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The Arno Elettronica E-H Antennas

Left: Close-up of the 40m E-H antenna, with its outer fibre-glass sheath removed.

The E-H antenna is one of several controversial small antennas that have appeared in recent years. It is claimed that they are based upon the theories of Poynting Vector Synthesis, originally proposed by Maurice Hately, GM3HAT, in the mid-1980s. The 40m and 20m E-H antennas reviewed here are manufactured in Europe under licence by Arno Elettronica in Italy, who kindly supplied the antennas for review.

The E-H antenna was designed (US Patent 6,486, 846) and is still being actively developed by Ted Hart, W5QJR, who has made available a large body of constructional information on his website (see 'Websearch' below). In essence, the E-H antenna comprises two metal cylinders which constitute a short dipole. These cylinders are fed via a phasing network located beneath the lower cylinder. The purpose of the phasing network is to cancel the phase shift between the applied voltage and the displacement current through the natural capacitance of the dipole, causing the E and H fields produced to be in phase. This provides the conditions for Poynting Vector Synthesis (PVS) to take place in the zone between the cylinders.

The E-H antenna in its present form is essentially a monoband device which has a wide SWR bandwidth, typically 400kHz between the 2:1 SWR points for the 7MHz model. The antennas are constructed on a fibre-glass cylinder which is enclosed within a second fibre-glass cylinder that provides protection from the weather. The whole assembly is robust and clamps are provided for fixing the assembly to a stub mast. A six-page document contains advice on installing the antenna and contains some advice about routing the feeder to reduce pick-up on the coax sheath. The manufacturer's specification is given in **Table 1**.

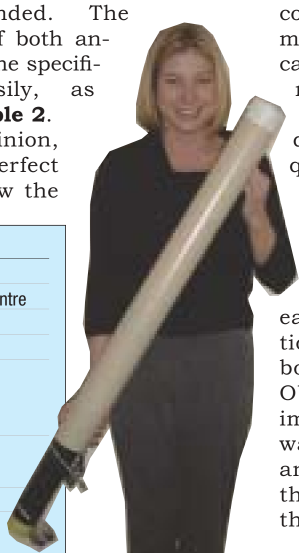
Before installing either antenna in its final position, I mounted it approximately 5m above ground and checked the SWR and bandwidth using an MFJ-259 analyser with its case grounded. The bandwidth of both antennas met the specifications easily, as shown in **Table 2**.

In my opinion, there is no perfect way to review the performance of an antenna for amateur use. Testing under ideal conditions can produce very false impressions of how it might perform at a typical amateur suburban location. Accordingly, this review makes comparisons between my normal antennas – a full-size G5RV and a 12AVQ vertical – and the 40m and 20m E-H antennas.

The G5RV runs north-south at a height of 10m. The stub hangs almost vertically from the centre of the antenna and is fed via a balun with approx 60ft of RG8 coaxial cable. This cable enters the rear of the house at first floor level via a grounded metal box along with other lengths of RG8. Because the cables run beneath the first floor alongside mains wiring, considerable care has been taken to minimise RF on the outside of these cable sheaths. On 40m the G5RV returns the sort of performance one might reasonably expect from a dipole mounted at approximately a quarter-wave above ground.

THE 40m E-H ANTENNA

The 40m E-H antenna was first mounted on a short stub pole at the side of the garage on the east side of the house. In this position it was approximately 20ft from both my house and my neighbour. Obviously its performance would improve as its height above ground was increased, but this is true of any antenna and it was felt that this position was not untypical of that where a small, discrete anten-



Left: Faye Millward, M3FAY, with the 20m E-H antenna.

	7MHz	14MHz
Frequency coverage:	7.0 - 7.1	14.0 - 14.350
Input impedance:	50+j0 at band centre	50+j0 at band centre
Bandwidth (2:1 SWR):	200kHz	1MHz
(±3dB):	400kHz	2MHz
Maximum power rating		
AM & RTTY:	150W	150W
SSB & CW:	500W	500W
Dimension of beaming part (sic):	2% λ	2% λ
Efficiency:	>95%	>95%
Gain (compared to full size dipole):	0 - +2dB	0 - +2dB
Polarisation:	Vertical	Vertical
Radiation pattern:	Optimised for medium and DX signals	
Dimensions:	116 x 12.5cm	107 x 8cm

Table 1: Manufacturer's specifications for the antennas reviewed.

	7MHz	14MHz
Min SWR:	1.6:1 @ 7.17	1:1 @ 14.17
Bandwidth (2:1 SWR):	7.08 - 7.30	13.7 - 14.47

Table 2: SWR minima and 2:1 bandwidths as measured by G3IHR.

▶ *Right: 20m E-H antenna (centre) at 30ft and approximately 20ft from one end of the G5RV. The 40m antenna is mounted on the side of the garage (extreme right).*

na had to be used. It was used in this position for several days and a number of QSOs were made with signal reports comparing well with the G5RV. However, I decided that a fairer comparison could be made if I temporarily replaced my 2m Yagi with this antenna at a height of 30ft and approximately 20ft from one end of the G5RV.

Comparison tests are difficult to make for several reasons. Firstly, one relies heavily upon the cooperation of many other amateurs of whom only a few will be disposed to help through several changes of antenna. Accordingly, the majority of the contacts used here only rely upon comparison of the received signal. A single comparison could produce a result that was entirely due to chance and not the change in antenna!

The major element of this review is a summary of the performance that I observed over the period of the review and under a reasonable range of propagation conditions. A second element of the review is based upon a small number of tests conducted with three stations on 40m. In these tests each station recorded their 'S' meter reading for the reference G5RV and the E-H antenna. The receiving station in the test was not informed of the order of the tests at the time. All results were confirmed later by e-mail. In order not to try the patience of the stations who kindly assisted in these tests each test was only repeated five times, ie five groups of three tests with the order rotated pseudo-randomly. Obviously all the tests with all stations could not take place simultaneously, so propagation conditions added another variable, the effect of which could only be estimated.

Test	G5RV Reference antenna ('S' units)
1	6.1
2	6.5
3	6.5
4	6.5
5	7.0

Table 3: The average signal level in 'S' points from the G5RV reference antenna over all three stations for each of the five tests.

Test	Stn 1	Stn 2	Stn 3
1	-3	-0.5	+1
2	-3	-0.5	-1
3	-4	-0.5	-1
4	-3	0	-1
5	-3	-0.5	-1.5
Mean:	-3.2	-0.4	-0.7
Distance (km)	375	474	475

Table 4: 40m E-H antenna received signal compared with reference antenna ('S' units).

Call area	Total QSOs	+3	+2	+1	0	-1	-2
		Relative SignalLevel ('S' units)					
G	13	-	-	4	8	1	-
DL	17	1	1	7	8	-	-
F	8	-	-	-	8	-	-
EA	2	-	-	-	1	-	1
I	3	-	-	-	3	-	-
OH	1	-	-	-	1	-	-
OK	1	-	-	-	1	-	-
HA	1	-	-	-	-	1	-
PA	1	-	-	1	-	-	-
LZ	1	-	1	-	-	-	-
4X	1	1	-	-	-	-	-
UR	2	-	-	1	1	-	-
UA4	1	-	-	-	-	1	-
W/K	9	-	-	-	7	1	1
VE	4	-	-	2	1	1	-
PY	1	-	-	1	-	-	-
VU*	2	2	-	-	-	-	-
Totals:	68	4	2	16	39	5	2

Table 5: Comparison of received signal strengths from various call areas. The difference is 40m E-H antenna compared with G5RV; units are 'S' points. (* = Heard but not contacted.)

Table 3 averages the signal level from the reference antenna over all three stations for each of the tests and it indicates that propagation to all three stations remained sensibly constant during the period of the tests, ie within ±0.5 'S' point.

In **Table 4** I have calculated the difference between the received signal from the standard antenna and that from the E-H antenna for each test. At first sight this would suggest that the signal from the E-H was consistently below that of the reference antenna. However, Table 3 indicates a one 'S' point spread in the average received signal so the results deserve a more detailed examination. The question to ask here is whether there were significant differences between the two antennas, if the recorded differences were due to other factors, or if they could have occurred just by chance. Analysis of the results showed that the difference between the antennas could only have occured by chance in 1% of cases, ie the difference was highly significant, as was the difference between the observations of the three stations. This latter difference was consistent with different station equipment and different propagation paths. So we can conclude from these tests that the E-H antenna performance was between 0.5 and 3.0 'S' points below the G5RV with a mean of 1.4 averaged over the three stations.

How did this result compare with operational experience? The majority of contacts on 40m during the review period have been inter-G and continental, the more numerous being with G, DL and F. On average, the difference was small but the standard deviation shows considerable variability. With the remainder of Europe, east to beyond the Urals and south to Italy, Spain and Greece, north to Norway and Sweden very similar results were obtained. During a CW contest contacts were made with N2, K3, N9 and VE1; serial numbers were deliberately only sent once and were received without repetition - together with the obligatory 599! Two VU stations were heard but not worked; these were both at S7 on the E-H antenna and only about S4 on the G5RV. This latter points up more than any other result the very different radiation characteristics of the two antennas. Other semi-DX worked during the review were VO1 and VE3 during the 'BERU' contest, UA9 and PY7.

Reports from these contacts compared well with those I normally enjoy with the G5RV. On the odd occasion when I sought co-operation to compare with the G5RV the signal report was in favour of the E-H. **Table 5** summarises the received signal levels as compared with the G5RV over various call areas. Bearing in mind these reports embody several variables other than the two aerials, it is reasonable to conclude that on the longer distance paths the E-H performance is on a par with the G5RV; on shorter paths, ie inter-G, it is likely to be lower than the G5RV. This is consistent with what one might expect if comparing a horizontal and a vertical antenna and was borne out by the results in Table 4 in which the two stations who were located furthest away (Stations 2 and 3) observed the smaller differences.

THE 20m E-H ANTENNA

The 20m E-H antenna was originally mounted on a 5m pole in the centre of my garden, with a consequential coax run of some 25m to the shack. In this position I could conveniently measure its SWR bandwidth and also assess the effect, if any, of inserting braid-breakers in the feeder near to the antenna. It was then transferred to the site previously occupied by the 40m E-H antenna.

Organised tests such as that conducted with the 40m E-H were not contemplated. Instead, the received signal was compared with a 12AVQ vertical antenna, mounted at ground level approximately 25m from the shack. Where the opportunity arose, transmission comparisons were made between the two antennas also.

Unfortunately for much of the review period, short skip conditions prevailed and most contacts were with stations in Europe. The E-H antenna compared very favourably with the 12AVQ and often with the G5RV which is, of course quite directional on this band. On receive its characteristics are almost identical with the 12AVQ, ie a considerable increase in solar noise as compared with the G5RV which exhibits a quiet background on 14MHz, and an improved response to stations over 500km. The same increase in solar noise was noted with the 7MHz E-H antenna suggesting that it has an additional high-angle lobe.

Sixty-five contacts were made over a period from 8 March to 21 April 2003 at various times during the day. Outside the short-skip that prevailed most of the time, some DX was worked, notably 579 from VP5 against a considerable pile-up; three JA stations in a row during a contest; CT3 and EA8. Ed, W2HTI, in North Carolina gave me 569 on the E-H and 579 with the 12AVQ, whilst Ted, F5MW, in Marseille found negligible difference between the two antennas and the G5RV. Similarly in a QSO with Lars, SM6FPZ, where my signal was 599 on both antennas. The E-H appeared at all times to be omni-directional in the horizontal plane but the solar noise level at times was detrimental. In particular, VU2VJT was worked on the 12AVQ but was inaudible on the E-H.

Table 6 summarises these results and gives the average signal report received from each area. The caveats given for the 40m comparisons apply here too. The variation against the 12AVQ was less marked and the antenna held its own very well.

CONCLUSIONS

To summarise, from an operational stand-point both of the E-H antennas performed extremely well as general-purpose antennas, exhibiting no significantly different performance to my normal antennas. They both exhibit characteristics that are similar to a ground-plane antenna or a vertical dipole, showing some enhanced low-angle radiation as compared with a horizontal antenna. Both antennas worked quite well at ground level but only compared favourably with the other antennas when operated under similar conditions, ie at a similar height and position with relation to surrounding objects. The nature of the above tests preclude any possibility of verifying the manufacturers claim of 0 to+2dB over a dipole.

Where space is restricted I believe they will produce comparable or better results than a wire antenna that has to be bent to fit into a restricted space, eg a loft, or other 'stealth' antennas. The main disadvantage is that the E-H is a mono-band antenna.

The E-H antenna is claimed to produce a better signal-to-noise ratio on receive than a conventional Hertzian antenna. I did not experience this on either band; the response to local noise was lower, but as noted above the level of solar noise was equal to that of my 12AVQ vertical.

One problem that needs to be resolved is that of RF on the coax sheath. In common with many installations I have to route my feeders under floors and alongside mains cables. It is essential that RF on the cable sheaths is kept to a minimum. To this end I make frequent use of ferrite toroid chokes. The manufacturers claim that any RF on the feeder is due to pick-up within the intense field of the antenna and not due to any common-mode currents caused by mis-match at the antenna. However, they also warn that the use of a choke near the antenna will cause phase changes that may detune the antenna and we cannot have it both ways! On the 40m E-H I have successfully used a choke in the coax feed where it enters the house without causing any detuning of the antenna. RF in the shack is negligible although the field strength from the antenna is very high as compared with that measured from the G5RV. On 20m it is a different story. With a braid-breaking choke closer to the antenna than 10m the antenna was seriously detuned. In its present position at 10m above ground I have a six-turn coil of coax and a coax braid-breaker but there is still some RF in the shack. There has been considerable discussion of this problem on the Internet E-H forum and some solutions have been suggested. I believe it is important that the manufacturer should address this problem. This antenna will I am sure be attractive to those amateurs who have little space or suffer from planning restrictions. In those situations, it is essential that RF can be piped around with minimal EMC problems.

I understand that an 80m E-H antenna is available and a design for 160m is on the cards. I can imagine that mounting these at any height may pose significant problems due to their size. Nevertheless, it will be interesting to see how they perform on bands where lack of real estate poses an even greater problem.

I am indebted to Pat, PA3EZJ; Howard, EI5EG, and Stan, GM3KXQ, for their time and patience in assisting me in the above tests. Thanks too to the manufacturer, Arno Elettronica, Via Volteranna, 208/1 56033 Capannoli (PISA), Italy, for the loan of the antennas reviewed. The price of the 7.0 and 14.0MHz antennas is 144 euros (approx £100) each inc VAT (P&P extra). Models are available for the bands from 3.5MHz to 50MHz.

Editor's note: the manufacturers have informed us that the power rating of all models of E-H antenna has now been increased to 2kW on SSB and CW, and 500 watts on RTTY or AM. Each E-H antenna is also now equipped with an external coaxial sleeve fine tuning system that allows it to be tuned to exactly the desired frequency on each band. ◆

Call area	Total QSOs	Relative +1	Signal 0	Level -1	Report received (average)('S' units)
DL, F, PA	11	1	7	3	7
UA (European)	11	6	4	1	7
UA (Asian)	12	7	3	2	6
Other E Europe	6	1	5	-	8
Scandinavia	4	-	4	-	8
S Europe	11	3	5	3	8
CT3 / EA8	3	2	1	-	7
W	3	-	2	1	5
VP5	1	-	1	-	7
JA	3	-	3	-	9*
Totals:	65	20	35	10	

Table 6: 20m E-H antenna received signal level compared with 12AVQ vertical (* = Contest report!)

WEB SEARCH

Arno Elettronica	www.eheuroantenna.com
Ted Hart, W5QJR	www.eh-antenna.com
Internet E-H forum	http://groups.yahoo.com/group/eh-antenna