

Small Pump Controller

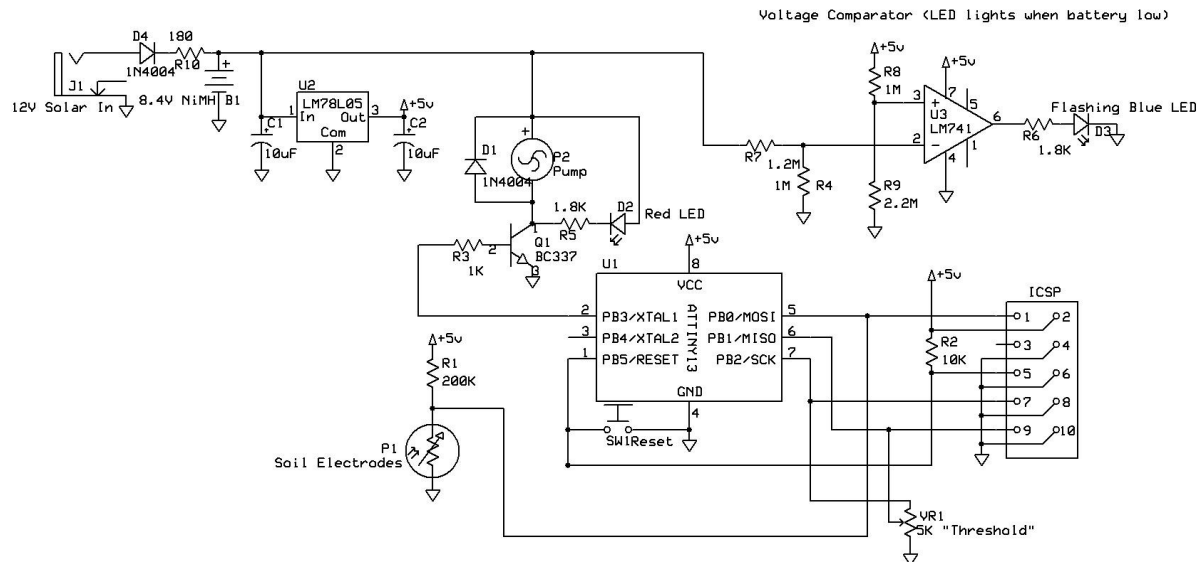
Designed by RM

This project file details a microcontroller based pump control system, designed for watering pot plants automatically. Using soils roughly proportional conductance and moisture content, the device turns on the watering pump when the soil is too dry.

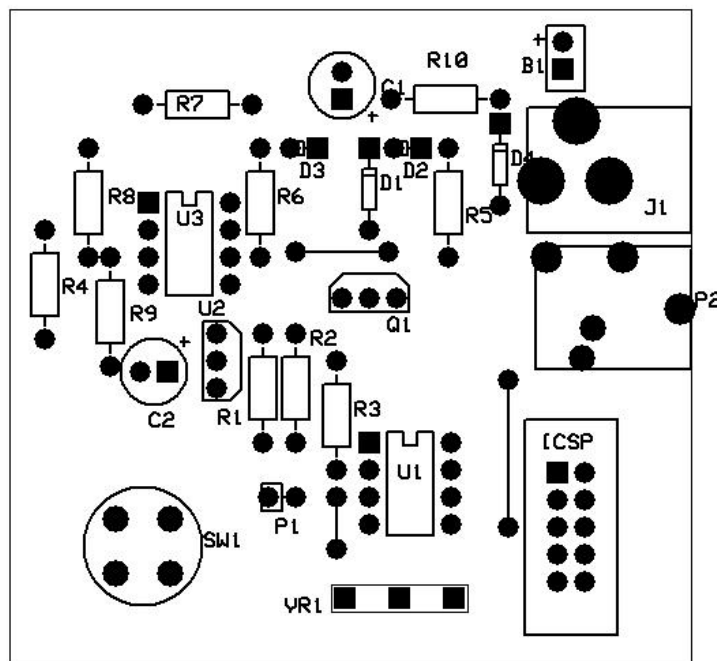
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Schematic, PCB and Layout



Pump Controller



Resistors/Capacitors:

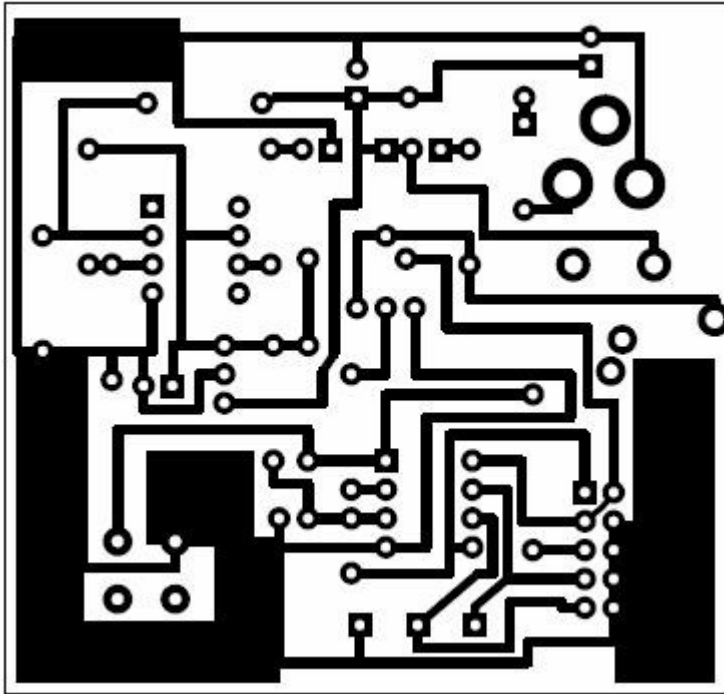
C1	10uF
C2	10uF
R1	470K
R2	10K
R3	1K
R4	1.2M
R5	1.8K
R6	1.8K
R7	1M
R8	1M
R9	2.2M
VR1	5K Lin
P1	Electrodes

Misc:

SW1	Pushbutton
ICSP	10 pin header
J1	Switched DC socket
P2	Power socket for Small Pump
B1	8.4V NiMH (9V rechargeable)

Semiconductors:

U1	ATTINY13
U2	78L05 Regulator
U3	LM741
Q1	BC337
D1	1N4004
D2	Red LED
D3	Flashing Blue LED
D4	1N4004



Scale to 2.5Inches Wide by 2.4Inches Tall.

Assembly Code

The program was written using assembly language, and programmed into the microcontroller using AVR Studio 4.12 and PongProg2000 (with ATTiny13 support). The programming hardware was a DIY parallel port programming dongle.

```
.include "tn13def.inc"
.def temp = r16
.def temp2 = r17
.def temp3 = r19
.def temp4 = r20
.def temp5 = r21
.def temp6 = r22

;PB0 - N/A
;PB1 - VR1 Base (In)(Comp)
;PB2 - VR1 Power (Out)
;PB3 - Pump (Out)
;PB4 - Electrodes (In)(Comp)
;PB5 - Reset

reset:
ldi    temp, 0b00001100
out    DDRB, temp
ldi    temp, 0b00000010
out    ADMUX, temp
ldi    temp, 0b00000000
out    ADCSRB, temp

sbi     PORTB, 2 ;turn on VR1

main:
sbic    ACSR, 5
rjmp    pumpon
cbi     PORTB, 3
rjmp    main

pumpon:
ldi     temp3, 255          ;check ADC is on consistently
pumpon1:
dec     temp3
breq    pumpon2

sbic    ACSR, 5
rjmp    pumpon1
clr     temp3
rjmp    main

pumpon2:                      ;turn on pump for set time
sbi     PORTB, 3
rcall   seconddelay          ;set number of seconds pump is turned on for
rcall   seconddelay
rcall   seconddelay
rcall   seconddelay
rcall   seconddelay
rcall   seconddelay
rcall   seconddelay
rcall   seconddelay
rcall   seconddelay
rcall   seconddelay
rcall   seconddelay
rcall   seconddelay
rcall   seconddelay

cbi     PORTB, 3
rcall   longdelay ; remain off for some time
rjmp    main
```

```

longdelay:
ldi    temp3, 255
ldi    temp4, 255
ldi    temp5, 255
ldi    temp6, 42 ;255
delaya:
dec    temp3
brne   delaya
ldi    temp3, 255
dec    temp4
brne   delaya
ldi    temp4, 255
dec    temp5
brne   delaya
ldi    temp5, 255
dec    temp6
brne   delaya
ret

seconddelay:
ldi    temp3, 255
ldi    temp4, 255
ldi    temp5, 6
delayb:
dec    temp3
brne   delayb
ldi    temp3, 255
dec    temp4
brne   delayb
ldi    temp4, 255
dec    temp5
brne   delayb
ret

```

External Apparatus

Naturally, this system requires external hardware to implement it. In addition to the wiring, you will need the following things:

- Water container
- Small pump
- Plastic tubing
- 12V Solar Panel
- Shelter for the device

As the device is obviously going to be sensitive to water, it is not going to be happy if it gets wet. To this end, you must shelter it somehow from the rain. The 12V solar panel is essential, as without it the battery will run out in about a day or so.

First, submerge the pump (with tube attached) in the water container. Then, using cable ties, secure the other end of the tube to a small/shortened garden stake. Drive the stake into the soil such that the tube points downwards at the soil, but not too close to the plant. Make sure that the water level in the container is not higher than the end of the tube, or the water will siphon out by itself. The pump should have a wire connected to it that is long enough to reach the device, and have a 3.5mm plug on it. Make sure you wire it right, so it doesn't try to pump in reverse.

It is recommended that the soil in the pot be covered in mulch (e.g. sugar cane mulch), to limit the loss of water by evaporation. The mulch really does cut the amount of watering required.

How it works

Instructions

The controller must be calibrated before use, but don't worry – it's a very simple calibration. First make sure the electrodes are secured in the soil, and lie about a foot apart, either side of the plant. Wait until the soil becomes relatively dry (i.e. plant is starting to wilt), and then follow this procedure:

- Turn the knob to its minimum, and press reset
- Whilst continuously pressing reset (but not holding it down), slowly turn the knob until the LED comes on. Mark this point.
- Drench the soil so it becomes very moist. Repeat the previous procedure, and again mark the point where the LED comes on.
- These two points indicate the watering range. You must then set it to give the right balance of keeping the soil moist, but not watering too much. This takes the odd tweaking of the knob every now and again till its set perfectly, but when it is it can be left to its own accord.

The system works in a relatively simple way. It compares the voltage at the soil to the voltage at the potentiometer, and turns on the pump if the soil conductance is too low. In order to allow the water time to seep into the soil, it turns on the pump for a set period, and then holds it off for a short while. It repeats this process continuously.

Miscellaneous

Programming

If you do not have a commercial AVR programmer, you can build your own very simple one, using the details from the following website: <http://www.tothemax.web1000.com> – under “PIC and AVR”. You will need to download PonyProg2000 and get the ATtiny13 support executable.

Parts

The pump is available from Jaycar Electronics (<http://www.jaycar.com.au>), and costs about \$AUS20 (code YH5451). The clear tubing is available from Bunning’s – make sure it fits the pump. The solar panel is commonly available for car trickle-charging purposes, and was purchased from Super Cheap Auto. The water tank was purchased from a camping store. For all other parts I would recommend <http://www.futurlec.com> or <http://www.futurlec.com.au>.

Use of this document

If you want to use the information in this document in commercial designs, go for your life. If you make millions and retire in a beach-front villa with a super-model wife and a Ferrari, I’m cool with that.

Modifications & Other Uses

The system could theoretically be used for a multitude of things. Anything that alters the resistance between the electrode pins will be able to trigger the pump on and off. E.g. using a LDR could make the device turn a pump on in the morning, or it could turn a pump on when water in a tank drops below a certain level.

It is also theoretically possible to have the system water many pot plants. This would require some way of splitting the pump output to several tubes. One electrode would go in the first pot, the other electrode would go in the last pot, and then the pots would all be ‘wired in series’. This would likely require the pumping time to be multiplied by the number of pots.

Help

If you have any questions, please forward them to tothemax6@hotmail.com. I am afraid I have little time for debugging questions. I built a unit myself and it worked successfully.