<html><head></head><body><pre style="word-wrap: break-word; white-space: pre-wrap;">Date: Sun, 29 Sep 1996 09:55:46 PST
From: wb2vuo@juno.com (William K Hibbert)
To: qrp-l@Lehigh.EDU
Subject: [676] The G5RV Antenna (Long)
Message-ID: <19960929.100301.4719.1.wb2vuo@juno.com>

This is a 4-part posting that I have on the BARK PBBS.
I didn't update the calls, so my prior call is still
there. NOTE: There is NOTHING NEW here, I had just
gathered it together for the Klub so the info was
easily accessed. Sources are credited at the end.

Hope this is useful...73, Keith, WB2VUO, QRP-L #582
Trusett, KB2YTW/B 10 Mtr Beacon (28.2860 MHz)
"In the Depths of the Great Bergen Swamp...FN13ac"

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THE G5RV ANTENNA

The G5RV is a very popular antenna on the HF amateur band today. Despite it's widespread use on the bands, there are some myths and misconceptions concerning the G5RV that seem to have a life of their own. Working with text from the ARRL "Antenna Compendium", Volume 1, I would like to shed some light on this versatile antenna.

First, from Louis Varney, G5RV, of West Sussex, UK, here is some back-ground and insights into the G5RV.

"The G5RV antenna, with its special feeder arrangement, is a multiband center-fed antenna capable of efficient operation on all HF bands from 3.5 to 28 MHz. Its dimensions are specifically designed so it can be installed in areas of limited space, but which can accommodate a resonably straight run of 102 ft for the flat-top."

Louis further states that, "In contradistinction to multiband antennas in general, the full-sized G5RV antenna was NOT designed as a half-wave dipole on the lowest frequency of operation, but as a 3/2-wave center-fed long-wire antenna on 14 MHz, where the 34 ft open-wire matching section functions as a 1:1 impedance transformer. This enables the 75-ohm twin-lead, or 50/80-ohm coaxial cable feeder, to see a close impedance match on that band with a consequently low SWR on the feeder. However, on all the other HF bands, the function of this section is to act as a "make-up" section to accommodate that part of the standing wave (current and voltage components) which, on certain operating frequencies, cannot be completely accommodated on the flat-top (or inverted-V) radiating portion. The design center frequency of the full-size version is 14.150 MHz, and the dimension of 102 ft is derived from the formula for long-wire antennas which is:"

LENGTH (ft) = 492(n-.05)/f(MHz)
= (492 x 2.95)/14.15
= 102.57 ft (31.27 m)
where n = the number of half wavelengths of the wire (flat-top)

"Because the whole system will be brought to resonance by the
</pre></body></html>

use of a matching network in practice, the antenna is cut to 102 ft."

As the antenna does not make use of traps or ferrite beads, the dipole portion becomes progressivily longer in electrical length with increasing frequency. This effect confers certain advantages over a trap or ferrite-bead loaded dipole because, with increasing electrical length, the major lobes of the vertical component of the polar diagram tend to be lowered as the operating frequency is increased. Thus, from 14 MHz up, most of the energy radiated in the vertical plane is at angles suitable for working DX. Furthermore, the polar diagram changes with increasing frequency from a typical half-wave dipole pattern at 3.5 MHz and a two half-wave in-phase pattern at 7 and 10 MHz to that of a long-wire pattern at 14, 18, 21, 24 and 28 MHz.

Although the impedance match for 75-ohm twin-lead or 80-ohm coaxial cable at the base of the matching section is good on 14 MHz, and even the use of 50-ohm coaxial cable results in only about a 1.8:1 SWR on this band, the use of a suitable matching network is nessessary on all the other HF bands. This is because the antenna plus the matching section will present a REACTIVE load to the feeder on those bands.

Thus, the use of the correct type of matching network is essential in order to ensure the maximum transfer of power to the antenna from a typical transceiver having a 50-ohm coaxial (unbalanced) output. this means unbalanced input to balanced output if twin-lead feed is used, or unbalanced to unbalanced if coaxial feeder is used. A matching network is also employed to satisfy the stringent load conditions demanded by such modern equipment that has an automatic level control system. The system senses the SWR condition present at the solid state transmitter output stage to protect it from damage, which could be caused by a reactive load having an SWR of more than 2:1."

In Part 2, I will discuss the theoretical operation of the G5RV antenna band-by-band...Keith, KE2DI

END OF PART 1.

THE G5RV ANTENNA
(PART 2)

THEORY OF OPERATION

The general theory of operation follows. As I can't put the diagrams in the file, I will paraphrase the text from the ARRL "Antenna Compendium", Volume 1, which is a great book for the antenna fan (NOT A COMMERCIAL, JUST AN OBSERVATION..[WKH]). Please keep in mind that this is the THEORETICAL information, and the actual operation will depend on placement, height above ground, metal siding, power lines, trees, UFO flight patterns, Etc.

3.5 MHz: On this band, the antenna acts as a shortened half-wave flat-top, with about 17 ft of the total length made up by the matching section. The ramainder of the matching section introduces an unavoidable reactance to the antenna between the feedpoint and the feedline. The antenna pattern

is effectively the same as a half-wave dipole on this band.

7 Mhz: The flat-top, plus 16 ft of the matching section makes up a partially folded up 2 half waves in phase, (collinear) antenna. The antenna pattern is somewhat sharper than a dipole because of its collinear charecteristics. The match is somewhat degraded due to the unavoidable reactance introduced by the extra length in the matching section. This reactance can be easily tuned out with an antenna tuning unit (ATU).

10 MHz: On this band, the antenna functions as a 2 half-wave collinear. It is very effective, but the reactance presented at the feedpoint requires a good ATU. The pattern is basically identical to the 7 MHz pattern.

14 MHZ: This band is where the G5RV really shines. The antenna is operating as a 3/2 wave long, center-fed antenna with a multi-lobed, low angle pattern of about 14 degrees elevation, which is very effective for working DX on this, the most popular DX band. The antenna presents a 90-ohm load with basically no reactance present. Even the use of a 50-ohm coaxial feed will present a SWR of only about 1.8:1, easily tuned out with an ATU.

18 MHz: The antenna performs as 2 full-waves in phase, combining a lower angle with the broadside gain of a collinear array. The load is high-Z, with somewhat low reactance.

21 MHz: On this band, the antenna works as a 5/2-wave, center-fed long wire. This produces a multi-lobed, low angle radiator, with a high-Z resistive load. When matched with the ATU, it makes a highly effective antenna for DX contacts.

24 MHz: The antenna again functions effectively as a 5/2-wave long wire, but due to the shift in the position of the current loops on the array, the load is resistive, approximating the load on 14 MHz. Again, the pattern is multi-lobed, with a low radiation angle.

28 MHz: On this band, the antenna acts as a 3-wave, center-fed long wire. The pattern is similar to 21 or 24 MHZ, but with additional gain due to the colliner effect obtained by feeding two 3/2-wave antennas in phase. The load is high-Z, with low reactance.

In Part 3, I will discuss the construction of the G5RV... Keith, KE2DI

END OF PART 2.

THE G5RV ANTENNA
(PART 3)

CONSTRUCTION TIPS

THE FLAT-TOP:

The dimensions of the G5RV flat-top are specified in Part 1. The antenna does not need to be put up as a flat-top array, but can be installed as an inverted-V. The center of the antenna should be as high as possible, of course, and the matching section should descend at a right angle to the array. It is recommended that the smallest wire gauge used for the flat-top be #14, although wire as small as #18 could be used. If the antenna is raised as an inverted-V, the included angle at the apex should not be less than 120

degrees.

THE MATCHING SECTION:

It is recommended that the matching section be constructed of open-wire feeder for minimum loss, as it always carries a standing wave on it. Due to the standing wave on it, the actual impedance is unimportant. A satisfactory construction technique for the open wire line matching section would be to make your own spreaders out of scrap lucite, or similar plastic of low dielectric loss. The plastic strips would be cut about 2 inches long, 3/8 inch to 1/2 inch wide, and be notched on the ends to fit #14 wire. The spreaders would be drilled about 1/2 inch in from each end for the binding (tie) wires, and the spacers would be spaced 12 inches center-to-center.

The next most-desirable matching section would be made from window-type open wire line, either 300-ohm, or 450-ohm. This is basically a ribbon line, like heavy duty TV-type twin lead, with #16 to #20 wire, and "windows" cut in the insulation every 4 to 6 inches. The advantage of the "window" line is that the conductors won't short together if the line twists in a high wind.

Lastly, and the least desirable, (although it will work), is "TV-type" twin lead. The main disadvantage of the TV-type twin lead is durability. The conductors on the twin lead are usually #22 to #28 gauge, and the plastic used for the insulation deteriorates faster in the sun and/or rain. The advantage of it is that it is readily available at electronics outlets, or even most department/home improvement stores. The quality is proportional to price, if a choice is available. Do not use the "shielded" twin lead. The shield will degrade the matching section, especially on 3.5 or 7 MHz.

MATCHING SECTION LENGTH:

The length of the matching section is an ELECTRICAL half-wave on 14 MHz. The actual physical length is determined by the following formula:

L= (492 x VF)/f (MHz), where VF is the velocity factor of the matching section.

The velocity factor is determined by the type of line, and the dielectric properties of its insulation. For the three types of line discussed so far, the VF is:

Open wire - .97
"Window" line - .90
"TV" twin lead - .82

By substituting the VF in the formula, and calculating for a center frequency of 14.15 MHz, you come up with the following matching section lengths:

Open wire - 34 ft
"Window line - 30.6 ft
"TV" twin lead - 28 ft

This matching section is connected to the center of the array, and allowed to descend vertically at least 20 ft or more, if possible. It can

then be bent and tied off to a suitable post or line, and connected to the coaxial line, which is run to the shack, and the ATU.

THE FEEDER:

In the original article descibing the G5RV antenna, publshed in the "RSGB BULLETIN" for November 1966, it was suggested that, if a coaxial feed was used, a balun might be employed to provide the nessessary balanced-to-unbalanced transformation at the base of the matching section. However, later experiments, and a better understanding of the theory of operation of the balun indicated that such a device was unsuitable due to the high reactance in the load presented at the base of the matching section. In a nutshell, DON'T USE A BALUN ON THE G5RV !!!!!

If a balun is connected to a 2:1, or higher SWR, its internal losses increase. The result is core heating and/or saturation. If saturated, the core can actually distort the RF wave, generating harmonics, and in extreme cases, with QRO, the core and balun can burn up (literally). An unbalanced-to-unbalanced ATU can accomodate the variable load, and cancel out the reactance present. It will also tend to reduce any harmonic energy present, which will, due to the multi-band nature of the G5RV, tend to be radiated. In general, the automatic ATU's in modern rigs will load the G5RV on all but the 10 MHz band.

END OF PART 3.

THE G5RV ANTENNA
(PART 4)

ALTERNATIVE FEED SYSTEM:

Doug DeMaw, W1FB, in his "W1FB'S ANTENNA NOTEBOOK", states that the G5RV can be fed directly with open wire to the ATU. If this is done, the antenna will load on all bands with no problems. In this case, the ATU needs to have a balanced output to accommodate the balanced line. This would lend itself to the portable operator, who could use "TV"-type twin lead, and a small tuner designed for balanced feed on all the HF bands. This would be an elegant solution for a campsite or cottage, reducing the bulk of the gear to be carried. A convenient length of twin lead, allowing for the VF, would be 72 ft. The whole antenna would coil up into a small bucket, or even a backpack with #18 wire.

In closing, if you need a good , multi-band, and unobtrusive antler for your station, give the G5RV a try. Best of luck, and have fun!
73, Keith, KE2DI

SOURCES:

ARRL "ANTENNA COMPENDIUM", VOLUME 1
ARRL "W1FB'S ANTENNA NOTEBOOK"
ARRL "W1FB'S NOVICE ANTENNA NOTEBOOK"
TAB PUBLICATIONS "73 WIRE AND DIPOLE ANTENNA"
EDITORS AND ENGINEERS "RADIO HANDBOOK"

END OF PART 4

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And, I run a Double-sized G5RV for 160 & up here...Keith

Date: Sun, 29 Sep 1996 10:02:57 PST
From: wb2vuo@juno.com (William K Hibbert)
To: qrp-l@Lehigh.EDU
Subject: [675] G5RV ideas for 160 thru 6 Meters
Message-ID: <19960929.100302.4719.2.wb2vuo@juno.com>

This is from a posting on the BARK PBBS...Keith, WB2VUO

SOME IDEAS ON THE G5RV

The G5RV multiband antenna is a very popular design on the HF bands. The "common" G5RV is configured as a 3/2-wave dipole on 20 meters, and works as either a shortened dipole, or a collinear-fed long wire on the other bands. In this configuration, the overall length is 102 ft, with a 28 to 34 ft matching line. In some cases, this is still too large to fit in one's yard, and not everyone can convince their neighbors to allow one to stretch the wire across property lines. In this case, a 1/2-size version, covering 7 to 28 MHz is useable. Conversely, some amateurs would like to have 1.8 MHz capability, and have the 204 ft length necessary for this array. I have dimensions included here for both the half-size, and double-size G5RV antennas.

Bands	1.8-28 MHz	3.5-28 MHz	7.0-28 MHz
Flat-top	204 ft	102 ft	51 ft
	Matching lines		
Open wire	67.3 ft	34 ft	17 ft
Ladder line	62.4 ft	31.5 ft	21.2 ft
"TV" twin lead	56.9 ft	28.5 ft	14.4 ft

[All of the above-mentioned antennas will work on the 6 Meter band, sometimes without an ATU.]

Of the listed antennas above, the 7-28 MHz version was referred to in Louis, G5RV's article in the ARRL "ANTENNA COMPENDIUM" Volume 1, the 1.8 - 28 MHz version is in use at Evhan, WB2ELB's QTH, (with a single feedine, directly matched with the internal ATU in his Kenwood, I am also running the double-scale G5RV here on 160 - 6 Meters and the 3.5-28 MHz version in use by more local hams than I can remember right now.

Just for reference, the ladder line is available at most amateur dealers, over-the-counter, or mail-order, and the polycarbonate (Lucite) plastic for the spreaders for home-built open wire is available at any major plastic supplier at scrap prices here in Rochester.

If you have any questions on the G5RV, parts, referrence books, Etc, drop me a line,on packet at WB2VUO@WB2VPH.#WNY.NY.USA.NOAM, or call on the phone, (716)494-1239...73, Keith

Keith, WB2VUO, QRP-L #582
Trustee, KB2YTW/B 10 Mtr Beacon (28.2860 MHz)
"In the Depths ofthe Great Bergen Swamp...FN13ac"

Date: Mon, 25 Nov 1996 09:17:13 -0700 (MST)

From: jhunter@tein.net (Jim Hunter)
To: qrp-l@Lehigh.EDU
Subject: [5066] g5rv antenna
Message-ID: <199611251617.JAA25585@tein.net>
Mime-Version: 1.0
Content-Type: text/plain; charset="us-ascii"

I am sure there are several out there that use the G5RV antenna.

Do they work well? Has anyone had any experience with the MFJ g5rv? I
suppose I will have to get a better tuner than my random wire tuner.

Tnx --- Jim
James K. Hunter (WA7ZXN)
109 Agate
Lewistown, MT

Date: Mon, 25 Nov 1996 10:47:10 -0700 (MST)
From: rhight@primenet.com (Roger Hightower)
To: jhunter@tein.net, "Low Power Amateur Radio Discussion" <qrp-l@Lehigh.EDU>
Subject: [5072] Re: g5rv antenna
Message-ID: <199611251747.KAA07842@primenet.com>
Mime-Version: 1.0
Content-Type: text/plain; charset="us-ascii"

At 09:17 AM 11/25/96 -0700, Jim Hunter wrote:
>I am sure there are several out there that use the G5RV antenna.
>
>Do they work well? Has anyone had any experience with the MFJ g5rv? I
>suppose I will have to get a better tuner than my random wire tuner.
>
Jim,

I've been using a G5RV on all my QRP trips to the field, and with good
results. Mine is the Antennas West version, fed with coax. The last two
years I've used the MFJ 901B mini tuner with it. As long as you can get it
up at least 40 feet, it plays well.

OTH, the only DX I've gotten afield has been with a random wire, :-)

72/73 de Roger N7KT (ex AA7QY)

NorCal 1099   CoQRP 176 QRP-L 62   G-QRP 9081 ARCI 8946 NE-QRP 383

Date: Mon, 25 Nov 1996 09:43:57 -0800
From: "Michael A. Gipe" <mgipe@reliablemeters.com>
To: <jhunter@tein.net>
Cc: "QRP-L list server" <qrp-l@Lehigh.EDU>
Subject: [5073] Re: g5rv antenna
Message-ID: <199611251851.MAA29517@multi13.netcomi.com>

MIME-Version: 1.0
Content-Type: text/plain; charset=ISO-8859-1
Content-Transfer-Encoding: 7bit

Jim --

I have used a G5RV at several locations for close to 20 years. I used 102 feet total, fed with open wire line and a 4-1 balun, tuned with whatever antenna tuner I had at the time, usually a T match. I mounted the antennas as inverted Vs at various heights from 25 feet to the current 53 feet.

Yes, you will need something with wider range than the random wire tuner. You will need a tuner that can handle a wide range without losing too much efficiency.

I can load mine up on all bands from 80 to 10. Theoretically, 30 meters should be difficult since it is a half wave, but the random length of feedline seems to have transformed that to something more manageable. 80 meters is more of a challenge here. Some tuners can do it. Some can't.

I suspect that most of the efficiency is lost in the balun, so I would recommend a balanced tuner if you can get hold of one and are able to run the open line directly to it.

How's the performance? Well, that's a long story.

I had always felt that my G5RV wasn't getting out as well as a simple antenna could. The tribander on top of the tower blows it away on 20, 15, and 10, of course. My dissatisfaction, however, was on 40 and 30. The foxhunt and EZNEC showed me what was happening. The G5RV inverted v performs very much like a resonant dipole with somewhat different lobes depending on the frequency. However, the elevation pattern is the same. On 40, my antenna does well up to about 1000 miles, after which, it dies. The problem is elevation angle. The strongest radiation is almost straight up, which is fine if you want to talk to yourself and listen to local noise. (I usually need QRO for that, though, because I rarely pay attention to myself.) This is also a problem with a tuned dipole. It is a problem with any horizontally polarized antenna located close to the ground, which is anything less than 1/2 wavelength high. If you can get your whole G5RV up 1/2 wavelength, you should work very well. The effective height of an inverted v is less than its center height.

I just placed an order for a Gap vertical to supplement the G5RV. Although all verticals suffer from ground effects because of the polarization, even if you have two thousand radials, they do have better low elevation characteristics. Over the next few months, I will be comparing the two antennas for short and long haul foxes.

To summarize, the G5RV allows you to put out a signal on nearly any band. You can work a lot of stations, but not all of them. It's probably the best bang for the buck, but not the loudest bang.

BTW Jim, would you be interested in serving as 'Statesman' in the upcoming WAS challenge for 1997? It would be a great way to test that antenna, and we could use MT.

gl,

Mike K1MG

> I am sure there are several out there that use the G5RV antenna.
>
> Do they work well? Has anyone had any experience with the MFJ g5rv? I
> suppose I will have to get a better tuner than my random wire tuner.
>
> Tnx --- Jim
> James K. Hunter (WA7ZXN)
> 109 Agate
> Lewistown, MT
>

Date: Mon, 25 Nov 1996 11:01:05 -0700 (MST)
From: Bob Hightower <ki7mn@dancris.com>
To: jhunter@tein.net
Cc: qrp-l@Lehigh.EDU
Subject: [5074] Re: g5rv antenna
Message-ID: <199611251801.LAA20808@dancris.com>
Mime-Version: 1.0
Content-Type: text/plain; charset="us-ascii"

At 09:17 AM 11/25/96 -0700, you wrote:
>I am sure there are several out there that use the G5RV antenna.
>
>Do they work well? Has anyone had any experience with the MFJ g5rv? I
>suppose I will have to get a better tuner than my random wire tuner.
>

I use a G5RV in the inverted vee configuration at home. Center point is only
20' up, so it is not that well situated, but in the recent CQWW CW contest,
running qrp, I made contacts with Alaska, Virgin Islands and several
Canadian stations from here in AZ. It's not the best antenna, but for the
space I have, it works well.

In the field, the G5RV is about all I use...if you can get it high enough,
it is great.
73,
Bob KI7MN
NorCal #1221   ARCI #8918 Qrp-l #271 CQC #274 AK QRP #30 ARRL

Date: Mon, 25 Nov 1996 10:24:25 -0800 (PST)
From: "'AB7HI' Stephen Lee" <slee@u.washington.edu>
To: "Michael A. Gipe" <mgipe@reliablemeters.com>
Cc: Low Power Amateur Radio Discussion <qrp-l@Lehigh.EDU>
Subject: [5075] Re: g5rv antenna
Message-ID: <Pine.A41.3.95b.961125100206.66384E-100000@homer08.u.washington.edu>
MIME-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII

I would like to add that my experience with using the G5RV
at 25 feet up is about what Michael experienced. The max
range for me was 1000 miles in most cases with power at 5

watts to 100 watts. Sometimes I could work some long skip
and reach the southeast. At levels less than 5 watts, for
instance using either of our NorCal 40 rigs (both around
2-1/2 watts max), the farthest I could reach was 25 miles
to the south and less than 5 miles to the north. It's a good
"local" antenna. A fellow 15 miles north of me uses his on
30 meters QRP and I receive him fine business.

In comparison, my Butternut HF9V mounted on the ground is
the dx antenna of choice for me. All my radios work fine
business with the Butternut. This one transmits well out to
20 miles then there's a black hole out to 120 miles where
the signal just begins to be heard again. If I'm having
success beyond 1000 miles distance, it's because of the
Butternut.

Stephen Lee, AB7HI
slee@u.washington.edu
QTH: Tacoma, Washington...about 25 miles south of Seattle, WA.

Date: Tue, 26 Nov 1996 06:46:11 -0500 (EST)
From: "L. B. Cebik" <cebik@utkux.utcc.utk.edu>
To: Jim Hunter <jhunter@tein.net>
Cc: Low Power Amateur Radio Discussion <qrp-l@Lehigh.EDU>
Subject: [5108] Re: g5rv antenna
Message-ID: <Pine.SOL.3.94.961126063747.8903B-100000@utkux4.utcc.utk.edu>
MIME-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII

On Mon, 25 Nov 1996, Jim Hunter wrote:

> I am sure there are several out there that use the G5RV antenna.
>
> Do they work well? Has anyone had any experience with the MFJ g5rv? I
> suppose I will have to get a better tuner than my random wire tuner.

Jim,

Yes, G5RVs do work, especially when fed with ladder line all the way to
the shack to an ATU. With this system, I recommend one of the C-L-C or
L-C-L networks (PI or Tee) or the Z-match. The antenna is 3.8 wl long on
80, which is just about the minimum for efficient operation, and of course
is longer than 1/2 wl on all other HF bands. Hence, it will work quite
well. If you have 135', then try the same treatment on the 1/2 wl
80-meter dipole--better pattern on 80 and slightly different patterns on
the upper bands. For any of these antennas, put a lot of thought into
getting them just as high as you can manage.

Incidentally, there are many G5RV kits available--check around for the
best price and highest quality materials. Or just get a couple of 70'
rolls of #14 antenna wire from RS, a parallel feedline center clamp from
W6EMT, a couple of end insulators, and as long a run of 450-ohm line as
you need. Cost: about $30 or so. Then assemble as carefully as you
would have done with a $100 kit. The kits are convenience, not
improvements.

-73-

LB, W4RNL

Date: Tue, 26 Nov 96 06:48:00 PST
From: Cecil A Moore <Cecil_A_Moore@ccm.ch.intel.com>
To: qrp-l@Lehigh.EDU
Subject: [5117] Re: G5RV antenna

>From: "Michael A. Gipe" <mgipe@reliablemeters.com>
>I have used a G5RV at several locations for close to 20 years. I used
>102 feet total, fed with open wire line and a 4-1 balun, tuned with
>whatever antenna tuner I had at the time, usually a T match. Mike K1MG

Hi Mike, a lot of people use this configuration. Here's what can happen.
EZNEC sez that the SWR on 75m is around 20:1. Divide that into the
characteristic impedance of the open wire line to see what the minimum
impedance can be. 300/20=15 450/20=22.5 The 4:1 balun divides that
by 4 resulting in 4-5 ohms at the tuner. As one can see, the balun has
transformed the impedance in the wrong direction. OTOH, the maximum
impedance possible is 450x20=9000 ohms. I don't know of a commercial 4:1
balun that will match 9000 ohms on 75m. In general, the lossier the
balun and tuner, the better the SWR. I know one can get lucky by
accident but IMO it is better to get lucky on purpose. :-) A modeling
program like EZNEC can come close to predicting what impedance the balun
is seeing.

73, Cecil, W6RCA, OOTC

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