

9:1 VOLTAGE UNUN

9:1 voltage unun using a T-200-2 powdered iron toroid core

With the view to establish a quick and easy multi-band antenna deployment for portable and camping operations a simple long wire antenna with an earth or earth plus counterpoise arrangement with a 9:1 voltage unun is one possible solution. Rewiring it unun to feed a long wire antenna is easily achieved using a 9:1 voltage unun design using a T-200-2 toroid core was selected.

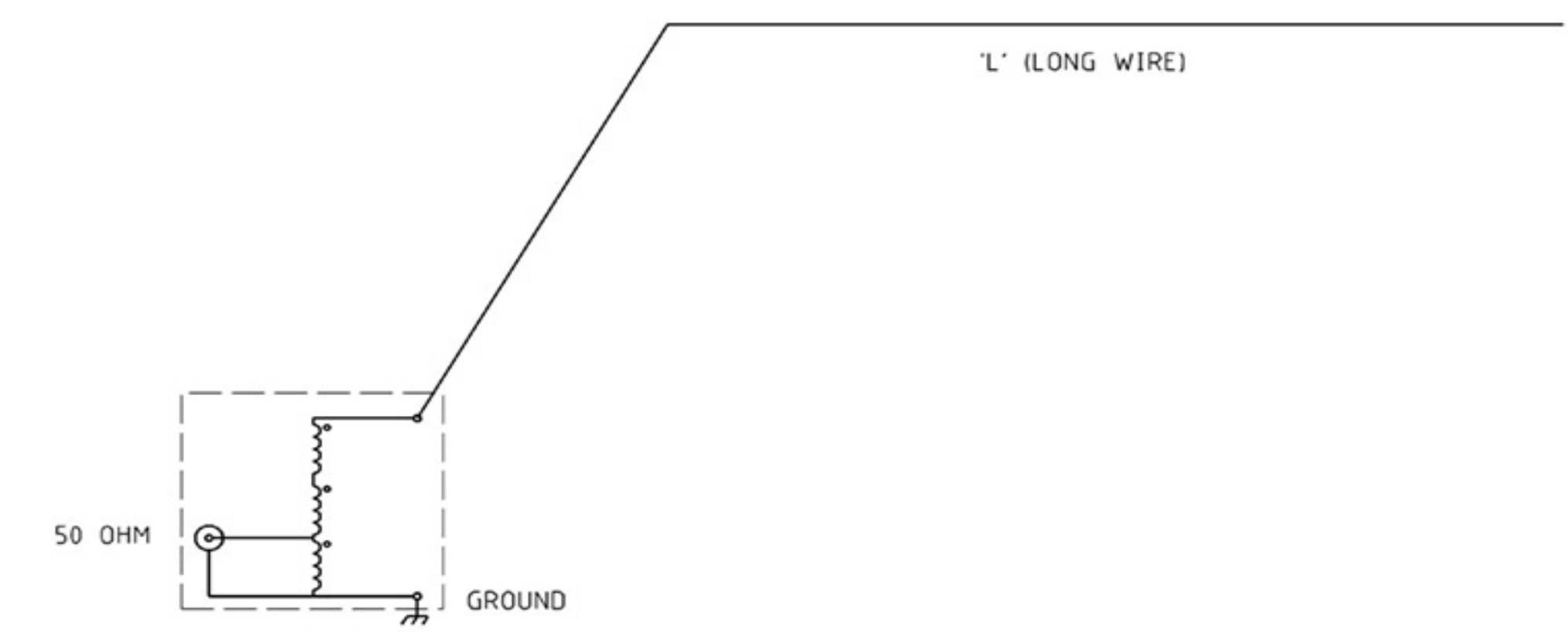


Figure 1 Typical 9:1 voltage unun and long wire antenna configuration.

Construction

PVC covered 1mm diameter copper wire was used with the view that the thicker insulation may reduce the possibility of insulation puncture due to the higher nominal impedance. The triple bifilar winding of 10 turns are wound evenly spaced around the T-200-2 powdered iron toroid core with the three individual windings wound close together. A Green binding posts was selected to clearly identify the common earth connection.

The length of enamelled copper wire per winding for the T-200-2 powdered iron toroid core is determined by length per winding = 50mm per turn plus 250mm tails.

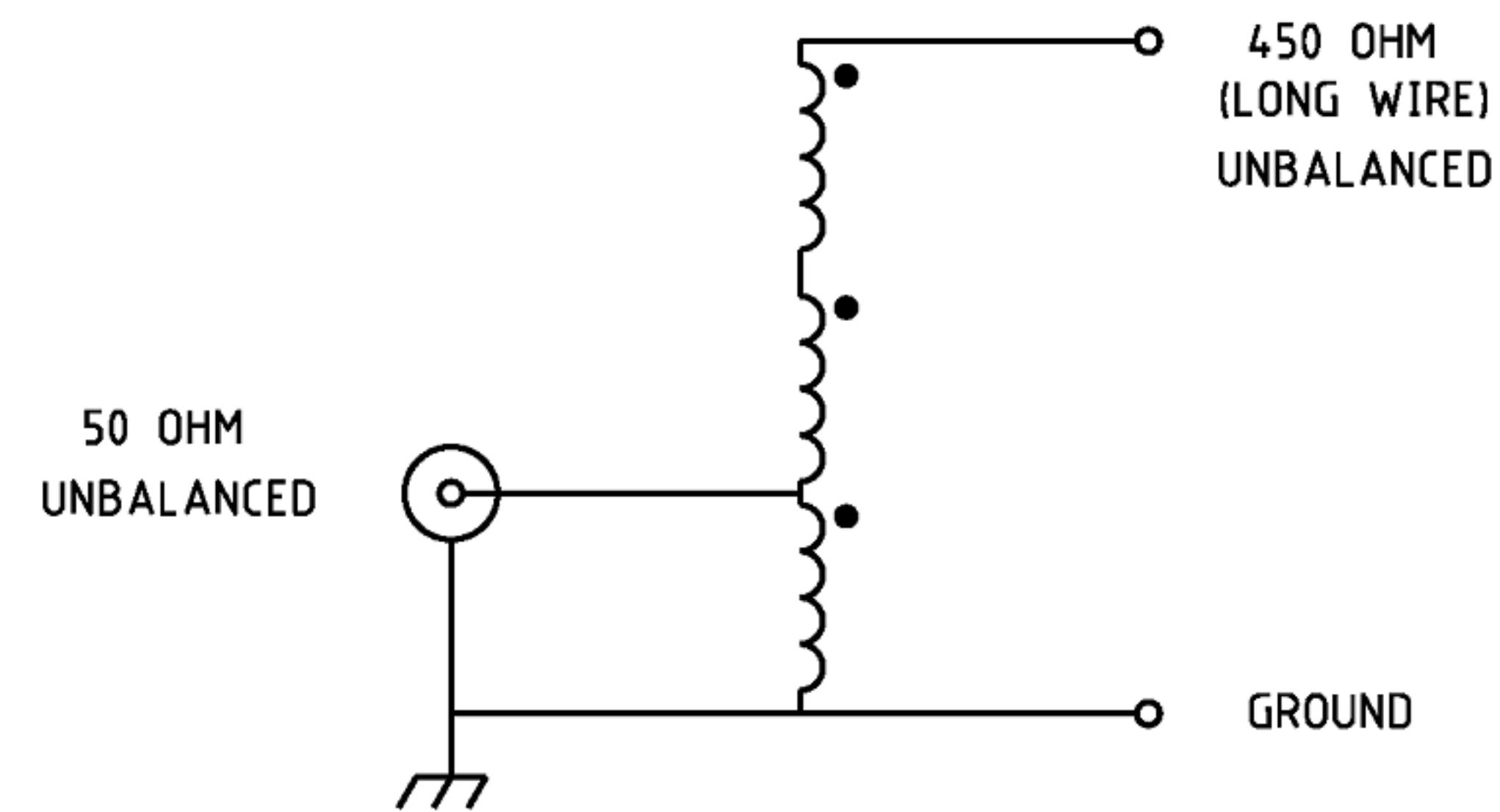


Figure 2 Schematic of the 9:1 voltage unun. Typically unbalanced = 50/75 ohms too unbalanced = 450/675 ohms.

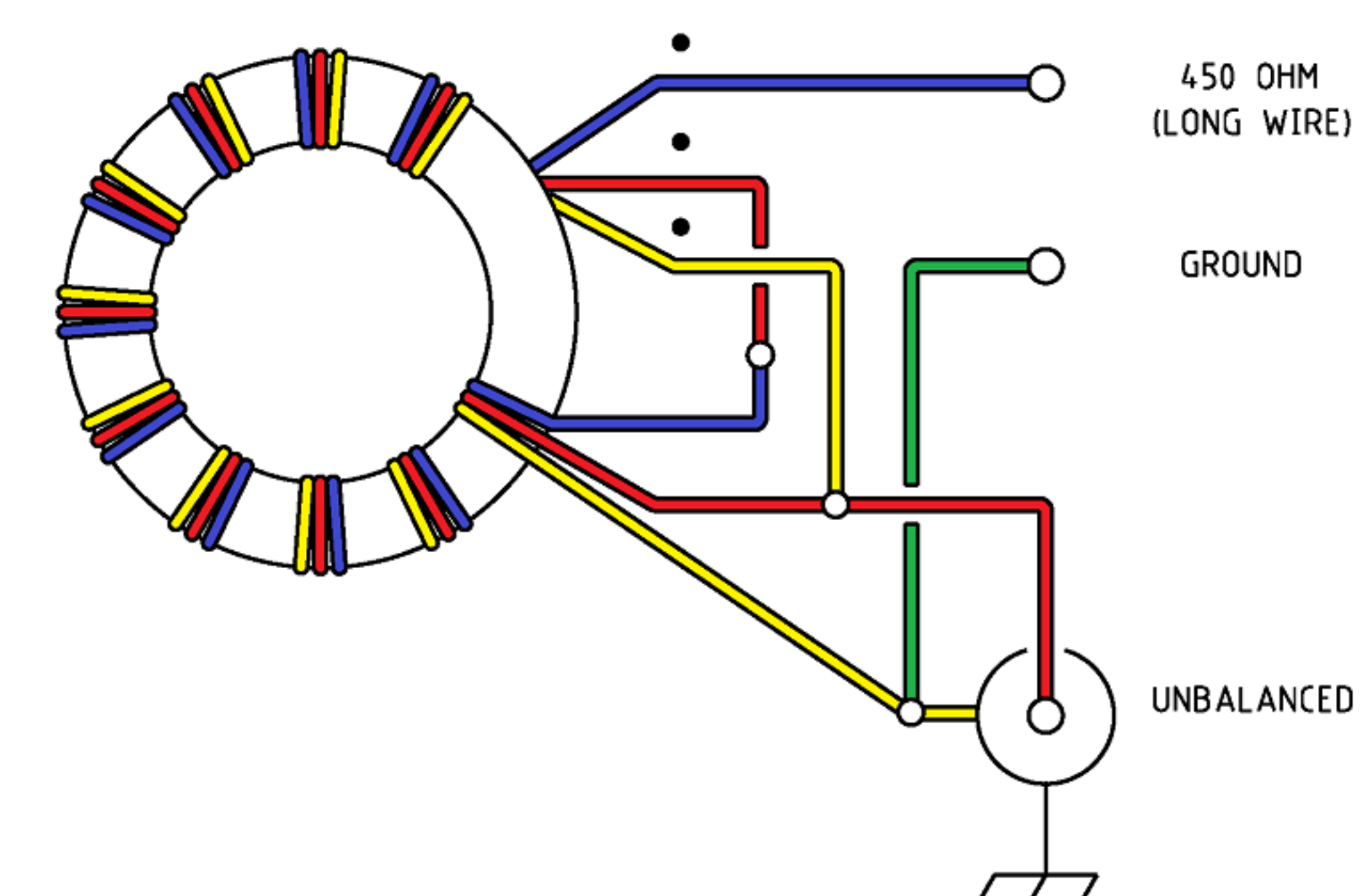


Figure 3 Wiring of the 9:1 voltage unun. Note this drawing shows winding connections and not the number of turns required. See article for details.

TOROID	NUMBER OF TURNS	POWER RATING
T200-2	9	400 Watts

Table 1 Toroid core with winding suggestions.

Parts list.

- T-200-2 powdered iron toroid core from [Amidon](#)
- About 750mm of 1.0mm Covered copper wire per winding.
- Black and Green binding posts
- SO-239 UHF chassis mount connector
- Sealed Polycarbonate Enclosures 82 x 80 x 55mm from [Jaycar](#). See Fig 4 for details

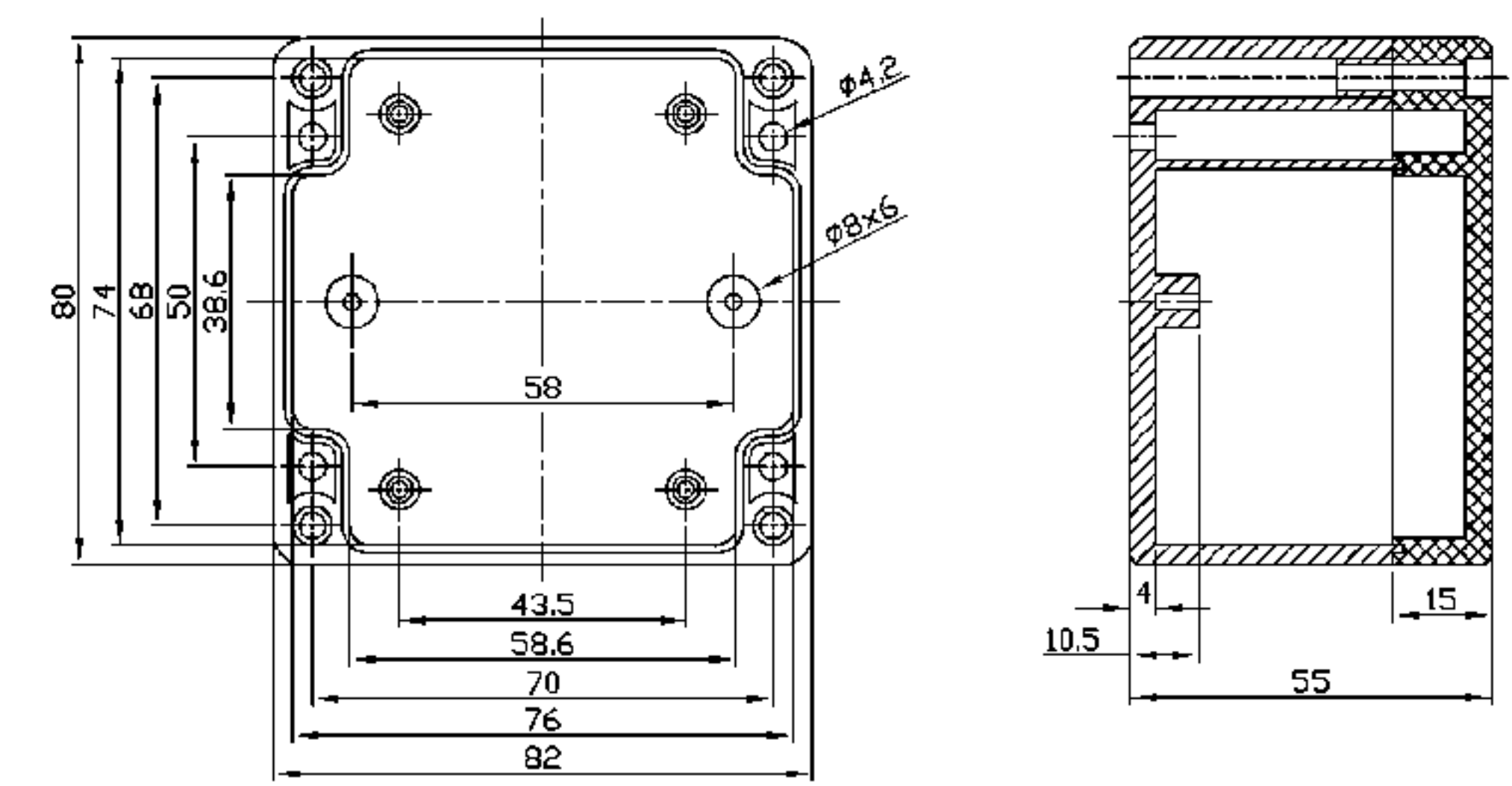


Figure 4 Sealed Polycarbonate Enclosures 82 x 80 x 55mm details

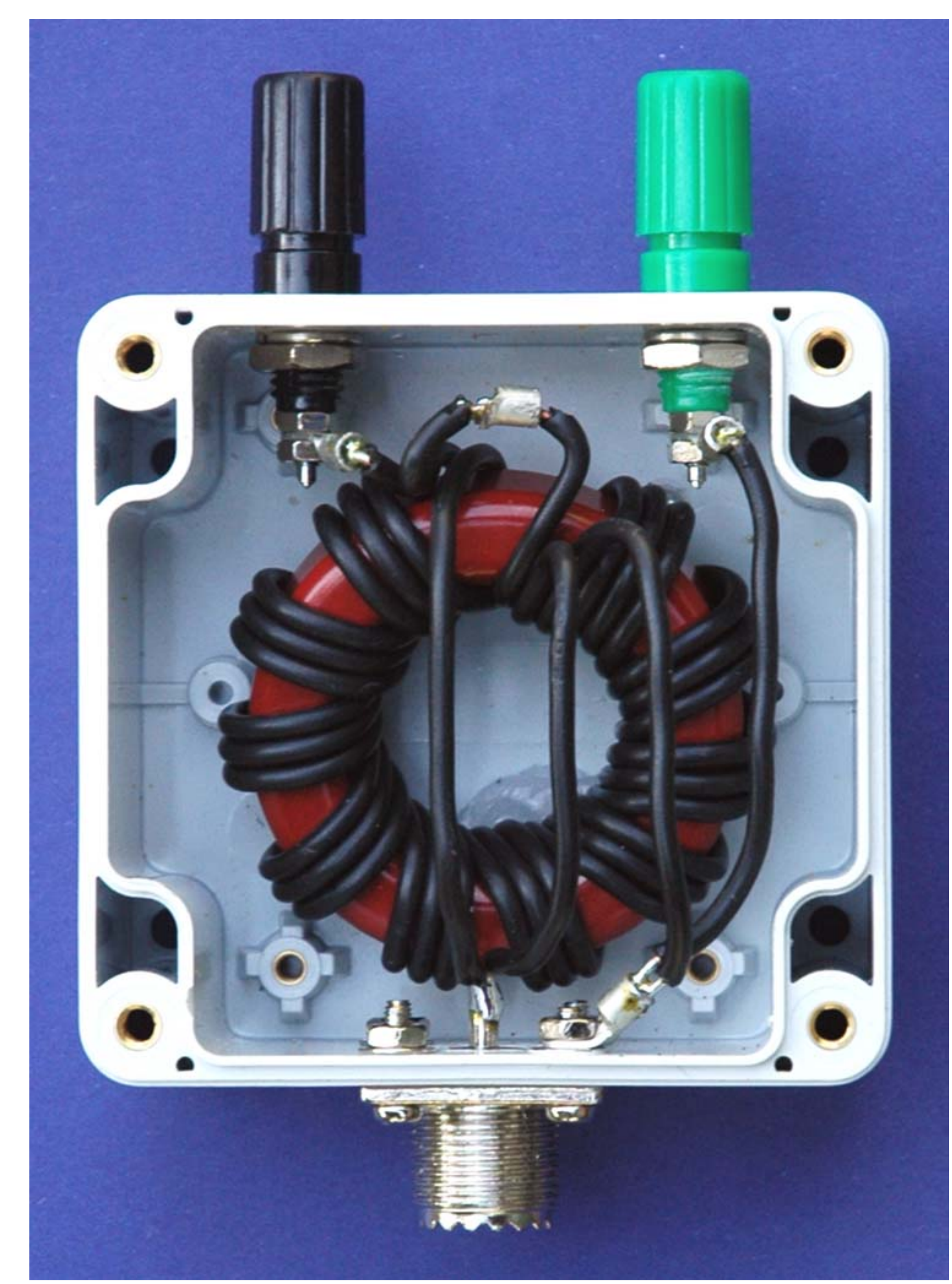


Photo 1 9:1 voltage unun assembled.

The evaluation of the efficiency of the unun over the desired bandwidth (1.8 - 30MHz) was carried out by testing the impedance that could be seen from transceiver side of the unun to a resistive load applied to the antenna side of the unun using an antenna analyser. The efficiency is shown to cut off sharply below 5MHz and gradually taper off at about 30MHz. The below antenna analyser plot viewing a 450ohm resistive load attached to the balanced side of the balun and measured at a nominal impedance of 50ohms presented as anticipated an approximate 50ohm load to the analyser and produced about a 1:1 SWR. Despite not having carried out this test previously the results are more or less what was expected and demonstrates that the unun's 1:9 voltage transformation occurs efficiently from 7 to 25MHz. The results are not as satisfying as those carried out on the 1:1 voltage balun showing significant reactance across the band. The results are less than ideal and the application of the design is to be reviewed, but is useful over a limited frequency range from 7MHz to 25MHz.

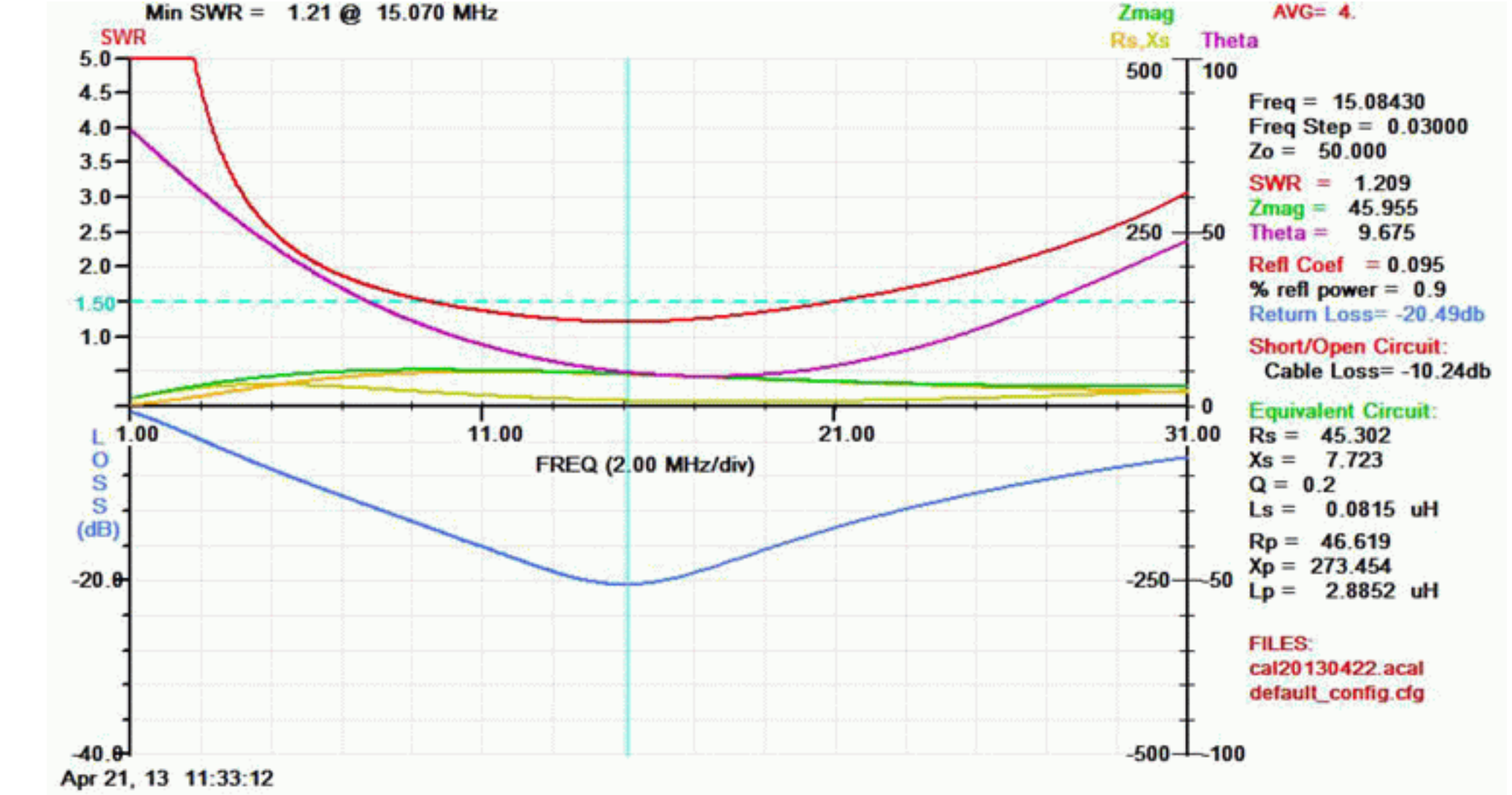


Figure 5 AIM 4170C antenna analyser plot viewing a 450ohm resistive load through the unun. Note the 450ohm resistor appears as 50ohms due to the 9:1 unun ratio resulting in an ideal SWR of 1:1.

AIM 4170C antenna analyser explanation:

SWR	Standing Wave Ratio
Zmag	Total Impedance.
Rs	Resistive component of the total impedance
Xs	Reactive component of the total impedance also indicating the +/- sign of the value. Inductive being a positive value and capacitive being a negative number.
Theta	Phase angle between voltage and current.
Return Loss	Total reflected system loss.

An additional evaluation of the efficiency of the unun was preformed by simply measuring the RF power at selected frequencies fed into the balun and measuring the out put power from the balun using the set up shown in Figure 8. In this set up it was necessary to have two identical 9:1 ununs, the second to step the impedance back down to the 50 ohms for measuring. It is critically important that the two ununs be made in an identical fashion as the results need to assume that half the losses are as a result of each of the ununs as that the below formula simply halves the resultant overall loss.

For example, RF was applied to the input of the unun at a frequency of 1.8 MHz at a power of 5 Watts with 0.45 Watts being measured at the output meter. The below formula was applied revealing a Balun loss of 5.2dB at this frequency per unun.

$$10 \log_{10} \left(\frac{P_{out}}{P_{in}} \right) = 10 \log_{10} \left(\frac{0.45}{5} \right) = -5.2 \text{ dB}$$

Figure 6 shows the results of measurements taken at various frequencies including the calculated loss. Figure 7 shows the graphed results of the losses versus frequency.

Conclusion of this evaluation is that the efficiency between 8.0 MHz to 25 MHz is very low as to be unnoticeable and that even at 25 to 30 MHz the loss would be almost unnoticeable however the losses are high at 3.5 MHz representing a full 'S' point drop or half the power being lost in the unun. At 1.8 MHz the losses are very high at -5.2 dB, almost 2 'S' points. This unun should be useful from 7.0 MHz to 30 MHz and at push on 3.5MHz if nothing better was available.

The limitation of this evaluation is that it is under an ideal situation of 50 ohms and that more extreme loads will likely show greater losses.

Freq	Input PWR	Output PWR	dB Loss
1.60	5.00	0.40	-5.5
1.80	5.00	0.45	-5.2
3.60	5.00	1.20	-3.1
7.10	5.00	3.40	-0.8
10.10	5.00	4.32	-0.3
14.50	5.00	4.90	0.0
21.10	5.00	4.50	-0.2
28.10	5.00	3.10	-1.0
29.70	5.00	2.75	-1.3

Figure 6 Table of test results.

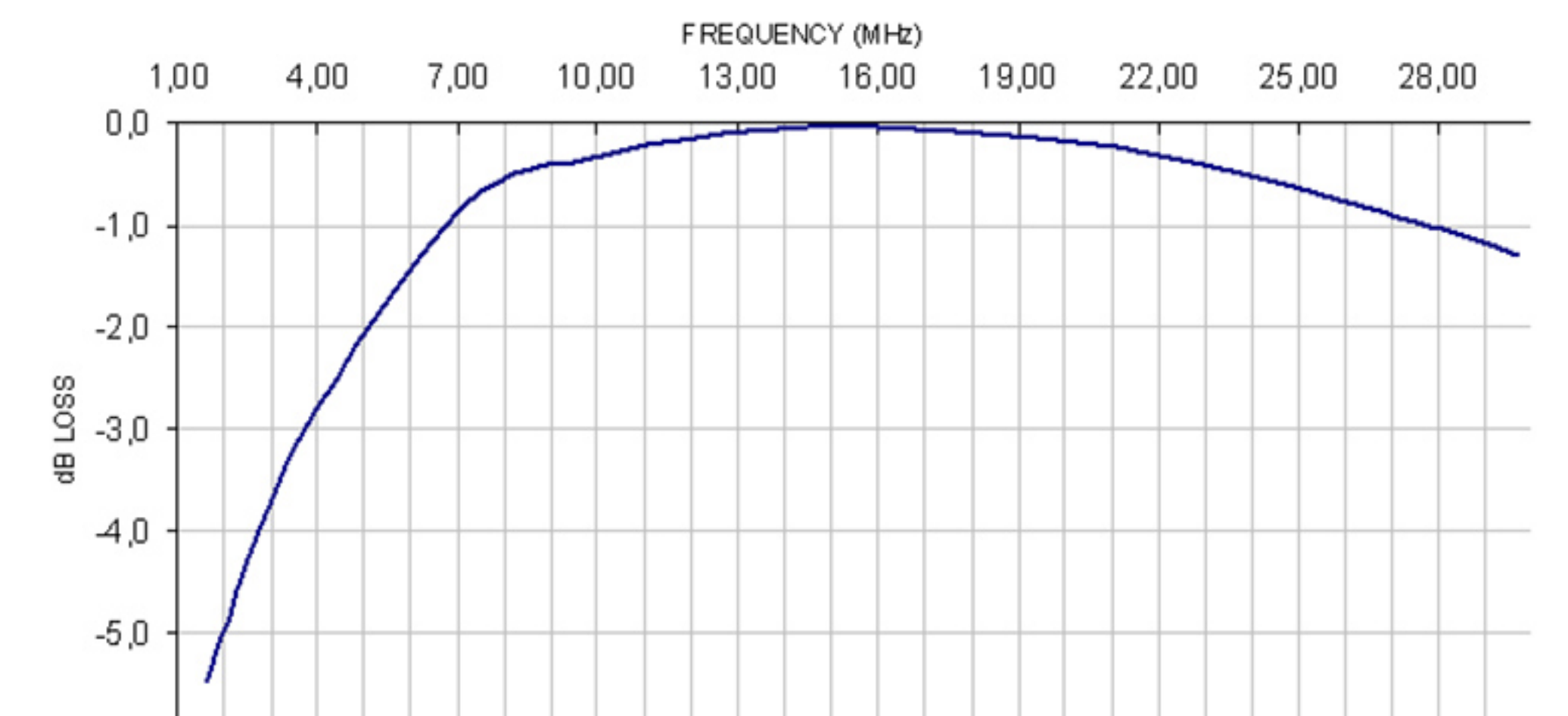


Figure 7 Plot of Balun losses versus frequency.

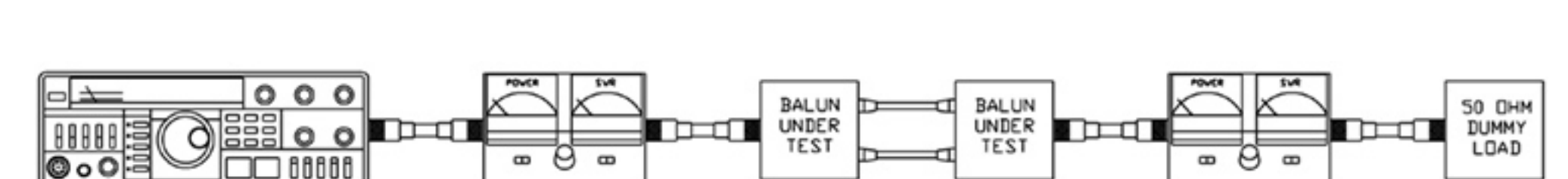


Figure 8 Efficiency evaluation set up.

Also see other baluns and ununs:

- [BALUN 1:1 CHOKE & 1:4 BALUN](#). HF ladder feed-line to coaxial cable combination choke and 1:4 balun. (0.1MHz - 30MHz).
- [BALUN 1:1 CHOKING](#). Choking balun for lower HF and MF bands. (200kHz - 10MHz).
- [CHOKING 1:1 BALUN - HF BANDS](#). Reserret choking balun. (1.0MHz - 30MHz). FT140-43 Ferrite Toroid Core.
- [CHOKING 1:1 BALUN - LOW VHF BANDS](#). Reserret choking balun (1.5MHz - 30MHz). FT140-43 Ferrite Toroid Core.
- [BALUN 1:1 CURRENT 1:1 Guanella Current balun using a L15 ferrite core \(1.8 - 30MHz\).](#)
- [BALUN 1:4 CURRENT 1:4 Guanella Current Balun using a L15 ferrite core \(1.8 - 30MHz\).](#)
- [BALUN 1:4 SINGLE CORE CURRENT 1:4 Guanella Current Balun, single FT240-43 ferrite toroid cores. \(0.3MHz - 30MHz\).](#)
- [BALUN 1:1 VOLTAGE 4:1](#) Ruthroff voltage balun using a T-200-2 powdered iron toroid core (1.8 - 30MHz).
- [BALUN 4:1 VOLTAGE 4:1](#) Ruthroff voltage balun using a T-200-2 powdered iron toroid core (1.8 - 30MHz).
- [BALUN 6:1 VOLTAGE - VERSION 1](#) 6:1 Voltage balun using a L15 ferrite toroid core (1.8 - 30MHz).
- [BALUN 6:1 VOLTAGE - VERSION 2](#) 6:1 Voltage balun using a FT140-43 Ferrite Toroid Core (1.8 - 30MHz).
- [BALUN 9:1 VOLTAGE - VERSION 1](#) 9:1 Voltage balun using a L15 ferrite toroid core (1.8 - 30MHz).
- [BALUN 9:1 VOLTAGE - VERSION 2](#) 9:1 Voltage balun using a FT140-43 Ferrite Toroid Core (0.5 - 60MHz).
- [UNUN 9:1 VOLTAGE](#) 9:1 voltage unun using a T-200-2 powdered iron toroid core (1.8 - 30MHz).
- [UNUN 9:1 VOLTAGE VERSION 2](#) 9:1 voltage unun using a L15 ferrite core (1.8 - 30MHz).
- [UNUN 9:1 VOLTAGE VERSION 3](#) 9:1 voltage unun using a FT140-43 ferrite core (0.5 - 60MHz).

References

Martin Ehrenfried G8JNJ experimentation with baluns and ununs see: <http://g8jnj.webs.com/balunsandununs.htm>

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