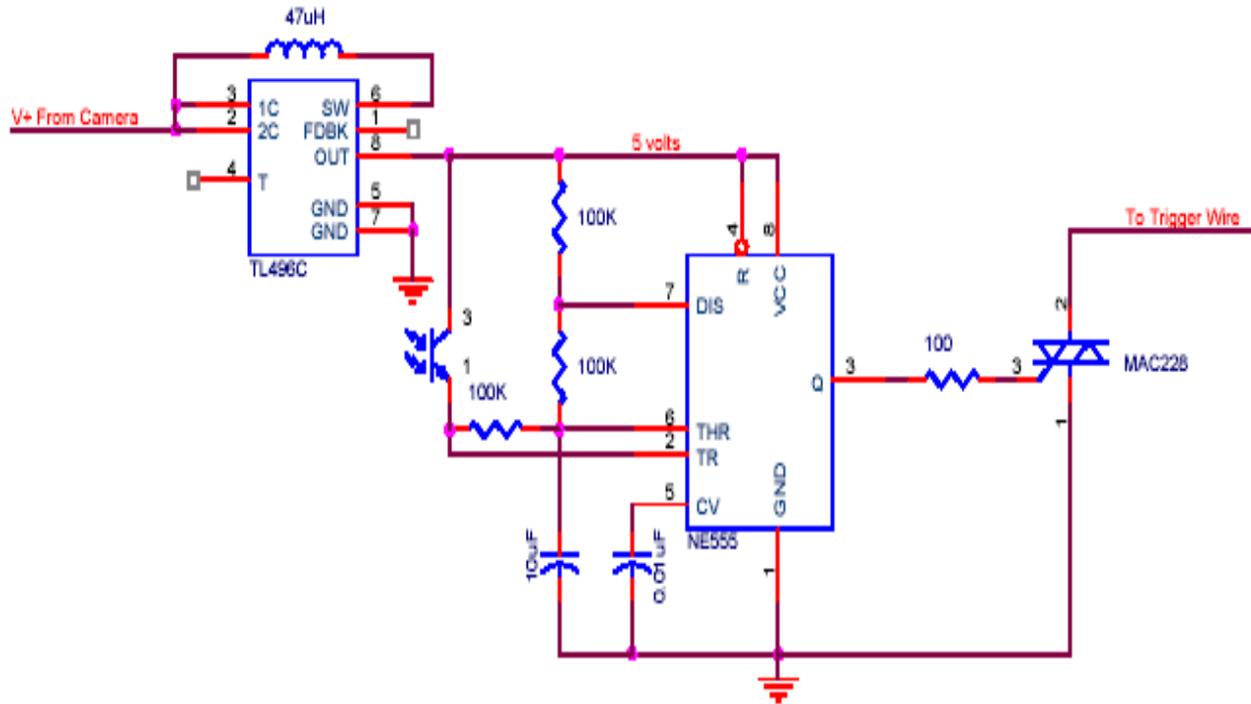
In lab you will use a TL496C DC-DC converter.



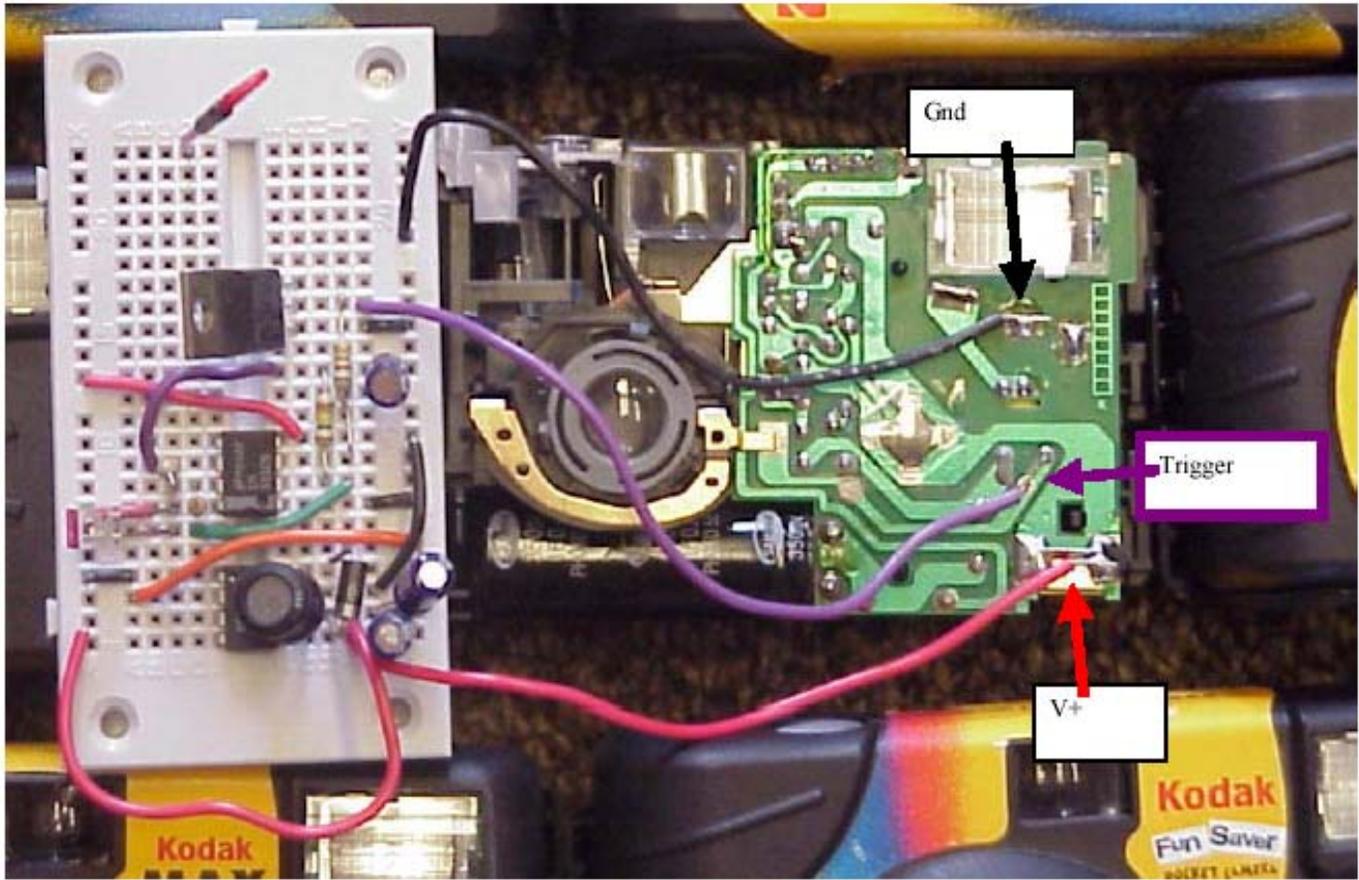
TL496C DC-DC CONVERTER

Make sure this circuit is working before you proceed.

## THE COMPLETE LAB CIRCUIT



The MAC228 is the triac that replaces the trigger switch in the camera. The phototransistor provides the trigger signal for the 555 timer. When no light is on the phototransistor, the 555 timer is in astable mode. This is because the resistance of the phototransistor is very low with no light on it and the 5-volt signal is applied to the trigger pin enabling the 555 timer into astable operation. With ambient light applied, the phototransistor acts as an open circuit and the threshold and trigger voltage levels are outside the operating range.



THE FLASH CAMERA

## ***Warnings and rules***

- 300 volts is a lot and will hurt!
- 300 volts will not kill but it will burn!
- 300 volts = pain!
- TA will show you how to discharge caps
- Don't flash in TA's eyes