AUTOMATIC TUNER FOR SMALL MAGNETIC LOOP ANTENNAS INSTRUCTIONS, PARTS LIST WITH PART NUMBERS FOR PRINTED CIRCUIT BOARD REV C, & PICTURES OF COMPLETED PROJECT

Circuit Created by Andrew Cornwall, VE1COR
PCB Design by Edward Thompson
December 2019

CONTACT
Email: acornwallns@gmail.com
Website: www.acornwall.ca

PARTS LIST

U1	PICAXE 18M2+	Microcontroller
U2	4N35	Optocoupler
U3	7805	Voltage regulator
U4	A4988	Bipolar Stepper Motor Driver Module
D1	Blue LED	Bright LED, mounted to extend beyond edge of PCB
D2	Yellow LED	Bright LED, mounted to extend beyond edge of PCB
D3	Red LED	Bright LED, mounted to extend beyond edge of PCB
D4	1N34a	Germanium Diode
D5	1N34a	Germanium Diode
D6	1N34a	Germanium Diode
D8	1N34a	Germanium Diode
D7	1N5401	3 Amp, 100 Volts Silicone Rectifier Diode
D9%	1N4001	1 Amp, 50 Volts Silicone Rectifier Diode; added if relay K1 is installed
C1	0.1 mFd	micro-capacitor, 30 volts
C2	0.1 mFd	micro-capacitor, 30 volts
C3	100 mFd	electrolytic capacitor, 30 volts
C4	0.1 mFd	micro-capacitor, 50 volts
C5	100 mFd	electrolytic capacitor, 50 volts
C6	0.002 mFd	micro-capacitor, 30 volts
R1	3,000 ohms	Resistor 1/8 watt (hole spacing allows 1/4 watt)
R2	1,000 ohms	Resistor 1/8 watt (hole spacing allows 1/4 watt)
R3	470 ohms	Resistor 1/8 watt (hole spacing allows 1/4 watt)
R4	470 ohms	Resistor 1/8 watt (hole spacing allows 1/4 watt)
R5	470 ohms	Resistor 1/8 watt (hole spacing allows 1/4 watt)

R6	10K ohms	Resistor 1/8 watt (hole spacing allows 1/4 watt)
R7	22K ohms	Resistor 1/8 watt (hole spacing allows 1/4 watt)
Other Resistor%	10K ohms experimental	1/8 watt added underside of PCB for the '180 sensor' connector. A position for this resistor is not included on the circuit board. See PCB Possible Modification, below, for its addition.
J1	earphone Jack	Stereo, 1/8" note pin arrangement (may be replaced by wire 'pigtail' 1/8" stereo earphone socket)
J2	see item 3 below	Connector for SPDT Sensitivity Switch *
J3	see item 1 below	Connector for Buzzer *
J4	see item 1 below	Connector for Power Supply
J5	2 pin Jumper	NOT capped (open) when Relay is installed - at X1 in circuit diagram
J6	2 pin Jumper	capped (shorted) when Relay is NOT installed - at X2 in circuit diagram
J7	see item 1 below	Connector for Sample Antenna
J8 (half)	see item 1 below	Connector for Stepper Motor Coil
J8 (half)	see item 1 below	Connector for Stepper Motor Coil
J9%	see item 1 below	Connector; added for 180 SENSOR to use with a 180 Deg. variable capacitor at the loop antenna
J10	2 pin Jumper	Provision for optional sensitivity resistor, usually capped (shorted) - at X3 in circuit diagram
K1%	relay SPST NO	SIP 1A05 Reed Relay, coil 5v, less than 20 mA; optional

BUZZER 5V max. 20 ma max. Buzzer
SWITCH SPDT sensitivity switch

Item 1: Two Pole PCB Screw Terminal Block Connector 5mm Pitch for 14-22AWG
Item 2: Three Pole PCB Screw Terminal Block Connector 5mm Pitch for 14-22AWG

NOTES:
- Capacitor voltages may be lower in parts of circuit where 5 volts prevails, resistor wattages, and power diode amps may be higher
- **Bolded** parts are connected to the board but located off the board

* Connectors may be replaced by jumpers for attaching cables, or wires may be

soldered directly to the board
% Optional components - see article text

PART ORIENTATION

- Polarization of diodes D4, D5, D8, D6, D7,D9 are indicated by a printed bar and a square solder pad at the Cathode.
- Polarization of LEDs D1, D2, D3 are indicated by a square solder pad for the Cathode and a small '+' for the Anode.
- Polarization for the Buzzer, J3, and power input, J4, are indicated by printed '+' and '-' characters.
- Polarization of the variable capacitors are indicated by printed '+'.
- Location of pin 1 (input) of the 7805, U3, is indicated by a square solder pad. Also, the back plate is toward the outside edge of the board, over the printed line.
- Location of pin 1 of the 4n35 and 18M2+ ICs are indicated by a square solder pad.
- Location of the 'Enable' pin of the A4988 module, U4, is indicated by the printed small circle.
- There is no orientation to observe for the optional relay, K1 (the inner pins are switch contacts and the outer pins are activation power).

See Picture 1, 'PCB Populated Top', below, for additional part orientation information.

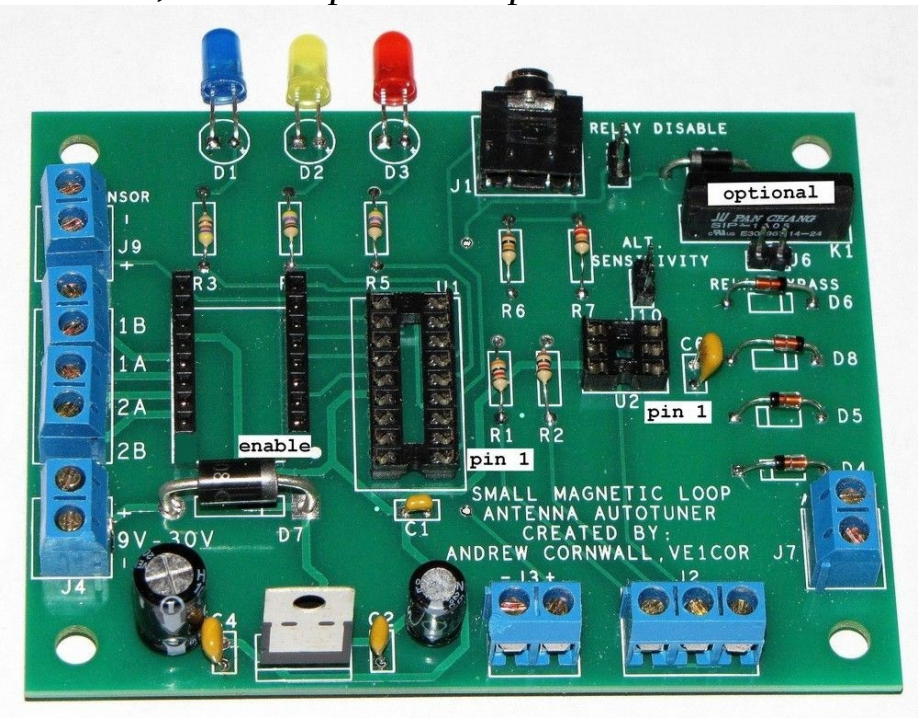
PCB POSSIBLE MODIFICATION

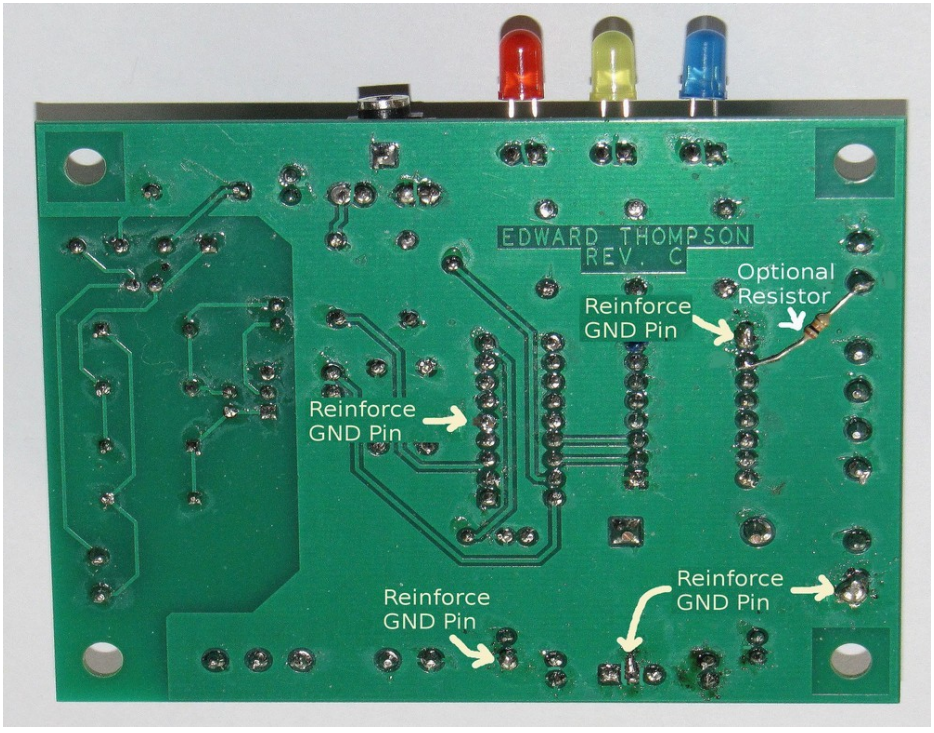
The ground plane lines to GND (negative voltage) pins seem thin. This may not be a problem, but for my own peace of mind I reinforced the GND-pin connections on relatively high amperage Negative voltage locations: power input at J4, electrolytic capacitor C3, and a GND pin of the A4988 module. I similarly reinforced pin 5, Neg. voltage, of U1, 18M2+; and the center pin of U3, 7805. I scrapped off a small spot of varnish to expose the copper ground plane adjacent to each of these pins and allowed solder at the pin flow over onto the ground plane. Other ground pins may be treated the same way as required.

There is not a position on the PCB for the optional 10K ohm resistor (value experimental) at the '180 SENSOR' connector. I failed to include this resistor in the circuit diagram provided to Ed Thompson, designer of the PCB. The resistor would be needed only where a half-turn limit variable capacitor is used by the small magnetic loop antenna, and this would require an alteration to the autotuner program. Fortunately adding the resistor is not difficult.

See Picture 2, 'PCB Underside' for the location of these modifications.

Picture 1, 'PCB Populated Top



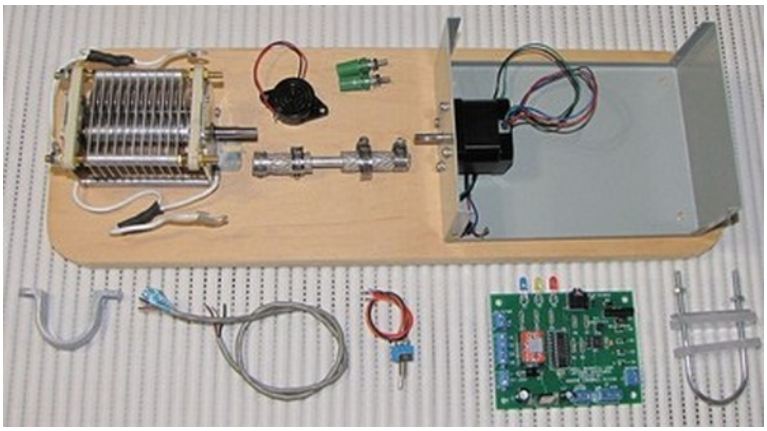


Picture 2 PCB Underside

PICTURES OF THE AUTOTUNER

This is the autotuner described in the article published in the winter 2020 edition of the Packet Status Register No. 144 published by TAPR. The autotuner is constructed on a 3/4 inch plywood board 18”x6”. Three-quarter inch plywood assures rigidity between the stepper motor and the variable capacitor, and provides a platform for screwing down parts, and 18”x6” happens to be a good size for mounting the autotuner box, variable capacitor, sampling antenna, and small magnetic loop antenna mounting hardware. There is, however, nothing vital about this setup.

These are the basic parts comprising the autotuner, not including the variable capacitor shield. Note, a printed circuit version of the circuit is not necessary but some form of the circuit is required.

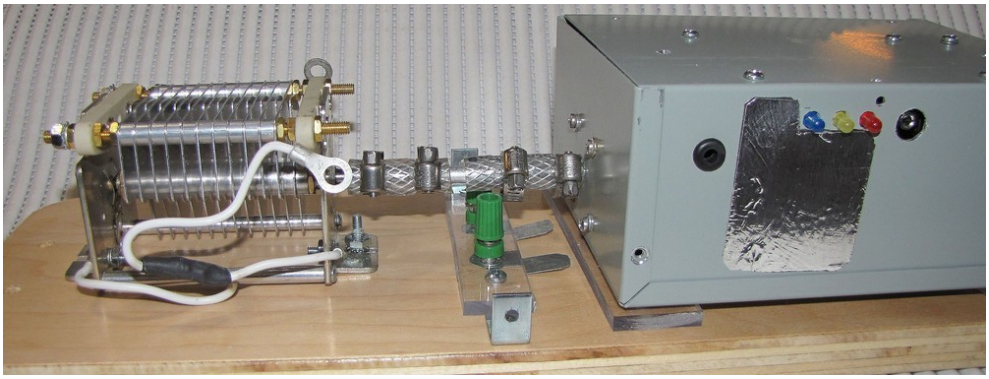


Picture 1. Autotuner Components

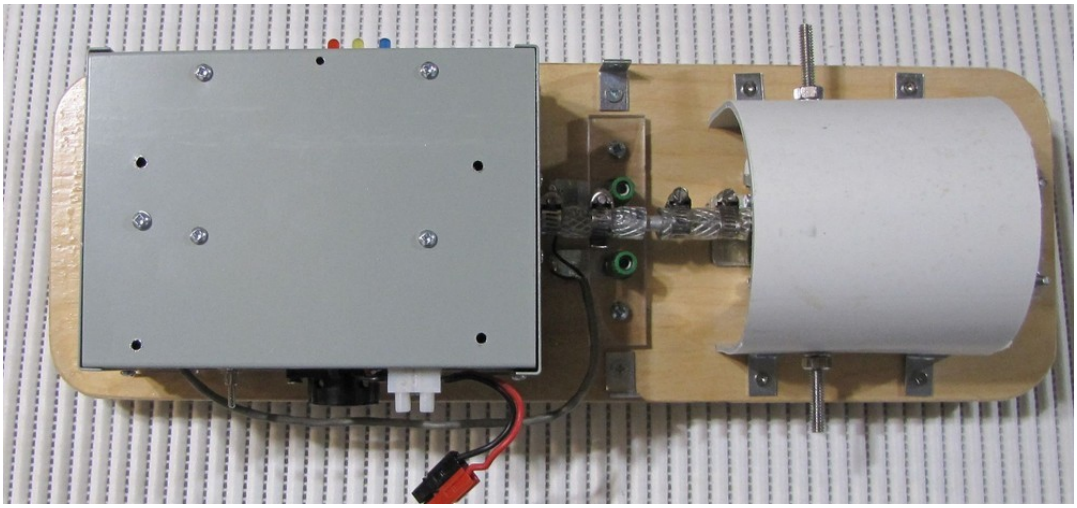
The variable capacitor shield is made from a length of PVC, 4” solid sewer pipe, long enough to cover the variable capacitor. I use a power saw with metal cut off wheel blade to cut the pipe. A hand wood saw can also be used. A slice is removed from the pipe. Then the sides are softened with a heat gun and straightened.

Picture 2. Making the Variable Capacitor Shield

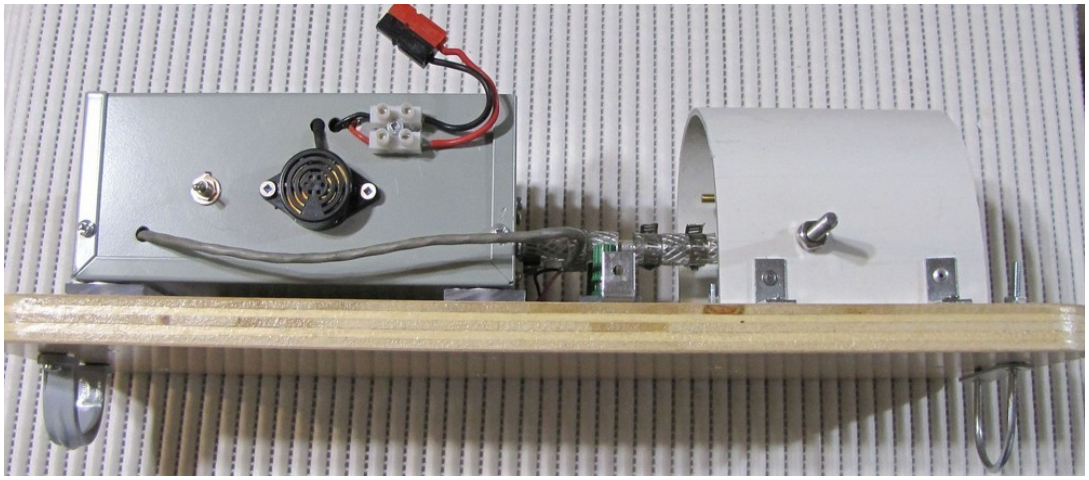
Autotuner box was repurposed. The silver tape on the side of the box covers holes of a previous project.



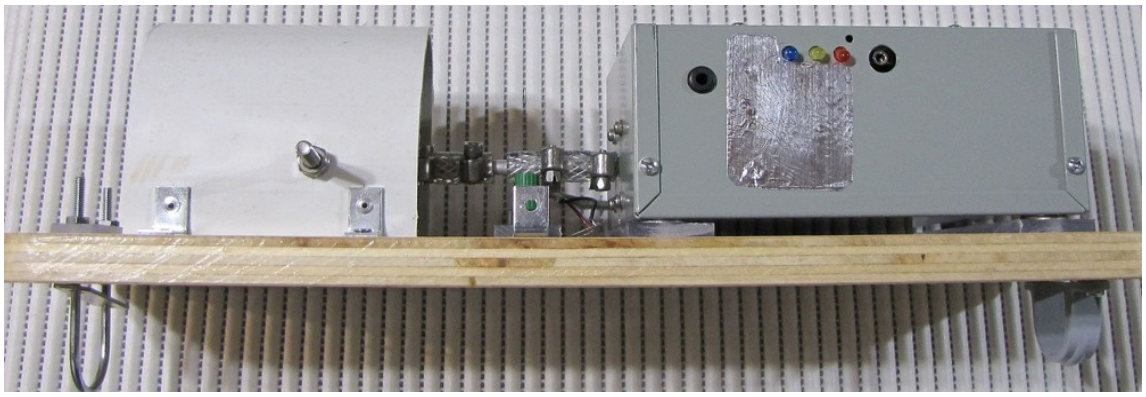
Picture 3. Drive Shaft and Provision for Sampling Antenna



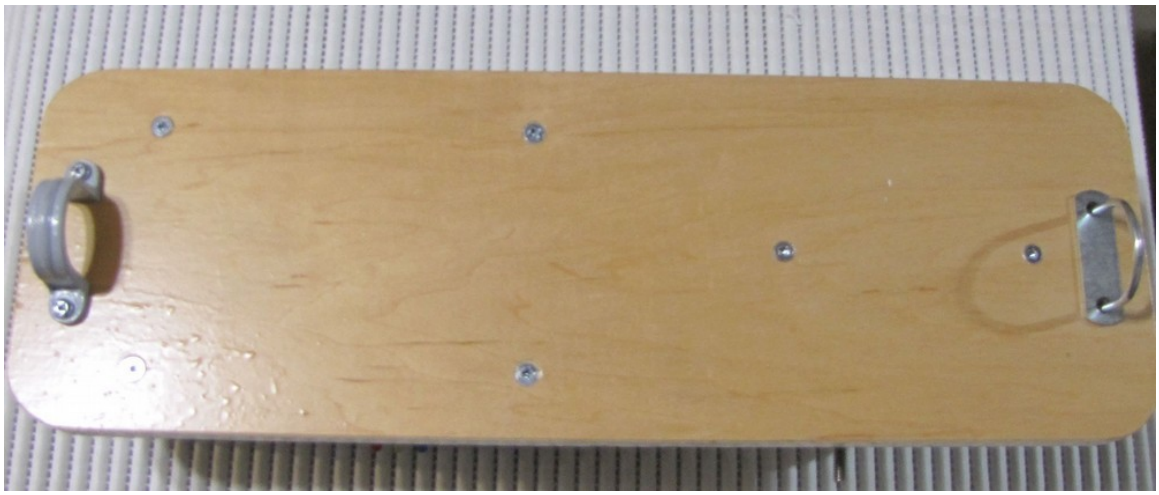
Picture 4. Top



Picture 5. Buzzer Side



Picture 6. LED Side (silver foil covers old holes)



Picture 7. Bottom

The Autotuner is mounted on the mast of a small magnetic loop antenna. Underside U-bolt and pipe holder secure the autotuner to the mast.

Picture 8. Autotuner Mounted on Mast of Small Magnetic Loop Antenna