ANTENNAS - ANECDOTES - AWARDS

Gus Taylor G8PG 37 Pickerill Road, Greasby, Merseyside, CH49 3ND

IT HAS BEEN A LONG, LONG TIME!

It was 31st May 1937 when I received my licence as G8PG. Nineteen months later I passed the examinations to become a Merchant Navy Radio Officer, and on 21st January 1939, set off on my first voyage. On 3rd September 1939 I received the signal that WW2 had begun. The next 6 years saw service in many places, and some narrow escapes. I was back ashore by the end of 1945 and G8PG was on the air again by mid-1946. There followed a period of coast station, aircraft ground station and part-time military radio work, then a change to being a Technical Author and later Technical publications manager. Also part-time teaching of students for the ham licence.

By 1971 I was getting just at little bit bored with ham radio when, on a whim, I bought a second hand PM3A QRP rig. One weekend using that rig brought all my enthusiasm back and made me a confirmed QRP man! A couple of years or so later George, G3RJV, announced he was forming G-QRP C, and I became Member 004. George soon had me working at things like the Award Scheme, Winter Sports etc. Later came the work with QRP people in many countries to produce an international framework for QRP working covering calling frequencies, power for various types of emission and so on. After that came a period of slowly establishing relations with QRPers in the then Soviet Block countries and seeing their QRP movements grow in strength and freedom. This brought one into contact with some wonderful people (too many to name here) and was enormously rewarding. Add to that all those met through antenna work, Award applications and other contacts and it has been a wonderful experience. Now with me having reached the age of 87 and my call the age of 70 it is time for someone younger to take over and for me to say

72 73 **ES CU QRP SN I HOPE**

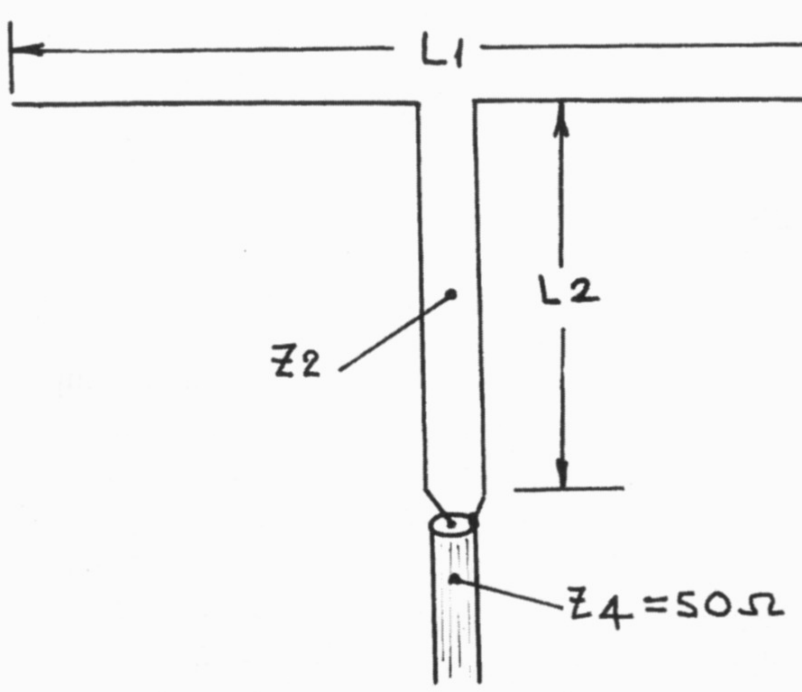
(But remember without the vision of G3RJV it would never have happened)

The ZS6BKW Antenna – from the horse's mouth

Brian Austin G0GSF (ex ZS6BKW) 110 Frankby Road West Kirby CH48 9UX

Imagine my surprise when told by a friend who'd caught his Sprat early that my old call sign featured prominently within issue No. 129. Sure enough, when I opened my copy, there it was: ZS6BKW that I'd not used in twenty years. Then I realised that it was my antenna and not me that was under the spotlight and so I suppressed my welling pride and read on with interest! How, I wondered had the antenna fared when Martyn G3UKV put it to the test? (See reference 1). Gratifyingly, it stood up very well and seemed to meet some useful needs. It might therefore also be useful if I provided a little background information about the antenna and also commented on how sensitive or critical the particular lengths and impedances of the ZS6BKW happen to be.

As pointed out by G3UKV, the basic ZS6BKW antenna is related to the famous G5RV first published in the RSGB Bulletin in 1958 by Louis Varney (ref.2). The G5RV is based on a clever idea in which a length of transmission line is used as a type of automatic ATU to produce an acceptable impedance match to a low impedance line on a number of HF bands. The beauty of the configuration is that it lends itself to careful analysis and therefore to optimisation. And that's where I started when I first looked at it seriously more than twenty years ago.



In my analysis of the G5RV configuration using both the Smith chart and my own computer program written in the early 1980s (and more recently using EZNEC) I always called the antenna proper L1 while the "series section matching transformer", that length of transmission line hanging down from its centre, is called L2 and its characteristic impedance is Z2. These details are illustrated in Fig 1.

Since 50 ohms is the impedance of coaxial cables most commonly used these days, rather than the 72-ohm twin-lead that Varney had in mind, I chose to make Z4 equal to 50 ohms. To qualify as a multiband antenna the combination of L2 and Z2 must be able to transform the impedance presented by L1 at its centre to some value relative to Z4 that'll satisfy some defined SWR criterion on all the bands of interest. I chose the upper SWR limit to be 2:1. This probably means that the antenna could be used without any other form of ATU since it's around about the point where the protection circuits kick in. My design target was clearly to have this happy state of affairs occur on as many HF bands as possible. G3UKV's measured results in Sprat Nr129 showed how well the antenna actually performed in practice. His finding that it also worked on 6m is an added bonus that I'd not considered but, as will be seen, it is certainly true that it does.

Anyone using the classical G5RV without an ATU will know that it only matches well on two of the HF bands: 14 and 24MHz. On all the others the SWR is never better than 3 or 4:1 and on most of them the best match actually occurs beyond the band limits. To be able to design the antenna (i.e. choose L1, L2 and Z2) so that the optimum match occurs within as many bands as possible requires a knowledge of the impedance at the centre of L1 on all HF bands. Such data were available in tabulated form in 1980 when I commenced my analysis, though probably not in 1958 when Louis Varney did his. Nowadays they can easily be determined by NEC and all its variants. Since L2 is just a transmission line it will act as an impedance transformer and the very best way of visualising that impedance transformation process is to use the Smith chart. For those who might be interested to see how this was done I refer you to my paper published in 1987, (ref. 3).

That paper also described how the Smith chart was used to design the antenna system and the beauty of the method is that one can see almost at a glance which combinations of L1, L2 and Z2 will work and then, if needs be, change them to suit particular objectives. Any method that allows such visualisation of what is a complex process has lots going for it and that was most certainly the case here. Since computers are supposed to do just what you tell them to (!), one can then write a program that'll test every sensible combination of those variables at will, and that is what my program did. And it was the Smith chart that made all this happen reasonably quickly by providing the "sensible combinations" to start with. What emerged were the dimensions of the antenna system that has since become known, at least in some circles, as the ZS6BKW.

It will've been noted from G3UKV's article that both L1 and L2 in the ZS6BKW differed from those in the G5RV. Whereas L1 was about three half wavelengths long and L2 a half wavelength on 20m in Louis Varney's antenna, in mine they bear no simple relationship either to each other or to a particular amateur band. It turns out from the analysis that the optimum lengths of L1 and L2 are about 1.35 and 0.62 on 20m. In addition, there is a range of values of Z2 that will produce the best match on five HF bands and over the widest possible bandwidths within those bands. The obvious question you will ask is how critical are these particular lengths. Fig 2 shows the limits of L1 and L2 that'll produce a better than 2:1 SWR on five HF bands. It must be remembered that those lengths of L2 in Fig 2 take no account of the velocity factor of the transmission line used in practice. So its actual physical length will be shorter than those shown here by an amount equal to that velocity factor, or about 0.9 for typical slotted lines.

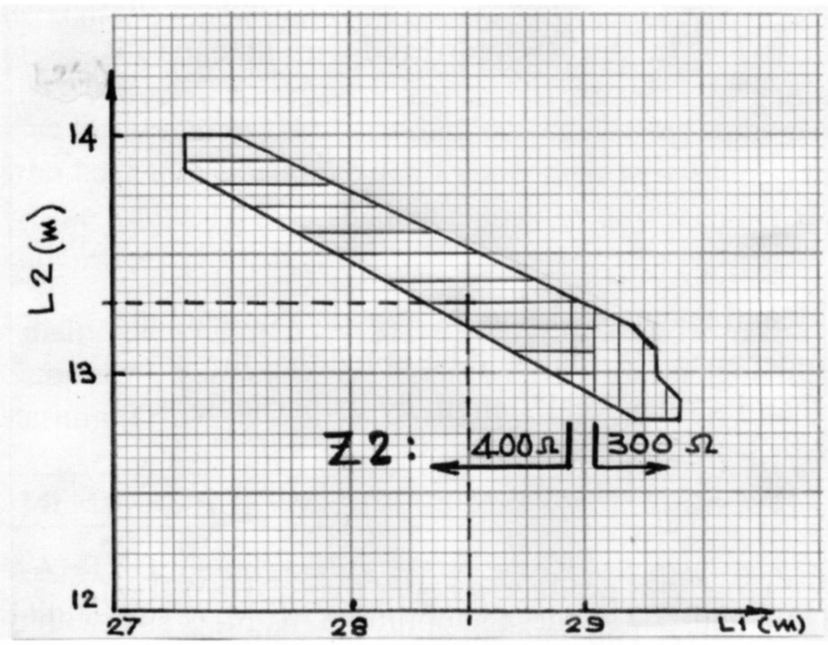


Fig 2 also shows the sensitivity of the multiband match to the value of Z2. It was clear from the analysis that 400 ohms was about optimum, though Z2 = 300 ohms is marginally better for the longest lengths of L1. If values of L1 and L2 close to the extremities within Fig 2 are chosen, the effect is to narrow the bandwidth over which matching will occur in some of the HF bands.

A very effective combination is shown in Fig 2 where L1 = 28.5m; L2 = 13.3m x V.F; and Z2 = 400 ohms. When erected horizontally at 10m above typical urban ground this antenna produced a better than 2:1

SWR on five HF amateur bands, viz. 40, 20, 17, 12 and 10m. The frequencies yielding the best match, and the 2:1 SWR bandwidths on each, are shown in the following table.

Band	40	20	17	12	10
Centre Freq. (MHz)	7.10	14.20	18.10	24.92	28.97
SWR min.	1.1:1	1.1:1	1.3:1	1.4:1	1.4:1
Bandwidth (kHz)	360	270	380	260	400

What about 6m? Martyn G3UKV's discovery that the ZS6BKW also matched well on the 6m band intrigued me so I tested it with EZNEC and sure enough it does. This particular version above produced its best match at 51MHz with SWR= 1.5:1. It also had a whopping gain of 12dBi with four major lobes at about 20 degrees to the wire in azimuth and tilted up at 25 degrees from the ground when the antenna was 10m high. Such features may well be useful to some.

So, if you want a simple antenna that will work on five HF bands without an ATU and on all of them with one, then maybe this is it.

References.

1) Martyn Vincent, Sprat, 129, Winter 2006, 32 -33, "The ZS6BKW Multiband HF Antenna Revisited".
2) Louis Varney, RSGB Bulletin, 34, 7, 19-20, 1958, "An effective multiband aerial of simple construction".
3) Brian Austin, J.IERE, 57, 4, 1987, 167-173, "An HF multiband wire antenna for single-hop point-to-point applications".

Captions

Fig 1: The configuration of the multiband antenna L1 and its impedance matching section L2 of characteristic impedance Z2. It should be noted that the physical length of L2 is less than its "electrical" length by its particular velocity factor VF; i.e. L2 (phys.) = L2 (elec.) x VF.

Fig.2: The lengths of L1 and L2 (elec.) that will produce a better than 2:1 SWR on five HF bands between 7 and 28 MHz. The hatched areas indicate the value of Z2 required to achieve this optimum matching condition. L1 < 29m requires Z2 of 400 ohms whereas antennas longer than 29m work better with Z2 of 300 ohms.