The ‘Tenna Dipper

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The “Tenna Dipper (“TD”) is designed to allow you to find the 50 Ω resonant frequency of an antenna or to adjust an antenna tuner for best match. A built in frequency counter with Morse audio output is used to determine the frequency at which the “TD” is tuned to. By using a low power oscillator and a sensitive detector, the “TD” will not cause any significant QRM. The “TD” is small enough to fit into an Altoids tin, along with a standard 9 volt battery, making the unit ideal for use in the field.

How it works

The circuit starts with a Voltage Tuned Oscillator (VCO), which is part of a 74HC4046 PLL chip (U1). C1 and R1 sets the frequency range of the oscillator. It is not possible to produce a stable output over the entire HF band with just one set of values for R1 and C1, so R2 is added in parallel to R1 in order to extend the range to over 30 MHz. The 74HC4046 is powered by 6 volts, which extends it’s operating range slightly over what is possible using just a 5 volt supply.

The frequency of the oscillator is set by the voltage going to pin 9. A bank of four trimmer pots, selected by DIP switches, are used to set the center frequency of the oscillator into one of four ham bands. A “fine tune” control allows setting the exact frequency desired. If all four DIP switches are open, than the fine tune control can tune the oscillator over it’s entire range, but of course, tuning is touchy.

The output of the 74HC4046 (pin 4) is a square wave. This signal drives the input to the built in frequency counter and is buffered by a 74HC00 NAND gate to drive the bridge. The output of the buffer is first fed though a low pass filter to remove VHF harmonics and then into the resistor bridge. R4 is used to make the input impedance to the bridge 51 Ω.

The bridge consists of three 51 Ω resistors. The unknown impedance, Rx, (antenna or ATU) is used to complete the bridge. If the impedance of Rx is equal to 0j+51, that is, there is no reactive component, the bridge will be in balance. Therefore, there will be no voltage between the R5/R6 and R7/Rx junctions. In order to determine if the bridge is in balance or not, a transformer is connected between the R5/R6 and R7/Rx junctions. By using a step up transformer here, some passive gain is realized.

The output of the transformer is coupled to a high gain, darlington amplifier, consisting of Q1 and Q2. R8 and R9 bias the amplifier just below the point of turning on. A red LED is used as a visual indication of the current flowing in the collectors of Q1 and Q2. R10 limits the current to a safe level if the amplifier is being driven with a large signal. When the bridge is in balance, there will be no current flowing in the amplifier, so the LED will be out. As the bridge goes out of balance and a signal is applied to the amplifier, the LED will get brighter as the signal gets larger.

This detector scheme allows using a much lower power signal source than would be needed if the detector were a traditional diode. It also eliminates the “dead zone”, where the signal drops below the diodes threshold voltage and making an exact null of the bridge impossible to find.

Frequency counter

Dan Tayloe, N7VE, of the Az ScQRPions, graciously supplied a modified version of the “Stinger” counter chip for use with this kit. The program was modified to only read out the MHz and KHz digits. Any more resolution than this would be pointless, given the stability of the oscillator, which is not great, but good enough for this application. Gates U2b and U2c are used to control the input signal to the PIC and are used to “clock out” the remainder left in the counter’s prescaler at the end of the timing interval.

Construction

Before you start mounting parts, the board needs a little rework. One track on the bottom of the board got connected to the wrong pin on U2. The Track connects pins 1+2 to pin 4 and should connect pins 1+2 to pin 5. Cut the track now and we’ll jumper it to the proper pin later. See layout diagram.

If the board is to fit into an Altoids tin, along with a 9V battery, the corners on the right side of the board will have to be rounded with a file. Actually, a “Whitmans Sampler” tin works better to house the “TD” and you don’t need to round the corners of the board. Once this is done, you might also want to mark the mounting holes for the board in the tin.

Resistors

- R1 - 22 K (red/red/org)
- R2 - 10 K (brn/blk/org)
- R3 - 51 K (grn/brn/org)
- R4 - 51 Ω (grn/brn/blk)
- R5 - 51Ω
- R6 - 51Ω
- R7 - 51 Ω
- R8 - 1 Meg (brn/blk/grn)
- R9 - 150 K (brn/grn/yel)
- R10 - 100 Ω (brn/blk/brn)
- R11 - 51 Ω
- R”T” - 51 Ω

Semiconductors

- D1 - 1N4001
- D2 - 1N4148
- Sockets are not used and are **not** recommended for U1 or U2. You may socket U3 if you like.
- U1 - 74HC4046
- U2 - 74HC00
- U3 - 12C508 PIC µP
- U4 - 78L06 (TO-92)
- Q1 - 2N3904
- Q2 - 2N3904

Capacitors

- C1 - 22 pF, npo (disk, 22)
- C2 - .1 µF mono (blue, 104) Though not absolutely necessary, removing the kink in the leads is recommended so that the cap sits flush to the board.
- C3 - Same As C2 -Note, you will have to reform the leads so it will fit in the .1”spaced holes.
- C4 - S/A C2
- C5 - S/A C1
- C6 - S/A C2
- C7 - S/A C1
- C8 - S/A C1
- C9 - S/A C2
- C10 - S/A C2
- C11 S/A C2 - same deal as C3.
- C12 - 10 µF/16V electrolytic

Miscellaneous parts

- V1/4 - 10 K trimmer pots (103)
- DIP switch
- L1 - L1 is made by close winding 10 turns of #24 wire on a 1/8” diameter drill bit. Square up the leads on the ends, trim to about ¼” and tin before removing from bit. You will need to stand the coil slightly above the board.
- T1 - wind 30 turns of the #28 red wire on the core. This will pretty much fill up the core. Wind 5 turns of the #28 green wire in the space left between the ends of the 30 turn winding. Trim and tin the leads before inserting into the board. The 30 turn winding goes in the holes marked “S” and the 5 turn winding goes into the holes marked “P”. The proper color wires will line up with the holes without crossing if you insert the coil at right angles to it’s final position. Give the coil a half twist to line it up after soldering the wires.
- X1 - 4.000 MHz crystal
- V5, 10 K , 9 mm vertical mount pot. NOTE: the mounting holes are too small for the pot tabs, so bend these under the body of the pot or snip them off, then solder the sides of the pot to the board.
- small push button “TAC” switch.
- LED - leave the leads longish.
- mini speaker
- Snip the 4 pin header pins in half to give two, two pin headers. Insert one into the holes marked “S5” near R2 and the other two pins in the holes near the power input connections labeled “S6” . These pins are used as the on/off switch
- 9V battery snap connector
- Using a short piece of left over magnet wire, jumper pins 1+2 of U2 to pin 5 of U2. See diagram. This must be done for the speaker to work.

Testing and set up

Set all the dip switches open. Center the fine tuning control. Do not connect a load to the Rx input yet. Connect up a 9V battery and place a shunt plug over the on/off header pins.

The frequency counter should sound “TDV1” and the LED should be brightly lit. Now tack the extra 51 Ω resistor left over across the Rx terminals. The LED

Should become very dim. Due to variations in the gain and biasing of the transistors in the amplifier, the LED may go completely out.

You can now test the functions of the counter. See "frequency counter functions" section below for the various counter modes and functions.

Trimmers V1 to V4, which are selected by the bank of DIP switches, are used to preset the VCO frequency in one of four ham bands. The table below shows the tuning range of each trimmer. Fine tune control is centered. Fine tuning range varies with the band selected, and on average has about 1 MHz of range.

Switch	S5 open (H/L jumper removed)
BD1	2.5 to 4.8 MHz (80M)
BD2	4.8 to 8.4 MHz (40 M)
BD3	8.4 to 11.65 MHz (30 M)
BD4	11.6 to 16 MHz (20 M)
	S5 closed (H/L jumped)
BD1	7 to 12.8 MHz (40 or 30 M)
BD2	12 to 20.6 MHz (20M)
BD3	20.6 to 27 MHz (15, 17 or 12 M)
BD4	27 to 35 MHz (10 M)

A terminal pad "EXT CNTR" is available on the board as a convent place to connect a counter with a digital display. This can make presetting the trimmers quicker than using the built in counter.

Frequency counter functions

The "program" switch controls the functions of the counter. The frequency can be sent out at one of two code speeds, high speed, (27 wpm) or low speed (15 wpm) The counter can send the frequency only once or can be set to repeat. Either the full frequency or just the KHz segment can be selected for sending.

Pushing and holding the Program button close will scroll through the options. To activate the desired option, release the button before the next options is sounded. Options are selected in the following order:

M - MHz + KHz, Leading zero is suppressed. An "R" is sent to separate the MHz and KHz digits.
K - Only KHz digits

Once one of the above modes is selected, pushing the button will repeat that function. To exit, hold the button closed for 1 second and an "X " will sound.
MR - repeats full frequency
KR - repeats KHz digits

The above two modes are exited by pushing the button closed for 1 second, then an "X" will sound.

Above options repeated at slow code speed. Once one of the slow speed code functions are selected, the counter will stay in that mode until power is removed.

Using the "Tenna Dipper"
To prune or test an antenna:

- Select the band you expect the antenna to be resonant in with the dip switches. Connect the antenna to the Rx input.
- Adjust the "fine tune" control until the LED goes out or gets very dim.
- Read the frequency with the counter.

Note: since the output of the "TD" is fairly rich in harmonics, (third is the strongest) you might find a weak dip where you don't expect to see one.

To adjust an antenna tuner:

- Set the frequency to where you want the match to occur.
- Connect the ATU to the Rx input.
- Adjust the ATU until the LED goes out.
- Remove the "Tenna Dipper" and connect your rig to the ATU.

Optional Modifications:

A meter could be added in series with the R10/LED load on the amplifier, or could be used to replace the LED.

If operation on the 160 meter band is desired, change R1 to a 33K resistor.