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 ight 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   **(31.27m)**

where n = the number of half wavelengths of the wire (flat-top)
(Anm.: 1 ft = 30,48 cm)

"Because the whole system will be brought to resonance by the 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. Furtermore, 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."

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.

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	0.97
"Window" line	0.90
"TV" twin lead	0.82

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, publushed 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.

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"

Thanks to Keith WB2VOU for passing on the information.
Frank G3YCC (+)

Anm.: 1 ft = 30,48 cm.
Drahtstärken: #14=1,63mm; #16=1,29; #18=1,02mm; #20=0,81mm; #22=0,64mm; #28=0,32mm