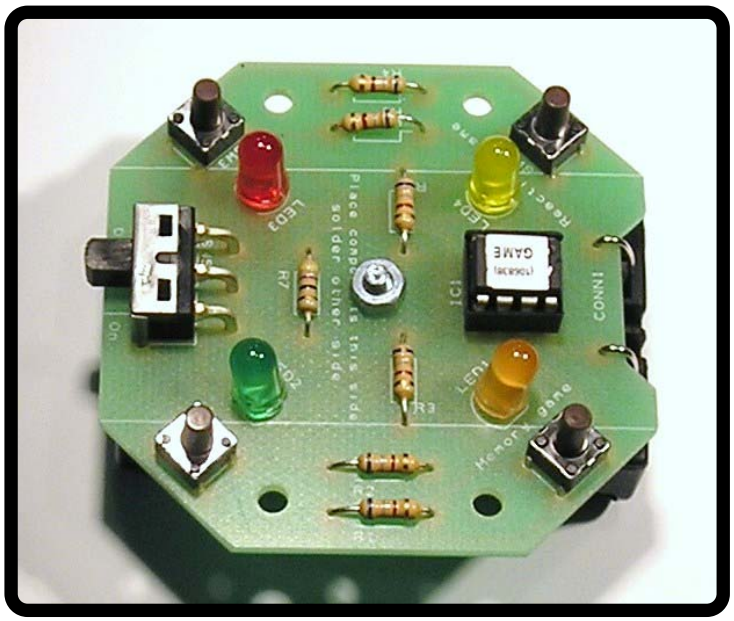
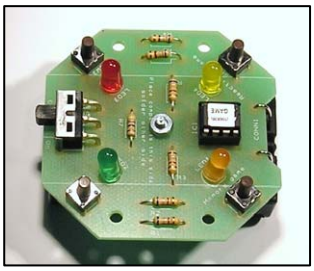
# Electronic
# Memory / Reactions Game




# Build Instructions

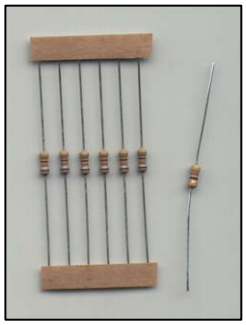
**Issue 1.2**

# Build Instructions



Before you put any components in the board or pick up the soldering iron, just take a look at the Printed Circuit Board (PCB). The components go in the side with the writing on and the solder goes on the side with the tracks and silver pads.

You will find it easiest to start with the small components and work up to the taller larger ones.

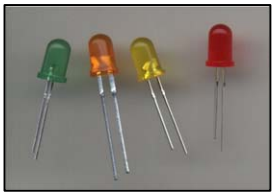


**Step 1**
Start with the seven resistors (shown right):
R1 – R6 are 680Ω (blue, grey, brown coloured bands)
R7 is a 47Ω (yellow, purple, black coloured bands)

The text on the board shows where R1, R2, etc go. Make sure that you put the resistors in the right place (i.e. the 47Ω goes in to R7)

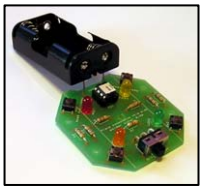
**Step 2**
Solder the four switches (shown left) in to the board where it is labeled SW1, SW2, SW3 & SW4. Once you have got the pins lined up with the holes they can be pushed firmly into place.

**Step 3**
Solder the Integrated Circuit (IC) holder (shown right) in to IC1. When putting this into the board, be sure to get it the right way around. The notch on the IC holder should line up with the notch on the lines marked on the PCB.



**Step 4**
Solder the four Light Emitting Diodes (LED) as shown left in to LED1 – LED4. It does not matter which colour goes where, but the game won't work if they don't go in the right way around. If you look carefully one side of the LED has a flat edge, which must line up with the flat edge on the lines on the PCB.

**Step 5**
Solder the PCB mount right angled on / off switch (shown right) in to SW5. The row of three pins that exit the back of the switch must be soldered, but it won't matter too much if you can't solder the other two pins.



**Step 6**
Finally place the battery holder into the board, so that it sticks out off the edge of the board (see left). This part should be soldered with the holder raised off from the board with around 5mm of lead going through to the back of the board.

**Step 7**
The IC can be put into the holder ensuring the notch on the chip lines up with the notch on the holder. Check that the board works before folding the battery holder under the board and fixing in place with the M3 nut and bolt.

# Checking Your Game PCB

Check the following before you insert the batteries:

**Check the bottom of the board to ensure that:**

- All holes (except the 5 large 3 mm holes) are filled with the lead of a component.
- All these leads are soldered.
- Pins next to each other are not soldered together.

**Check the top of the board to ensure that:**

- The notch on the IC holder / IC is near the edge of the board.
- The flat edge of each of the LEDs is next to the switch.
- The colour bands on R7 are yellow, purple, black.

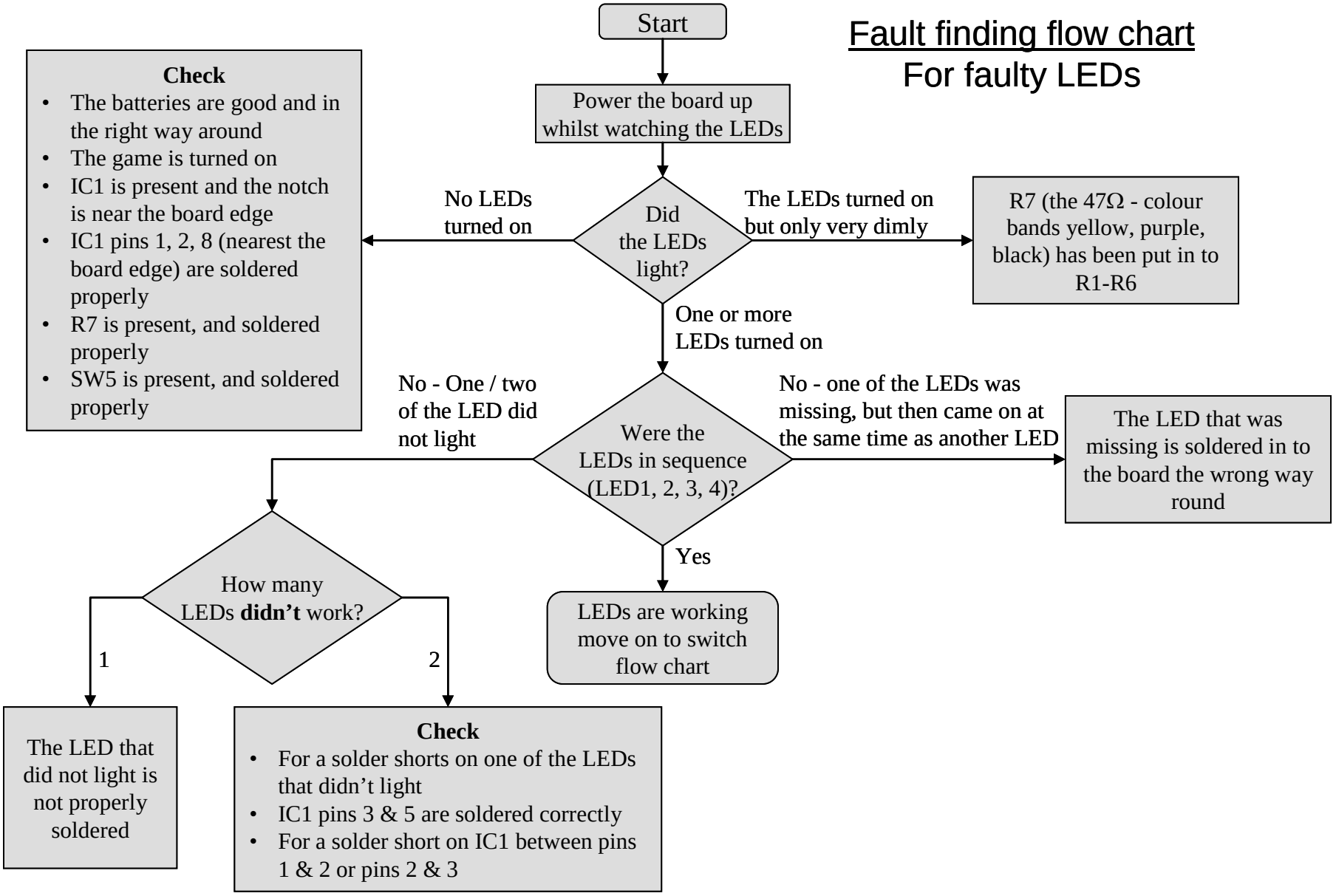
# Testing the PCB

The software on the microcontroller has been specially designed to allow easy testing of the PCB.

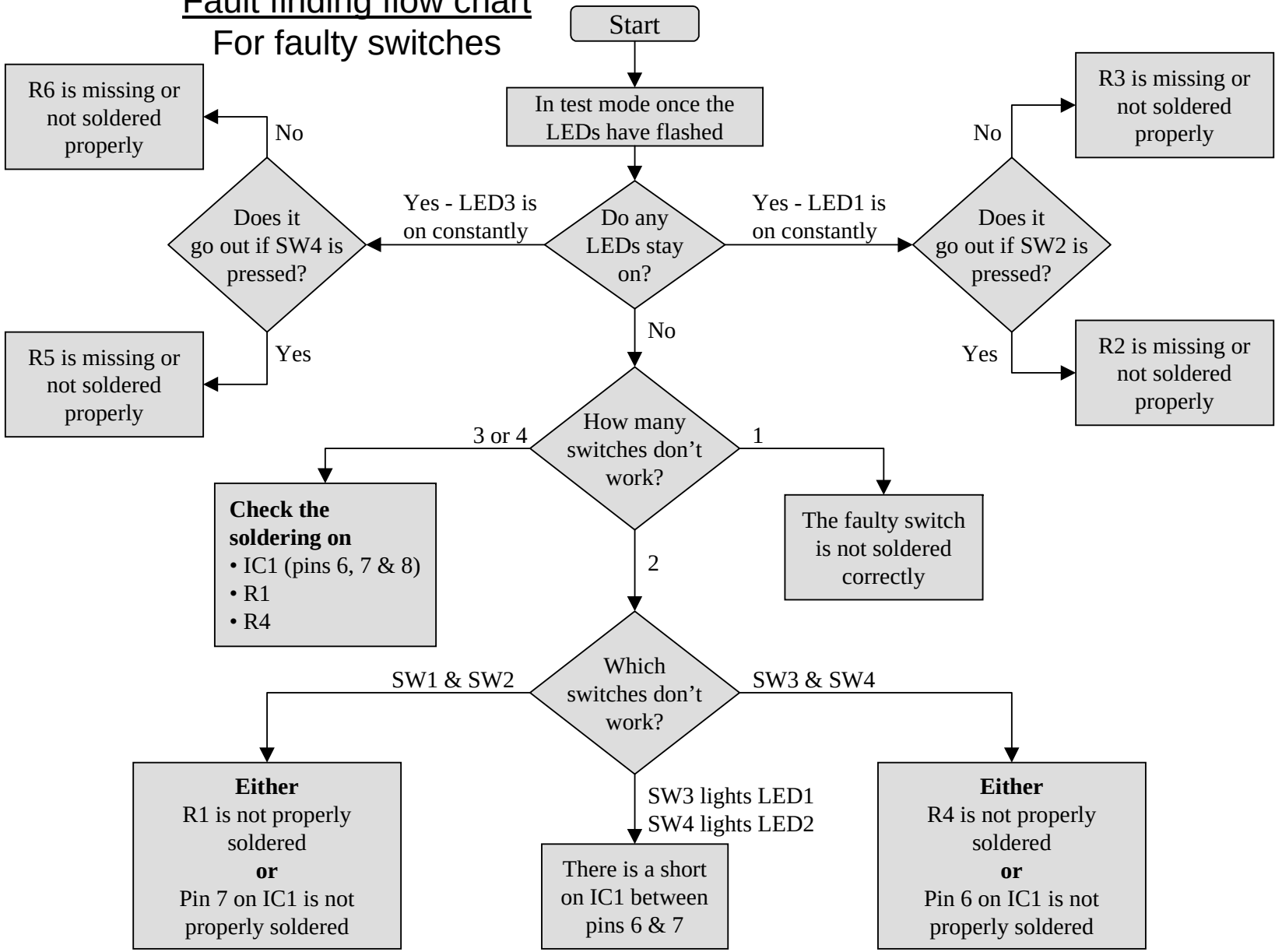
When the batteries are inserted and SW5 is in the on position, the game will:

- Illuminate LED1, LED2, LED3 & LED4 in sequence for one second each.
    - If the LEDs don't light in order stop testing and look at the LED faultfinding flow chart.
- Once the LEDs have gone out, pressing any of the four buttons will cause the LED next to it to light.
    - Check that all four buttons work, if this is not the case look at the switch faultfinding flow chart.
- Turn the game off using SW5.
- If all four buttons tested OK, next time the game is turned on it will work normally.

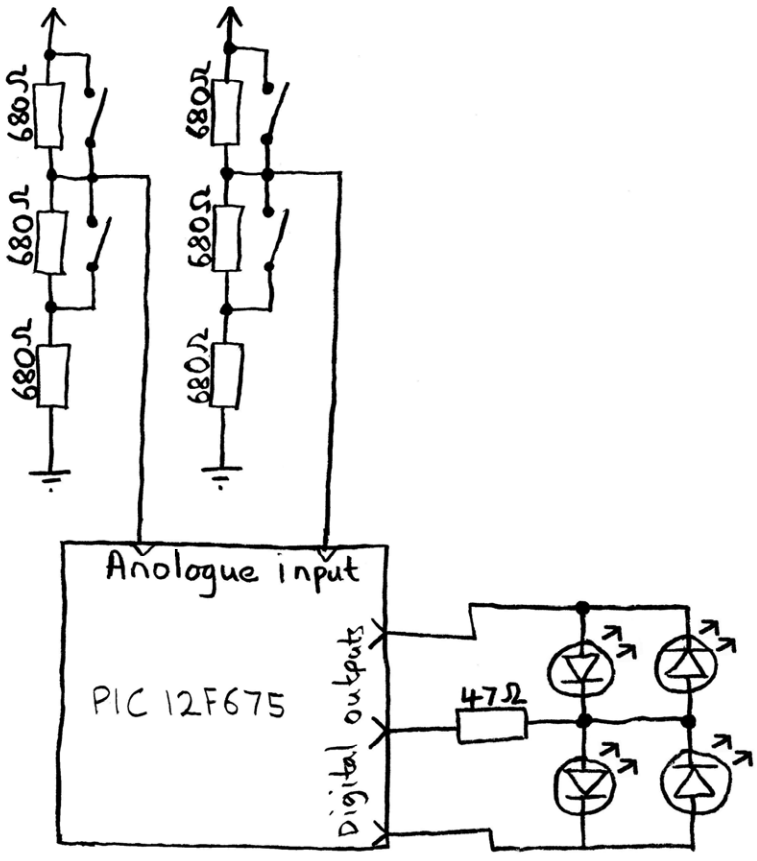
# Fault finding flow chart
## For faulty LEDs



# Fault finding flow chart
## For faulty switches



# How the Game Works




At the heart of the electronic circuit is a microcontroller. A microcontroller is in effect a small computer. The circuit uses a cleaver design to allow four switches and four LED's to be connected to only five input / outputs.

The switches are connected to an analogue to digital converter so that it gets a digital representation of the voltage on the input. A set of three resistors is used to make up a potential divider. As each of the resistors is the same value an equal amount of voltage is present across each of these resistors. The top two resistors also have a switch across them. When the switch is pressed the voltage across the resistor will become zero. So depending upon which of the two switches is pressed will depend upon what the voltage is at the point where it is fed into the PIC microcontroller. This allows the microcontroller to work out which button is pressed. The third resistor is used to prevent the batteries being rapidly flattened should both switches be pressed at the same time. The other two switches on the board work in the same way. This may sound overly complicated however it uses less input pins than switches with individual pull up resistors.

The LEDs are driven by three outputs. Because the LED only works when current flows through it in one direction the four LEDs can be turned on by changing the outputs to make one high, whilst another is low. More than one LED can be turned on if a little dimmer by taking it in turns to turn the LEDs on hundreds of times a second. The 47Ω resistor limits the current that can flow through the LED's. This protects the LED and controls the brightness.