HAVE TUNER, WILL TRAVEL !

Introduction

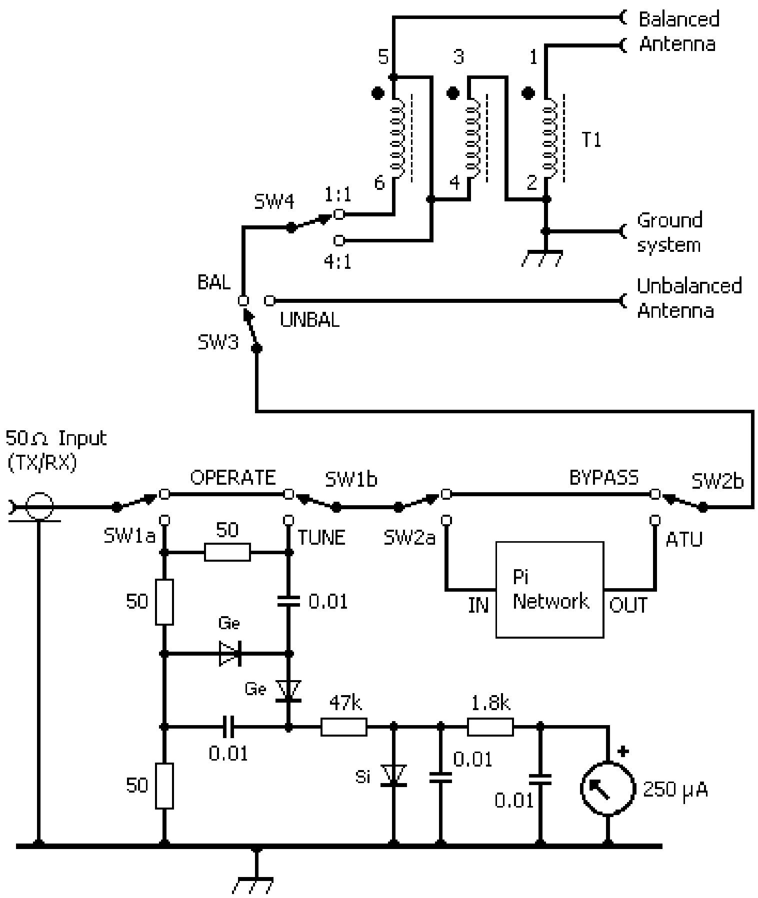
When I started going 'bicycle portable' with my Elecraft K2 QRP transceiver, it became apparent that I needed a single unit that would provide the combined functions of dummy load; SWR bridge; multi-band antenna tuning unit (ATU) [or, more correctly, antenna matching unit]; and balun.

The need for a balun arises because, when operating portable, I often use either a vertical antenna or a doublet, so the ATU needed to cope with both balanced and unbalanced loads.

The resulting design is described here. The *Carlton* was first used in the Power Management Challenge with an inverted V doublet having a 40 m top, with the apex at 7 m, and 10 m of low impedance balanced feeder (well, speaker cable, actually). The ATU successfully matched this antenna on all amateur bands 1.8 to 28 MHz.

The ATU is built into a matt black box of ABS plastic having external measurements of 198 x 112 x 64 mm (Maplin part number BZ75S).

Main Circuit Diagram



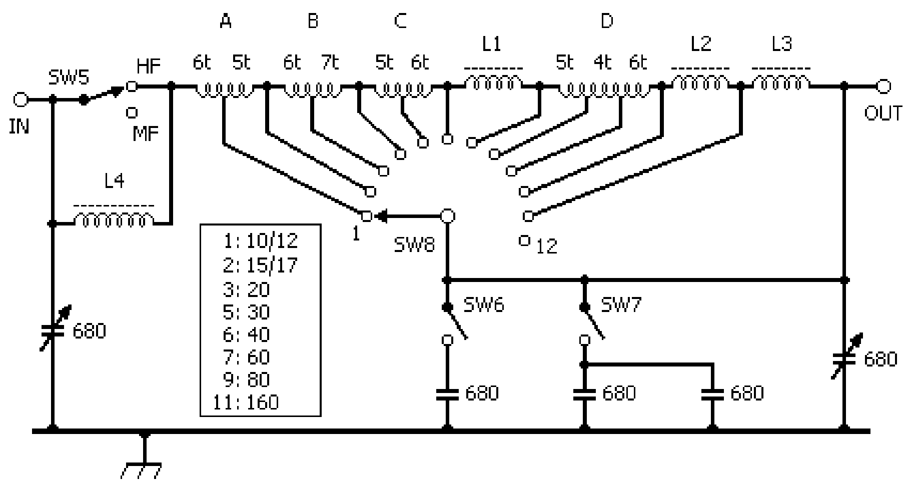
The circuit diagram of the *Carlton* is shown above. Details of the Pi Network are provided below. I am grateful to Ha-Jo Brandt DJ1ZB for the circuit of the tuning indicator which I have found works very well (see Page 63, G-QRP Club Circuit Handbook, 1983). For the germanium (Ge) diodes, I used type OA95 - but OA81 or OA91 would probably work fine too. For the silicon (Si) diode, I used a type 1N4148 which, in this circuit, is used to limit the current through the meter. The 50 ohm resistors should be carbon types. For each 50 ohm resistor, I used two 100 ohm (2 watt) resistors in parallel, obtained from Sycom Trading, although 1 watt components should suffice when using QRP (5 watt) transmitters. The moving coil meter was obtained from Maplin, part number LB80B, (internal resistance of 675 ohms, graduated '0' to '5').

In the TUNE mode (and with the transmitter 'ON') the meter indicates relative reflected power. The 1.8 k resistor sets the maximum meter deflection, using the silicon diode as a voltage limiter (0.6 volts). The 47 k resistor is used to provide FSD when the antenna is disconnected or severely mismatched. Under these conditions, the power amplifier stage in the transmitter is automatically protected by virtue of the resistive components in the bridge circuit which maintain a safe load for the transmitter under all load conditions.

Pi Network Circuit Diagram

The circuit of the pi network is shown below. A 12-position rotary switch (obtained from Sycom) was used to select the tapping points. L4 and SW5 provide additional inductance when using electrically short antennas on 1.8 MHz (for example, the 'MF' switch position is required when tuning my G5RV-sized doublet for 160m). The table included in the circuit diagram indicates the typical switch positions for each of the amateur bands, but the exact switch position required for a given band will depend upon the impedance presented by the antenna. SW6 and SW7 and the associated 680 pF capacitors are required to provide sufficient tuning range on

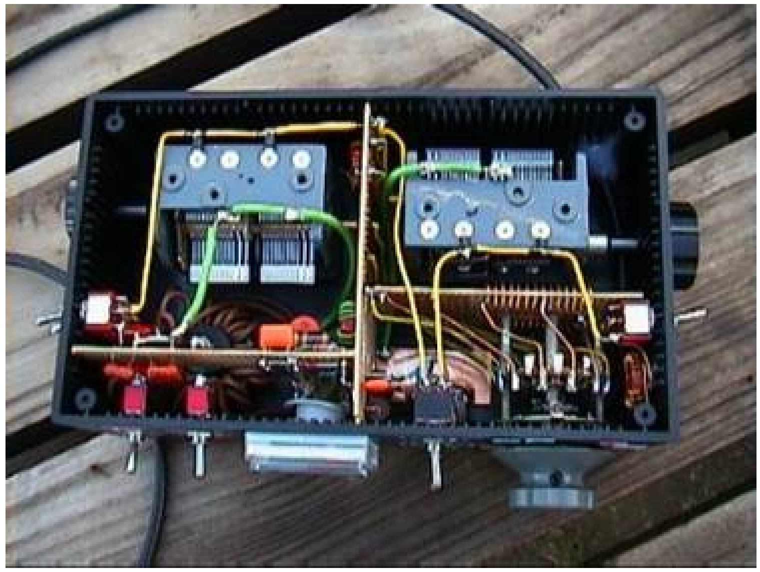
80/160 m, but these may be omitted if operation on these bands is not required.



Lack of space in the box required the use of space-saving coils wound on plain 0.1 inch matrix board. Coils A and B were each wound on the matrix board in the form of a solenoid. Coils C and D were also wound on matrix board, but were wound 'flat'. Coils L1; L2; L3 and L4 were wound on T50-2 and T80-2 ring cores (see below).

The ATU may be used with unbalanced antennas (such as marconi antennas, or end-fed wires); or with balanced antennas (such as doublets and half-wave dipoles). I am grateful to John G3WGV who, in an Email to the 'Summits On The Air' (SOTA) Email reflector pointed out that baluns can be used very successfully to couple balanced feeders to unbalanced ATUs. (For over 30 years, I had avoided such a configuration due to my mistaken belief that a balun could only be used successfully if the impedances presented at each of the two ports were resistive - not so!)

A novel feature of the balun transformer in the above circuit is the use of a changeover switch to select antenna-to-source impedance ratios of 1:1 or 4:1. As noted by G3WGV in his Email to the SOTA group, having the choice of 1:1 and 4:1 baluns greatly improves the ability of the antenna matching unit to cope with the wide range of impedances often presented by doublets used for multiband operation.

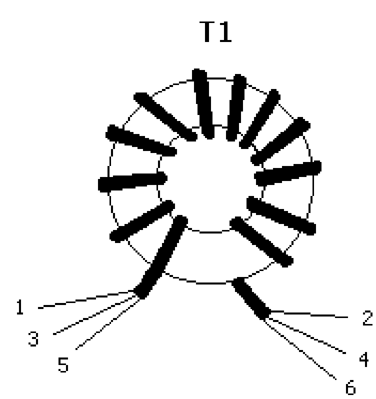


The above picture shows how I mounted the variable capacitors in an opposing configuration. Ideally, the panel knobs would be forward-facing, but the size of the box would not permit such luxury! Nevertheless, I have become used to adjusting the matching unit, and no longer find it tedious to adjust the side-mounted controls for the best match (i.e. minimum meter deflection while in the TUNE position).

Constructing the balun

The balun transformer, T1, is wound on a T130-2 ring core. The wire gauge is not critical: multi-strand wire salvaged from a length of mains flex would be fine. It helps if the conductors are colour-coded.

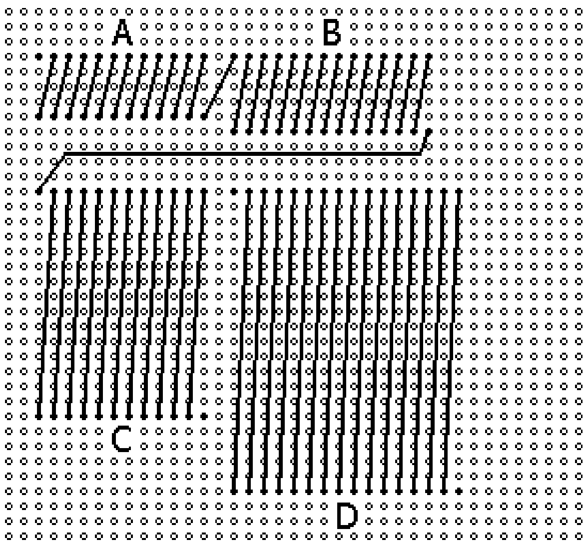
Start by twisting three wires together at about one twist every 15 mm. Wind twelve turns on the toroid, and label each of the three wires at the start of the winding with the identification numbers 1; 3; 5. Then label the other end of each wire with 2; 4; 6 respectively. Refer to the circuit diagram to ensure correct installation. Neither the number of turns, nor the direction of the turns, is critical in this design. During testing, I found no difference in performance between a transformer of 10 turns, and another wound with 14 turns.



Construction of coils A; B; C; and D

Each of the coils was wound as shown below. Note that the coils in my ATU occupied different relative positions to one another. Nevertheless, the diagram does serve to show the dimensions of each coil. For all coils

A - D, I used plain, solid-conductor copper wire that just happened to be a clearance fit in the holes of the matrix board. Of course, there is nothing particularly special about the size of coils that I ended up with - they just happened to work!

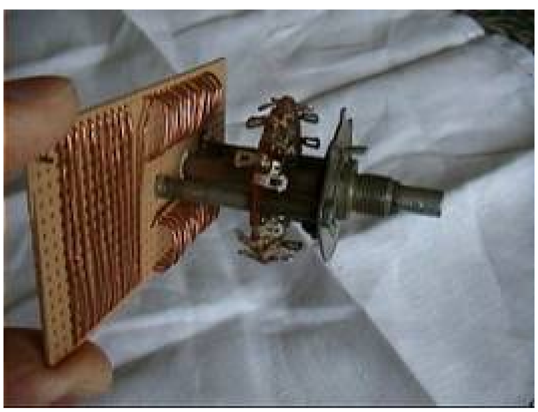


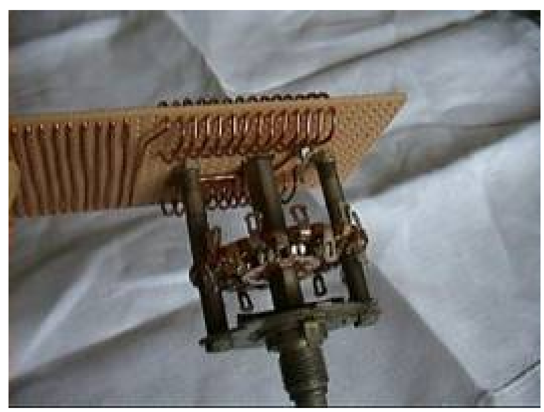
Coil A: 11 turns, 3 clear holes.

Coil B: 13 turns, 4 clear holes.

Coil C: 11 turns, 14 clear holes.

Coil D: 15 turns, 19 clear holes.





These pictures show the actual contruction of coils A; B; and C after having been mounted on the switch assembly, but prior to wiring.

Construction of Coils L1; L2; L3; and L4

L1 through L4 are single-layer coils, wound using 26 SWG enamelled copper wire on ring cores of '-2' material.

L1: 17 turns, 26 SWG on T50-2 core.
L2: 23 turns, 26 SWG on T50-2 core.
L3: 23 turns, 26 SWG on T80-2 core.
L4: 38 turns, 26 SWG on T80-2 core.

Feedback from other constructors and correspondents

25/11/2002

Obtaining air-spaced variable capacitors is getting more difficult (and more expensive) these days. The cheapest source is from discarded portable radios, but Mick Brett, M3JTX writes:
"A company called Mainline Electronics who make Jackson Brothers capacitors list a LA1 cap priced at £9.98 ex. vat. This is only 400pf but they will make a 600pf to special order althougth this increases the price to £25 each plus vat. Postage and packing is £3.75 per order. I did not think this too excessive and they are really nice capacitors. Delivery is about three weeks and you can view there webbsite at www.mainlinegroup.co.uk"