The G5RV – Setting the Record Straight

By Eugene Morgan – WB7RLX

The subject of the G5RV[1] has often come up and many people have characterized my position of not being a fan of this misunderstood antenna. So much so that some started to tease me about putting a G5RV in there attic. But in total honesty, I'm not a fan of the attic based GR5V. In this article I hope to set the record straight regarding my position in regard to the G5RV and to dive into some of the technical aspect of the antenna and explain why it is perhaps not the best choice for an attic antenna. I will however offer some alternatives to the G5RV.

I also want to state that the intent of this article is to educate, not to chastise or belittle. Please understand that I speak from personal experience and when it comes to antennas I've probably made more mistakes than anyone. My hope is to share what I have learned from both firsthand experience and from what I have read and researched over the years.

The G5RV was invented in 1946 by Louis Varney, whose call sign was strangely enough G5RV. He was in search of a 20 meter antenna that would fit on his garden. The original article describing the G5RV appeared in the R.S.G.B Bulletin in July of 1958[2]. It should be noted that the antenna he describes in his article is not the same as the G5RV that is in common use today. In his original design he uses an open wire feeder of a "convenient length" with feeder taps specific to each band, see Figure 1.

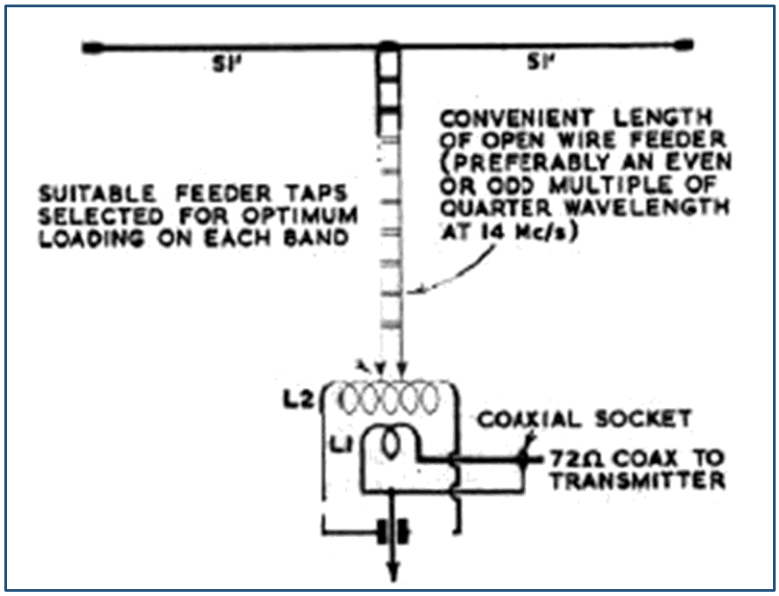

Figure 1: Original Varney G5RV Design

[1] In this article the term "G5RV" includes the G5RV and all of its derivatives, such as the G5RV Junior and the ZS6BKW.

[2] I was not able to find Mr. Varney's article on the Internet but it is included in the supplemental files included with the ARRL Antenna Handbook for Chapter 10 in the 24th edition of the ARRL Antenna Handbook.

Additionally Mr. Varney was a bit unclear on a number of other aspect of the antenna, specifically the matching section of open-wire line or 300 ohm line; a feeder comprising 50 ohm coax, 80 ohm coax, 75 ohm twin-lead, or no feeder at all. Then there was the question of the balun: balun, no balun, or an HF choke? So it's no surprise that there are a diversity of opinions regarding the actual construction of a proper G5RV. Today's G5RV is typically of the design describe in the ARRL Antenna Handbook[3] although there are several popular variations such as the G5RV Junior and the ZS6BKW.

Since its invention the G5RV antenna has become one of the most popular and widely used "all around" multi-band antennas in the world. Even though it is not a truly multi-band antenna and uses a feedline that can be problematic if not installed correctly. It does have good overall performance on most HF ham bands when used with an antenna tuner. It's fair to say that some internal tuners do struggle with matching the G5RV simply because they don't have enough range to "tune" this all band wonder on all the HF bands from 80 meters on up.

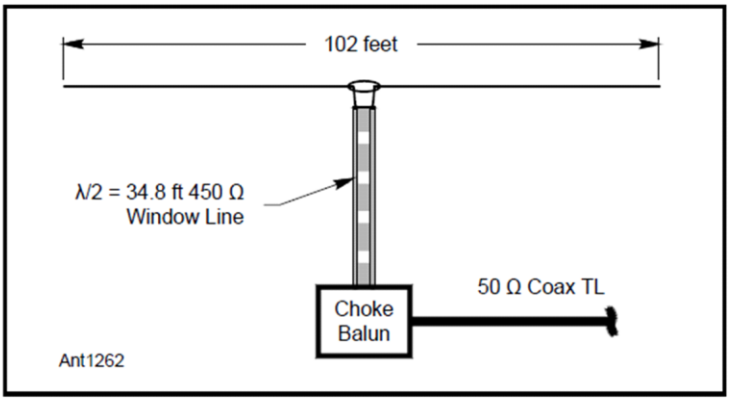

Figure 2: The basic G5RV as describe in the ARRL Antenna Handbook

Before we go on I want to touch on two idea's that often are a part of the discussion when it comes to the G5RV and are often given as reasons some decide on the G5RV.

A Common Myth – the Multi-band Antenna

Let's talk about the idea of an all band antenna. I'll begin by saying there's no such antenna. I put it in the same category of the mythical isotropic radiator. Many of the antenna's that are considered to be multi-band are not when you look closer. For example there are the fan variety, the DX Commander being a perfect example. In reality these antennas include an element for each band of operations. Another variety use some type of electrical device such as a trap or tap coil to achieve multi-band status. Another multi-band antenna uses a series of motors to lengthening or shorting the elements in order to cover more than one band. Let me extend this thought even further, there no such thing as a multi frequency antenna. Physics requires that an antenna will be resonate at only one frequency and the harmonics of that frequency.

Every antenna has a built in resonance at some frequency. When you operate the antenna away from its resonant frequency or between its harmonic frequencies the SWR starts to go up. The further away

[3] See "ARRL Antenna Handbook" 24th edition, section 10.1.5 beginning on page 10.6

from the resonate frequency you operate the higher the SWR. If you operate the antenna beyond a certain SWR limit the transmitter will start to throttle back the output power. If you want to operate an antenna outside of its sweet spot then an antenna tuner needs to be added to the antenna system in order to extend the frequency range of the antenna system while still allowing the transmitter to see a 50 ohm load. This is true for practically all antennas. I once heard Dave (KD7GR) refer to this phenomenon as a game called "Will it Tune?" Which I thought described the situation perfectly.

What this means is because there is no such thing as a multi frequency or multi-band antenna nearly all antennas will use some sort of a device to make it multi-band or at the very minimum broad banded. This would infer that there is nothing unique about the G5RV when it comes to being a multi-band antenna. Virtually any antenna when coupled to a proper tuner can become a multi-band antenna.

Anecdotal Antenna Performance, Can They Be Trusted?

There's another concept that I want to also mention which will be important to understand as we start to go deeper into the G5RV. "Everything Works!" from the preverbal light bulb to the 102" whip on 75 meters. If you can tune it you can use it. But the real question is "how well does it work?" In the case of the light bulb and the 102" whip on 75 meters, not very well. The problem with most anecdotal claims of antenna performance are the people making those claims of grandiose performance don't always know what they are missing. For example I know of a ham in our club that had been using a low hanging 40 meter inverted vee for years, a pretty marginal antenna at best. He added a properly deployed vertical antenna to his installation and was now hearing countries that he had never heard before. He was amazed at the difference. So whenever you hear someone make one of these claims understand that they may not be aware of what they are missing and think that making a contact into Washington, Texas, or Florida is a big deal, when the ham just down the street with his end fed wire is working Chile, Australia, New Zealand and Japan and receiving 59 signal reports.

At the risk of over stating the point let me offer another consideration regarding anecdotal performance. After spending several hundred and sometimes thousands of dollars on an antenna or spending several hard days of effort building or deploying and antenna system do you think the user will be in a position to give an unbiased appraisal of an antenna's performance? In my own case the answer is no. Every antenna is pretty darn good at first. But after a time when reality starts to set in and the money spent or the effort expended becomes old news one often starts to get a better sense of the reality of his or her antenna. Thus the never ending quest for the better antenna. So always be suspicious of the anecdotal claim of antenna performance.

The Properly Deployed G5RV

Let me begin by saying the G5RV is a good antenna when deployed properly. But of all the antenna's to choose from it is perhaps one of the worst choices if you can't deploy it properly, and it should never be considered for attic installations. What is true for the G5RV is also true for the G5RV's variants. What is a properly deployed G5RV?

The biggest challenge with the G5RV is the feedline. Coax was invented because of the short comings of twin lead in that it is affected by any metallic objects that come near it. This is why the military adopted coax for use in World War Two.

Twin lead likes to couple with things like nails, HVAC ducting, electrical lines, conduit, metal rain gutters and siding. All of this metal interacts with the feedline causing imbalances in the system which results in in detuning the antenna and inducing common mode currents. In addition, you should never coil the feed line or let in come in contact with the ground. Additionally the feedline should run perpendicular to the horizontal elements and in most attic installations this is not possible, instead the feedline wanders away from the antenna and down to the radio room. The other commonality with the G5RV that I see, especially in the case of the attic G5RV, it is often deployed with no balun or choke, which only make the RFI problem worse.

In the case of the G5RV the feedline is designed to be a part of the antenna system. So the feedline will do two things. On transmit it will introduce RF into any metal object in the vicinity of the feedline and if that metal object is an electrical line that feeds the TV room or the sewing room it can create what I call the poltergeist effect. The TV mysteriously turns on, the washing machine develops a mind of its own, the computer reboots, and so on. On receive the feedline will act like an antenna, because that's exactly what it is. Unlike coax the feedline in the G5RV is also a part of the antenna and it's designed to pick up and radiate RF. That feedline wandering through the attic is actually an antenna picking up all the stray RF your household electronics may be producing. It can be picking up RF from things like the motors found in washing machines, freezers and refrigerators. That feedline may also be picking up RF from devices like LED light bulbs and USB chargers and so on.

I've often asked those who have put G5RV's in their attic why? There are usually three answers. The first is usually, "because so and so said he has one" or "so and so recommended it." The other reason often given is, "because it's a good multi-band antenna." Hopefully you see why I mentioned the fallacy of multi-band argument earlier as well as the argument regarding anecdotal performance claims. The third answer often given is usually a combination of all of the above.

Let me state for the record, the G5RV is perhaps not the best choice one could make for an attic antenna due largely to issues with the feedline. If you want to reduce the problem with the G5RV then replace the twin lead with coaxial cable. But then you no longer have a G5RV but a good old dipole. Later in this article I will make some recommendations that you might consider that I think would be equal to the G5RV in terms of performance but without all the shortcomings of the feedline. Although I do have to say that any attic based antenna is going to be extremely compromised and susceptible to noise and can cause poltergeist like behavior with some electrical appliances, it's just the nature of the beast as they say.

Now let's consider the elements that constitute a properly deployed G5RV.

1. The feedline needs to run perpendicular from the horizontal portion of the antenna. It can be sloped or hang straight down from the center of the antenna.
2. The center support mast should NOT be made of metal. Fiberglass poles or PVC makes for a good center support for the antenna.

3. The antenna should be high enough that the feed line does not come within two feet of the ground. At the very minimum it should not touch the ground. For the standard G5RV that's at least 35', for the ZS6BKW that's 45'.
4. Ideally the antenna should be deployed in what we call a flat top configuration but can be deploy as in inverted vee, however there will be some loss of gain and the resonate frequency will go down some.
5. At the connection point between the coaxial cable and the twin lead a 1:1 current balun or choke should be inserted. The key here is controlling and minimize common mode current that so often occurs in the G5RV.
6. Use an antenna tuner to ensure the radio sees a 50 ohm load.

A G5RV that has been deployed using the recommendations above makes for a good multi-band antenna and is one I would be comfortable recommending. If one can't follow these six rules then I would recommend consideration be given to a different solution.

Alternatives to the G5RV in the Attic

Now let's talk about the attic antenna. There no question that the ham limited to an attic installation is at a real disadvantage, but all is not lost. People often think I'm a big proponent of the vertical antenna, and they would be wrong. I am a proponent of using the best antenna as dictated by the constraints of the situation. The vertical is not always the best choice, nor is the horizontal wire antenna always the best choice. Let your given set of constraints determine what the best choice is for you. This is a common theme with me and one I'm sure you have all heard me state time and time again.

The other necessity when it comes to attic based antennas is to understand that due to size limitations you may not be able to operate on all the bands. So you need to set realistic expectations especially when attic space is limited. Exploit what you have and don't pine over what you don't have.

Option 1, the common dipole: Perhaps one of the best choices would be a standard dipole which can be made to be multi-band when connected to good antenna tuner. To extend its frequency range traps may also be added if one has the attic space. As with most dipoles a balun is important, especially in an attic installation. It will help to overcome the inherent imbalance of an attic antenna and help to reduce common mode currents. For the dipole use a 1:1 current balun at the feed point and preferably one that also can provide some choking to minimize common mode currents.

Option 2, the OCF dipole: The OCF has been shown to also be a good multi-band antenna. By using a 4:1 balun one can usually get a good match. Here again you should use a balun that provides some choking capability or add a choke if common mode currents continue to be a problem.

Option 3, the loop: The loop might be another option. Although often not as multi-banded as the OCF, for a given situation it might be a good option. Here again a 2:1 balun and choke should be used.

Option 4, the vertical: I know one ham who uses an attic based antenna on 10 meters and has good results with it. In his case (Larry AD7GL) uses an MP-1. See: Amazon.com: Super Antenna MP1C All Band HF VHF Ham Radio Portable MP1 : Electronics One could also build a vertical for 10 meters given the antenna is only about 102" tall and the radials would be equally as long. And you could get by with two

to four radials. But you would be limited to 10 meters, although you might find that with a good antenna tuner the DIY vertical might also be usable on 12 and 15 meters.

Option 5, the end fed wire: This is perhaps the last option I would consider unless you have access to a good ground such as the electrical stand pipe. This antenna requires a 9:1 unun and a choke to control common mode current. You will want to keep the ground wire as short as possible, that is why I recommend you only consider this option if you have access to the electrical stand pipe for your electrical service.

Feedline for the attic antenna: For the feedline use a top quality RG-8 type coaxial. The reason for this is not because of line loss, the reason is for noise reduction. The better coax will help minimize the noise, something like RG-8x or RG-58 will be more susceptible to electrical noise. Electrically the attic can be a pretty noisy place so you should take advantage of the extra shielding that is inherent in the better quality coax like UltraFlex 10 or DXE-400 MAX. For most attic installations the feedline will be short, so cost should not be a factor and the benefit I believe would outweigh the cost of a top quality feedline.

Conclusion

I hope I have helped to demystify the G5RV and to provide specific reasons why the G5RV is not a good antenna for attic installations. The G5RV is a good system under the right conditions, but the attic is not one of them. I would also like to note that of all the G5RV antenna systems or ones based on the G5RV theory, the ZS6BKW antenna system comes the closest to achieving the goal that is part of the G5RV mythology: a multi-band HF antenna consisting of a dipole like configuration with a simple matching system to cover as many of the amateur HF bands as possible. From 80 to 10 meters, the ZS6BKW provides an acceptable match on a majority of the HF ham bans and provides a low enough SWR to be within range of most antenna tuners.

If you've a mind to build a G5RV antenna they are very easy to build and are not expensive. Other than the twin lead everything you need to build one can be had at the local big box store. The exception being the balun or choke, that you can buy commercially or you can build one for around $25.

If you would like to see an example of a homebrew G5RV let me know. I built one for the club that we used at last year's Field Day and I think all who used it were pleased with its performance. For comparison we also used a Hustler 4 BTV with a proper radial system and the performance of the G5RV was on par with the vertical.

73,

Gene

(WB7RLX)

For more information see:

- "*The G5RV Antenna System – An Analysis*" by Rick Hiller – W5RH Slide 1 (bvarc.org)
- "The G5RV Antenna System Re-Visited" by L.B. Cebik W4RNL The G5RV Antenna System Re-Visited (nonstopsystems.com)
- "*The Truth about the G5RV Antenna*" by Mike Waters – W0BTU The Truth about the G5RV Antenna (dxzone.com)
- "*G5RV Multiband Ham Radio Antenna*" G5RV Multiband HF Antenna » Electronics Notes (electronics-notes.com)
- "G5RV Antenna" by G3TXQ G5RV Antenna (karinya.net)
- "*The G5RV Antenna - Can We Do Better?*" by G3TXQ The G5RV Antenna - Can We Do Better? by G3TXQ (hamuniverse.com)
- "*ZS6BKW vs G5RV*" by Larry James LeBlanc Slide 1 (w5ddl.org)
- "*The Real Truth About the G5RV Antenna*" Top Band Hams - THE TRUTH ABOUT THE G5RV ANTENNA
- "*The ZS6BKW Multiband HF Antenna Revisited*" by Martyn Vincent G3UKW sprat_zs6bkw.pdf (ab4oj.com)
- "*History of Coaxial Cable*" Microsoft Word - History of coaxial cable.doc (silvercometars.com)
- "Open Lines: A Short History of Coaxial Cable" http://www.arrl.org/files/file/Technology/pdf/QST_Aug_2001_p62-64.pdf