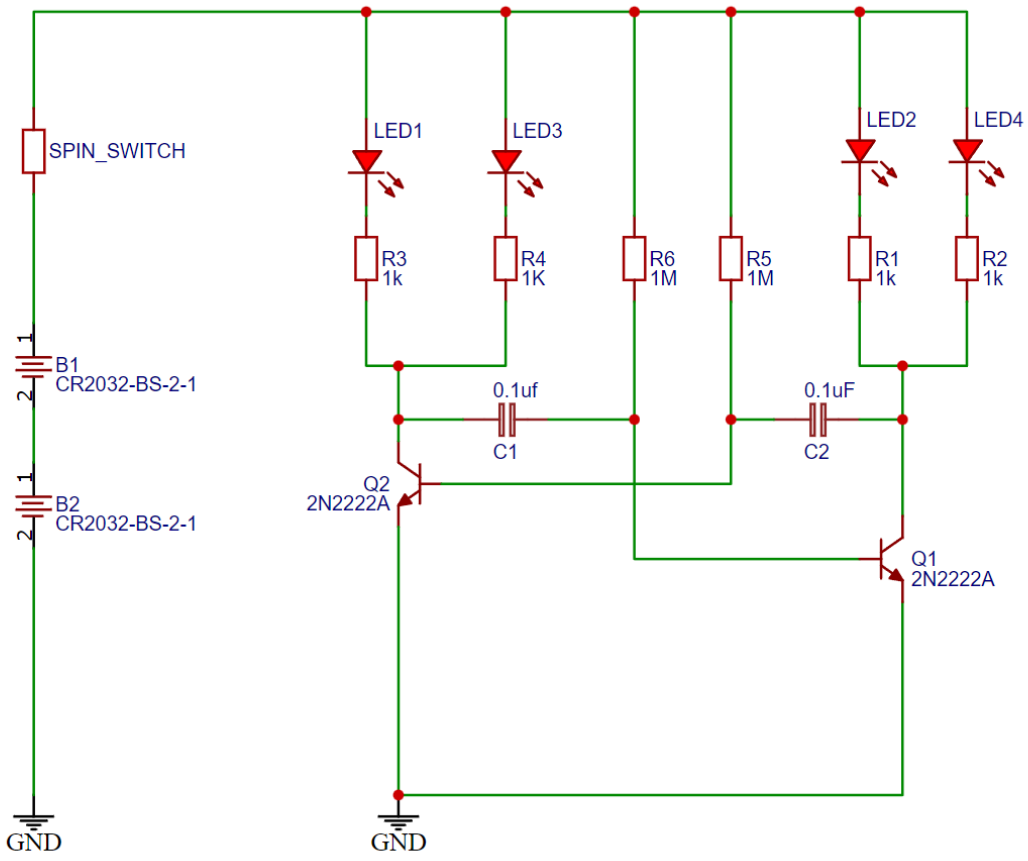
Kaleidoscope Spinning Disk

Welcome to the Kanga Soldering practice kit. If it's been a while since you built a kit or maybe this is your first attempt at kit building the kanga Practice kit is a great way to get your soldering skill ready for bigger projects.

This kit uses a number of common parts such as Resistors, capacitors, LED's and transistor's. The typical type of parts you will find in just about all projects!

There are almost 40 solder joints to make but we have designed the board to be easy to handle with larger than standard solder pads too.

The circuit for this kit is shown below.



Parts list

Spinning Disk PCB

R1-R4	1K Resistors coloured bands Brown, Black, Red, Gold
R5, R6	1M Resistors coloured bands Brown, Black, Green, Gold
C1, C2	100nf MLCC Capacitor marked 104
T1, T2	Transistor 2N2222
LED1-LED4	Red, Green, Blue, Yellow
Switch	SW-400D in-line motion switch
Bead	5mm Red Spacer bead
Holder	2 x CR2032 PCB mount battery holder
Battery	2 x CR2032 3v Cells
Handle	30mm plastic handle shaft
Fixing Nut	M3 metal Nut

The circuit is an astable multivibrator type. In simple terms the two transistors act like switches that turn on and off. When one transistor is turned on its associated LED's light and it turns off the other transistor. The length of time that each transistor (and so the LED's it controls) is on is controlled by the value of the capacitor C1 and C2 together with the value of R5 and R6. While one of the capacitors is charging via its resistor current flows to the base of the alternate transistor, making the emitter-collector path conduct, making one set of the LEDs light. When the capacitor is charged, it stops conducting and switches off the transistor, and then the other capacitor begins to charge switching on the other transistor, at the same time the first capacitor discharges, then the cycle repeats, and repeats and repeats….. If we just started this circuit without spinning you would just see a slight flickering of the LED's. Because we are spinning the disk many times a second we see a pattern as the disk spins and the LED's flash, as the speed of the disk slows down the pattern will change. The rate of flashing does not change but something called persistence of vision allows us to see the pattern. If we photographed the spinning disk with a high-speed camera you would just see two LED's on at a time and no pattern at all.

Ok lets look at the parts one by one. Let's start with the resistors. We have two different values in the kit. It is very important that we put the right ones in the right place so fit them slowly and double check their values. If this is your first kit let's spend a little time identifying their values.

The resistors used in the kit are 4 band 0.25W carbon types. These are the easiest to read.

They have 4 coloured bands. Each colour has a number associated with it. We have two values 1K ohms (that's 1000 ohms) and we have 4 of these (R1-R4). The second value resistor is 1M ohms (that's 100,000 ohms)

Be careful as some of the bands are the same colour. We are only interested in the first 3 bands, the 4th band is to do with the precision of the devices value in percent, for this task 5% is fine. (that's a Gold band)

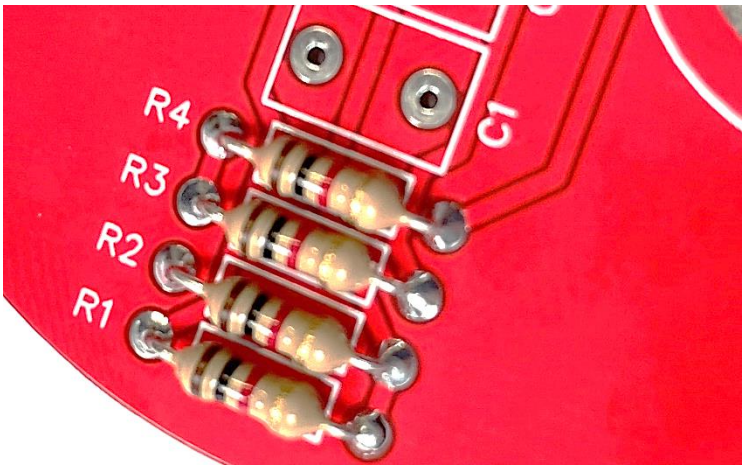
R1-R4 = 1K ohms Bands colours are Brown, Black, RED, gold.

R5 & R6 = 1M ohm Band colours are Black, Brown, GREEN, gold.

Make sure you select the right ones as its only the 3rd band that is different!

The fourth band on all the resistor in this kit is Gold, that stands for 5% tolerance (or accuracy)

OK Lets make a start and fit the resistors.



You will see the position for the resistors and in fact all the parts are numbered on the spinners board.

Find R1 and gently bends its legs to allow it to be put into position on the board, you should push the resistor down so its body is flat to the board. Before you fit this and all resistors let me give you a worthwhile tip.

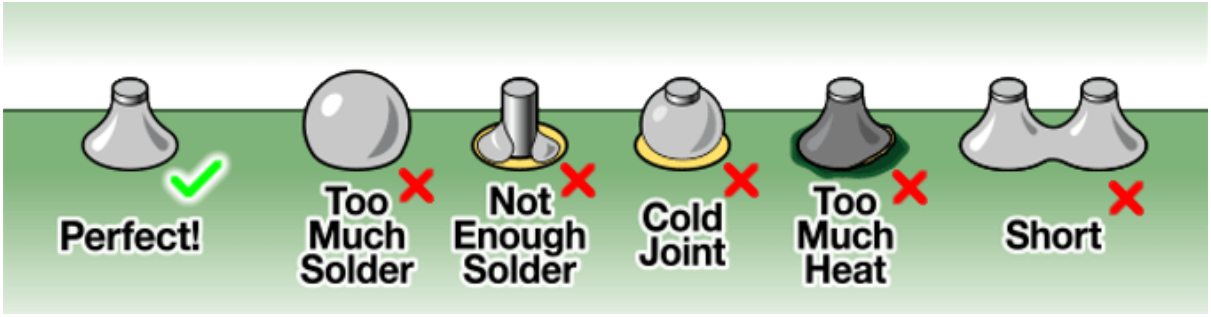
Most instructions say you can fit resistors either way round, yes you can and they work just the same either way BUT…..

If you make a mistake and need to come back later to check resistor values it really helps if you can put all the resistors the same way so you can read the bands without constantly having to turn the board around. The convention is that we read from left to right or up to down, so the first coloured band (in our case brown) should be on the left side of the resistors body if mounted horizontally or the brown band on the top if mounted vertically.

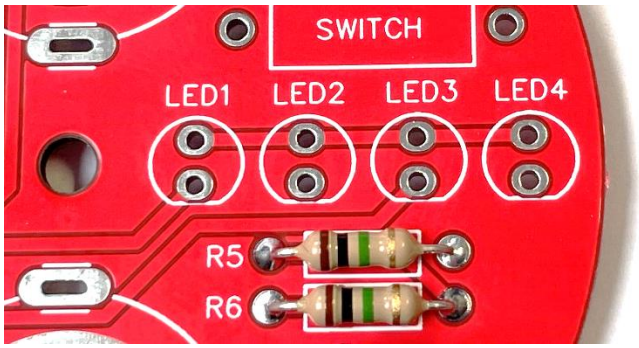
Again the resistor will work just the same either way, this is just a tip I find helps after 40+years of kit building.

Take your time and fit the first batch of resistors R1-R4 (all 1K ohm). When you have fitted these make sure that they all are sat nice and flat to the board and the leads on the back of the board have been trimmed flush.

Since these are the first parts you have fitted take a good look at the joints you have made. the image below shows the good ,bad and the ugly in the world of solder joimts.



Now lets fit the remaining two resistors R5 and R6 (1M ohm)



These have brown, black and GREEN as their first three bands.

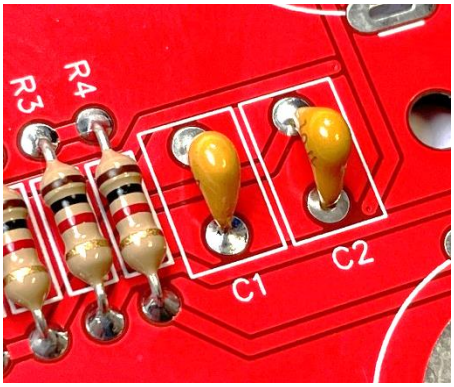
Fit these as you did for the other resistor, the brown band will be on the left hand side.

Check how well they have been fitted and trim the leads.

Well done, lets move onto the two capacitors.

Capacitors come in a number of different types, we are using a type called Muilt-layer Ceramic capacitors MLCC for short, most of these look like small yellow blobs of plastic. We have used these with an extra wide lead spacing so they are nice and easy to fit.

The value of these is printed on one side of the body, for this project we need 100nf (sometimes called 0.1uF) capacitors , the marking for this value is 104 and that will be printed on one side. Since both of the capacitors in this kit are the same value you can't get this wrong but check the value anyway, you need to be able to do this for other larger projects.



Capacitors of this type (BUT NOT ALL TYPES you will find in other kits) can be fitted either way round but another tip, try to fit them so other parts don't cover the printing showing the value, this makes it better if you need to trouble shoot projects later.

Fit C1 and C2 as shown and trim the leads on the back of the board.

Next let look at the transistors

This project uses two transistors and they are the same type, there are many different types, NPN, PNP, FET and so on and each type has many different variations that are identified by their part number, we are using one of the a very common transistor in our project, that's a NPN type and its part number is 2N2222A, this is a general purpose type that works great in our project.

The part number is printed on the flat side of the transistors body.

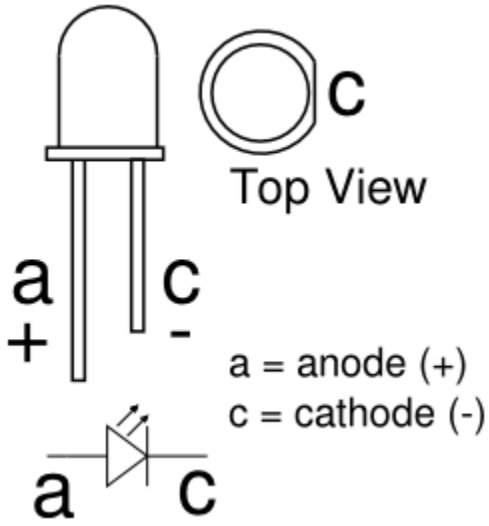
On our board the location of these transistors is marked Q1 & Q2

The silk screen printing shows the outline of these devices and its clear to see which side has the flat edge. Make sure when you fit these transistors that you position the transistors so they match the outline printed on the board. The two flat sides should be facing each other. Push the transistors down so that about 3 or 4mm of leg is still above the board when they are soldered in place, these transistors will need you to bend the legs out a little to allow you to pop them into the board. Don't try and push them right down or you will break their legs,

Again after fitting them trim the legs nice and flush on the back of the board.

Now we can fit the LED's, this stage needs a lot of care as its very easy to fit these the wrong way round. Let's look at a LED more closely.

The LEDs have a coloured body that shows what colour they are.



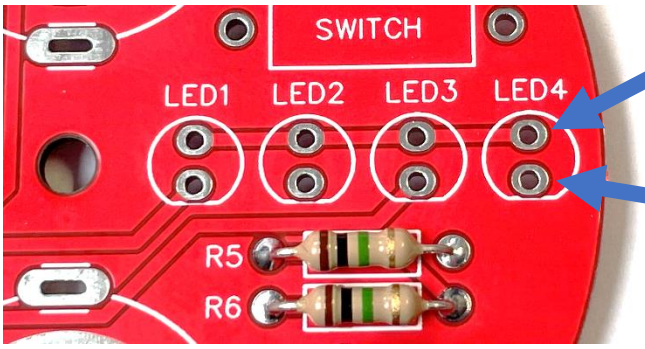
Also, and a very important thing to note is that **one leg is longer than the other.**

You will also see if you look carefully that here is a **flat edge** on the base of the LED next to the shorter leg. This can be hard to see.

These two features on the LED indicate which leg is '+' and which '–'

On our PCB we have shown the outline for the LEDs and the outline shows the small flat edge of the LED, this is the side that the short leg must pass thought. The long leg will be in the hole nearest to the position for the SWITCH, make sure that you put the LED's this way round.

So that's the Long Leg nearest to the SWITCH and the short leg nearest to the two resistors.



Long Leg side

Short leg side

The order that you fit the LED's in is up to you, drop them into place without soldering and move them around till your happy with the colour order then solder them one by one. Double check that they are fitted the correct way round as detailed above.

Now we can fit the Switch. The switch is an interesting thing. It looks like big black resistor but in fact it's made up from a metal tube with a ball bearing inside.

We have two wires coming from the Switch and they are different colours, one in Sliver and the other is gold. One lead is connected to the body of the switch which is the main tube part of the switch, inside the tube a ball bearing sits. The other wire is connected to a small metal plate, like a cap on the tube, The 'cap' is insulated so it makes no electrical connection to the tube. If you shake the tube the ball bearing slides up the tube and touches the insulated cap which connects the cap and tube together making the action of a switch. The board layout is such that when the board rotates the ball bearing moves up the tube and turns on the circuit.

The one problem with such a simple switch is that it can turn on even if the board is just sat on a flat surface, to make sure the spinner only turns on when we spin it we need to fit the switch slightly higher on one side than the other to keep the ball bearing at the bottom of the tube when we are not spinning the disk.

Important! Arrange the switch so that the **gold wire** is nearest to the edge of the board. Put the supplied red 5mm bead over the Gold lead and bend the legs and fit the switch to the board. I repeat, the gold lead with the red bead **MUST** be on the side nearest to the edge of the board, as shown above. The other side of the switch needs to be right down flat on the board.

Solder and trim the leads.

Now we have the battery holders. These MUST be fitted the right way round.

Look at the holder, it's a simple round disk with three tags.

The PCB shows the location of these and you will see that each holder position has two holes and a rectangle shown on one side of the silk screening for each holder. You must position the holders so the two tags pass into the holes and the third shorter tag sits on the marked rectangle on one side of the silk screened circle. Mounted this way you will be able to slide the disk type batteries into the holders. Fit both holders the same way.

A word of warning. The batteries are standard CR2032 cells that are widely used in many domestic products, bathroom scales, watches, calculators etc but because of the size they are easy for children to swallow and dangerous if they do. Make sure you don't allow young children to play with them and that when the kit is finished that if children use the spinner that they are supervised and aware of the danger batteries can bring.

Ok now we need to fit the spinner handle, with the kit you have a 30mm long black plastic shaft with a 6mm threaded end. Pass the handle through the top of the disk and secure with the M3 nut, finger tight will be fine, don't over tighten the nut or you will strip the plastic thread.

Now fit the batteries, on one side of each battery you will see a '+' sign and some writing. This side of the battery must be on the top as you slide them into the holders.

The LED may flicker while you handle the board, that's normal. Now hold the spinner by the shaft and spin the disk, if all ok the LED's will light as the disk spins and the pattern will change as the speed of the disk changes.

If some of the LED's do not come on look carefully at them and you may find that you have fitted the ones that don't light the wrong way.

If No LED's come on then first double check both batteries have been fitted the right way.

I hope you have enjoyed building our simple spinner and gained some confidence to tackle bigger projects.

As a reward for reading all the instructions here is code that you can use at the Kanga Web site checkout to get 5% off any further kits you buy, just enter code **KITBUILDER5** in the discount code box.

Thank You

Paul Webb
Kanga Products