FK109 - 2 LED Flasher (Teacher Resource)

Description of this document:
This document is intended to help Teachers and Supervisors who are charged with delivering a successful classroom activity to build FK109. This document is expected to be read in conjunction with the "Instruction Sheet for Students" . Special comments and extra information for Teachers has been included into this document and highlighted in red text.

Fig 1: Finished Product

Technical Specifications:

- Supply Voltage: 9 – 12 V DC (Recommended to use with 9V DC Battery)
- Consumption: 16-22 mA (max.)
- Adjustable Flashing rate with on board potentiometer
- PCB dimensions: 35.3 X 31.0 mm (1.39 X 1.22 in.)

How it works:

The comments in this section relate to the "Instruction Sheet for Students"

Transistor 1 ("TR1") and Transistor 2 ("TR2") are configured as a "multi-vibrator". This means when TR1 turns ON, it will turn OFF TR2 for a short period. Then when TR2 goes ON, it will turn OFF TR1 for a short period. What controls the "short period" and also which transistor turns ON and OFF is the Capacitors ("C1" and "C2) and the resistors ("R2" , "R3" and "VR").

KitStop and KitStop Retail Systems are units of
Perrin Wright and Associates ABN 86 481 210 935

Address: P.O. Box 5422, Clayton ,Victoria 3168 Australia.
Phone +61 (0) 432 502 755

When power is first applied to the module, one transistor will turn ON just a fraction of a second faster than the other.

Let us assume for a moment that TR1 turns ON first (but in reality it could be either of the transistors). As soon as TR1 is ON, it will:

- Pull the output of LED1 low, and so LED1 will also turn ON.
- Pull the "+" end of C1 low, and so instantly turn OFF TR2.
- With TR2 OFF, LED2 will also stay OFF.
- Start to charge up Capacitor C2 .
- Start to discharge Capacitor C1.

As the charge in C1 has falls, it will allow the voltage stored in C1 to fall also, and hence the "-" end of the C1 will approach the same voltage as the "+" end. Eventually the "-" end of C1 will rise to a point where it turns ON TR2.

Once TR2 is ON, it will:

- Pull the output of LED2 low, and so LED2 will now turn ON.
- Pull the "+" end of C2 low, and so instantly turn OFF TR1.
- With TR1 OFF, LED1 will also go OFF.
- Start to charge up Capacitor C1 .
- Start to discharge Capacitor C2.

As the charge in C2 has falls, it will allow the voltage stored in C2 to fall also, and hence the "-" end of the C2 will approach the same voltage as the "+" end. Eventually the "-" end of C2 will rise to a point where it turns ON TR1.

And so the process will keep repeating while there is power applied.

The rate of charging and discharging of the capacitors is controlled by:

- The values of C1 and C2
- The values of R2, R3 and VR
- The supply voltage applied.

  Consider changing values of R2 & R3 by adding 1K Ohm Resistors in parallel with the supplied 3K3 resistors. This will allow the unit to flash so fast that the human eye cannot detect the OFF time.... Both LEDs will appear to be ON! (Useful for demonstration of Curriculum requirement explaining on how the human body receives and reacts to light)

Resistors R1 and R4 limit the current flowing in the LEDs, which directly affects the brightness of the LEDs.

Consider changing the 470 Ohm resistors to change the brightness of the LEDs. Use caution ... Increasing the resistance will make the LEDs seem duller. However do NOT use a resistor value under 180 Ohms as the LEDs will burn out very quickly if R3 or R4 go below 180 Ohms. (Refer to Curriculum requirement on how energy travels through Electric circuits).

EXTRA COMMENT FOR TEACHERS: If you would like a more detailed analysis of how this circuit works, we have a dedicated presentation "Explaining Current Flow in FK109 kit - Ver 3.pdf" which is available for free. Just contact us and ask for a copy.

Assembling the Circuit:

Please read our tips on constructing our kits, in our Application Note titled “Towards Better Soldering”.

The Application Note is useful for students who have not done any soldering before! Pay special attention to what a good solder joint looks like, and what a poor joint looks like! For most students the temptation is to rush their soldering, and not allow the heat to flow from the Iron into the component lead and the PCB copper Track. This is a very powerful demonstration of how heat travels through different media (and how it does not travel well through air!) If you would like free copy of our “Towards Better Soldering”, just contact us and request your free copy, which will be sent via email.

The Application Note gives more details on correct soldering techniques, tools, and handling of components.

The key steps of Assembling the Kit are:

i) Lay out all components in the supplied kit, and correctly identify them all. Ensure none are missing. Encourage students to open and read the Construction guide included with all kits. This contains a list of all components, and the Circuit Diagram inside the kit has values on it.
ii) Start by inserting the “lowest profile” components first. (This means the resistors and diodes in most kits).
iii) Solder these components into place, and trim their leads.
iv) Repeat steps 2 & 3 for the capacitors, then the transistors, then the Potentiometer, then the LEDs, then the terminals and supply leads.
v) Take care when inserting the Capacitors, transistors, LED’s and the supply leads. These MUST all be assembled with the correct polarity. Refer to the diagram on the back of the FK109 packaging container for component installation guidance or the “Instruction Sheet for Students”

Notes to Teachers:

A) The LEDs have TWO methods of identifying their polarity!
  1) When new and first supplied, the Anode (“+”) lead is the longer one!
  2) However this is usually trimmed off once assembled, and becomes an unusable identifier! All LEDs also have a flat side on their Cathode (“K’ or “-“).
B) The capacitors have:
  a. Longer lead is Anode (“+”)
  b. Most have the Cathode marked as “-“ on the case.
C) The potentiometers for this kit may be one of three different sizes. The PCB is laid out with holes to accept any of the three different types. Therefore it is most likely that a well assembled kit will still have two holes unused.

Testing:

1) Double check your work . Ensure all components are installed and oriented correctly.
2) Check for solder bridges (solder blobs across multiple tracks and leads).
3) Check for any “cold-solder” joints. (All joints should look bright and shiny… not smoky of crazed. If any joints are not “shiny”, re-melt them with your soldering iron and allow them to cool without any movement.)
4) Connect the power supply.
5) The LED’s should start to blink alternatively.
6) Adjust the flashing rate with the potentiometer.
7) If steps 6 & 7 work, your kit is working properly!

Trouble shooting:

Most problems with this kit arise from the following causes:

- Component inserted incorrectly. (Check LED's, Transistors and Capacitors for correct orientation)
- Solder bridge is creating a "Short Circuit" path.
- Poor solder joint is not making connection (This is a "Cold Solder" joint). Please read our tips in "Towards Better Soldering" on how to recognize a good solder joint versus a poor joint.

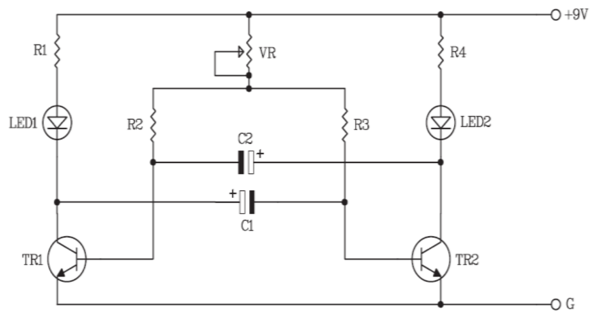
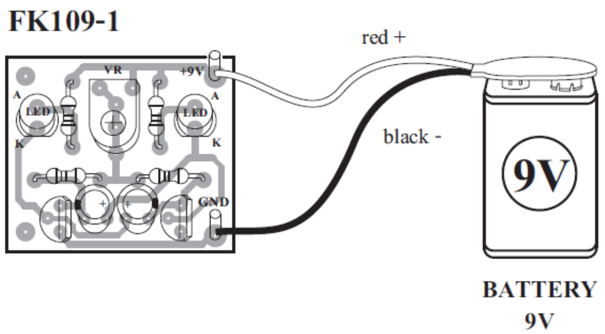


Figure 2: Circuit Diagram for FK109

Figure 3. Circuit connecting



Extension suggestions:

1) Change the rate of the flashing by changing R2 and / or R3.
   Note: increasing R2 &/or R3 will slow the flashing.
   decreasing R2 &/or R3 will speed up the flashing.

2) Change Capacitors C1 and/or C2 to change the rate of flashing.
3) Consider making R2 unequal to R3. The LEDs will flash in an "uneven" pattern.
4) Change R1 and/or R4 to make the LEDs brighter or duller.
5) What other applications can be found for multi-vibrator circuits?
   a. Consider: Pedestrian Crossings, Railway crossings, other warning applications.
   b. IF the frequency was increased, they can be used to drive loud speakers such as in alarm sirens.

6) IF we made R2 and R3 change their resistance with changes in nature, what would happen?
    a. We can use “Light Dependent Resistors” which typically decrease their resistance as the light increases in brightness.
    b. We can use Temperature Dependent Resistors (known as “Thermistors”) which can either increase OR decrease their resistance as temperature increases.
    c. We can use resistors which change their resistance value as strain is applied to surfaces. (These are commonly used as “Strain Gauge Transducers” for detecting vibration or over loading on buildings and lifting equipment)
    d. Can students think of any applications where these characteristics could be used?
7) IF we changed the supply voltage from9 V DC to 12 V DC, what would happen.
    a. Watch for small increases in LED brightness
    b. Watch for small increases in speed of flashing.