ProScan Pulse Induction Metal Detector

Schematic (PDF-131K)
PC Board (JPEG-167K)
Parts Placement (JPEG-134K)

Here it is!

This is the PI metal detector first introduced in ProScan site (www.polbox.com/p/proscan/schemat.htm). The schematic was redrawn and revised by me (Paulo Viegas) and Piotr from Proscan.

The components

Capacitors:

Non-polarized: Use good quality polyester capacitors, except for pF capacitors which can be ceramic.

Polarized: Electrolytic, voltage as indicated on plan.

Resistors

Use 1/4 watt, 1% or 5% tolerance

IC's

DO NOT USE IC SUPPORTS (sockets), those can create inductance and capacitance, and we do not want that! For 709 I recommend using the TO99 version.

VR's

Use the mini version, horizontal placement.

USE ONLY NEW COMPONENTS

Component List

Part	Value
Capacitors	
C1	100uF/16
C2,C13	47nF/63
C3,C11	100nF

C4	1nF/63
C5,C24,C15,C16,C17,C19	47uF/16
C6	47nF
C7,C10,C12	150nF
C8	10pF
C9	3.3pF
C14	15nF
C18	68uF/25
C21,C22,C23	1nF

Diodes

D1,D2,D3,D4,D6,D7	1N4148

Variable Resistor (mini VR)

P1,P2	100K
P3	10K

Resistors (1/4W, 1% or 5% Tol.)

R1	43K
R2,R7,R13	1.1K
R3,R10	1K
R4	330
R5,R12	220
R6	100
R8	300
R9	820
R11	520K
R14,R16	10K
R15	110
R17,R21	2.3K
R18	750K
R19	220
R20	6.8K
R22	1M
R23,R26	11K
R24	130K
R25	30K
R32,R35	18K
R33,R36	8.2K
R34	91K
R709	100K

Transistors

T1	BC560C
T2	BD911

T3	BF245
T4	BC560C
IC's	
U1,U5,U6	555
U2	79L05
U3	709 (MAA501 as in plan, is a Czech equivalent to 709)
U4	741
U7	78L10C
U8	4093
Other	
L1	Search Coil, 20cm diameter of 25 windings of insulated copper wire (~22AWG)
S1	Female Jack Phones for PCB (optional)

PCB

The PCB for this project is a JPG file (PCB1), the final printed dimensions should be ~65mm X ~130mm. I recommend using the photo process to create the tracks, since the circuit is more or less complicated. After printing PCB1 flip the paper, the printed surface is the one that will be in contact with the copper layer. The components placement is in file PCB2.

Please note that there's four jumps, make then with standard isolated copper wire. The S1 (jack support) is optional, and can be placed in the case. Keep the components with short leads, and close to the pcb, to avoid capacitance and inductance.

Note: I've taken much care in making this pcb, I believe no tracks were forgotten (since this is insured by the software), nevertheless if any error as to be found, please inform me right away. [paulo@cm-portimao.pt]

IMPORTANT

After making the pcb, please check the tracks that go inside 4093 pins, insure that they are not short-circuited (correct with a x-acto blade if needed).

Circuit Description

"Basically U1 is a timer integrated circuit that is wired as a pulse generator. The output on pin 3 is a negative going pulse of a width that determines the width of the transmitter pulse. This is repeated at a certain frequency that is the transmitter pulse rate. This pulse train drives T1, which inverts it so that it is then a positive pulse driving the base of T2. T2 is the transmitter output stage driving the search coil, L1, in its collector. U2 is a voltage regulator that takes the negative battery voltage and gives -5V output for the receiver amplifiers U3 and U4. R7 across the coil is a damping resistor to stop the coil ringing. The live side of the coil then goes through a 300? ohm resistor to pin 2 of U3 which is a wide band receiver amplifier. The two back to back diodes prevent the transmitter switching transients from damaging U3.

After amplification the signal goes to the sampling gate T3. This acts as a switch that is closed until a short time after the transmitter pulse has ended (pulse delay) This delay is generated by the 4093 dual monostable which is triggered via C4 from the transmitter waveform. The first half on the 4093 generates the delay duration while the second half generates the time that the gate stays open. U4 is a single ended integrator which takes a running average of the samples of the amplified receiver waveform. When there is no metal near the coil the sample will be approximately zero; bring metal near to the coil and the sampled decaying waveform from the metal will cause the output of U4 to rise. This dc output goes via R17 to the transistor T4 which controls another timer IC, U5, to generate the audio pulses. The audio output is a tick that increases in frequency as metal is brought closer to the coil. The threshold tick is set by P3 that alters the bias on the other input of U4. Headphones can be connected to pins 3 and 2 of the connector on the right of the schematic. A resistor in series here might be necessary to adjust the volume. At the top left of the schematic U6, is another timer that generates a separate pulse train that is then rectified by the diodes D1-D4 to give a positive dc voltage which is then supplied to the positive 10V regulator U7 which gives the positive supply necessary for the receiver IC's. P1 is a preset resistor that sets the dc output level on pin 6 of U3 to 0 volts. It is useful to connect an oscilloscope to this point for testing to see that everything is working OK. The only thing that I can't show here are the various waveforms and their relationship with each other. These are controlled by the components around the timers and the monostables and are fixed by the values given in the schematic. So if everything is assembled right the only setup adjustment is P1." Eric Foster

Eric's suggestion:

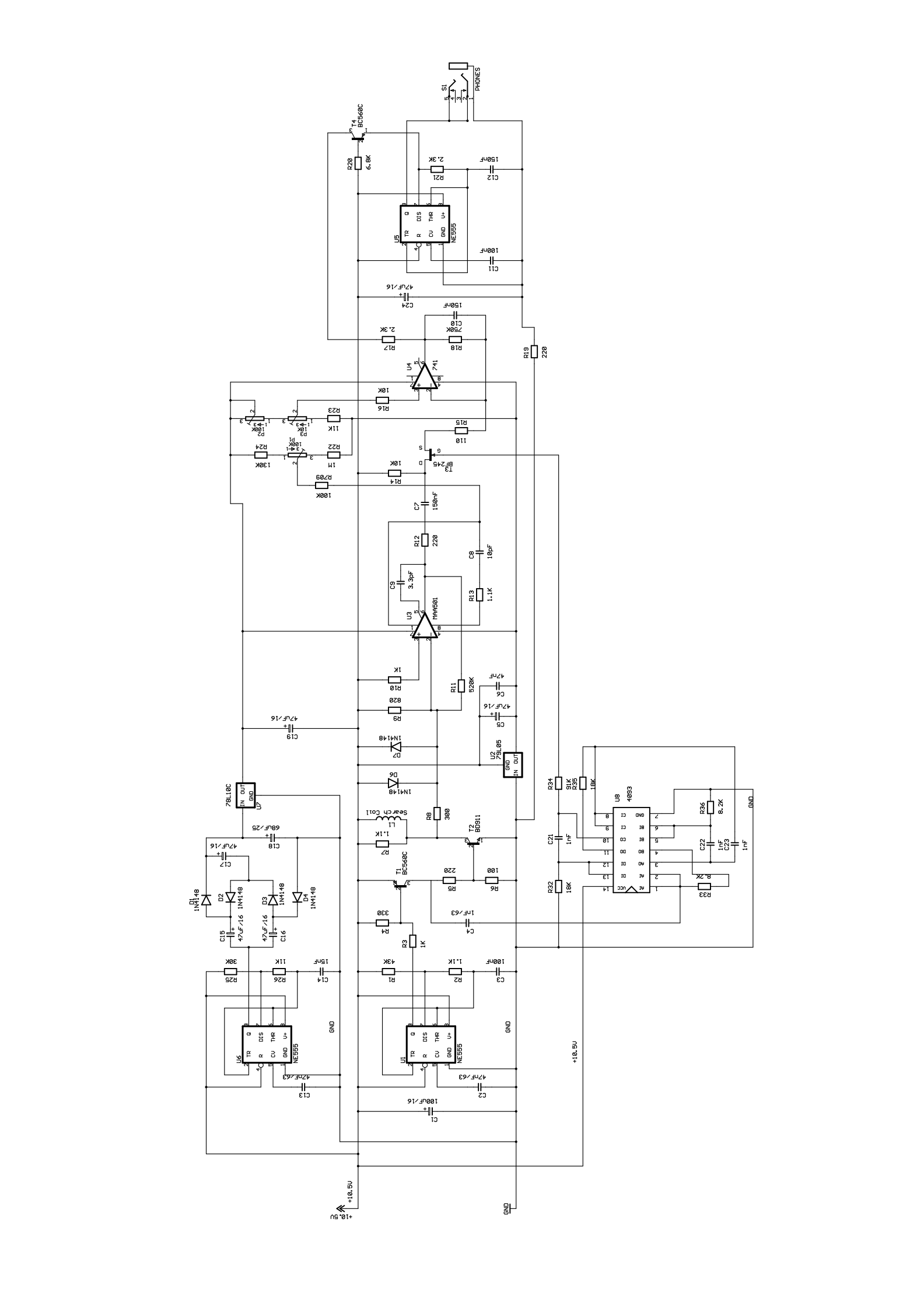
"I would suggest making R8 1K0, R11 1M0 and deleting R9. This will give a gain of 1000 for the first stage and the 709 will be stable with the compensation values given. What sometimes fails rather than the diode is the input resistor R8 and possibly the damping resistor. Both of these resistors experience the peak voltage across them and can go open circuit unless a high quality metal film resistor of adequate rating is used."

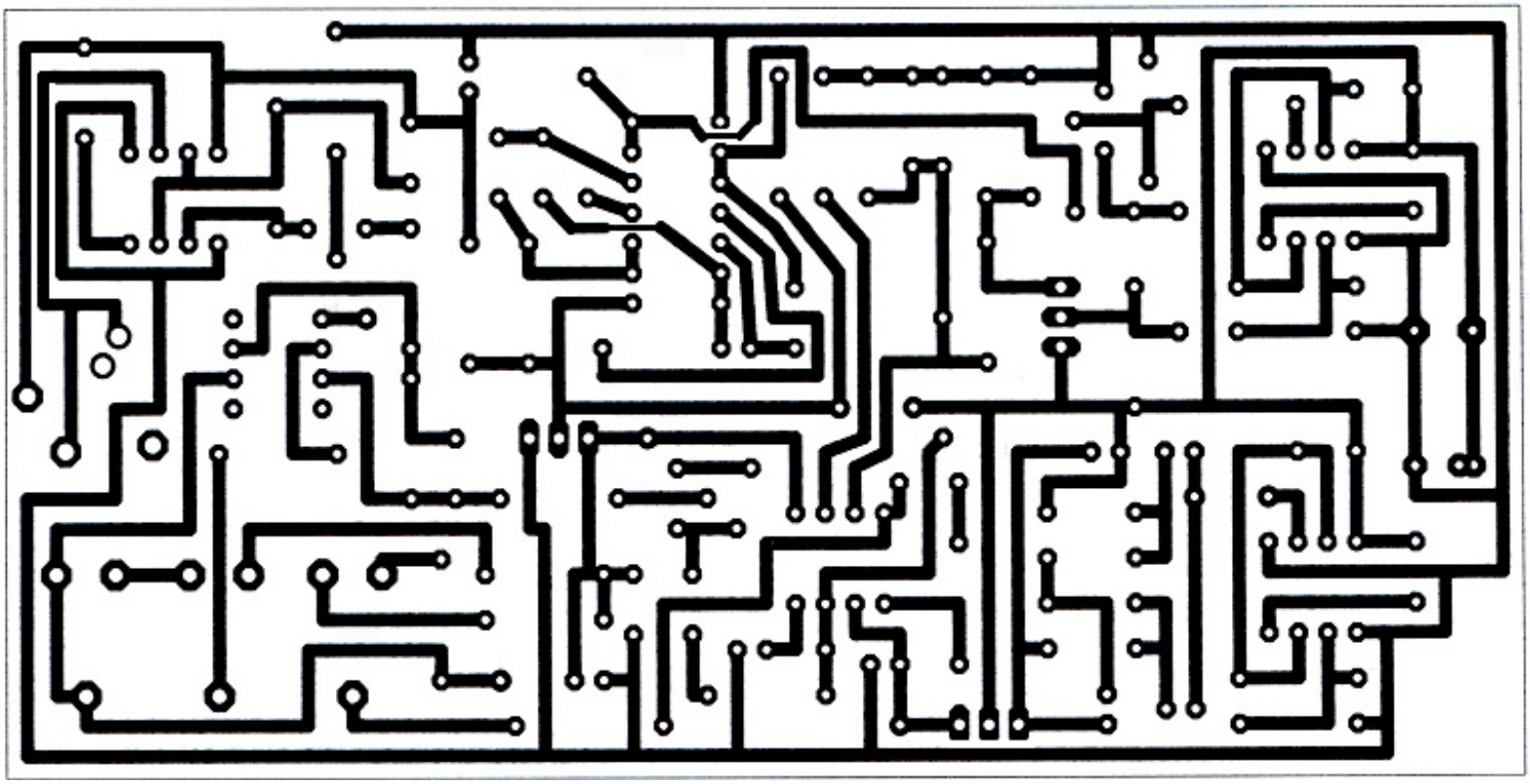
Acknowledgements

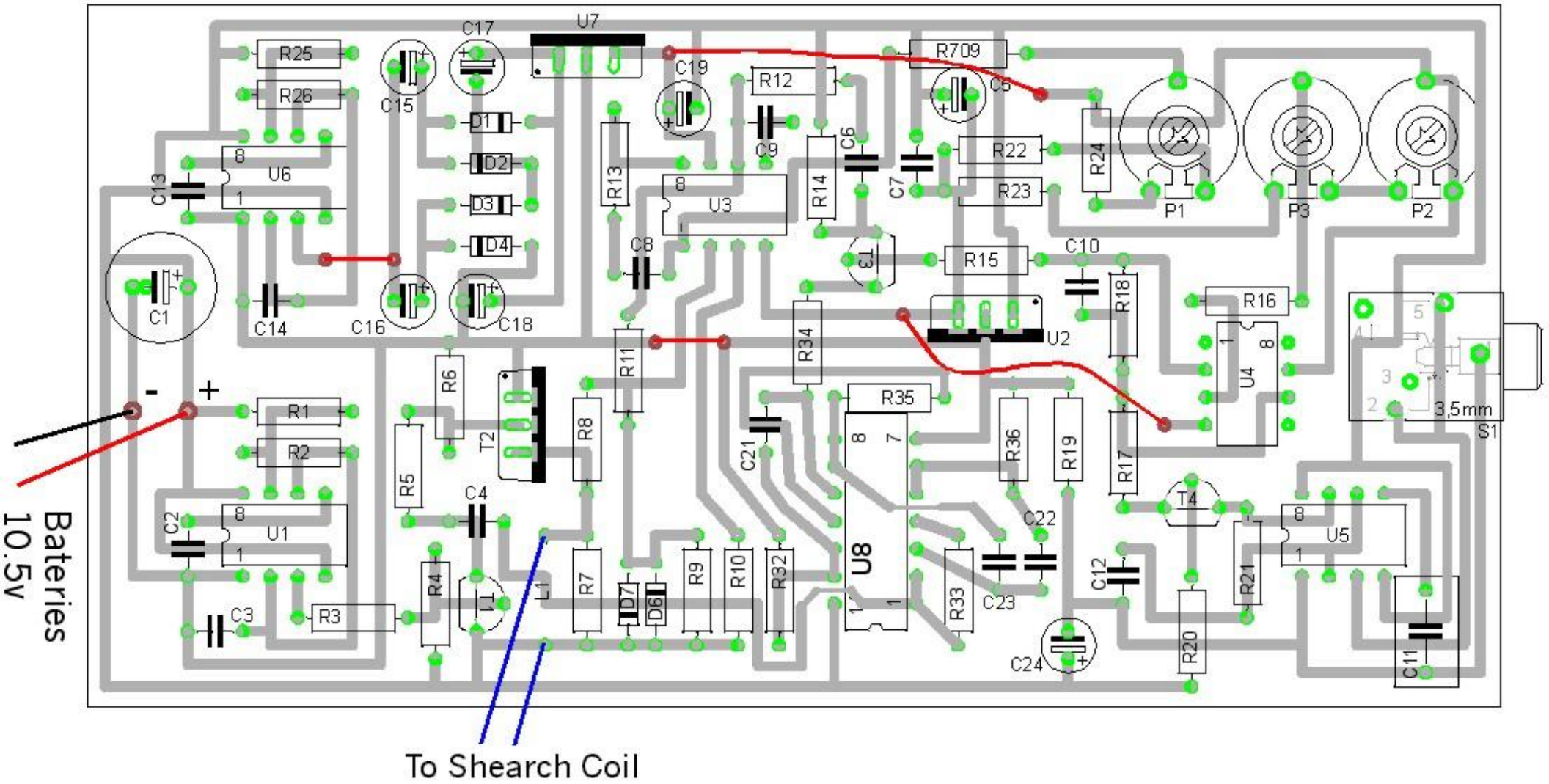
I would like to thank:
Piotr for giving the first schematic and revising the new one.
Eric Foster for giving the explanation on the circuit, and commenting it
All the guys (Phil, Vlad, ...) that commented this on Eric Foster's Forum (http://www.findmall.com/metal/school1/config.pl)

My wife, for being sooooo patient when "I'm on the computer".

Regards to all,
Paulo Viegas, Portugal
paulo@cm-portimao.pt
P.S. - Sorry for any English error!!


PHONES
S1
T4 BC560C
R20 6.8K
R21 2.3K
C12 150nF
U5 NE555
C11 100nF
C24 47UF/16
C10 150nF
R17 2.3K
R18 750K
R19 220
U4 741
R16 10K
R23 11K
R15 110
R22 1M
R24 130K
T3 BF245
R14 10K
R709 100K
C7 150nF
R12 220
C8 10pF
C9 3.3pF
R13 1.1K
U3 MAA501
R10 1K
R11 520K
C6 47nF
R9 820
C5 47UF/16
C19 47UF/16
D7 1N4148
U2 78L05
D6 1N4148
78L10C U7
C18 68UF/25
C17 47UF/16
R8 300
L1 Search Coil
R7 1.1K
T2 BD911
T1 BC560C
R5 220
R6 100
R4 330
C4 1nF/63
R3 1K
D1 1N4148
D2 1N4148
D3 1N4148
D4 1N4148
C15 47UF/16
C16 47UF/16
R25 30K
R26 11K
C14 15nF
R1 43K
R2 1.1K
C3 100nF
U6 NE555
U1 NE555
C13 47nF/63
C2 47nF/63
C1 100UF/16
GND
+10.5V
R34 91K
R35 18K
U8 4093
R36 8.2K
C21 1nF
C22 1nF
C23 1nF
R32 18K
R33 8.2K




Bateries
10.5v
To Shearch Coil
3,5mm
S1
U1
U2
U3
U4
U5
U6
U7
U8
T1
T2
T3
T4
L1
P1
P2
P3
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
R21
R22
R23
R24
R25
R26
R32
R33
R34
R35
R36
R709
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
C18
C19
C21
C22
C23
C24
D1
D2
D3
D4
D6
D7