COMPARISON TESTING
EIGHT ACTIVE OUTDOOR ANTENNAS

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INTRODUCTION

A number of articles have been written on the various technical aspects of active antennas. Lawrence Magne in his White Paper on the subject[1] lists the gain versus frequency, 3rd order intercept and the noise figure of the electronics. Ted Benson[2] in his Antenna Survey gives an excellent description of the performance of a number of active antennas. The U. S. Army Electronics Command[3] publishes a pamphlet on "Electrically Small Antennas" which covers in depth all of the factors involved in active antenna design performance. With all of this information and the detailed manufacturers description given in the short wave equipment catalogs, it would seem like a simple matter to choose the "best" active antenna. This is not the case!

Several years ago, in Houston, Texas, four active antennas were placed in a large attic space (no outside antennas permitted) and equal leads run to a four position switch and on to the receiver. With this set-up, it was very easy to find the best performing antenna in a subjective way. The procedure was that the antennas were switched around to find the one that gave the best signal. In many cases there would be one antenna that was significantly better than the others. The antenna that produced the best results was not always the one with the most impressive technical specifications or with the highest price tag.

Having now moved to Oklahoma with plenty of space the comparison testing of active antennas was repeated and expanded to include seven active antennas. Again they were set up through switches so that a direct comparison of performances could be measured and judges. In this new series of tests in Oklahoma a passive eighty foot sloper antenna was added to the test set up as a good accepted reference antenna.

TEST SET-UP

Some preliminary testing was done to find out how close the antennas could be placed without affecting their performance. It was surprising to find that the whips could be as close as two (2) feet without any noticeable change in reception. This test was not extensive or carefully controlled so to be on the safe side the antennas were mounted about six feet apart.

A 32 foot 2 by 6 inch board was placed across the garage roof, supported level, and running generally North and South. This board was about 17 ft. above the ground. The antennas were then secured to this board at equal intervals. The DATONG AD-370 dipole was mounted in a vertical manner at one end of the board.

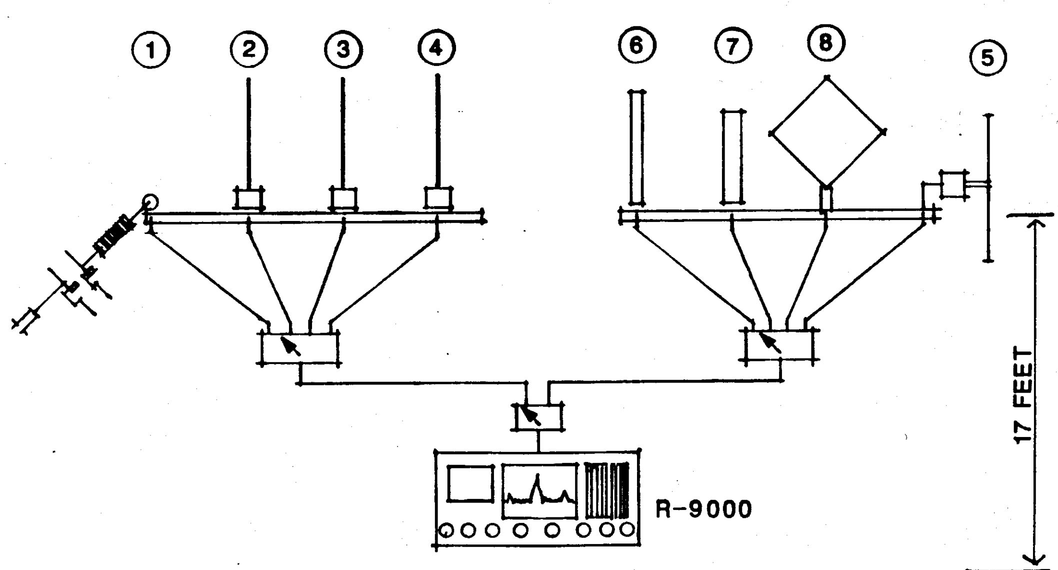

FIGURE 1. TEST CONFIGURATION

All mounting was temporary so that in the end, antenna positions could be changed to be sure there was not bias in the location.

Equal forty foot lengths of RG 8-X were used to connect the antennas to the switch boxes. Four antennas each were connected to a Daiwa CS-401 switch and the output of these two switches connected to a Daiwa CS-201 which was connected to the receiver. (Figure 1)

For the receiver a R-9000 was chosen over others simply because it has a 10 db. and 20 db. antenna input attenuator which was felt might be necessary with all the gain in some of the active antennas. The R-9000 also has a very large S-Meter and a spectrum display. These features helped in measuring signal and noise strength. Experience quickly proved it was very difficult to measure numerically the values of signal and noise on the S-meter so the spectrum display proved to be the best way to compare relative signal and noise values. (Figure 2)

CALIBRATION

Since the test of these antennas was to be a comparative one, it was not necessary to obtain an absolute calibration of the set up. A simple calibration of the spectrum scope deflection was carried out. This was done by selecting a strong signal and adjusting the R. F. gain to give a deflection of exactly 5 large divisions on the scope. The antenna attenuators were switched to give 10, 20 and 30 db attentuation. With each change of 10 db, the signal deflection decreased on the scope by one large division. This indicated that the scope was logarithmic and that each large division was 10 db.

Because the scope deflections were logarithmic then the ratio of two reading is their arithmetic difference ie: (S+N)/N db = [(deflection signal) - deflection of noise)] x 10 db.. [Remember from your algebra log A/B = log A - log B]

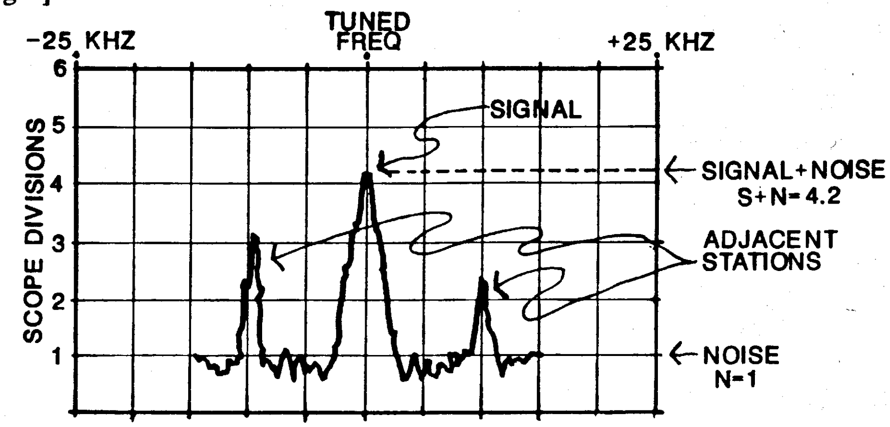

FIGURE 2. R-9000 SCOPE DISPLAY

TESTING

The tests were carried out on two different types of signals to cover the different interests in SWL. Test I was on signals of listening quality. This was usually S-5 or better. The second series, Test II, was for the DX'er who is trying to pull some intelligence out of a cesspool of noise.

PROCEDURE TEST I

The test procedure was quite straight forward. The R-9000 was set on AM, narrow IF, fast AGC and unless indicated, the antenna attenuator was at 0 db. A station was tuned in and then the strength and noise were observed on the scope and the deflections recorded. With the spectrum display, it was easy to observe the height of the signal and the height of the noise deflections either side of the signal. (Figure 2)

The antenna selector switches were than moved to the next antenna and the signal and noise again recorded. This procedure was repeated through all the other antennas. After all 8 antennas were measured, the switches were then returned to the first antenna and the readings taken again. If the second reading of the first antenna differed by more than 1/4 scope division, all readings were repeated. If the propagation conditions were changing so rapidly that repeatability could not be achieved, then the test on that station was abandoned until a later date.

Time stations were used for most of the measurements, because of their uniform modulation and narrow band width. This allowed for enough space between adjacent signals to get a good noise reading.

In all cases, the antennas were operated at maximum gain, where adjustment was provided. At this test location there are no nearby AM, FM, or TV stations that could overload the amplifiers.

DATA TEST I

The measurements below are in units of deflection on the R-9000 scope. As explained previously these deflections are logarithmic; therefore the difference between the two readings is the ratio of (S+N)/N and since each unit of deflection was 10 db, then multiplying this difference by 10 gave the (S=N)/N value in db.

F-MHz	.060-WWVB			0.512 XKQ			KTOK 1.0-5KW-50 MILES			2.5-WWV		
UTC	19:00			19:47			20:15			20:28		
ANT	S+N	N	S+N/N db	S+N	N	S+N/N db	S+N	N	S+N/N db	S+N	N	S+N/N db
1	0.2	0	2	0.7	0	7	3.3	0	33	3.5	0.2	33
2	2.0	0.5	15	2.1	0.1	20	3.0	0.1	29	4.6	1.5	31
3	0.5	0	5	1.7	0.1	16	3.5	0	35	3.5	1.0	25
4	3.1	1	21	3.3	0.7	26	5.3	0.5	48	6.0	2.5	35
5	2.1	0.7	14	3.5	1.0	25	6.0	0.5	55	6.0	3.0	30
6	0	0	0	0	0	0	0.3	0	3	2.0	0	20
7	3.0	3.0	0	2.0	0.3	17	4.0	0.1	39	5.5	2.0	35
8	3.5	2.0	15	2.2	0.5	17	3.0	0.1	29	4.5	1.5	30

F-MHz	3.330-CANADA			5.00-WWV			7.335-CANADA			10.00-WWV		
UTC	02:38			02:50			03:11			18:33		
ANT	S+N	N	S+N/N db	S+N	N	S+N/N db	S+N	N	S+N/N db	S+N	N	S+N/N db
1	3.0	1.5	15	6.0	1.5	45	3.5	1.5	20	5.0	0	50
2	3.0	1.0	20	5.2	1.0	42	3.0	0.5	25	4.1	0.1	40
3	3.0	1.0	20	5.0	1.0	40	3.0	1.0	20	5.0	0	50
4	4.0	2.0	20	6.5	1.5	50	4.0	2.0	20	5.5	0.9	46
5	5.0	3.0	20	6.5	1.5	50	5.0	2.0	30	6.0	1.0	50
6	0.5	0	5	3.0	0.1	29	2.0	0.1	19	3.0	0	30
7	4.0	2.0	20	4.0	1.0	30	4.0	1.2	28	5.2	0.1	51
8	4.2	2.0	22	4.5	1.0	35	4.0	1.5	25	5.5	0.2	53

F-MHz	14.670-CANADA			15.00-WWV			20.00-WWV		
UTC	18:25			19:23			20:10		
	S+N	N	S+N/N db	S+N	N	S+N/N db	S+N	N	S+N/N db
1	2.5	0	25	2.8	0.1	27	1.0	0	10
2	3.5	0.5	30	3.0	1.0	20	2.0	0.3	17
3	2.8	0	28	2.2	0.1	21	1.0	0	10
4	3.5	0.6	29	3.0	1.0	20	1.5	0.2	13
5	4.0	0.8	32	3.0	0.5	25	2.0	0.6	14
6	2.8	0.1	27	2.0	0	20	0	0	0
7	3.0	0.8	28	2.7	0.6	21	1.0	0	10
8	2.0	0.2	18	1.7	0.1	16	0.5	0	5

RESULTS TEST I

There is no clear cut winner in these tests. There are however several important general conclusions that can be made:

1. Antenna # 6 (Diamond D-707) has very low sensitivity and it provided a usable signal only between 5 to 15 megahertz. The gain of this antenna was so low that it was double checked. The co-ax cable was changed, the amplifier was changed and finally a second antenna was installed, but the results were the same. Unless you have excessive gain in your receiver, this antenna would not be a good choice.

2. Antenna #5 (Datong-370) and #4 (MFJ-1024) followed closely by #2 (McKAY DAMEK DA-100D) and #7 (DRESSLER ARA-60) gave the best performance across the frequency test range. These antennas appear to be the best over all in gain and signal to noise ration. The choice of the best suited for a particular set up might be in the different features in the control boxes and price. (See Appendix)

PROCEDURE TEST II

To test antennas for Dx'ing, a barely readable signal was tuned in using the reference antenna and then each other antenna was switched in rapidly to determine if the signal was "the same", "better", or "worse", or not readable at all.

For this test the reference antenna would be No. 1 (Alpha-Delta Sloper) and then each antenna would be rated as: S, the same; -1, poorer, but readable; 0, not readable at all; or +1 and +2 as better than S. This type of test is very subjective and no numerical signal valves can be measured at these levels as the signals are well below the S-meter readings, but the results are meaningful.

In looking at the results, keep in mind that the Alpha-Delta Sloper is an excellent outside antenna so that an S or even a -1 rating of an active whip antenna is a good performance.

The receiver used in this series of tests was a RACAL-6793A. This receiver is extremely stable, has a low noise front end, wide dynamic range and tunes in 1 Hertz steps. It was set in the AM mode, fast A.G.C. and a 3.2 khz IF filter.

No attempt was made to stay on a station long enough to identify it as it was important to switch antennas rapidly before propagation conditions changed.

DATA TEST II

B	LF	MW	120	80	75	60	49	41	31	25	21	19	16	13	11
F	.206	.720	2.390	3.250	3.913	4.800	6.090	7.27	9.540	11.655	13.666	17.63	17.63	21.45	25.9
UT	01:56	04:00	12:15	12:20	12:30	02:28	12:50	12:55	13:00	02:48	13:10	12:20	12:45	13:00	13:30
1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
2	+1	+1	+1	S	S	S	S	S	S	+1	S	S	+1	S	+1
3	+1	S	S	S	S	S	S	S	S	S	S	S	S	S	S
4	+1	+1	S	S	S	S	S	S	S	S	-1	S	S	-1	S
5	+1	+1	S	S	S	S	S	S	S	+2	S	S	+1	+1	+1
6	0	0	-1	0	-1	-1	-2	-1	S	-1	-1	-1	-1	0	-1
7	0	S	S	S	S	S	S	S	S	S	S	S	-1	S	S
8	+1	+1	+1	S	S	S	S	S	+1	+1	S	S	S	S	-1

B-Band in Meters, Except: LF=.15 to .5 MHz, MW=.50 To 1.7 MHz; F-Frequency in MHz; UT-Time in UTC

RESULTS TEST II

The S rating is a station received on the Alpha-Delta Sloper that was barely distinguishable in the noise.

This data indicates that active antennas compare favorably with and outside antenna. In fact, some active antennas surpassed the sloper antenna in several frequency ranges. It is important to remember that a +1 or +2 rating means that as the antenna switch was flipped back and forth between the active antenna and the reference antenna, there was a definite improvement in signal readability.

CONCLUSIONS

For general SW listening, all of the active antennas, with the possible exception of NO. 6, provided very good performance. The best choice would probably depend on the frequency range of interest, the features of the control box and of course, the price.

For DX hunting, three of the antennas; McKay Dymek DA-100D (2), MFJ-1024 (4), and Datong AD-370 (5), regularly produce signals as good or sometimes better than the long wire sloper.

If I were to pick one active antenna as being the overall best, it would be the DATONG AD-370. It gave top performance in both series of test, however it is pricey and lacks many control box features that could be important to someone else.

One other factor that is important to consider in the choice of an active antenna is overloading. If these antennas are used near a strong AM station, the system can be overloaded at both the antenna amplifier input and the receiver input. The receiver input problem is easily solved with a filter or attenuator, but there is no nice solution to the problem of antenna amplifier overload. The problem of overload was not included in these tests. If you live in a strong signal area you should also consider the information in the references.

APPENDIX

After a thorough search through the literature, the following seven active antennas were chosen as apparently the highest quality available on today's market. Only antennas suitable for outside mounting were considered.

1. ALPHA DELTA DX-SWL SLOPER*
   Frequency range - 0.5 to 30 mhz
   Output impedance - 50 ohm
   Antenna length - 60 feet
   Universal Radio - $67.95

2. McKAY DYMEK DA-100 D
   Frequency range - 0.5 to 30 mhz
   Output impedance - 50, 100, 500 ohms
   Attenuator - 0, 10, 20 db
   Gain Control - none
   Antenna height - 56 inches
   Universal Radio - $179.95

3. SONY AN-1
   Frequency range - 0.15 to 30 mhz
   Output impedance - 50, 75 ohms
   Attenuator - 0, 20 db
   Gain Control - none
   Antenna height - 59 inches
   Universal Radio - $84.95

4. MFJ-1024
   Frequency range - 0.05 to 30 mhz
   Output impedance - 50 ohms
   Attenuator - 0, 20 db
   Gain Control - none
   Antenna height - 54 inches
   Universal Radio - $129.95

5. DATONG AD-370
   Frequency range - 0.2 to 30 mhz
   Output impedance - 50 ohms
   Attenuator - none
   Gain Control - 0, 12 db
   Antenna height - 2 X 4 in., dipole
   E. E. B. - $149.95

6. DIAMOND D-707
   Frequency range - 0.5 to 1500 mhz
   Output impedance - 50 ohms
   Attenuator - none
   Gain Control - 0 to 20 db
   Antenna height - 37 inches
   Universal Radio - $149.95

7. DRESSLER ARA-60
   Frequency range - 0.2 to 30 mhz
   Output impedance - 50 - 75 ohms
   Attenuator - none
   Gain Control - 0 to 10 db
   Antenna height - 37 inches
   Gilfer - $189.95

8. R. F. SYSTEMS DX-1
   Frequency range - 0.05 to 50 mhz
   Output impedance - 50 ohms
   Attenuator - 0, 6, 10, 20, 30, 40 DB
   Gain Control - none
   Antenna height - 48 inches
   Universal Radio - $359.95

ENDNOTES

[1] Magne, Lawrence *"RDI Evaluates Active Indoor Antennas"*, Radio Data Base International

[2] Benson, Ted WA6BEJ *"The SWL Antenna Survey"*, Tiare Publications

[3] Goubau, G. and Schwering, F. *"Proceedings of the ECOM-ARO Workshop on Electrically Small Antennas"*, U. S. Army Electronics Command