BALUN, UNUN and MULTIMATCH Transmission Line Transformers

by Jerry Sevick

Introduction

Transmission line transformers have been in existence for more than four decades. But very little information has been available on specific design principles and in the characterization and specification of ferrites for their use in high-power applications. In fact, practically all of the research and development on ferrites have been directed toward their uses in conventional transformers and inductors.

This catalog is very likely, in a commercial way, to give the first information on new transformers and the availability of their various components for use in power applications in the MF and HF bands. Availability has been a major problem as noted in the feedback forms returned to the publisher from the author's book Transmission Line Transformers (1). The principles reviewed here should also be of some help for their uses in other applications.

This catalog also attempts to present, briefly, the following: a) the theory of these very broadband, highly efficient and flexible transformers, b) the power rating considerations of this class of transformers, c) the practical considerations in their uses and d) a list of transformers that are available from Amidon Associates, Inc. All of these transformers were selected from the author's book. Many of the examples listed here are improvements over those in the book since they offer more margins at the low-frequency end where excessive core flux (and hence possible damage) could occur.

Theory

The earliest presentation on transmission line transformers was by Guanella in 1944 (2). He proposed the concept of coiling transmission lines to form a choke that would suppress the undesired mode in balanced-to-unbalanced matching applications. His 1:1 balun, also known as the Basic Building Block, is shown in Figure 1. The choking reactance, which isolates the input from the output, is usually obtained by coiling the transmission line around a ferrite core or by threading the line through ferrite beads. The objectives, in practically all cases, are to have the characteristic impedance, Z0, of the transmission line equal to the value of the load, RL, (which is called the optimum characteristic impedance) and to have the choking reactance much greater than RL (and hence Z0). Meeting these objectives results in a 'flat' line and hence maximum high-frequency response and maximum efficiency since conventional transformer currents are suppressed.

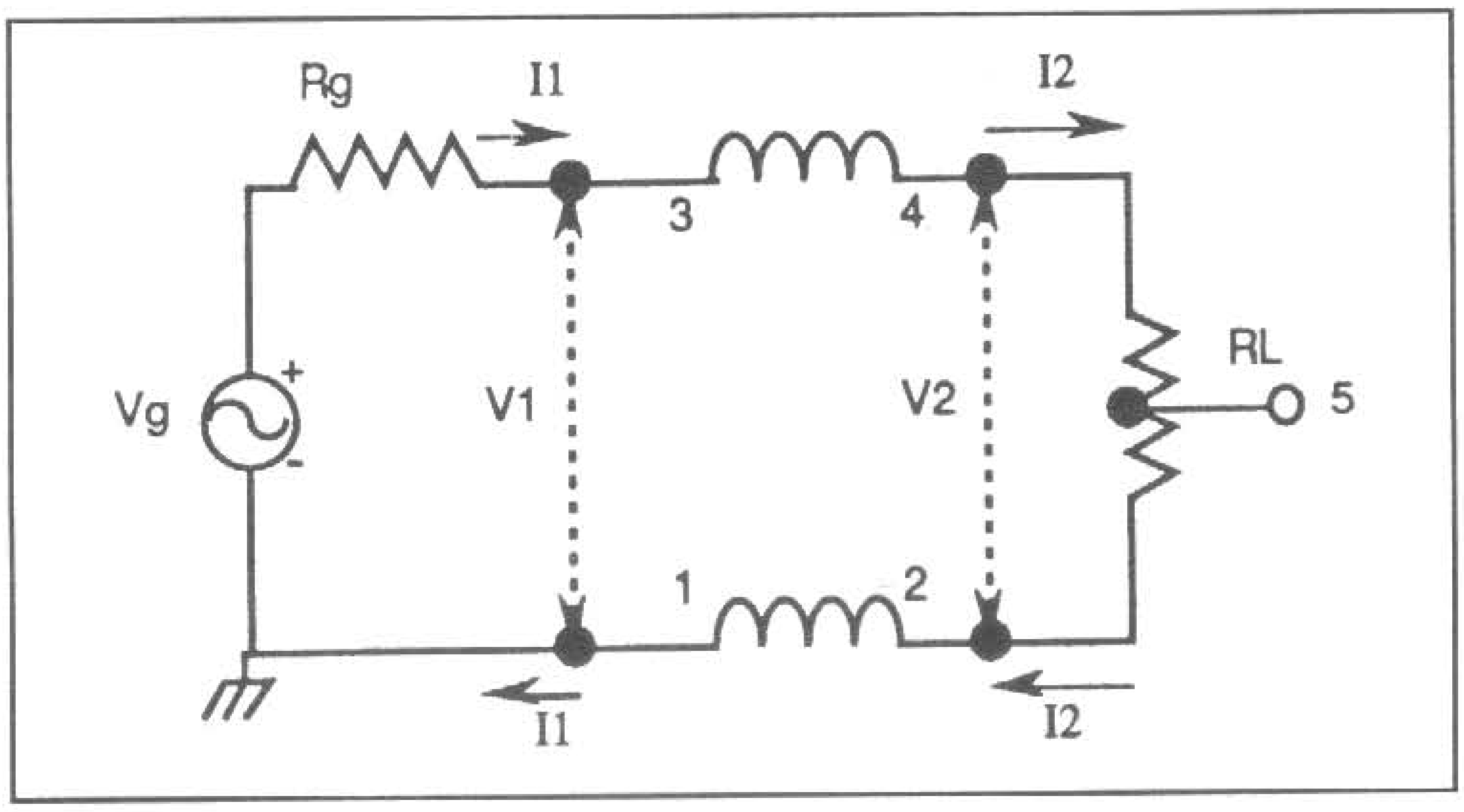

Figure 1. The Guanella 1:1balun : the basic building block

By combining coiled transmission lines in parallel-series arrangements, Guanella was able to demonstrate very broadband baluns, with ratios of 1:n2 where n is the number of transmission lines.

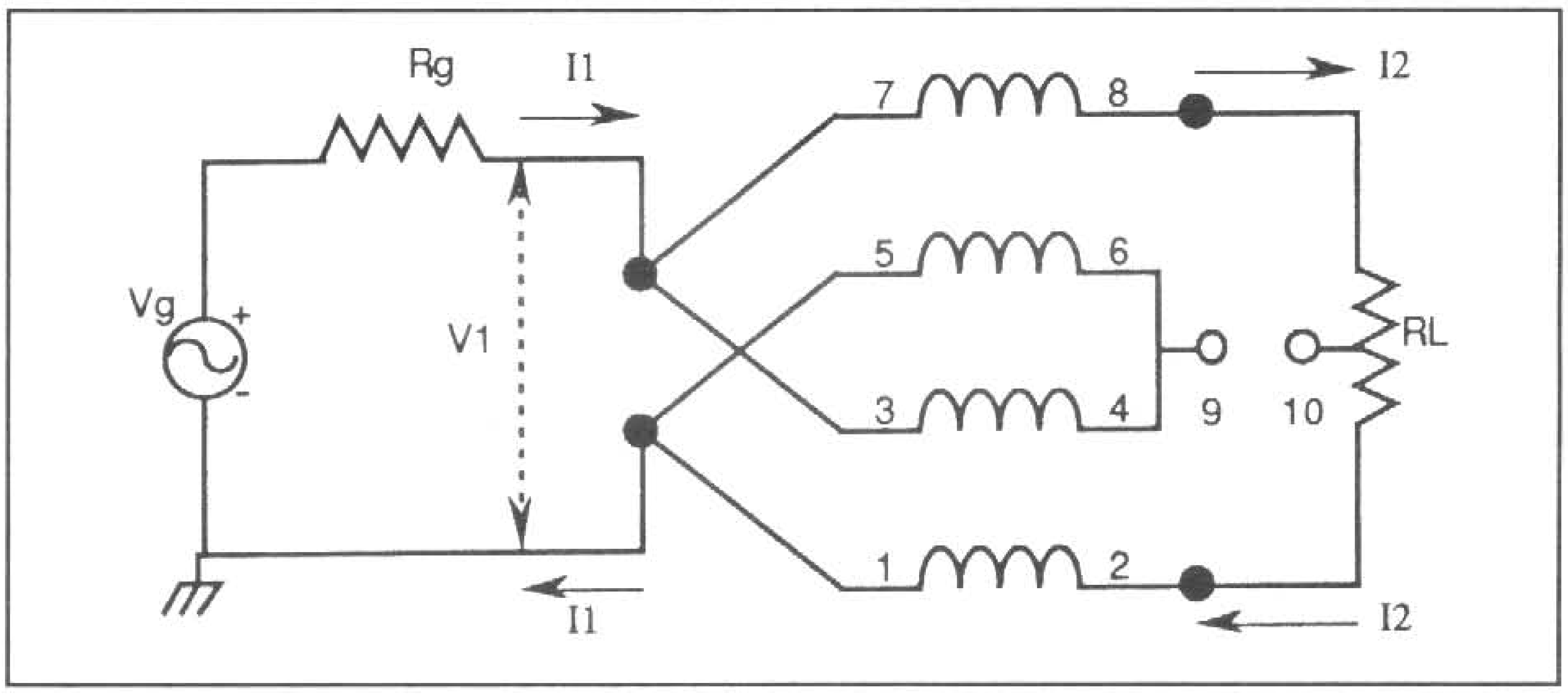

Figure 2. The Guanella 1:4 balun

Figure 2 shows the schematic for his 1:4 balun. His simple and important statements, "a frequency independent transformation," which appeared in his paper, had been overlooked by almost everyone as is evidenced by the scarcity of information in the literature on his approach to this class of transformers. Using straight, beaded lines or having sufficient separation between bifilar windings on a core, results in near-ideal transformers. Further, Guanella's baluns can also be easily converted to very broadband ununs (unbalanced-to-unbalanced transformers) by accounting for their low-frequency circuit models.

Ruthroff presented, in his classical 1959 paper (3), another technique for obtaining a 1:4 impedance transformation. It involved summing a direct voltage with a delayed voltage which traversed a single transmission line. Figure 3(A) shows his 1:4 unun and Figure 3(B) his 1:4 balun.

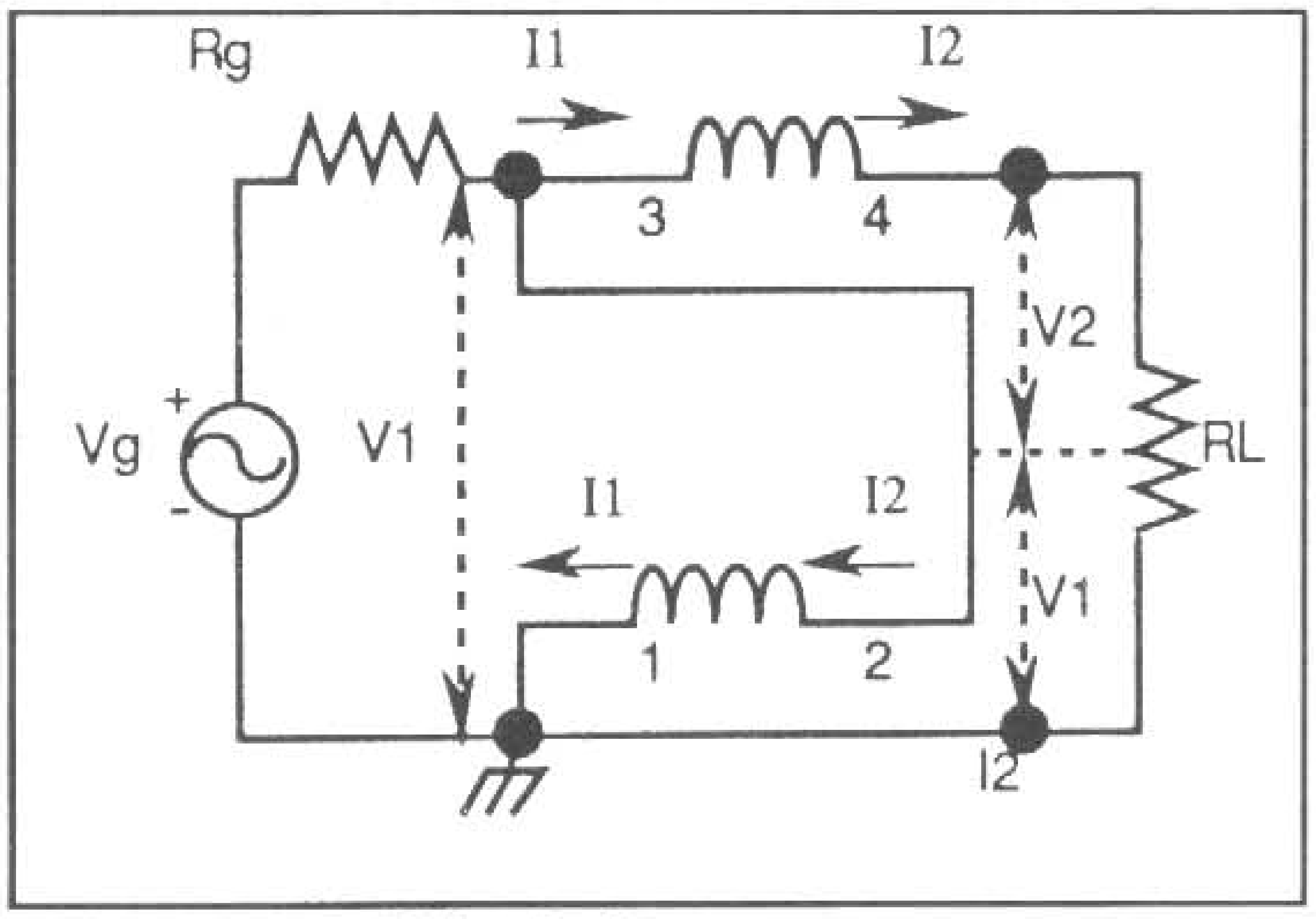

Fig 3-A

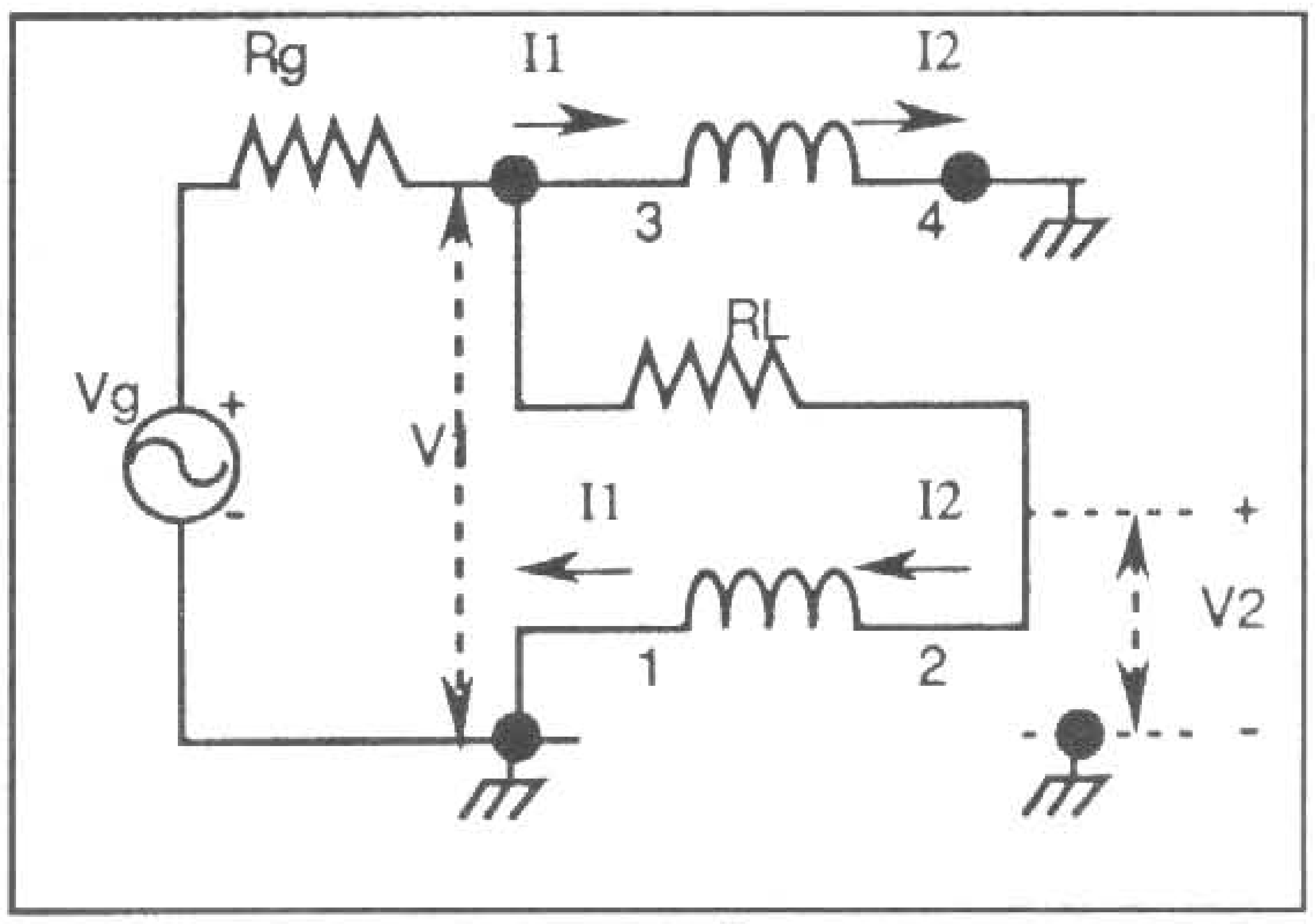

Fig. 3-B

Figure 3. The Ruthroff 1:4 transformer : (A) Unun and (B) Balun

(1) J. Sevick, Transmission Line Transformers, Newington, CT ARRL 2nd ed., 1990. Also available from Amidon Associates.

(2) Guanella G. 'Novel Matching Systems for High Frequencies,' Brown-Boverie Review, Vol 31, Sept 1944, pp 327-329.

(3) Ruthroff C.L., 'Some Broad-Band Transformers, Proc IRE, Vol 47, August 1959, pp 1337-1342.

Figure 3(A) shows the basic building block connected in the "boot-strap" configuration. By connecting terminal 3 to terminal 2, the transmission line is "lifted-up by its own boot-straps" to V1. The choking reactance of the windings prevents conventional transformer currents to flow resulting in a voltage of V1 + V2 across load, RL . Figure 3(B) shows the basic building block connected in the "phase-inverter" configuration. Since a negative potential gradient now exists along the tansmission line, the voltage access the load, RL , is now V1 on the left side and -V2 on the right side.

Since Ruthroff's transformers summed a delayed voltage with a direct voltage, his transformers had a built-in, high-frequency cut-off. Although his transformers don't have the inherent high-frequency response of Guanella's transformers (which sums voltages of equal delays), they are easier to construct and many of his ununs should find use in matching 50 ohms to 12.5 ohms in the 1.5MHz to 30MHz range. This also includes rod transformers which do not possess as high a choking reactance because of the much higher reluctance of the large air-path for the magnetic field. Further, Ruthroff's "boot-strap" technique has been the basis for the author's very broadband fractional-ratio ununs which use higher-order windings (trifilar, quadrifilar, etc.).

Power Ratings

Transmission line transformers exhibit far wider bandwidths over conventional transformers because the stray inductances and interwinding capacitances are generally absorbed into the characteristic impedance of the transmission lines. With transmission lines, the flux is also effectively cancelled out in the core and extremely high efficiencies are possible over large portions of the pass band -- losses of only 0.02 dB to 0.04 dB with certain core materials. A 0.02 dB loss translates to a 99.5 percent efficiency! Therefore very small transformers can safely handle surprisingly high powers. Experiments by the author have shown that toroids of 1-inch OD and wound with No. 18 wire can handle 600 watts of continuous power without thermal runaway. Reports have also been made of transformers, of the high-power types available here having withstood over 50KW of peak power without damage. Therefore it can safely be said that, with properly designed transformers, the power ratings of transmission line transformers are more determined by the ability of the conductors to handle the voltages and currents than by the size of the cores.

Accurate measurements have also shown that ferrite permeabilities of 300 and less are necessary for the extremely high efficiencies these transformers are capable of. Further, the measurements showed that loss is related to impedance levels. This indicates that the losses are more of a dielectric type than those experienced by conventional transformers (hysteresis, ohmic and eddy current).

Measurements have also shown that, even with permeabilities below 300, there are trade-offs in low-frequency response for efficiency, Here are some of the expected efficiencies for permeabilities of 250 to 300 (which are used in many of our transformers) as a function of the characteristic impedance of the transmission lines:

Characteristic Impedance	**Efficiency:**
50 ohms or less	99 %
50 ohms to 100 ohms	97-98 %
100 ohms to 200 ohms	95-97 %

These results show that with impedance levels of 50 ohms and less (including a 50:50-ohm balun), the ferrite of choice is in the 250 to 300 permeability range. Further experiments have also shown that transformers matching 50 ohms to 300 or 400 ohms (or even 600 ohms) using Guanella's approach, can achieve 99 percent efficiencies by using permeabilities of 40. But this is at an almost 10-fold (300/40) expense in low-frequency response. Instead of 1.5MHz, the low-frequency limit would be raised to 15MHz.

Since the establishment of power ratings for transmission line transformers have not been made by any professional group (and the above results are the only available data on efficiency), we have arbitrarily used the following levels:

a) Low-power; 150 watts continuous and 300 watts peak power
b) High-power; at least 1KW of continuous and 2KW peak power

Experiments have shown that the power ratings for the transformers offered in this catalog are very conservative. Some of the low-power units, which use rather thick wires in order to achieve the optimum characteristic impedances, could very well be placed in the high-power category. More work has to be done in this area of power-ratings of transmission line transformers.

Practical Consideration

1) Transmission line transformers are basically low-impedance devices. In practice, characteristic impedances as low as 5 ohms and as high as 200 ohms are obtainable. Thus broad bandwidths in the impedance-ratio range of 2.5:50-ohms and 50:1000-ohms are possible.

2) Transmission line transformers are basically unilateral devices. For example, a 4:1 transformer (with 50 ohms at one terminal) is only designed to match 50 ohms to 12.5 ohms or 50 ohms to 200 ohms. It cannot handle both conditions. Only when the impedance-ratio is low, say 1.5:1, is bilateral operation practical. Even then the bandwidth in the favored direction is usually twice as great as in the other direction.

3) Since high-impedance transformers require higher choking reactances (and hence more turns) and characteristic impedances, they are generally larger and more difficult to construct. Their power ratings are not any greater than their low-impedance counterparts. In fact their losses (which are dielectric) could be greater!

4) Broadband baluns operating at high-impedance and high-power levels are generally easier to design and construct than ununs (unbalanced-to-unbalanced transformers). Important considerations in either type of transformer requires an understanding of their low-frequency circuit models and trade-offs in efficiency for bandwidth.

5) In power applications where efficiency is an important consideration, only low-permeability nickel-zinc ferrites (40-300 range) have been found (by the author) to be required. Powdered- iron, because of its very low permeability is not recommended for any transmission line transformer applications.

6) Transmission line transformers are completely different from their conventional transformer counterparts. They are a combination of RF chokes and a configuration of transmission lines. Therefore, their designs and applications involve conventional transmission line theory, RF choke limitation, core losses (dielectric) and parasitics.

7) Since one of the objectives in designing these transformers is to obtain the optimized characteristic impedance of the transmission lines (for maximum high-frequency response), the spacing between the conductors is generally a critical parameter. Therefore, the thickness of the coatings on the wire as well as the use of other dielectrics like Teflon tubing and polymide tape, play important roles, The electrical insulation properties which determine the voltage-breakdown capability, are only of secondary importance.

8) Because transmission line transformers are so efficient, they can be combined in many ways offering applications heretofore untried. These combinations could be in series (even on the same core) or in parallel. Their flexibility has yet to be explored.

LIST OF HIGH-POWER TRANSFORMERS

A.UNUNS (unbalanced-to-unbalanced transformers)

	Impedance Level	Part Number	Bandwidth	Comments	Page
1)	50:32-ohms	W2FMI-1.5:1-HU50	1MHz to 40MHz	1MHz to 20MHz at 75:50-ohms	11
2)	75:50-ohms	W2FMI-1.5:1-HU75	1MHz to 40MHz	1MHz to 20MHz at 50:32-ohms	12
3)	50:22.22-ohms	W2FMI-2.25:1-HU50	1MHz to 40MHz		13
4)	50:25-ohms	W2FMI-2:1-HU50	1MHz to 30MHz		14
5)	50:28-ohms	W2FMI-1.78:1-HU50	1MHz to 50MHz	Very broadband transformer	15
6)	50:22.22-ohms 50:25-ohms	W2FMI-2:1-HDU50	1MHz to 30MHz	Dual output transformer	16
7)	112.5:50-ohms	W2FMI-2.25:1-HU112.5	1MHz to 40MHz		17
8)	100:50-ohms	W2FMI-2:1-HU100	1MHz to 30MHz		18
9)	112.5:50-ohms 100:50-ohms	W2FMI-2:1-HDU100	1MHz to 30MHz	Dual output transformer	19
10)	50:12.5-ohms	W2FMI-4:1-HRU50	1.5MHz to 40MHz	Rod version	20
11)	50:12.5-ohms	W2FMI-4:1-HCU50	1MHz to 40MHz	Coax version, 5KW cont. 10KW peak power	21
12)	50:5.56-ohms	W2FMI-9:1-HRU50	1MHz to 30MHz	Rod version	22
13)	50:5.56-ohms	W2FMI-9:1-HUH50	1MHz to 30MHz	2KW cont., 4KW peak	23
14)	Multimatch Unun	W2FMI-HMMU50			24
a)	50:5.56-ohms (9:1)		1MHz to 30MHz		
b)	50:8.68-ohms (5.76:1)		1MHz to 15MHz		
c)	50:12.5-ohms (4:1)		1MHz to 20MHz		
d)	50:22.22-ohms (2.25:1)		1MHz to 25MHz		
e)	50:34.72-ohms (1.44:1)		1.7MHz to 20MHz		
15)	50:28-ohms 50:12.5-ohms	W2FMI-1.78:1-HDU50	1MHz to 30Mhz	Dual output transformer	25
16)	Multimatch Unun	W2FMI-1.78:1-HMMU50			26
a)	50:36.76-ohms (1.36:1)		1MHz to 25MHz		
b)	50:28.13-ohms (1.78:1)		1MHz to 45MHz		
c)	50:22.22-ohms (2.25:1)		1MHz to 40MHz		
d)	50:16.34-ohms (3.06:1)		1MHz to 30MHz		
e)	50:12.50-ohms (4:1)		1MHz to 30MHz		
f)	50:5.56-ohms (9:1)		1MHz to 25MHz	500watt continuous, 1KW peak power	
g)	50:4.08-ohms (12.25:1)		1MHz to 20MHz	500watt continuous, 1KW peak power	
h)	50:3.13-ohms (16:1)		1MHz to 20MHz		
17)	50:32-ohms 50:18-ohms	W2FMI-1.56:1-HDU50	1MHz to 40MHz	Dual output transformer	27

B. BALUNS

	Impedance Level	Part Number	Bandwidth	Comments	Page
1)	50:50-ohms	W2FMI-1:1-HBL50	1MHz to 50MHz	2KW continuous, 4KW peak power	28
2)	50:50-ohms	W2FMI-1:1-HBH50	1MHz to 50MHz	5KW continuous, 10KW peak power	29
3)	200:50-ohms	W2FMI-4:1-HBL200	1MHz to 50MHz	1KW continuous, 2KW peak power	30
4)	200:50-ohms	W2FMI-4:1-HBM200	1MHz to 50MHz	2KW continuous, 4KW peak power	31
5)	200:50-ohms	W2FMI-4:1-HBH200	1MHz to 50MHz	5KW continuous, 10KW peak power	32
6)	300:50-ohms	W2FMI-6:1-HB300	1.5MHz to 30MHz		33
7)	450:50-ohms	W2FMI-9:1-HB450	1.5MHz to 30MHz		34
8)	112.5:50-ohms	W2FMI-2.25:1-HB112.5	1.5MHz to 45MHz		35
9)	50:12.5-ohms	W2FMI-4:1-HB50	1.5MHz to 45MHz		36
10)	600:50-ohms	W2FMI-12:1-HB600	1.7MHz to 22MHz		37
11)	600:50-ohms	W2FMI-12:1-MB600	3.5MHz to 30MHz	500W continuous, 1KW peak power	38

LIST OF LOW-POWER TRANSFORMERS

A. UNUNS (unbalanced-to-unbalanced transformers)

	Impedance Level	Part Number	Bandwidth	Comments	Page
1)	50:32-ohms	W2FMI-1.5:1-LU50	1MHz to 40MHz	1MHz to 20MHz at 75:50-ohms	39
2)	75:50-ohms	W2FMI-1.5:1-LU75	1.5MHz to 50MHz	1MHz to 25MHz at 50:32-ohms	40
3)	50:22.22-ohms	W2FMI-2.25:1-LU50	1MHz to 50MHz	Very broadband transformer	41
4)	50:25-ohms	W2FMI-2:1-LU50	1MHz to 40MHz		42
5)	50:22.22-ohms 50:25-ohms	W2FMI-2:1-LDU50	1MHz to 40MHz	Dual output transformer	43
6)	112.5:50-ohms	W2FMI-2.25:1-LU112.5	1MHz to 30MHz		44
7)	100:50-ohms	W2FMI-2:1-LU100	1MHz to 25MHz		45
8)	112.5:50-ohms 100:50-ohms	W2FMI-2:1-LDU100	1MHz to 25MHz	Dual output transformer	46
9)	50:12.5-ohms	W2FMI-4:1-LRU50	1MHz to 40MHz	Rod version	47
10)	50:12.5-ohms	W2FMI-4:1-LFU50	1MHz to 30MHz	Floating-third-wire model	48
11)	50:12.5-ohms	W2FMI-4:1-LCU50	1MHz to 50MHz	Coax version	49
12)	50:5.56-ohms	W2FMI-9:1-LU50	1MHz to 50MHz		50

B. BALUNS

Do It Your Self: Construction Help

Introduction

Transmission line transformers can be said to be difficult to construct because of the sensitivity of their high-frequency responses to the characteristic impedances of the windings (and hence spacing of the windings) and to the work-hardening of the copper wires upon winding them about a core.

At low characteristic impedance levels, a difference of only 6 mils in spacing can change the characteristic impedance from 45 ohms to 55 ohms. This could lower the high-frequency response from 30MHz to 20MHz. This would not necessarily increase the loss in the transformer since the currents are still of a transmission-line-type and hence flux canceling. If the characteristic impedance is too low, the impedance transformation ratio can become complex (have an imaginary part at the high-frequency end) and become larger in magnitude. If it is too high, the ratio can become smaller. The primary function of the insulation on the wires is to obtain the proper spacing in order to achieve the optimum characteristic impedance of these windings (and hence maximum high-frequency response). The secondary function is for voltage-breakdown improvement.

In the winding process, copper wire (which is normally soft) can become very stiff and difficult to manage. In many cases, the windings have to be rolled-back a quarter- or half-turn in order to reposition them or to wind them closer to the core. A pair of pliers and a strong thumb are indispensable tools.

This write-up attempts to help the builder to construct transformers that meet the objectives they are capable of. It includes the following: a) wire preparation, b) winding rod and toroidal transformers and c) connecting and tapping wires.

Wire Preparation

The first step is to determine the length of the wire needed in coiling it about the core and then making the proper connections. Experience has shown that 4 to 5 extra inches are needed beyond the coiled winding. About a third should be at the beginning of the winding and the other two-thirds at the end. A simple technique for determining the length is to take a piece of string, wind it about the core with the proper number of turns) and then add 4 to 5 inches to that length. Another technique is to calculate the length-per-turn, multiply it by the required number of turns and then add 4 to 5 inches to it. Generally, the kits are supplied with enough wire, insulation and other components (except cores) to allow for two attempts in constructing the transformers. One will find that the wire cannot be reused because of work-hardening.

The second step is to straighten-out the wire as much as possible. This can be accomplished by holding the wire at one end with a pair of pliers and then pulling the wire between the clenched thumb and forefinger several times. Some work-hardening will take place but it will not prove to be a problem. Each wire is then skinned-back (insulation removed) about 3/4ths of an inch at one end. This is usually the beginning end of the winding. One will find that scraping off the insulation (with a jack-knife, usually) is probably one of the more difficult (and boring) tasks in constructing these transformers.

Three of the more popular wires (known as magnet wires) used in these transformers are Formvar, Thermaleze and Imideze. Formvar is generally available with a single coating of insulation (0.08 mils thick) and has the designation SF. Thermaleze and Imideze usually have a thick coating (1.6 mils) and have the designation H. All three have the same dielectric-breakdown-per-unit-thickness (2000 volts/mil). They only differ in their thermal capabilities which are important in motors, generators and 60 hertz power transformers and not transmission line transformers. Incidentally, Imideze has the greatest thermal tolerance (220 degrees centigrade) and Formvar the least (105 degrees centigrade).

Extra insulation on the wire, like Scotch No. 92 or Teflon tubing is necessary in many cases in order to achieve the proper spacing between the wires and hence obtain the desired optimum characteristic impedances. When striving for characteristics impedances of 50 ohms, sometimes one layer of Scotch No. 92 tape (a thickness of 2.8 mils) is required. In other cases, two layers are needed. The author has found that by laying the Scotch No. 92 tape (which is 1/2 inch wide) edgewise on the wire and then rolling it around like a rug or window shade, two layers are practically realized on No. 12, 14 and 16 wire. A little less will be on No. 12 wire and a little more on No. 16 wire. Electrically, the objectives will be met. A U-frame will be found helpful in holding the wire. The two-layer thicknesses can also be accomplished by controlled-spiral winding.

The goal to achieve a single layer thickness of Scotch No.92 (2.8 mils) is a little more difficult. One has to slit the 1/2-inch wide tape so it just covers the circumference of the wire. The width can be calculated by multiplying the diameter by 3.14 (pi). For No. 14 wire, this amounts to about 4/10ths the width of the 1/2-inch tape. Since generally two pieces now become available from the 1/2-inch wide tape, the starting length is one-half of the final length needed. The slitting process involves laying the Scotch No. 92 tape on a smooth surface (like glass or metal) and using a safety razor blade and ruler with a metal edge. Incidentally, the thickness of Scotch No. 92 tape is made up of 1 mil of polyimide and 1.8 mils of adhesive. This tape has excellent electrical and thermal properties and is highly recommended.

Winding Rod and Toroidal Transformers

The rod transformer, although not as popular as its toroidal counterpart, is the easier transformer to wind. This is because it can be wound one wire at a time and hence, work-hardening becomes less of a problem. Further, the turns can be wound much more tightly (i.e., less space between adjacent turns). This allows one to easily obtain a characteristic impedance of 25 ohms which is necessary with transformers matching 50 ohms to 12.5 ohms. With toroidal cores, one has to resort to low-impedance coaxial cable or stripline or a floating-third-wire.

The major trick in ending up with a tight bifilar winding on a rod is to put on the first winding as tightly as possible. The second wire is then fastened firmly at its beginning by lightly soldering it to the first wire. It is then wound around the rod by actually stuffing it between the turns of the first winding. One then finds it becomes fast to the rod and results in the best electrical and mechanical condition. For a trifilar winding, the first winding should have about 1-wire-diameter spacing between turns. For a quadrifilar winding, the spacing should be 2-wire-diameters, etc.

The best procedure for toroidal transformers is to make a ribbon out of the wires and then wind them all at the same time. This assures their spacings and hence performances. The ribbon can be easily constructed by using thin sections of Scotch No. 27 glass tape as clamps every 5/8- to 3/4-inches. The tapes should be about 1/4-inch wide and long enough to wrap around the wires twice. These dimensions were achieved by first cutting the 1/2-inch wide tape lengthwise for the proper width.

Connecting and Tapping Wire

Figure 1 shows the definite patterns that exist with rod, toroidal and coax windings. The schematics, in these cases, are for Ruthroff 1:4 unun transformers. Figure 2 shows the patterns that exist for quintufilar transformers. The trifilar and quadrifilar transformers can be easily visualized from Figure 2. Putting numbered tags on the ends of each wire will also help in keeping track of them. The photographs supplied with each kit will show how the connections can be made.

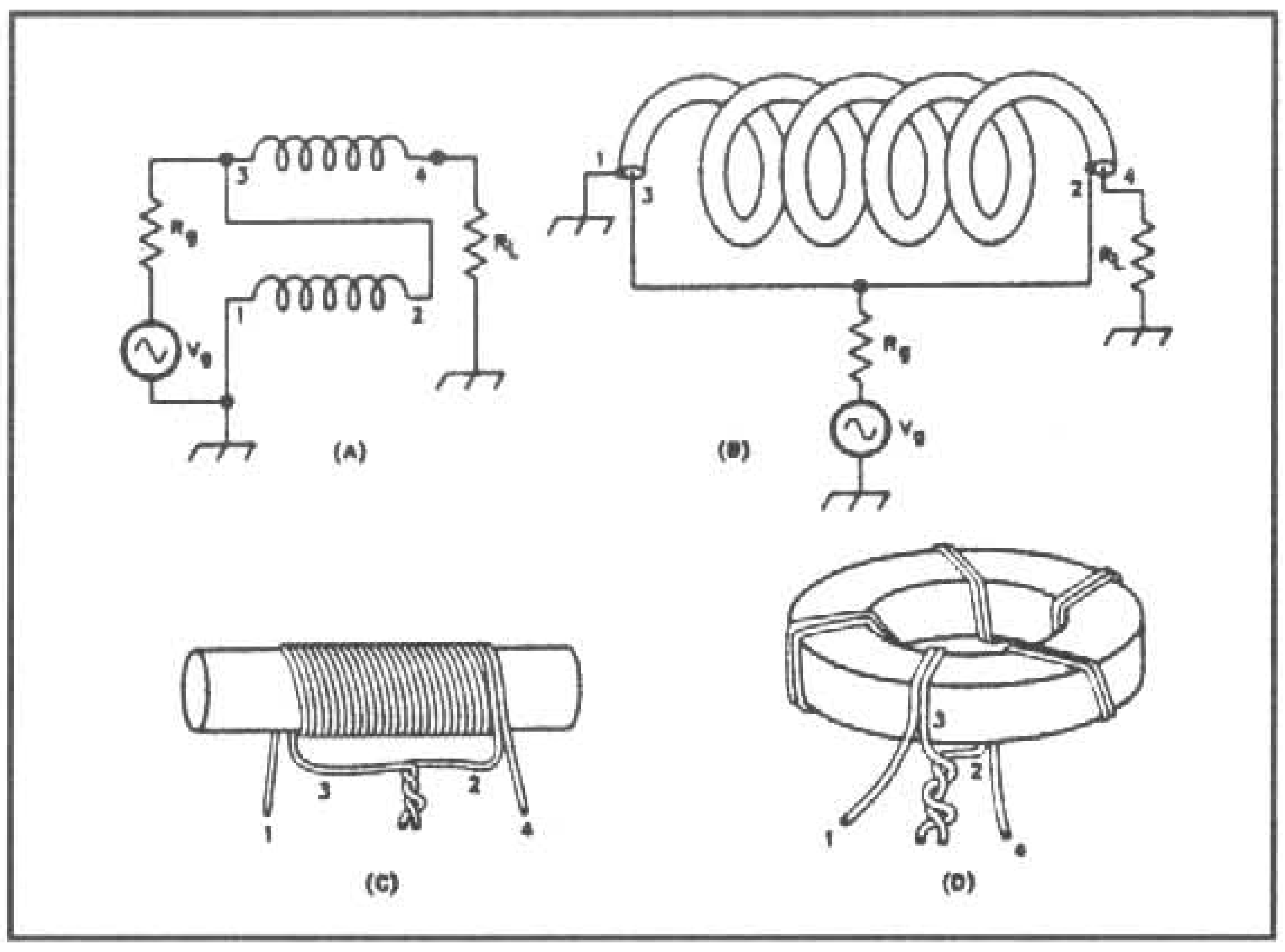

Figure 1 - The Ruthroff 1:4 unun: (A) wire schematic, (B) coaxial cable schematic, (C) rod pictorial and (D) toroid pictorial

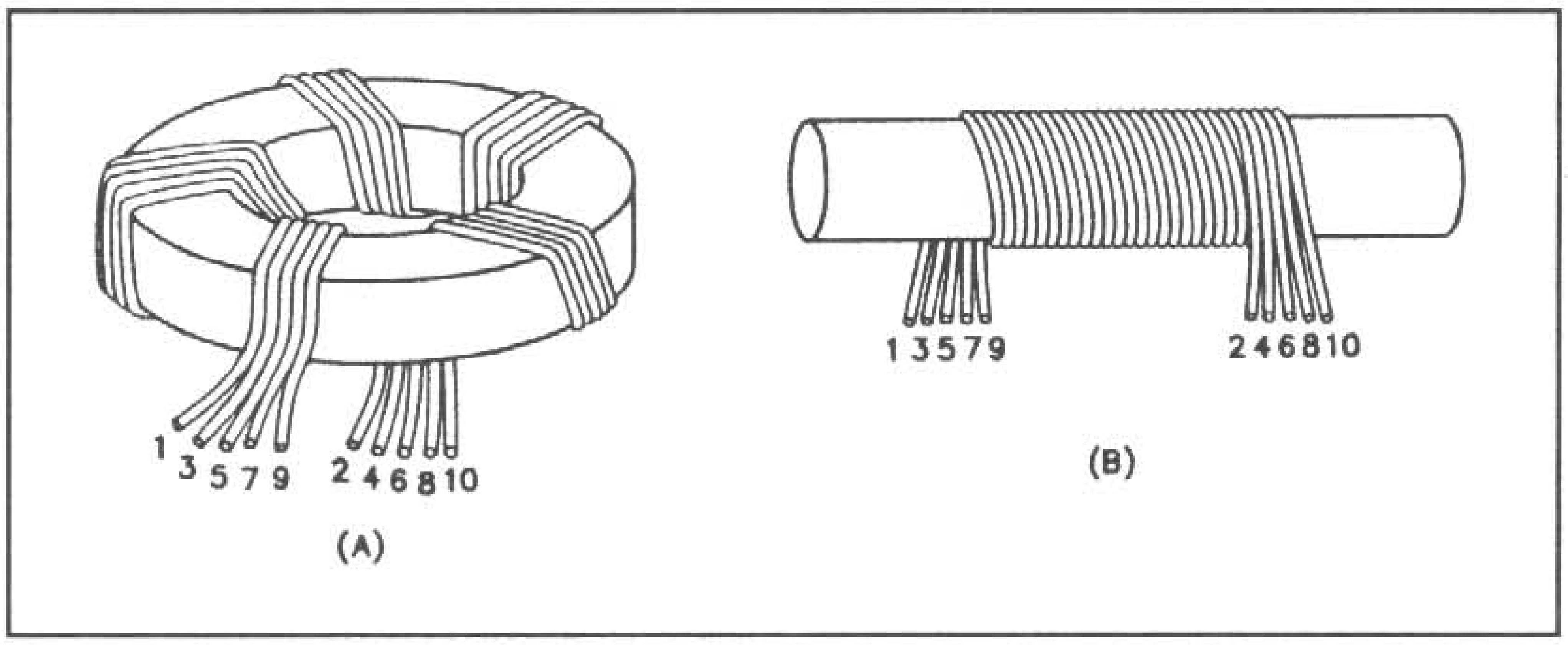

Figure 2 - Pictorials of quintufilar windings: (A) toroid and (B) rod.

Generally, the trifilar transformer with a 2.25:1 impedance transformation ratio or the quadrifilar transformer with a 1.78:1 ratio, can satisfy most 2:1 ratio requirements. They are much easier to construct. But in some cases, like 2:1 transformers and multimatch transformers, tapping is necessary in order to meet the objectives.

The author has found that a small, fine file has been found to be very helpful in obtaining successful taps, First, the coating of the wire is removed (about an 1/8-inch wide) at the right distance on the straight wire by the edge of the file. A narrow copper strip or flattened wire is soldered to the bare part of the wire. The connection is then rendered smooth by the edge of the file. Finally, two thicknesses of Scotch No. 92 tape are placed on the connection in order to provide adequate insulation between the wire (which is straight at this point) when the tap is required to be near the center of the winding (like 4 out of 8 turns). In this case, the winding of the transformer is started at the center of the wire where the tap should be.

A) Description

The W2FMI-1.5:1-HU is a high-power unun (unbalanced-to-unbalanced) transmission line transformer designed to match 50 ohms to 32 ohms. It has a constant impedance transformation ratio of 1.5:1 (actually 1.56:1) from 1MHz to 40MHz. In the reverse direction, matching 75 ohms to 50 ohms, the response is flat from 1MHz to 20 MHz. A conservative power rating is 1KW of continuous power and 2KW of peak power. The efficiency is 99 percent.

B) Circuit Diagram

Figure 1 shows the schematic diagram of this highly efficient and broadband transformer. Four quintufilar turns are wound on an Amidon PN FT-150-K. The center winding in Figure 1 is No. 14 Formvar SF wire. The other four are No. 16 Formvar SF wire.

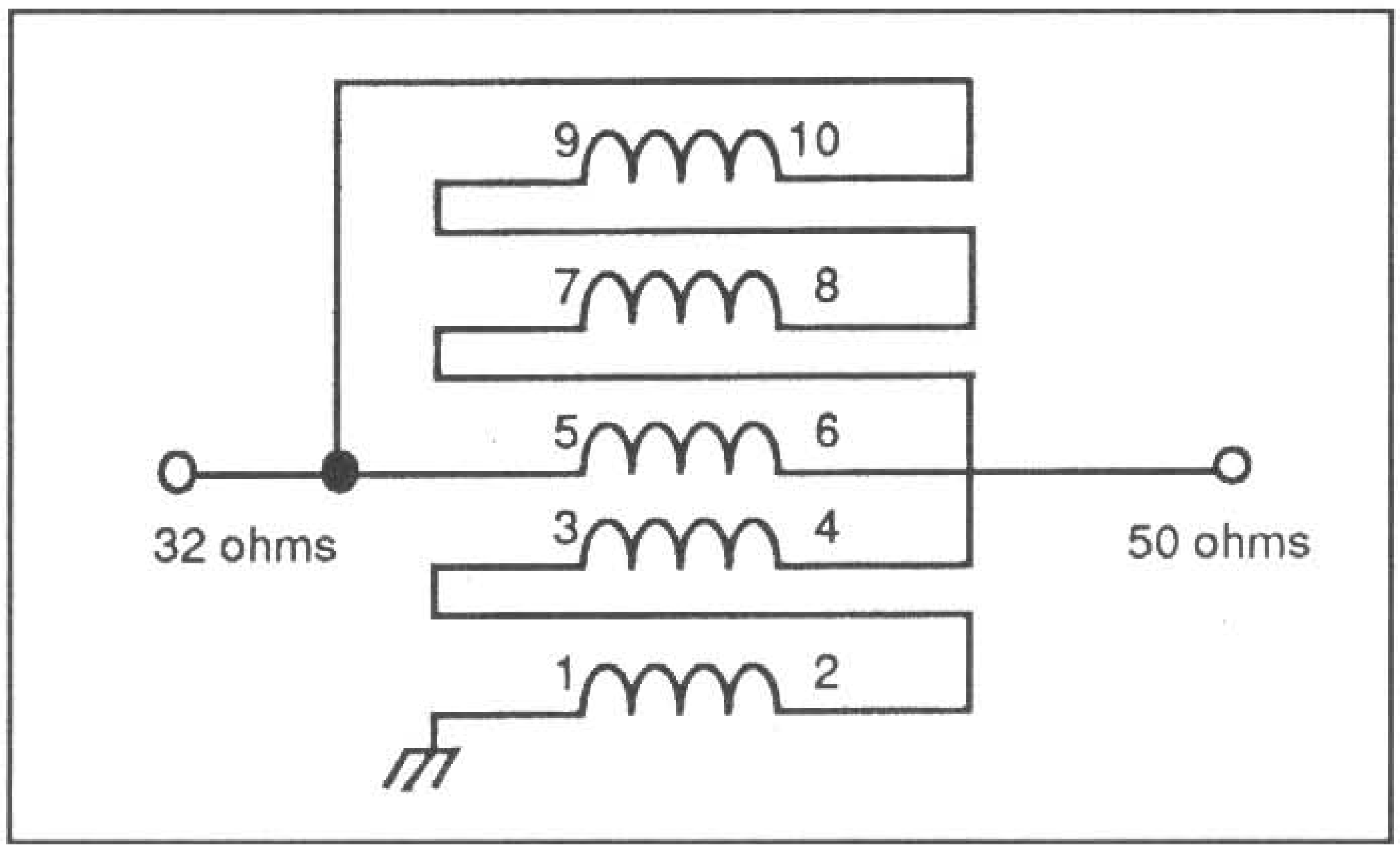

Figure 1. Schematic diagram of the quintufilar UNUN transformer designed to match 50 ohms to 32 ohms

C) Photograph

The bottom-view of the transformer (before mounting) is shown in Figure 2. The photograph attempts to show the various connections. The 50-239 connector is on the low-impedance side.

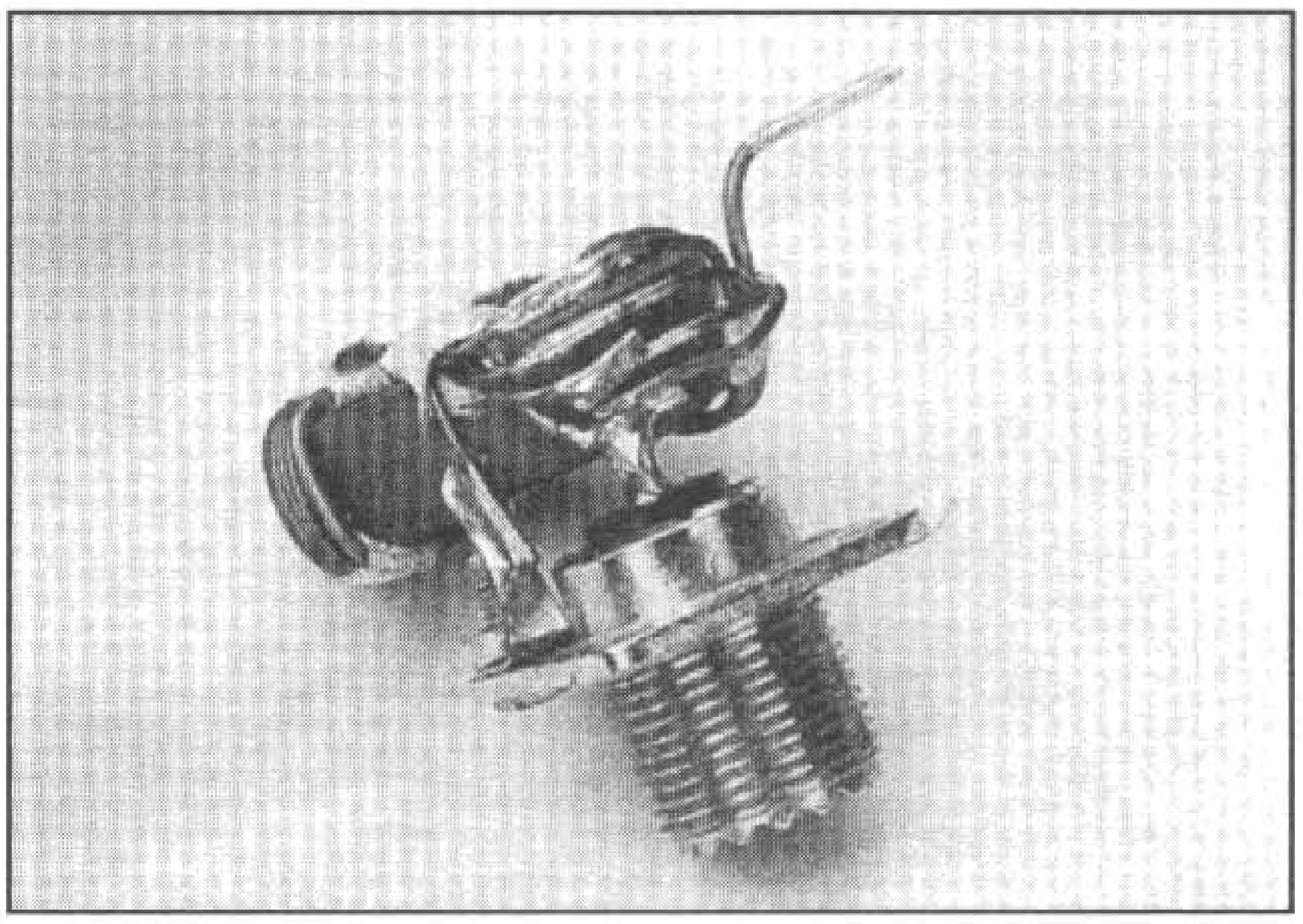

Figure 2 - Bottom-view of the highly efficient and broadband W2FMI-1.5:1-HU transformer.

W2FMI-1.5:1-HU75

A) Description

The W2FMI-1.5:1-HU75 is a high-power unun (unbalanced-to-unbalanced) transmission line transformer designed to match 75 ohms to 50 ohms. It has a constant impedance transformation ratio of 1.5:1 (actually 1.56:1) from 1MHz to 40MHz. In the reverse direction, matching 50 ohms to 32 ohms, the response is flat from 1MHz to 20 MHz. A conservative power rating is 1KW of continuous power and 2KW of peak power. The efficiency is 99 percent.

B) Schematic Diagram

Figure 1 shows the schematic diagram of this highly efficient and broadband transformer. Four quintufilar turns are wound on an Amidon FT-150-K. Winding 7-8 in Figure 1 is No. 14 H-Imideze wire. The other four are No. 16 H-Imideze wire. The thick coating (3 mils) of H. Thermaleze wire assures the optimum characteristic impedance of the windings. Formvar and Thermaleze wires with equal thicknesses of coatings would perform as well.

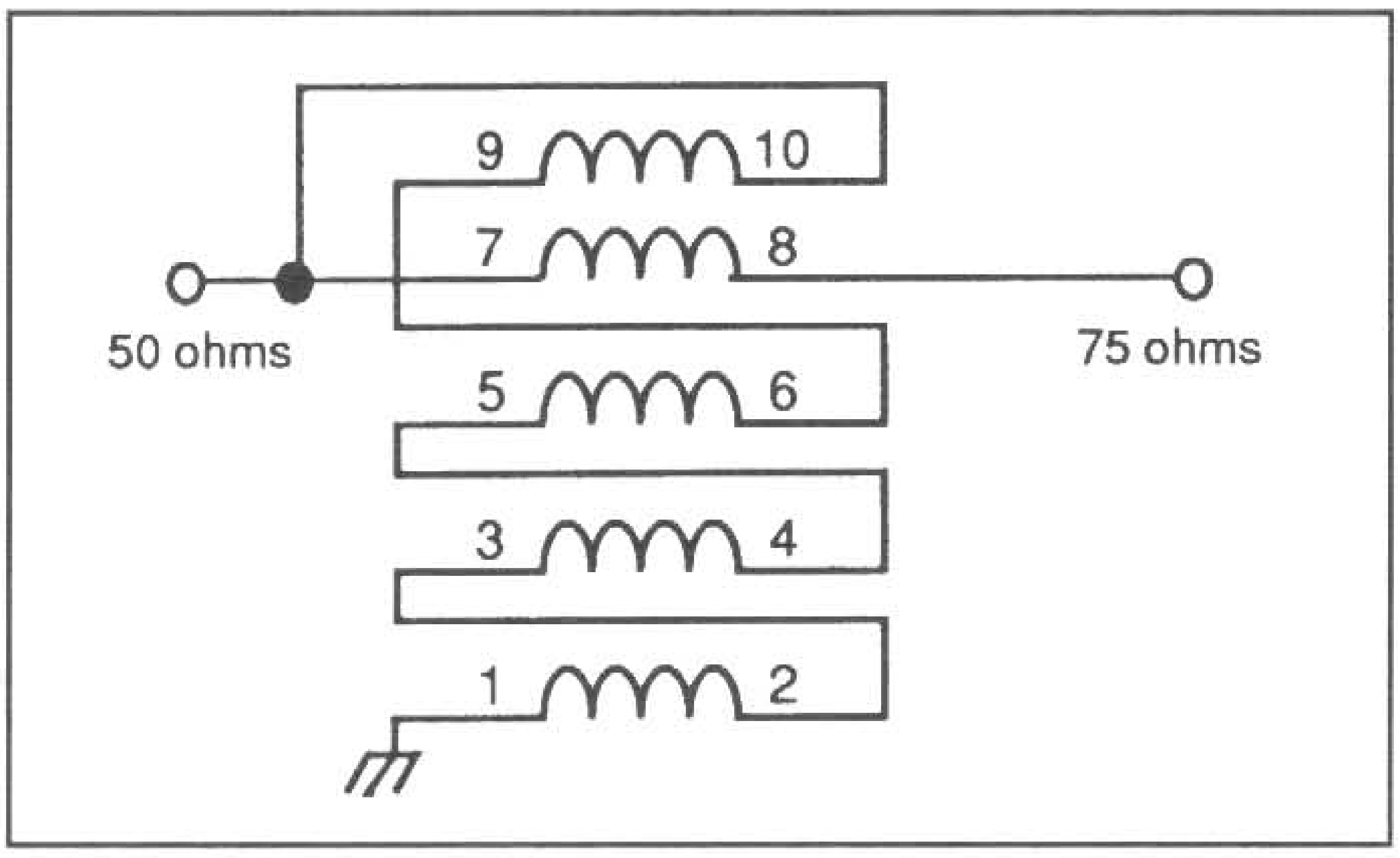

Figure 1. Schematic diagram of the quintufilar UNUN transformer designed to match 75 ohms to 50 ohms

C) Photograph

The bottom-view of the transformer (before mounting) is shown in Figure 2. The photograph attempts to show the various connections. The 50-239 connector is on the low-impedance side.

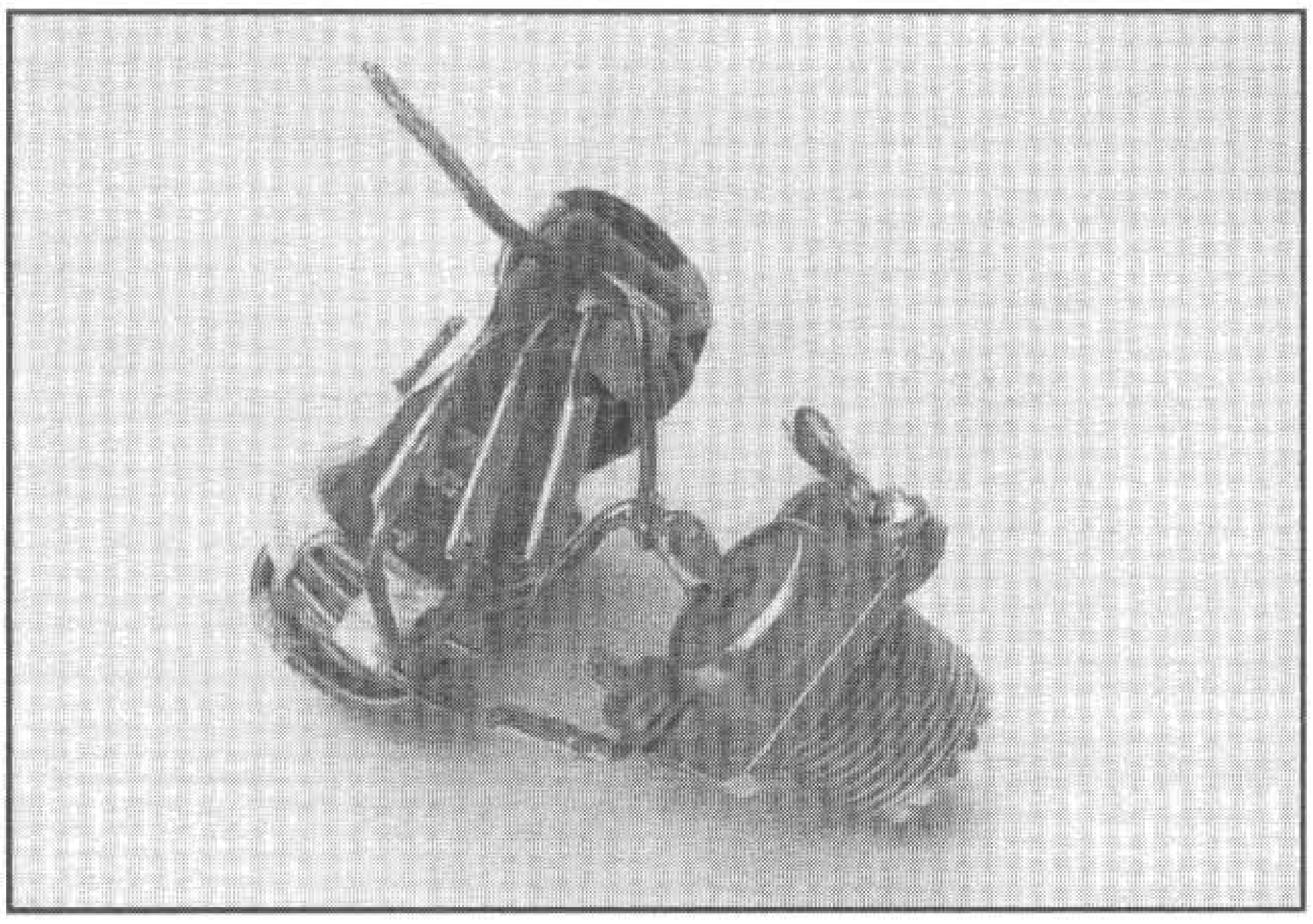

Figure 2 - Bottom-view of the highly efficient and broadband W2FMI-1.5:1-HU75 transformer.

A) Description

The W2FMI-2.25:1-HU50 is a high-power unun (unbalanced-to-unbalanced) transmission line transformer designed to match 50 ohms to 22.22 ohms. It has a constant impedance transformation ratio of 2.25:1 from 1MHz to 40MHz. This ratio should satisfy many of the 2:1 requirements, This is particularly true with antennas since their impedances vary with frequency. Only a small difference (from a 2:1 ratio) in the frequency for the best match-point (lowest VSWR) will be observed. Also there will be very little difference in the values of the VSWRs. Further, it is much easier to construct than a 2:1 transformer. A conservative power rating is 1KW of continuous power and 2KW of peak power. The efficiency is 99 percent.

B) Schematic Diagram

Figure 1 shows the schematic diagram of this highly efficient and broadband transformer. Six trifilar turns of No. 14 H. Thermaleze wire are wound on an Amidon FT-150-K.

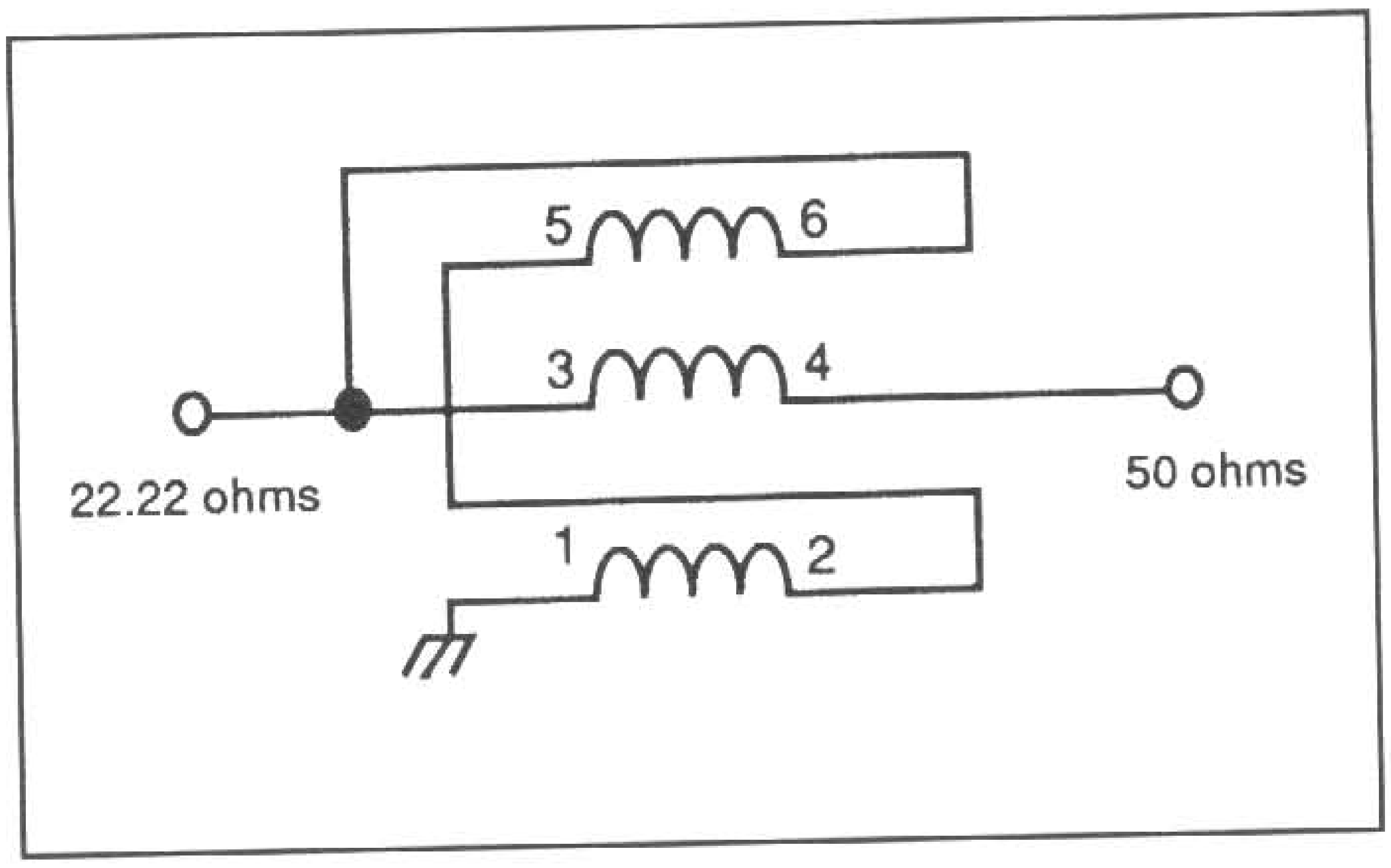

Figure 1. Schematic diagram of the trifilar UNUN transformer designed to match 50 ohms to 22.22 ohms

C) Photograph

The bottom-view of the transformer (before mounting) is shown in Figure 2. The photograph attempts to show the various connections. The connector is on the low-impedance side.

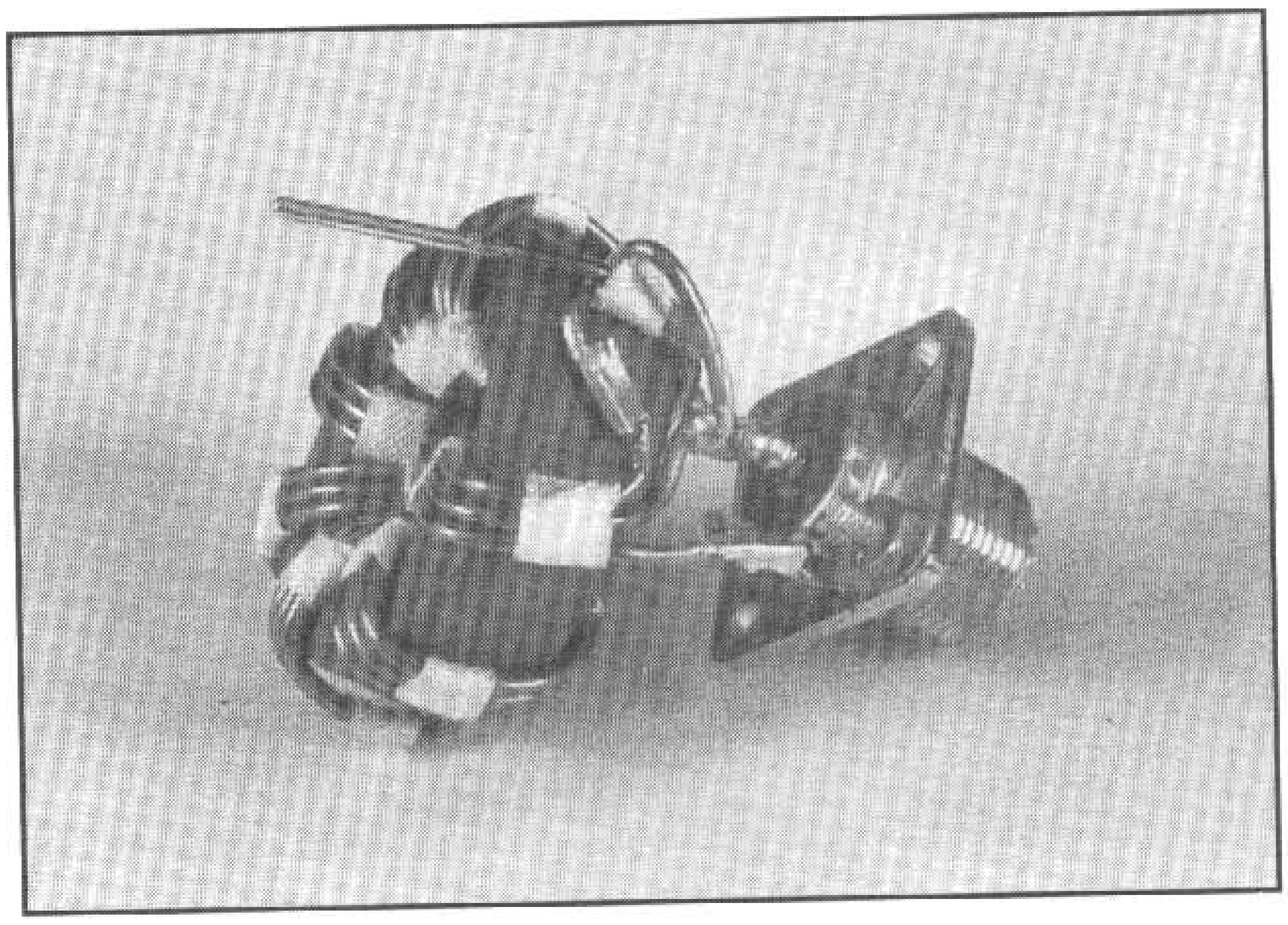

Figure 2 - Bottom-view of the highly efficient and broadband W2FMI-2.25:1-HU50 transformer.