Lambda/2 no Counterpoise: Fuchs Antenna matching unit

The Fuchs Antenna was introduced by Arwed Fuchs, an Austrian Radio Amateur in 1928. It was used as a high efficiency single band half-wave endfed antenna by many radio amateurs over a long period, but it was more or less forgotten when most radio amateurs started using coax-fed dipoles. In the 80s, some Swiss OMs rediscovered the Fuchs Antenna Tuner, especially for portable use. In 2000, Frank, DL7AQT, did lots of experiments with the Fuchs, and was happy to end up with a multiband version for portable use. QRPproject is now proud to make the Fuchs Antenna Tuner available as a kit. It is based on Franks' design with some small modifications we made because the variable used by Frank is no longer available.

The QRPproject Multiband Fuchs

is basically a half wave antenna. It can be used with good results at the original frequency and also at all harmonics. It is fed by a parallel circuit with inductive coupling. Tables 1 and 2 show the

Tabelle 1

Frequenz (MHz)	Halbwellen	Drahtlänge (m)
3,55	1	40,14
7,025	2	41,64
10,125	3	43,70
14,05	4	42,17
18,08	5	41,07
21,05	6	42,40
24,9	7	41,87
28,05	8	42,51

QRG	Lambda/2	Drahtlänge
7	1	20,28
14	2	20,82
21	3	21,02
28	4	21,12

optimal length of a wire from 1 half-wave at 80m to 8 half-waves at 10m. As you can see, the length increases from 80 to 10m. This is because the velocity factor of 0.96 is only exact at the ends of a wire antenna. If a wire antenna is longer then 1 half-wave, the middle part must be calculated using a velocity factor of 1. In practical use, we found that the Fuchs circuit easily compensates for this difference. When the total length is a multiple of a halfwave +/- 5 %, we found no difference. As you can see, a wire length of about 21 meters makes a good antenna for 40m and higher.

During his experiments, Frank used two different designs. For the upper bands only, it was ok to use one Amidon T80-2, but this design

L1: 6 x 1 turn
L2: 7 turns
on T80-2

L3: 56 turns
taped at 8 and 24 turns
on T80-2
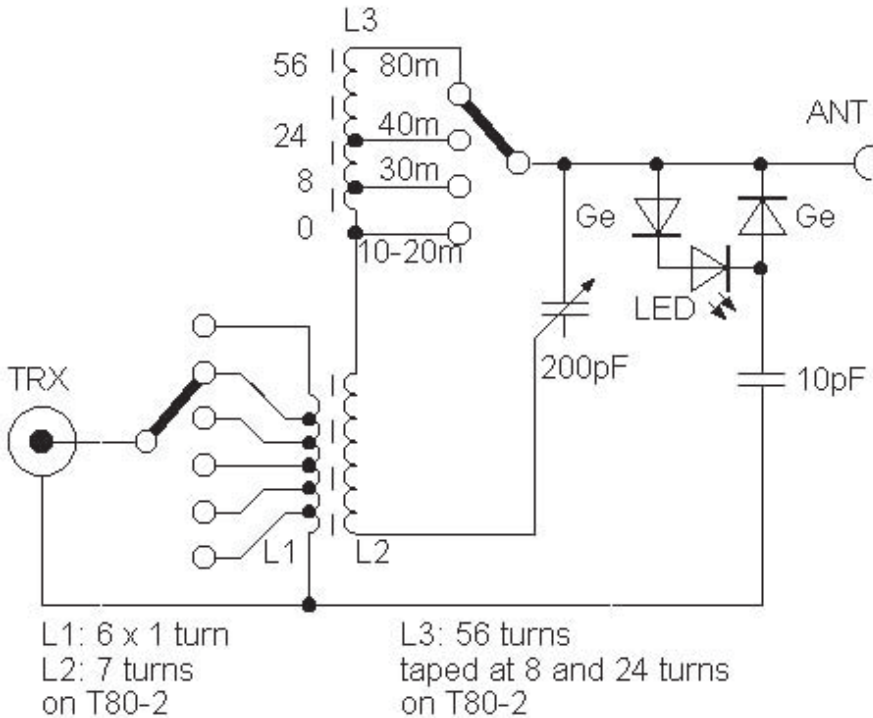
did not work if he tried to use it from 80 to 10 meters. Some tests in the QRPproject lab using our HP Network analyzer showed that there are some extra points of resonance in the 18 MHz range. We assume that they are caused by the unused section of the core in interaction with stray capacitance. Winding the complete Fuchs circuit on TWO toroids solved the problem. There are still unwanted resonance frequencies, but they now are in the 60 MHz range, and without any influence when we tune a SW antenna.
Due to a lot of questions:
NO, there is now ground connection missing at L2!! This is part of the genious Fuchs design :-)

LED RF Indicator
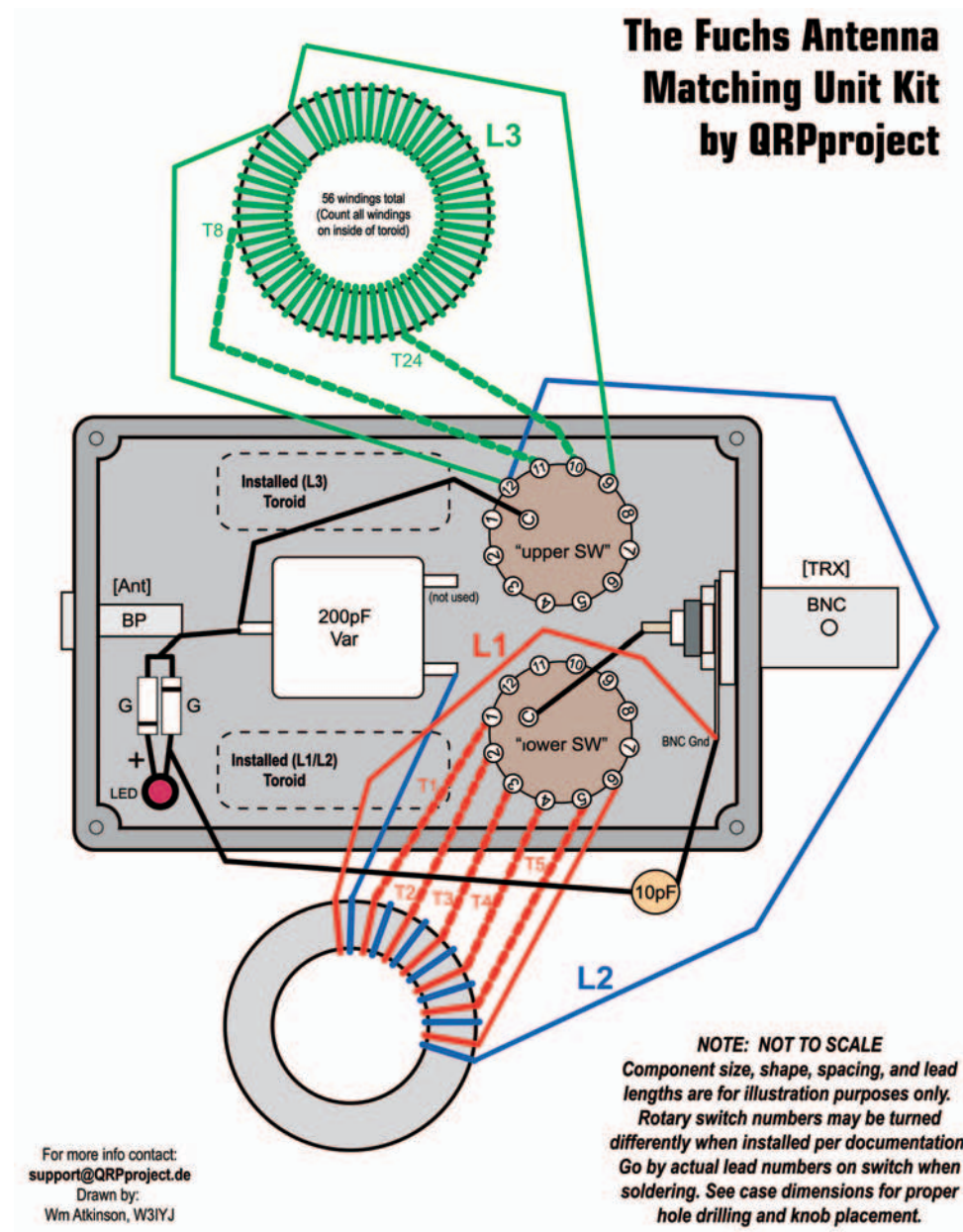The simple LED RF indicator detects the voltage at the feedpoint of the

antenna. While tuning the Fuchs circuit, when the RF voltage at this point has its highest value, the antenna is exactly in resonance, and antenna coupling of the transmitter is at its optimum.

Practical experience

The Fuchs circuit was built into a 70mm x 50mm x 25 mm plastic enclosure. We used a BNC jack for the transceiver input and a banana jack for the antenna connection. It is very easy to tune. The first step is to tune the variable capacitor to loudest noise or signal in receive mode. You must switch the main coil taps to get the best result. The point of resonance is very small, so you will hear the difference between resonance and non-resonance very clearly. Usually you will find resonance at two different taps of the main coil. If so, use the one with the better L/C ratio (more L = higher Q). Now hit the transmit key in CW or a tune knob to get a transmit signal. Switch the coupling section of the Fuchs circuit to get the brightest signal at the LED RF Detector (or lowest SWR if your transmitter has a built in SWR Meter).

Parts list of the QRPproject 80-10-FUCHS kit

1 enclosure
1 variable cap
2 Amidon Toroid T80-2
2 Miniature switch 1x12
1 Banana jack
1 BNC jack
2 Germanium Diode
1 LED
3 Knobs
Enameled wire 0,5mm
Ceramic capacitor 10pF
1 manual

The Fuchs Antenna Matching Unit Kit by QRPproject

L3
56 windings total
(Count all windings on inside of toroid)
T8
T24
Installed (L3) Toroid
"upper SW"
(not used)
[Ant]
BP
200pF Var
L1
[TRX]
BNC
○
G   G
+
LED
Installed (L1/L2) Toroid
"lower SW"
BNC Gnd
10pF
L2
T5
T2 T3 T4

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NOTE: NOT TO SCALE
Component size, shape, spacing, and lead lengths are for illustration purposes only. Rotary switch numbers may be turned differently when installed per documentation. Go by actual lead numbers on switch when soldering. See case dimensions for proper hole drilling and knob placement.

Attention: starting July 2008 we use another type of switch. It´s smaller and the common conector is placed exactly in the middle of the switch.
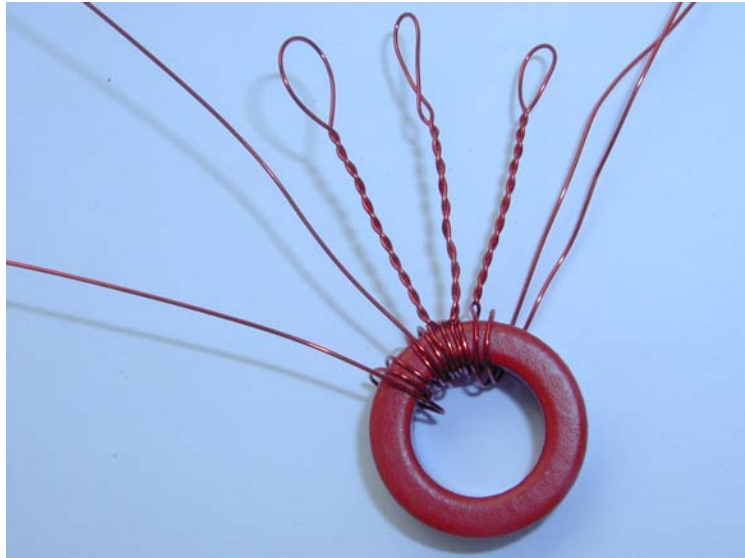
†1. Preparing the enclosure
Drill all holes as shown in the drawing. All distances refer to the outer side of the enclosure. The diameter of the holes are taken from the diameter of the provided parts. The BNC jack and the Banana jack

∅ 7,0
∅ 2,6
∅ 7
72
14
50
38
25
12
16
36

35
∅ **
25
17,5
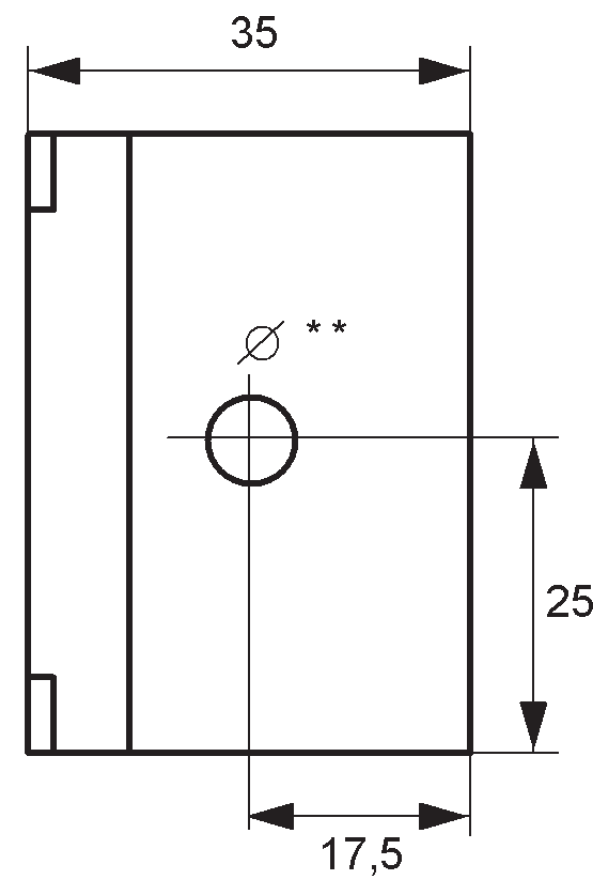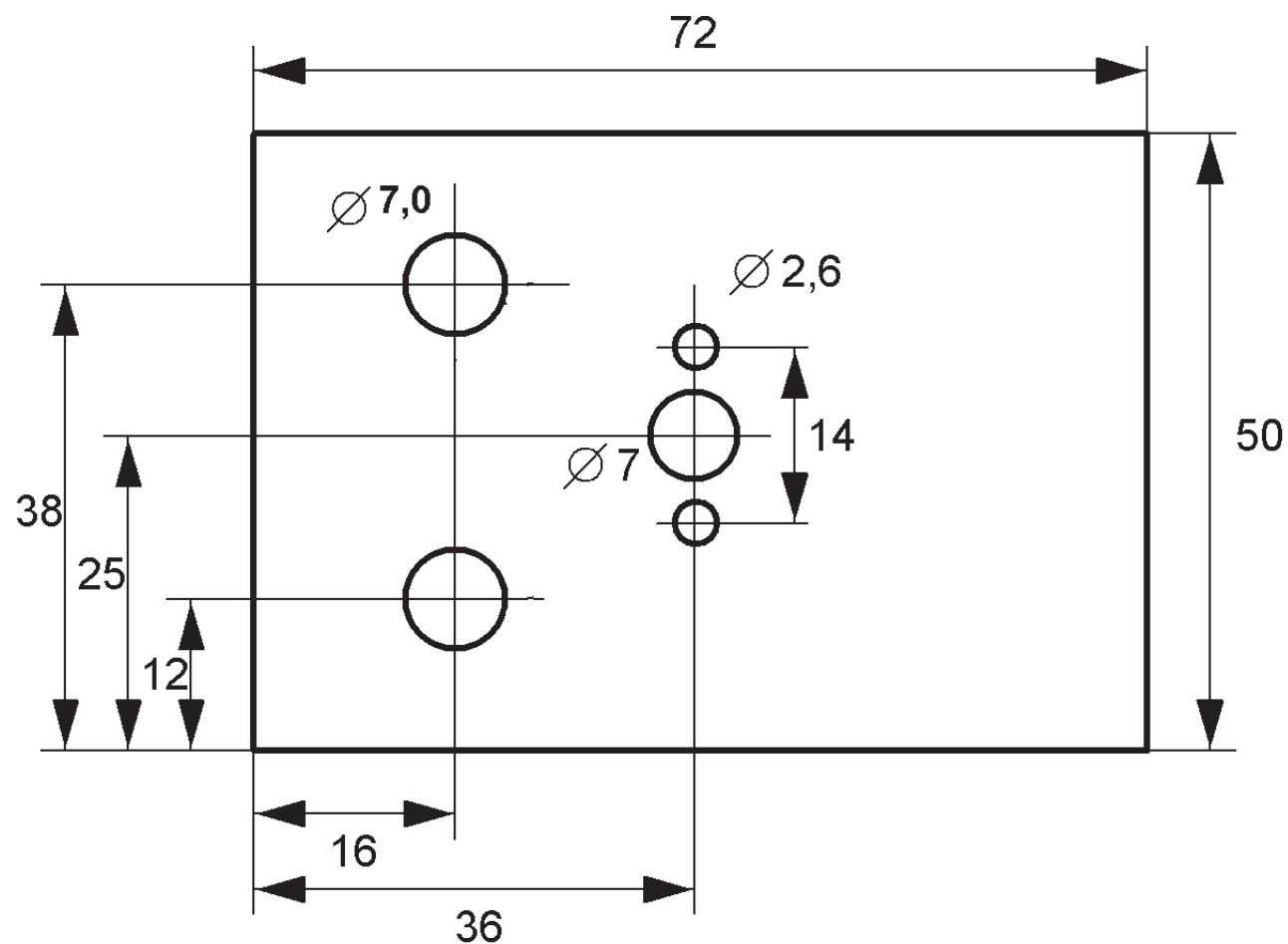
* * für Telefonbuchse 6,3 mm
* * für BNC-Buchse   8,5 mm

must be placed exactly in the middle of the front and back (short) sides, as shown on the pictures.
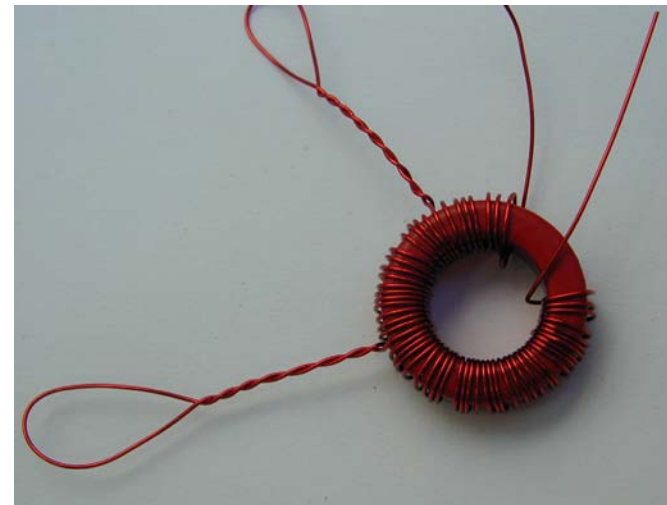
2. Winding the Toroids

L2/L1

Attentention, the pictures do not show the exact number of turns.

shown in the photo). Bend all wires to their places, and cut them to the desired length. The beginning of L2 goes to the stator of the variable cap, end of L2 to the Pin 12 of the upper rotary switch. The starting point of L1 goes to BNC Ground, first tap to Pin 1 of the lower rotary switch, second tap to pin 2, third tap to pin 3, and so on; all taps and the end of L1 to the lower rotary switch. Next step is to tin all the wire ends. We prefer the „BLOB" method. What is the BLOB method? Using a hot soldering iron, melt a drop of solder at the end of the tip and hold it to the wire you would like to tin. Wait until the coating of the wire starts melting. You will see and smell some smoke. Don't breathe the smoke; it's not very healthy! When the coating starts melting, move the solder „BLOB" back and forth. The result will be a nice tin coating at the end of the wire. Check to see if the tin is all around the wire. If not, do the same procedure again. When all the ends and taps are tinned, solder L1/L2 to the 1st place, as described.

Remember that turns on a toroid are always counted at the inner side of the ring. Start with 7 Turns for L2. Don't spread the 7 turns over the ring, but keep the turns close together at the inner side of the ring. Leave about 6cm at both ends of L1. Now, wind L1 (the coupling winding) between L2. For these to be in phase, lay the wire for L1 parallel to the L2 wire and start at the same point, where L2 starts. Do one turn through the Ring, and then form a loop (abt 3cm diameter) and twist the loop as shown in the photo. (ATTENTION, photo does not show all windings) Do the next five turns, forming such a loop after every turn.

To see how long the twisted loops must be, put the toroid at its place just below the lower 1x2 switch (BNC right sided, banana left sided, as

Next prepare L3

Take the other T80-2 toroid. Wind 8 turns and form a 4-5cm loop as you did for L1. Wind the next 16 turns in the same direction, giving you a total of 24 and form a second loop. Now, wind another 32 turns(total of 56) Now, place the toroid above the upper rotary switch, and prepare the wires. The beginning of L3 leads to Pin 12 (junction to L1), the first tap (turn 8) leads to Pin 11, second tap (Turn 32) to PIN 10, and the end of L3 to pin 9. Again, coat the wire ends with Tin, and solder them to their places.

3. solder all remaining solder-points:

Solder a wire between the middle pin of the lower rotary switch to the inner pin of the BNC jack. Solder another wire between the middle pin of the upper rotary switch to the rotor of the variable capacitor, and another short wire from the rotor to the banana jack. The only remaining thing now is the LED RF-Indicator.

Drill a hole for the LED somewhere in the top of the box, near the banana jack. Solder the cathode of one germanium diode and the cathode of the other Ge diode to the banana jack. The other side of both diodes must be soldered to the LED: (Ge-cathode to LED anode, and Ge-anode to LED cathode.) The cathode of the LED must be connected to BNC ground using a piece of wire and the 10pF ceramic cap.

That's all! The Fuchs circuit is now ready to use.

Remark:

By practical use we found that the Diodes plus the LED may cause intermodulation to your RX especially at winter evenings at 40m when using long antennas. If you run into this problem, remove the 10pF cap connected between the LED and ground. The LED will still work as an indicator, picking up energy by stray capacitance. It will not glow as strong as before but still enough to work as an indicator. Give it a try.

Start operating:

Connect the Fuchs using the BNC:BNC connector to your transceiver. Use a 41meter (or 21 meter) long antenna wire, connect it to the banana jack,and switch the receiver on.
At first, choose the coupling factor by switching the lower rotary switch. For 10 and 12 meters, this will probably be 1 turn; for 15, 17 and 20M, 2-3 turns; for 30 and 40M, 3-4 turns; and for 80M, 4-6 turns. Now adjust the main windings using the upper rotary switch and the variable cap. Start with the switch at its lowest position and rotate the variable cap. If you have chosen the right tap of the main winding, you will find a dramatic increase of noise if the capacitor has the right value to

resonate. If there is no point of resonance, try the next tap. If the circuit is in resonance, key the transmitter and adjust the coupling for best SWR (brightest LED).
This procedure seems to be complicated, but you will find, that it is very reproducible. So, in the future, you only have to remember which tap to use for which band, and tuning will be very fast. I hope you will enjoy your Fuchs antenna tuner! It's an excellent choice for portable use, because you will need only one port, and because it is a high efficiency tuner with very low loss.

Peter, DL2FI
If you have any questions or suggestions, please send me an e-mail, or phone: Support@QRPproject.de / +49 30 859 61 323