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The "Bevmatcher" Broadband Antenna Matching and Combining Unit

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This article presents a flexible solution to coupling Beverage and random-length longwire and vertical antennae to 50-ohm coaxial feedline suitable to transport a low-noise signal from a remote location to the receiving position. Several issues are involved: these must be discussed at the outset.

1. Inability to keep correct antenna orientation if the antenna is extended to reach the receiving "shack"

   A Beverage or other wire antenna laid out for a particular directional characteristic may only be feasible at a site not immediately adjacent to the receiving position. It is necessary to "capture" signals as if the receiver was "out in the field" at the end of the properly-aimed antenna.

2. Excessive manmade RF noise in the immediate vicinity of the receiving position.

   Noise from TV's, machines, fluorescent lights, computers, power lines, etc. obliterate serious DX signals in the area near the receiver. A remote antenna at a quieter nearby site is mandated. Active remote antennae may be overloaded by strong local stations, so a passive fix is required. Again, a means of delivering a true noise-free replica of the signal "in the field" at the base of the antenna to the operating position is needed. It goes without saying that signal attenuation due to cable loss should be minimized. Luckily, even 100' (30 m.) of RG-58 type coax. has relatively little loss below 5 MHz. Cable shielding must be effective and ground loops are to be avoided if noise is to be held at bay and if RF "leakage" (that could compromise directivity) is to be "plugged".

3. Wire antennae seldom provide a proper 50 ohm match: simply connecting a run of coax. to a remote wire antenna is a recipe for failure.

   A Beverage characteristically has an impedance of 500 to 900 ohms over a fairly wide bandwidth. DXers such as Nick Hall-Patch have constructed toroidal-transformer assemblies that take advantage of this fact by using a fixed ratio of transformation (e. g. 12:1) and ground isolation to get substantially better RF energy transfer to the 50-ohm feedline. Separating transformer primary ground from transformer secondary ground reduces noise as long as a decent earth ground can be provided at the field site at which the antenna-to-cable interface box is located. Tests by Pat Martin indicate that the matching / isolation transformer idea works quite well. The subject has also been covered by the 1988 & 1989 Fine Tuning "Proceedings".

It can be seen from the foregoing discussions that the problem of efficiently transferring, by passive means, the output of a remotely-sited wire antenna to a receiving position has been attacked and partially overcome. I say "partially" because of the Beverage-specific nature of the best-known current solution. Palomar Engineers had at one time advertised a passive remote whip that was efficiently broadband-coupled to a coaxial feedline by means of a matching-transformer scheme. It is doubtful that such an antenna could deliver much output on medium-wave and longwave, but shortwave performance on "big signal" bands like 49 meters was probably adequate. I've set about to assemble a unit that can match a wide variety of remote wire antennae to 50-ohm line without the need of active devices (that can overload) and tank circuits (that are narrowband and must be "tweaked"). Nick Hall-Patch's transformer box served as the starting point: I tossed one together and found that it even helped with wires of shorter-than-Beverage length, in some cases. Not being a big fan of homebrew transformers or inductors (at work we never use them), I did subsequent tests with some commercially-available matching transformers of differing impedance-transformation ratios. These models are made by Mini-Circuits (Brooklyn, NY). Experimenting with 16:1, 9:1, 4:1 and 1:1 ratio units, I found out that different wire antennae coupled most efficiently to my 50-ohm receiver input differently, in terms of the transformation ratio best suited to the job. This is to be expected. Therefore, a broadband matching box offering several ratios would seem to be a worthwhile DX tool - able to interface with a greater variety of wires than the single-transformer unit. Such a matching unit has potential to be a remote-site coupler and also an in-shack optimizer for wires coming right in the window.

Some time back, I experimented with a "combiner" box, a sort of poor man's (or - more accurately - lazy man's) phasing unit. The concept of the combiner was to take two wires, or two ends of the same longwire looped horizontally or vertically, and connect them to the receiver and ground in six different configurations meant to establish different directivities. Table 1 illustrates these configurations:

Table 1: Two Wire Connection Combinations

Set-up #	Antenna 1 to:	Antenna 2 to:
1	receiver	no connection
2	no connection	receiver
3	receiver	ground
4	ground	receiver
5	receiver	receiver
6	balun primary-A	balun primary-B
	[balun primary centertap to ground; secondary to receiver and receiver ground]	

Results both at home and at DXpedition sites were encouraging. Nulls of pests (allowing choice foreign DX to slide through) sometimes occurred, even with two ends of the same wire looped around the yard. Of course, phasing provides nulls more often and more controllably, but "combining" has operating simplicity as an advantage: less time tweaking, more time DXing. Time, especially on DXpeditions, is a valuable commodity.

A decision was made to put the combiner and the switchable-impedance-transformers into a single unit, dubbed the Bevmatcher. This allows added flexibility in either in-shack or field-remote-coupler applications. Impedance transformations of 16:1 (800 ohms antenna to 50 ohms receiver), 4:1 (200 ohms to 50), and 1:1 are selectable; in addition, by reversing the transformers, 1:4 (12.5 ohms to 50), and 1:16 (3.1 ohms to 50) ratios may be obtained. These low-ohms ratios may be useful in coupling short untuned loops to a 50 ohm system. Use of the balun in the combiner section allows use of balanced antenna systems such as V-beams and rhombics (as well as large wire loops).

In addition to the combiner and impedance-transformation sections, a third section was added to the Bevmatcher box: a resistive matching pad that can be switched in or out. The purpose of the pad is to improve the VSWR (voltage standing wave ratio) on the coaxial transmission line. Reducing VSWR equates to improving the impedance match: the result is an improvement in the shielding ability of the coax. cable. If shielding is good, near-field noise and directivity-spoiling leakage of broadcast signals into the feedline center conductor will be minimized. The resistance values chosen cause a 4.2 dB

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reduction in signal levels if the pad is switched in. In low-signal areas (the "boondocks"), it is generally wise to leave the pad switched out: every microvolt of signal counts, especially if the receiver is insensitive and a high-gain preamplifier (MWT-1, MWT-2, or similar) is not available to place ahead of the receiver input. In reasonable-signal-level conditions (characteristic of night-time), using the -4.2 dB pad may help retain directivity and noise-immunity: the penalty to system gain may be a lesser evil than a noise or interference increase. The pad assures that the maximum VSWR will be 2.2:1 (even if the antenna represents a virtual open or short). Such pads are often used in VHF, UHF, and microwave applications where keeping mismatches "localized" is of considerable benefit in preserving the shielded nature of coaxial cables.

Bevmatcher Assembly & Technical Data

The construction-related documentation is as follows:

Figures 1 & 2: schematic
Figure 3: TA1 transformer card assembly
Figure 4: TA2 transformer card assembly
Table 2: hole-drilling list
Tables 3-6: parts lists

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Brief Synopsis of Control Usage

S1: If a good low-resistance earth ground (separate from receiver ground) is available at the location of the Bevmatcher box, noise may be reduced by setting S1 to Float. This separates the grounds. If such a ground is unavailable, set S1 to Common.

S2: The setting of this switch depends on whether a single wire is being input to the unit, or two wires. With two wires, this switch is set for optimized reception of DX targets. This optimized reception is based upon the ability to reject noise and interfering stations (more than merely presenting the highest S-meter reading on desired stations). Refer to the schematic (Figure 1) and Table 1 for additional information.

S3: This switch selects the impedance transformation ratio. Beverages and longwires generally transfer maximum signal when the 16:1 or 4:1 ratio is chosen. Some wires may work best with the 1:1 ratio. Closed loops (one end to J1; other end to J2), especially if shorter than a quarter-wavelength, may perform better with one of the "step up" ratios (1:4 or 1:16) than with 16:1, 4:1, or 1:1.

S4: This selects Matching Pad In or Out. Using this -4.2 dB pad, as mentioned previously, reduces VSWR (possibly improving integrity of cable shielding and, thereby, noise-rejection and directivity quality). Switching out the pad gives greater signal throughput. In many cases, directivity and noise-rejection are not influenced by the pad; therefore, delivering maximum signal is the preferable situation.

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Conclusion

The Bevmatcher is a useful accessory for the DXer inclined toward antenna experimentation. In some cases, it may result in stations being heard that would otherwise be missed (though a loop or phasing unit will generally do more). For a fairly low-tech, low-cost, easy-to-use accessory, Bevmatcher has its merit.

Table 2: Bevmatcher hole-drilling list

Box = Mouser 537-TF-779 (5" x 4" x 3")

X = Horizontal distance, in inches, from the vertical centerline (VCL) on the side observed. Negative values of X are left of VCL, positive values of X are right of VCL.

Y = Vertical distance, in inches, from the bottom horizontal edge of the side observed.

D = Hole diameter in inches.

Hole loci are first marked on the box with a scriber and are then drilled with a .125" bit. Subsequently, as required, the holes are enlarged to the proper size by using progressively larger bits up to that corresponding to the final desired diameter.

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LEFT SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	J1	Ant. #1 In-red banana jack	-0.75	0.5	0.3125
2	G1	GND H/W - internal lug	0.0	2.0	0.125
3	J3	GND In - black banana jack	0.0	0.5	0.3125
4	J2	Ant. #2 In-red banana jack	0.75	0.5	0.3125

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TOP SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	S1	Ground mode switch - tab	-1.875	3.0	0.144
2	S1	Ground mode switch - shaft	-1.875	2.75	0.25
3	TA1	Balun card - H/W 2	-1.25	1.5	0.125
4	TA1	Balun card - H/W 1	-1.25	0.7	0.125
5	S2	Input combiner switch -shaft	-0.875	2.75	0.375
6	S2	Input combiner switch - tab	-0.375	2.75	0.144
7	S3	Impedance switch - tab	0.375	2.75	0.144
8	S3	Impedance switch - shaft	0.875	2.75	0.375
9	TA2	Imped. transformer card H/W4	0.5	1.5	0.125
10	TA2	Imped. transformer card H/W3	0.5	0.7	0.125
11	TA2	Imped. transformer card H/W2	1.7	1.5	0.125
12	TA2	Imped. transformer card H/W1	1.7	0.7	0.125
13	S4	Matching pad switch - tab	1.875	3.0	0.144
14	S4	Matching pad switch - shaft	1.875	2.75	0.25

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RIGHT SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	G2	GND H/W - internal lug	0.0	1.25	0.125
2	J4	RF out - BNC jack	0.0	0.5	0.375

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Table 3: "upper level" parts list

Vendor codes:

RS	= Radio Shack	/ Many locations worldwide
MOU	= Mouser Electronics	/ 11433 Woodside Ave. / Santee, CA 92071
MCL	= Mini-Circuits	/ P. O. Box 350166 / Brooklyn, NY 11235-0003

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GURE 1: BEVMATCHER INPUT (COMBINER) SECTION SCHEMATIC

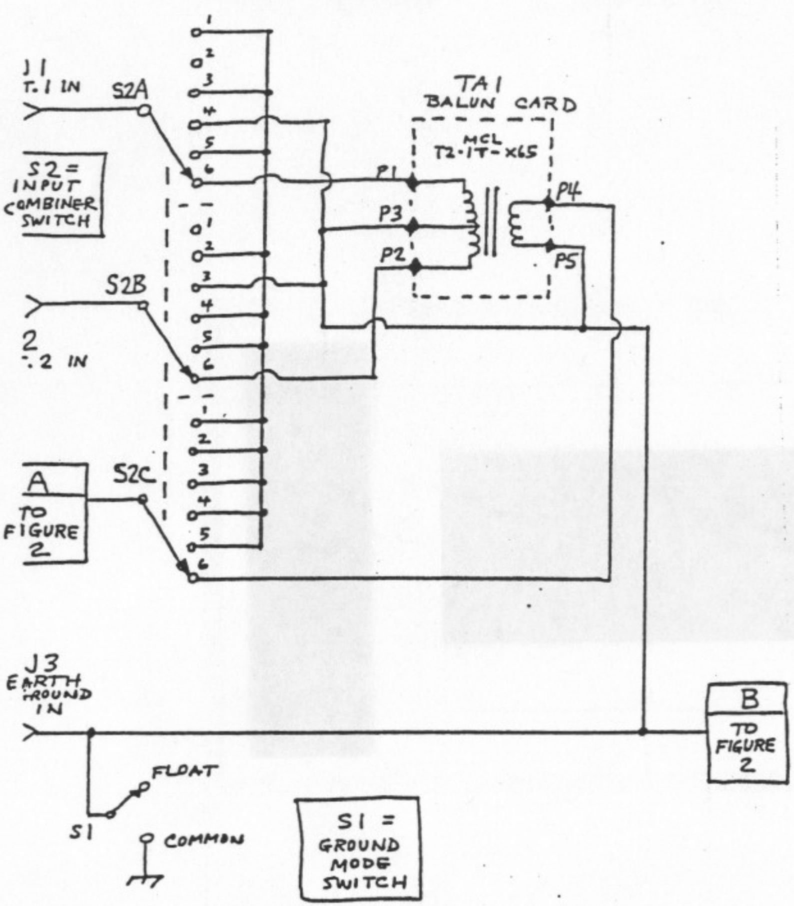
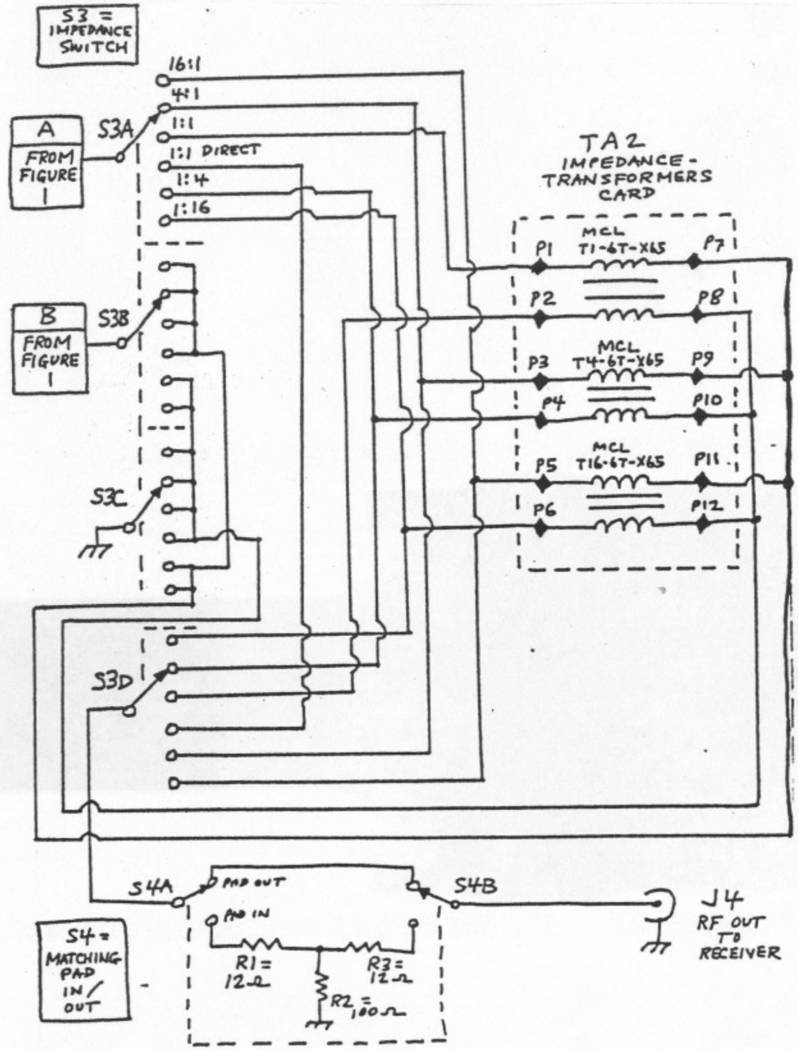


FIGURE 2: BEVMATCHER OUTPUT (Z-MATCH) SECTION SCHEMATIC



Item	Designator	Description/Value	Vendor	Vendor Stock #	QTY
====	====	==================	===	================	===
1	-	chassis box	MOU	537-TF-779	1
2	TA1	balun card ass'y		(see Table 4)	
3	TA2	impedance transformer card ass'y (see Table 5)			
4	(for S2, S3)	knob	RS	274-416	2
5	J1,J2	red banana jack	RS	274-662	2
6	J3	black banana jack	RS	274-662	1
7	J4	BNC jack	RS	278-105	1
8	R1,R3	resistor, 12 ohm	MOU	29SJ250-12	2
9	R2	resistor, 100 ohm	RS	271-1311	1
10	S1	switch, SPST	RS	275-612	1
11	S2,S3	switch/4pole/6pos.rotary	MOU	10WR046	2
12	S4	switch, DPDT on-on	RS	275-614	1

Table 4: Balun card parts list

See Table 3 for vendor codes.

Item	Designator	Description/Value	Vendor	Vendor Stock #	QTY
====	====	==================	===	================	===
1	BD	perfboard(1.2"X0.8")	RS	276-1396 (cut)	1
2	H1,H2	screw, 4-40 X .25"	MOU	572-01880	2
3	H1,H2	spacer, 4-40 X .5"	MOU	534-1450C	2
4	H1,H2	split lockwasher, #4	MOU	572-00649	2
5	P1-P5	flea-clip for .042 hole	MOU	574-T42-1/100	5
6	T1	balun transformer	MCL	T2-1T-X65	1
7	W	buss wire	RS	278-1341	approx.1'

Table 5: Impedance Transformers card parts list

See Table 3 for vendor codes.

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Item	Designator	Description/Value	Vendor	Vendor Stock #	QTY
1	BD	perfboard(1.2"X1.8")	RS	276-1396 (cut)	1
2	H1,H2,H3,H4	screw, 4-40 X .25"	MOU	572-01880	4
3	H1,H2,H3,H4	spacer, 4-40 X .5"	MOU	534-1450C	4
4	H1,H2,H3,H4	split lockwasher, #4	MOU	572-00649	4
5	P1-P12	flea-clip for .042 hole	MOU	574-T42-1/100	12
6	T1	RF transformer 16:1	MCL	T16-6T-X65	1
7	T2	RF transformer 4:1	MCL	T4-6T-X65	1
8	T3	RF transformer 1:1	MCL	T1-6T-X65	1
9	W	buss wire	RS	278-1341	approx. 1'

Table 6: small hardware parts list

See Table 3 for vendor codes.

Note: Mounting hardware is supplied with the following components: J1, J2, J3, J4, S1, S2, S3, S4.

Hardware is required by the following component designators: G1, G2, TA1, and TA2. All required hardware is listed below:

Used on	Description/Value	Vendor	Vendor Stock #	QTY
G1-G2(2), TA1(2),TA2(4)	screw, 4-40 X .25"	MOU	572-01880	8
TA1(2),TA2(4)	split lockwasher, #4	MOU	572-00649	6
G1-G2(2)	solder lug, #4	MOU	534-7311	2
G1-G2(2)	hex nut, 4-40	MOU	572-00486	2

FIGURE 3: BALUN CARD (TA1) ASSEMBLY

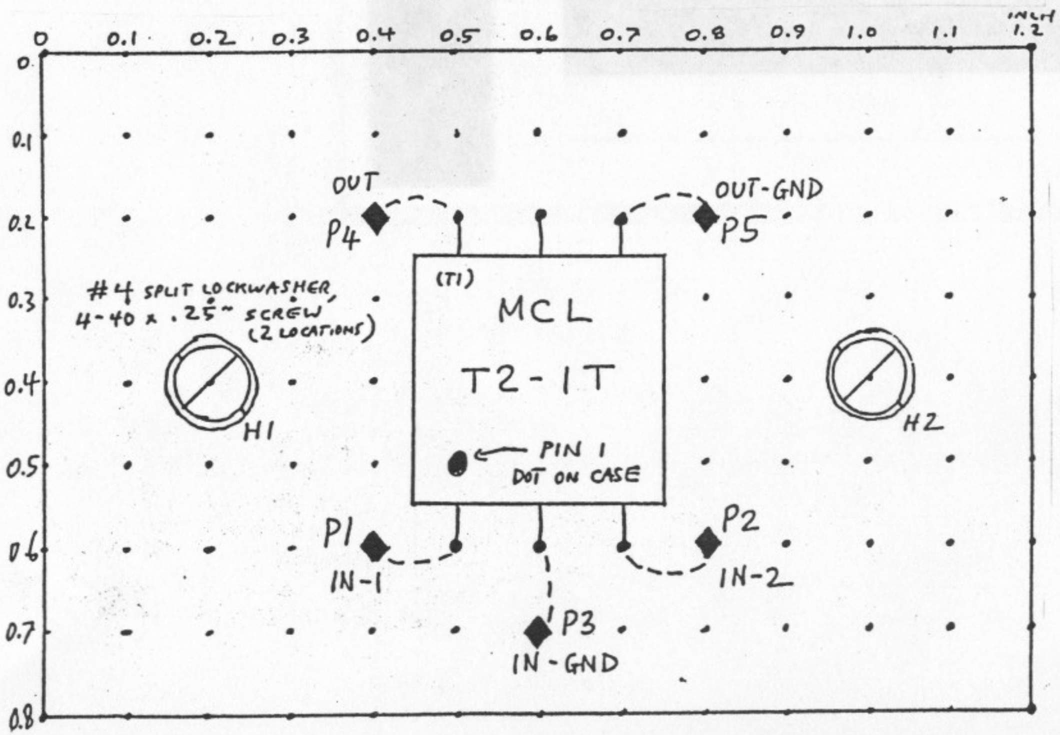

FIGURE 4: IMPEDANCE-TRANSFORMERS CARD (TA2) ASSEMBLY