WATER LEVEL DETECTOR

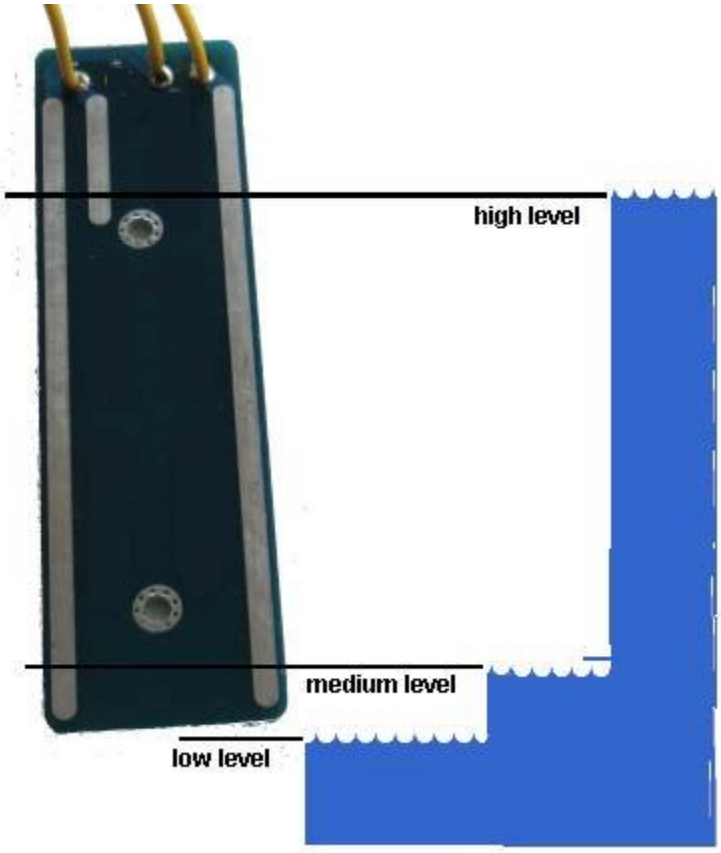
This set of modifications and improvements has been written by Colin Mitchell of TALKING ELECTRONICS (http://www.talkingelectronics.com) to help you understand and use this great little $6.00 project.

More kits:
DIY Kit Water Level Detection Sensor Liquid Level Controller Sensor Module
can be bought from e_zealot (55051
http://www.ebay.com.au/itm/131254362378
for about $6.00 posted. See eBay for the kit.

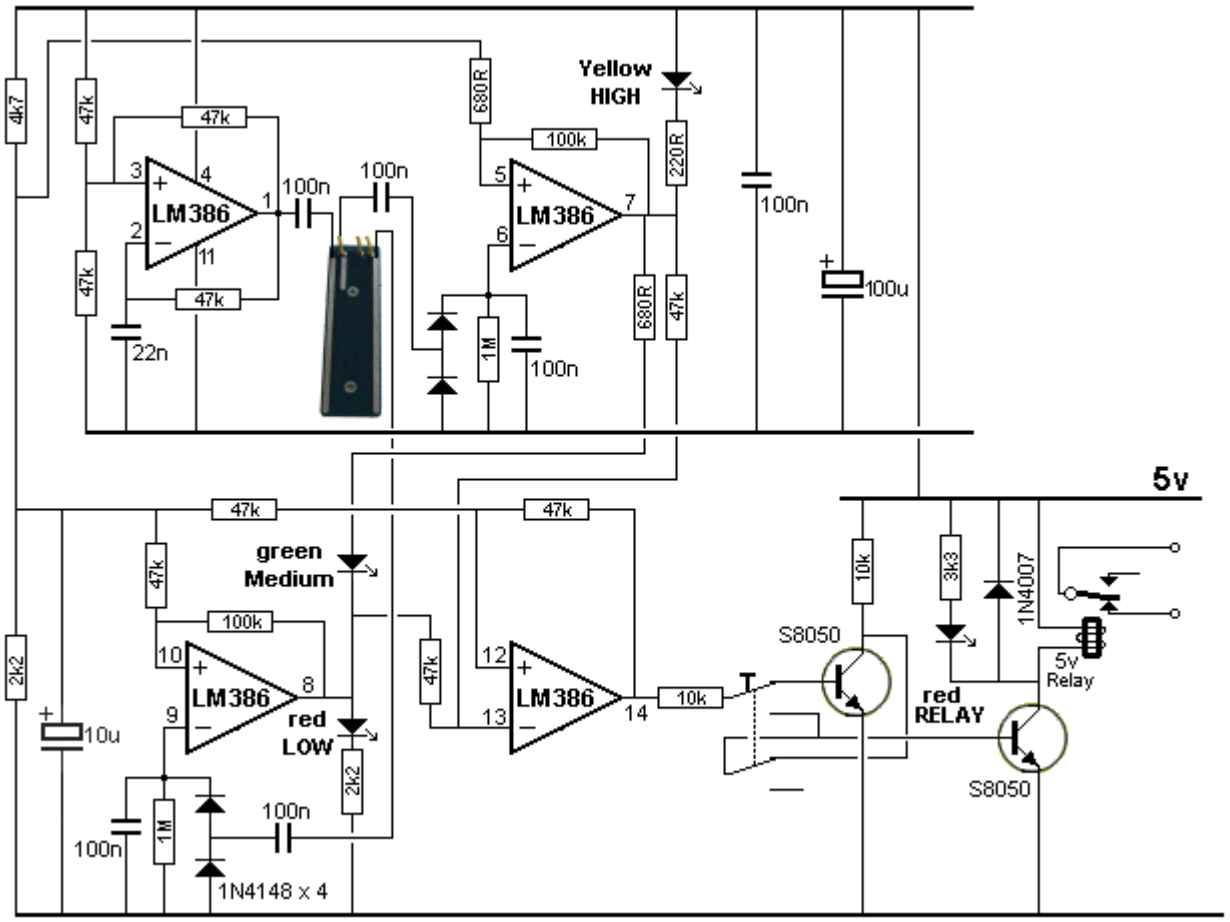
This project uses a quad op-amp and the 4 separate amplifier "blocks" are used in different configurations to produce amplifiers to control LEDs (2), a buffer transistor (1) and produce an oscillator (1).
The circuit starts with an oscillator using pins 1,2 and 3.
Pin 2 is initially connected to 0v because the 22n is uncharged and pin 3 sees a voltage that makes the output rise to about rail voltage. The voltage on pin 3 has a voltage divider arrangement so that the voltage on this pin will never rise above pin2 so that when pin 1 goes HIGH, its voltage is passed to pin 2 via a 47k resistor.
Pin2 takes a short period of time to rise due to the 22n capacitor charging and this produces the frequency of the circuit, but when it rises above pin3, the voltage on pin 1 drops and this means pin 2 has the effect of lowering the output voltage.
This continues until the output voltage reaches zero, and the voltage on pin 2 gradually drops as the 22n discharges.
Eventually the voltage on pin 2 drops below that on pin 3 and the output goes HIGH again to repeat the cycle.
The output is a square-wave of about 700Hz.
This waveform is passed to one of the long conductors on the water detection Printed Circuit Board via a 100n capacitor.
The capacitor only allows an AC waveform to appear on the water sensor and this means the sensor will not allow the copper track to be "eaten." This damage is not due to the salts in the water but a process called ELECTROLYSIS where the DC gradually eats away the copper strip by transferring the copper atoms from one track to another.

The water detector PCB consists of JUST two detection-points. 5 of the "lands" are not used and we have simplified the board in the second image to show which tracks are used in the project.
Here is the board:

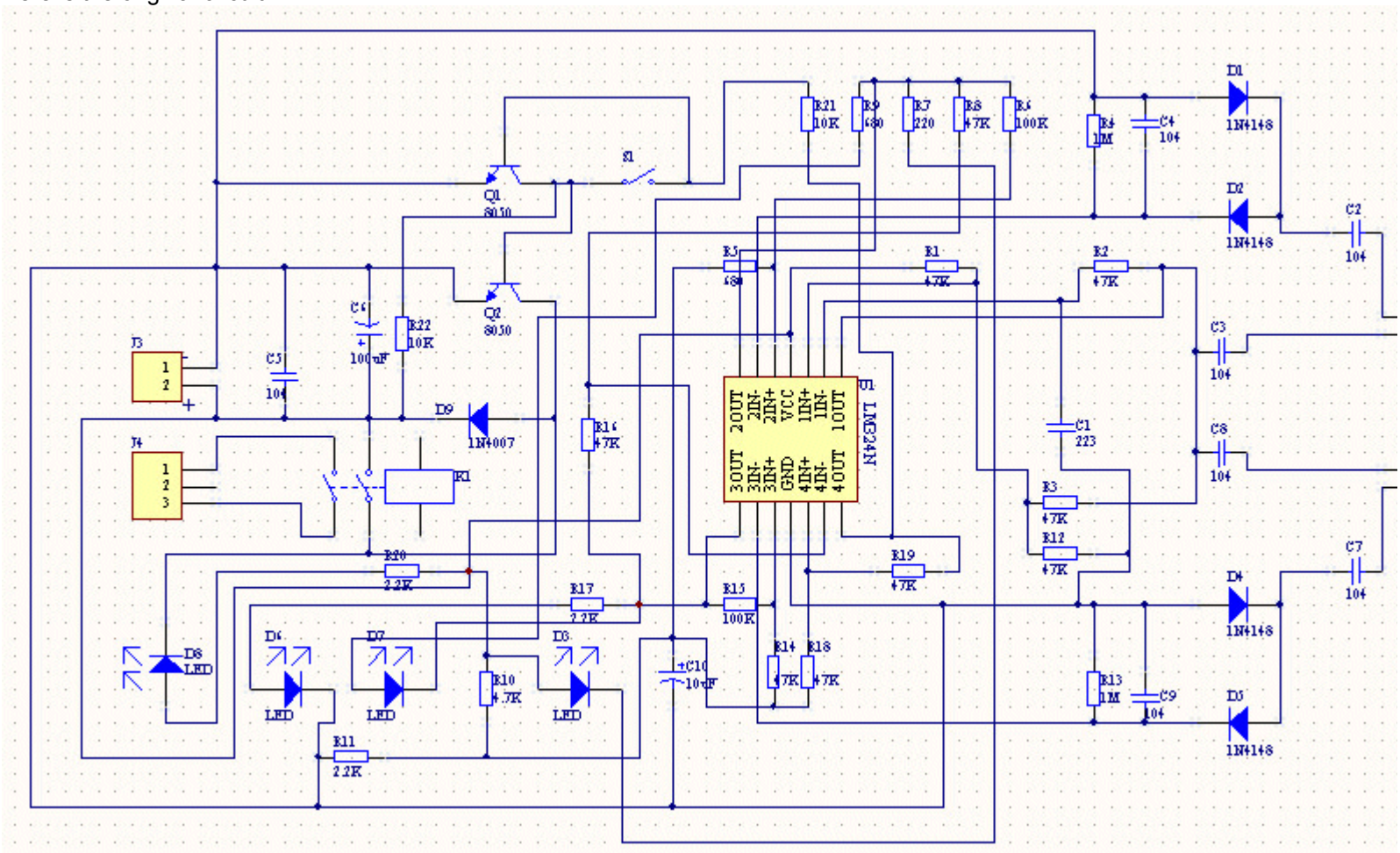
Here is a simplified version of the board and details of the levels it detects:

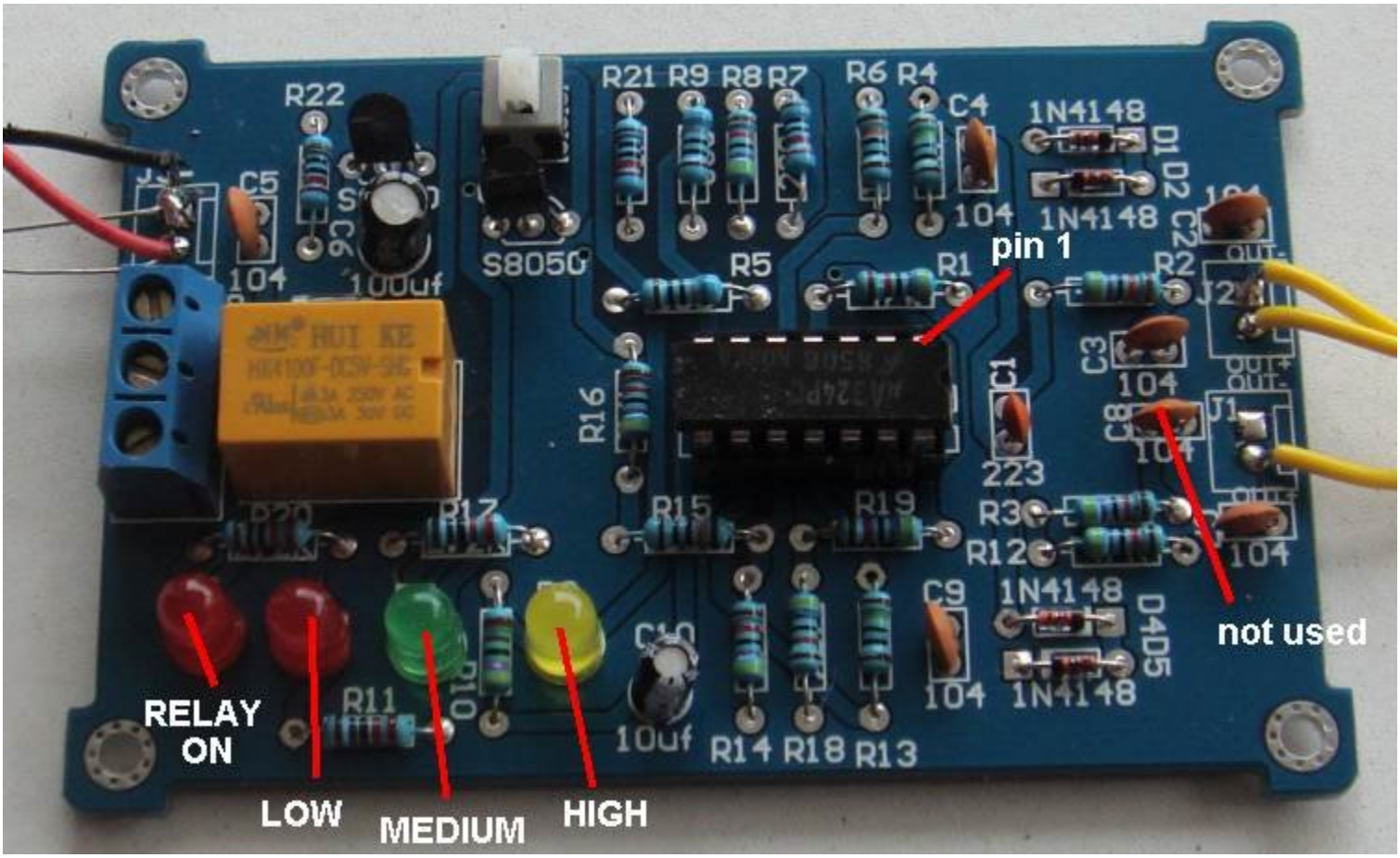


When the water level is BELOW the board, the red LED on the project is illuminated. This is the LOW LEVEL and the relay is no activated.
When the water rises and makes contact with the two outer long tracks, the green LED illuminates. This is the MEDIUM LEVEL.
When the water rises and makes contact with the short top track and the long track that you have connected to pin 1 of the IC (via C3), the yellow LED illuminates and the relay is activated. The first red LED is also turned ON.
This is the HIGH LEVEL.
Only one LED is illuminated at a time. The circuit is very clever by turning off the other LEDs when the highest LED is illuminated.
Water is a conductor and although it may have a resistance of about 100k between the conductors on the water detection PCB, a percentage of the signal will be transferred from the oscillator to another op-amp stage where the signal is delivered to a section we call a DIODE PUMP.
The signal is oscillating and it is called an AC signal. It must have an amplitude above 0.7v because the result must pass through a diode, where 0.7v is lost to activate the op-amp.
At the beginning, the capacitor connected to the join of the two diodes is uncharged and the signal received by the conductor on the water PCB rises. This rise will pass through the top diode and appear on the inverting input of the op-amp to make the output go LOW. At the same time it will charge the 100n on this input a small amount.
The 100n capacitor connected to the join of the two diodes will also charge slightly during this time and when the waveform drops from a HIGH to a LOW, the capacitor will be discharged by the lower diode, so it can "do its job" on the next cycle. If the capacitor was not discharged, it will charge fully and not be able to transfer a signal. This allows it to pass a signal to the input of the op-amp on the second and future cycles and gradually charge the 100n across the 1M.
This arrangement is called a diode pump.

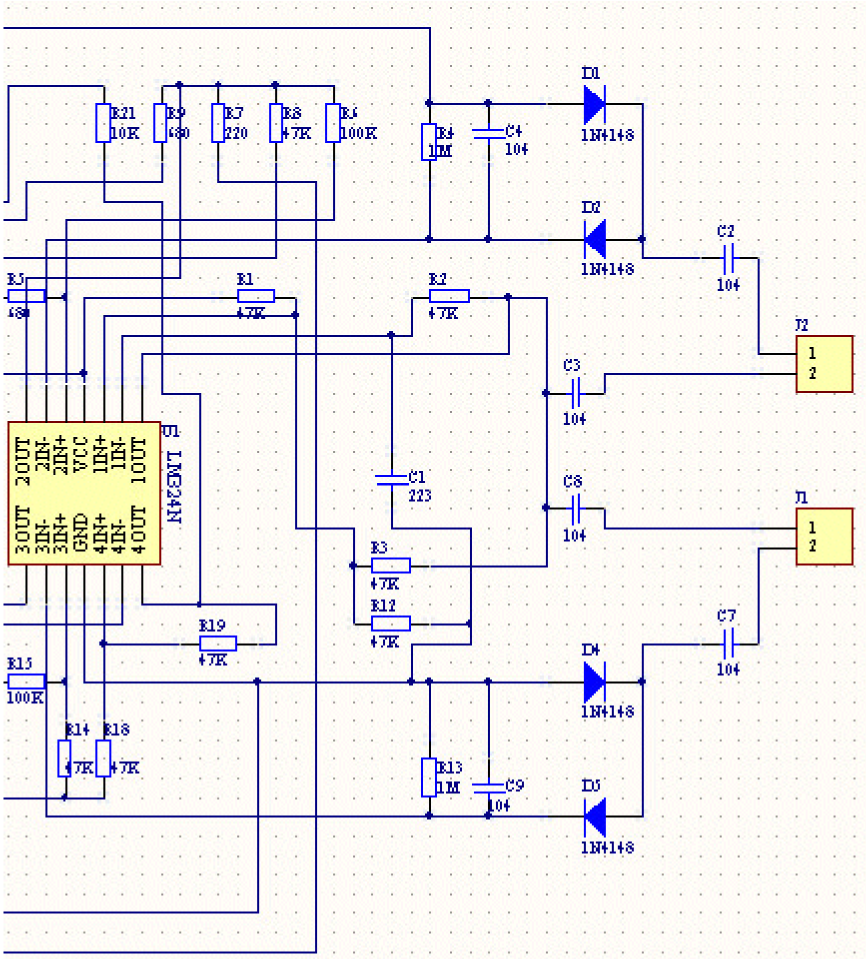


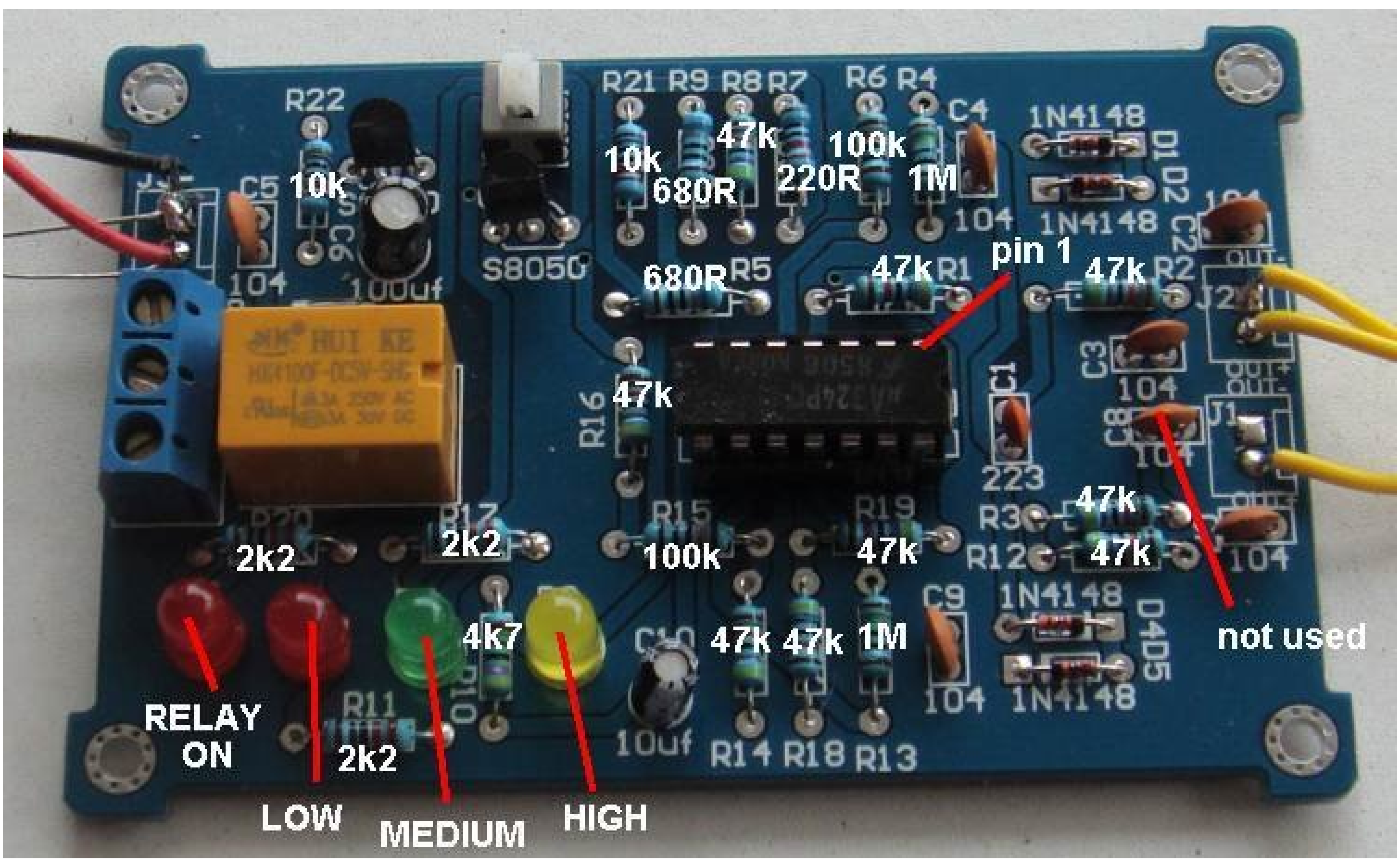
Here is the original circuit:



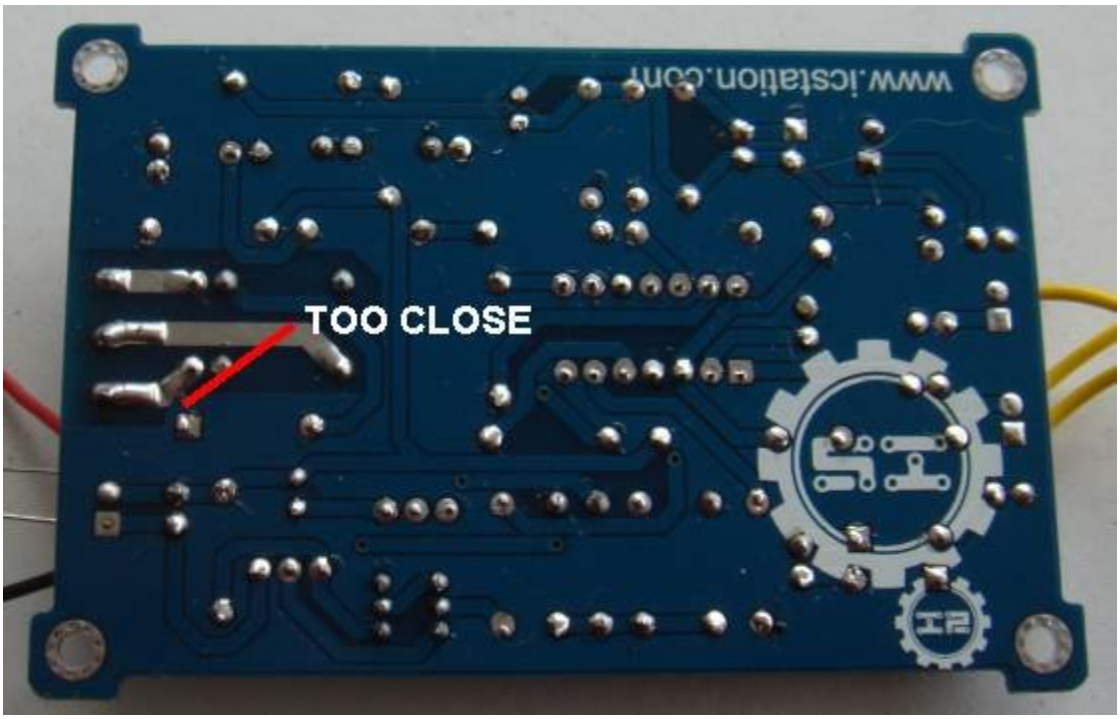


The Main PCB with all the components fitted. Note the chip pin 1. C8 is not needed.
All the resistors are 1%.
Here are the colours:
220 ohm - red-red-black-black-brown
680 ohm - blue-grey-black-black-brown
2,200 ohm - red-red-black-brown-brown
4,700 ohm - yellow-purple-black-brown-brown
10k - brown-black-black-red- brown
47k -yellow-purple-black-red-brown
100k - brown-black-black-orange-brown
1M - brown-black-black-yellow-brown


R21
10K
R9
680
R7
220
R8
47K
R6
100K
R4
1M
C4
104
D1
1N4148
D2
1N4148
C2
104
J2
1
2
R5
680
R1
47K
R2
47K
C3
104
U1
LM324N
2OUT 2IN- 2IN+ VCC 1IN+ 1IN- 1OUT
3OUT 3IN- 3IN+ GND 4IN+ 4IN- 4OUT
C1
223
C8
104
J1
1
2
R3
47K
R12
47K
R19
47K
R15
100K
C7
104
D4
1N4148
R14
47K
R18
47K
R13
1M
C9
104
D5
1N4148


R22
10k
C5
104
C6
100uf
S8050
R21 R9 R8 R7
10k
680R
47k
220R
R6 R4
100k
1M
C4
104
1N4148
D1 D2
1N4148
C2
104
680R R5
47k R1
pin 1
47k R2
J2
R16
47k
C1
223
C3
104
C8
104
J1
R3
47k
R12
47k
104
R20
2k2
R17
2k2
R15
100k
R19
47k
4k7
R10
R11
2k2
C10
10uf
47k 47k 1M
R14 R18 R13
C9
104
1N4148
D4D5
1N4148
RELAY ON
LOW
MEDIUM
HIGH
not used

The water detecting PCB with the 3 connecting wires



SETTING UP

Connect the water detecting PCB to the project with hook-up wire and lower the board into a glass of water.
You will see the LED illuminate in turn.
You can now make your own water detecting sensor with the HIGH and LOW levels to suit your requirement.

DRIVING A RELAY

This project drives a relay. But one of the tracks on the PCB is very close to the rest of the tracks and does not have 240v separation. You need to make this gap much wider to ensure a fault does not occur. If the voltage "flashes over" the project will come "LIVE" and the whole water tank will be a DEATH TRAP.
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Colin Mitchell April 2015