# SPEC. SHEET
# FOR
# 6022-KT

# DIY Kit 22. 9V POWERED XENON FLASHER

## INTRODUCTION

This Kit builds the circuit to trigger a high voltage xenon flashtube using a standard 9 volt battery. The flashrate can be varied by the trimpot. The Kit can be worn by runners or bicycle riders to aid in their visibility. The flashtube is similar to those seen on aircraft and signal beacons and those contained in camera flash units, photo kiosks and at discos. The frequency of flashing can be adjusted from about once every two second to about 4 a second.

(Actually the Kit contains TWO types of flashtubes. The xenon filled tube is the one which makes all the light. However, there are other flashtube which contains neon gas. They flash as well but provides a different function as will be explained below.)

At a flash rate of 1/sec and with one neon in the circuit the average current drain is about 11mA. A standard 9V battery should last 20 hours.

The Kit is constructed on a single-sided printed circuit board (PCB). Protel Autotrax and Schematic were used to design the board.

## ASSEMBLY INSTRUCTIONS

1. Instructions for winding the transformer are provided below. It is most important that the coil winding is done correctly.

2. Assembly of the Kit is straight forward. The overlay on top of the PCB shows the orientation of the components especially the xenon tube and the trigger coil for it. Neon 3 is optional. It is suggested that you place a link in the neon 3 position to start with. Use a wire lead cut from one of the resistors. Later you can cut the link and put in the neon so you can see what effect it has.

## CIRCUIT DESCRIPTION

The pot core transformer (and the circuit around it) does two things: firstly it converts the 9V DC battery voltage to an alternating voltage. Second, it transforms this alternating voltage to a high voltage (which can give you quite a shock - put your fingers across the flashing xenon tube to find out!). The transformer is configured as part of a self oscillating circuit which is a variation of a Hartley oscillator. Coil N2 provides the primary winding of a transformer. The secondary winding N1 provides feedback to the driving transistor to make it oscillate. Let us look at how N1 and N2 work to make an alternating voltage from a steady 9V battery voltage.

When the battery is connected C1 and C2 are in the discharged state. They immediately begins to charge up via R1. When the potential difference rises one diode drop above zero, the transistor begins to turn on allowing current to run through the coil winding N2. As current begins to flow through N2 a voltage is induced in N1. This causes the transistor to turn on harder by pulling the base PD higher than the capacitor C1 PD.

When the current in N2 reaches its peak the magnetic field (which is caused by the changing magnetic flux) stops. The voltage being induced in N1 which was causing the transistor to turn on disappears. Thus T1 starts to turn off. The consequent induced voltage in N2 (this time of opposite polarity) combined with the loss of stored energy in C1 begins to turn the transistor off. The induced negative voltage causes it to turn off harder. When the magnetic field has collapsed the current in N1 is zero and there is no longer any induced voltage to turn T1 off. The PD across C1 now starts to turn T1 on and the cycle repeates.

The circuit is designed to turn the transistor off at a rate which does not put too much current through the transistor. This is done by C2 to cushion the induced voltages and by setting the value of C1 so that sharp cutoffs are prevented.

The oscillating magnetic field also cuts coil N3 - which is the reason for having the oscillation. N3 (large number of turns of wire) transforms the high current/low voltage oscillation in N1 and N2 (low number of turns of wire) to a high voltage/low current supply. This is a clear example of how transformers work.

This high voltage supply is then half-wave rectified by the diode D1. It charges C3 at a rate determined by the 100K trimpot. Thus the trimpot controls the flash rate. When C3 reaches about 140V the firing circuit is activated. It consists of a neon tube which has a firing voltage of about 70V. Space is provided on the PCB to make the firing circuit consist of two neons to increase the flash intensity. In this case the firing voltage must reach about 140V. The capacitor C4 charges up through neon 1 (and neon 3 if it is in the circuit) every time it discharges. When C4 reaches about 70V neon 2 breaks down and fires the SCR C106D. The SCR puts a voltage pulse into the trigger transformer which is stepped up to a voltage of about 5000V. The voltage across the flash tube is about 140V when only neon 1 is present (and 210V if both neon 1 & 3 are present.) When the high voltage pulse from the trigger transformer appears on the surface of the flash tube the electric field inside the tube initiates the breakover and the tube flashes. The cycle then begins again.

**Flash rate & brightness.** If the voltage across the flash tube is increased then the flash will be brighter. There are two ways to do this. You can increase the value of C3. Secondly, you can put another neon tube in series with neon 1. Neon 2 will still discharge when C4 reaches about 60V but the voltage across the flash tube will be about 200V instead of 140V. Provision has been made on the PCB for this third neon tube - neon 3 - and it has been supplied in the Kit. These changes to increase the brightness of the flash will decrease the flash rate. Of course a higher flash rate and higher brightness will drain the 9V battery supply quicker. Direct control of the flash rate can be made by adjusting the pot as already mentiones above.

The xenon flash tube & trigger transformer. The rated life of the xenon flashtube supplied in this Kit is two million flashes. When a potential difference of about 6000 volts is applied to a trigger electrode painted on the OUTSIDE glass of the tube then the xenon gas will ionize and current will flow between the electrodes at either end of the tube. This produces the characteristic bright flash. It is the transformer coil which provides the step up in voltage to produce the 6000 volts trigger pulse. It has a primary winding of 10 turns and a secondary winding of 500.

## WHAT TO DO IF IT DOES NOT WORK

Poor soldering is the most likely reason that the circuit does not work. Check all solder joints carefully under a good light. Next check that all components are in their correct position on the PCB, especially the C106D, diode, potcore transformer, flash tube and trigger coil. Thirdly, follow the track with a voltmeter to check the potential differences at various parts of the circuit. Does neon 1 flash when the battery is connected - it should.

Did you remove enough enamel from the six wires so that a good solder connection was made on each pad? Check for continuity with a multimeter.

Check again the direction of the three coil windings with the schematic.

## WHAT TO LEARN FROM THIS KIT

The operation of two types of flashtube, the neon and xenon flashtube; half-wave rectifier circuit; step-up transformers; SCR operation; relaxation oscillator circuit using a neon tube.

Why does the third neon tube cause the changes in flash rate and intensity that it does? If you can get a cathode ray oscilloscope attach it across the neon tubes and the flash tube to see what happens.

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### Instructions for Winding the Pot Core Transformer.

When you start this construction make sure you have plenty of time and will not be interrupted. Make a clean working area with a lot of light. Have the following items available before you start:

- soldering iron
- wire cutters
- screw driver
- razor blade/sharp knife
- adhesive paper labels

plus the following item from the Kit:

- the top and bottom of the pot core transformer
- the plastic bobbin with wire wound on it
- the nut, screw and washers to fix the completed transformer to the PCB

Read the following instructions through once so you understand why it is important to wind the coils correctly.

Note the dots next to each winding on the schematic. These indicate the phase relationship or the direction in which each winding is wound relative to the other windings.

1. What we want to have is three coils on the bobbin. N1 & N2 are only 9 turns of wire on the outside. N3 is 340 turns of wire and is wound inside. We have supplied a bobbin wound with about 360 turns of enamelled copper wire 0.13mm diameter, SWG # 39.

2. So untape the bobbin. Keep the insulated tape you unwind clean. Stick it somewhere safe so you can use it later. Carefully UNwind 20 turns of wire from the bobbin, cut the wire leaving 1" outside. Carefully examine the bobbin to determine the direction in which the wire is wound. Label the start of the winding (the trapped end) with a piece of adhesive label marked 6. The free end is marked 5. Hold the spool so that the side that you are facing is such that the wire is wound CLOCKWISE around the spool going FROM 6 TO 5.Mark this side of the spool because the other windings must be made in a particular direction relative to this winding. Take both of the wires on the spool out of the same slot on the bobbin. N3 coil is wound. Now use the wire you unwound to wind coils N1 and N2.

3. Take the wire and double it over, end to end. So you have two strands of wire of equal length. Starting at the opposite slot on the bobbin to N3, leave an inch of wire out and wind 9 turns CLOCKWISE relative to the side of the bobbin you marked earlier. Bring the two free ends out of the same slot. Wind the second strip of insulation tape around the wire to secure it.

4. Place the bobbin in the pot core shells taking care not to trap any wire between the shells. The shells should come together without a gap. Screw the potcore to the PCB gently. Point the N3 coil to pads 5 & 6 on the PCB overlay. The other 4 wires should point to pads 1 - 4.

5. Cut 4 pieces of adhesive paper and mark them 1, 2, 3 & 4. Take the two cut ends of the 9 turn coiled wire and mark them 1 and 4 with the labels. Now cut the loop of wire. Use a multimeter or continuity tester to find which of the cut ends connects to lead 2. Mark it 4. The other will be 1. (But test it also with the meter to make sure.)

What you have done is assembled a core which has 3 windings around it. N2 is effectively wound in the OPPOSITE direction to the other two coils. By marking the spool on one side & observing the direction of every winding relative to one another assures that the phase relationship between the windings is correct. If N3's winding direction is not noted before winding N1 & N2 then N1 & N2 could have been wound correctly relative to each other BUT N3 could be reversed. In this case the circuit will not operate in fly-back mode.

Remove the enamel from the ends of each wire 1 through 6 using either a knife to scrape it or heating the end with some solder on a soldering iron and burn it off. Solder the six wires into their correct holes.

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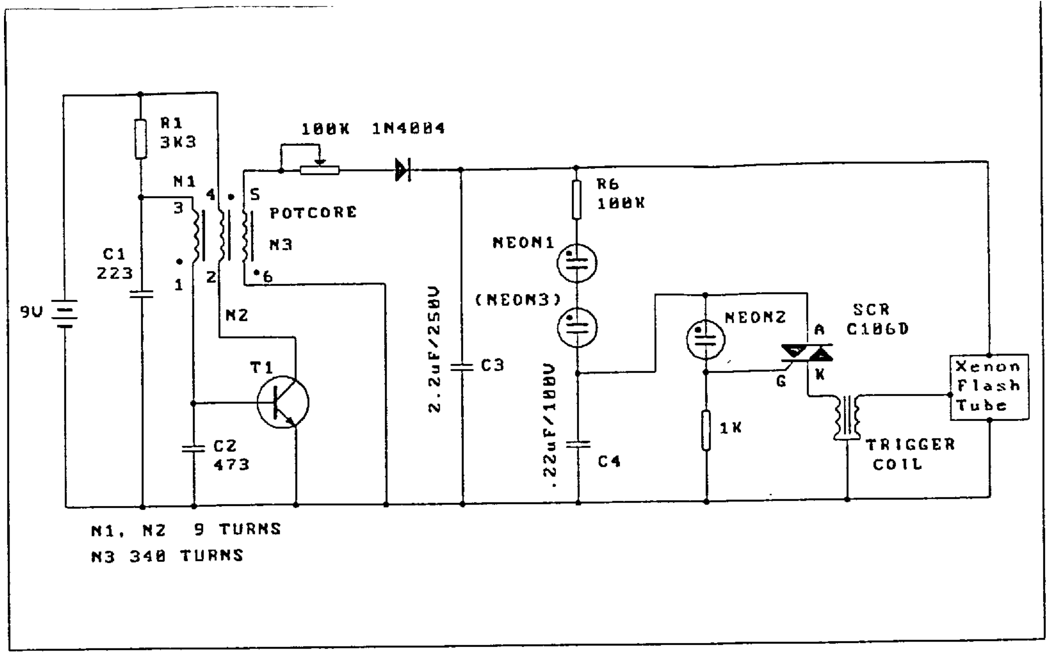


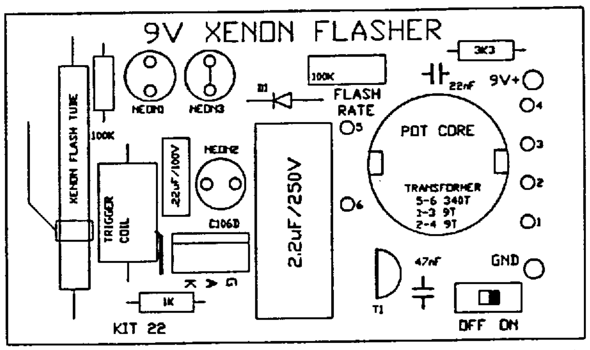


## COMPONENT LISTING

| | |
|---|---|
| Resistors(1/2W, 5% carbon): | |
| 1K (brown black red) | 1 |
| 3K3 (orange orange red) | 1 |
| 100K (brown black yellow) | 1 |
| 100K potentiometer | 1 |
| Capacitors: | |
| 22nF (223) ceramic | 1 |
| 47nF (473) ceramic | 1 |
| 0.22uF mylar | 1 |
| 2.2uF/250V MPE | 1 |
| T1 - BC108 or BC548 | 1 |
| C106D SCR | 1 |
| Pot Core 18x11mm | 1 |
| Bobbin with 360 turns wire | 1 |
| Trigger coil TTC-1050 | 1 |
| Neon tube | 3 |
| 9V battery snap | 1 |
| Xenon tube L3728S | 1 |
| D1 - 1N4004/7 diode | 1 |
| Kit 22 PCB | 1 |
| Brass nut, bolt, 2 washers | 1 set |

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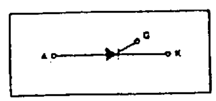


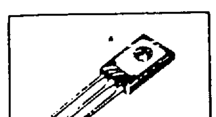

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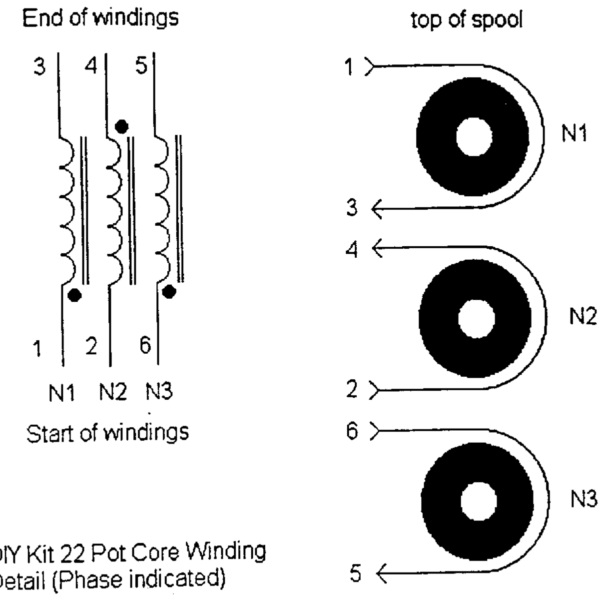
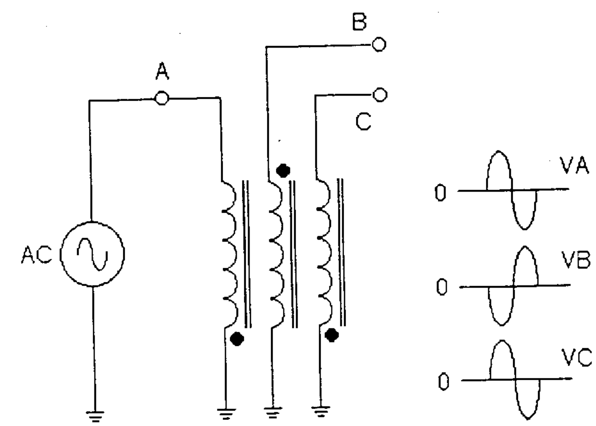



DIY Kit 22 Pot Core Winding Detail (Phase indicated)

Direction of each winding.




Turns Ratio
1:1:1

Example of hypothetical 1:1:1 transformer showing resultant induced voltages, polarity determined by the phase relationships of the windings.

As winding B is out of phase with winding A, the polarity induced is opposite.