

“2007 MARAC Mobile Bakeoff Results”

Held July 12, 2007 at the MARAC National Convention
Village Greens Park, Greenwood Village, CO, near the Cherry Creek Dam
Event designed and built by Larry Benko, W0QE, w0qe@bnk.com

This was not an antenna shootout!

The event was a measurement of radiated signal strength which included the transmitter, SWR seen by the transmitter (transmitter may reduce power due to SWR), vehicle, antenna, antenna mounting location, antenna grounding, coax, DC voltage supplied to the transmitter, etc.

Assumptions:

1. Measuring the field strength at a reasonable takeoff angle in the far field is a much fairer measurement than measuring at ground level when comparing hitch/bumper and roof mounted antennas.
2. No mobile antenna will have any nulls in the field strength elevation pattern for any measurement angle below 45 degrees due to the low antenna height on the vehicle.
3. Measuring both the field strength of the vertical and horizontal polarized waves and adding the power in each is a more accurate measure of the total field strength than just vertical polarization.
4. The fairest vehicle placement to the receiving antennas is to keep the distance constant to the vertical radiating element of the vehicle which is responsible for at least half of the overall field strength.

Event Format:

1. The receive antennas were two diamond shaped loops, 24” on each side and mounted at right angles to each other. They were fed at the far end from the transmitting vehicle and choked well before being able to be selected remotely via DC voltage on the coax.
2. The receiving antennas were placed 150 ft. away from the test vehicle and 40 ft. above the ground on a fiberglass pole resulting in measurements at a takeoff angle of 15 degrees. The antennas were tilted downward at a 15 degree angle toward the vehicles being measured.
3. The coax to the receiving antennas was extensively choked with 6 chokes consisting of 10 turns on FT-240-43 cores (each >1000 ohms impedance from 3.5 to 30MHz) and placed at distances of 5 and 10 feet apart resulting in no section of the coax being close to a half wavelength. The coax was routed downward at an angle of about 45 degrees away from the vehicles.
4. The signals were measured with an HP 8591E spectrum analyzer and the resulting signal strengths varied from -15dBm to -60dBm with a spectrum analyzer bandwidth of 1KHz.
5. All participants were asked to run 100W and generate a carrier of a few seconds for each measurement. Measurements were made in 4 possible directions relative to the vehicle and each participant decided what measurements were made and on what frequencies. Those stations with amplifiers operated the amplifier for a single measurement and the amplifier power was calculated based on the 100W signal measured in the same vehicle orientation. Slight antenna sensitivity corrections of a fraction of a dB. were made in order to fairly compare a signal generated on 7.05MHz to one on 7.25MHz. A constant was added to all values so that the values would all be positive making comparisons easier.

Conclusions:

I was quite surprised by the variation in signal strengths and several setups have room for significant improvement with minor changes. The following statements are guidelines for a stronger signal.

1. A larger vehicle will always help.
2. You can NOT ground the antenna too well. Multiple low impedance grounds as short as possible are desired. Less than 6" should be the goal. Trunk mounted antennas can benefit from additional grounding of the trunk itself to the vehicle body.
3. Highly oxidized braid is not a low impedance connection. Copper flashing is much better in the long run if the braid can not be kept shiny and the copper can be painted. All connections need to be weatherproof and the use of an anti-oxidant such as Penetrox or OX-Gard is good insurance.
4. Magnet mount setups including 3 and 4 magnet brackets will not be as good as a direct connection to ground especially on the lower frequencies.
5. Size does matter for the antenna especially the distance below the loading coil.
6. Roof mounting produced a much more symmetrical pattern than bumper or trailer hitch mounting.
7. Having the lower part of the antenna parallel and close to the vehicle reduces the effective height of the antenna even though the antenna looks large.
8. Mounting the resonators horizontally with a longer mast is preferable to a shorter mast and resonators mounted upward at an angle. This is assuming that you are placing an overall height restriction on the antenna which is necessary.
9. As the antenna is made more efficient the SWR will rise as the losses are reduced. This may necessitate matching in order for the transmitter to output full power and restore a reasonable SWR bandwidth. A tuner may be used with a small increase in the loss in the coax unless the tuner is mounted at the antenna. A better solution is a shunt coil to ground at the base of the antenna in the range of 1.0uH to 2.0uH which will work on all bands and will provide static protection for the radio.

Just a reminder when looking at the following data:

- A 6 dB. stronger signal is the same as changing from 100W to 400W.
- A 5 dB. stronger signal is the same as changing from 100W to 316W.
- A 4 dB. stronger signal is the same as changing from 100W to 151W.
- A 3 dB. stronger signal is the same as changing from 100W to 200W.
- A 2 dB. stronger signal is the same as changing from 100W to 158W.
- A 1 dB. stronger signal is the same as changing from 100W to 126W.
- A 1 dB. weaker signal is the same as changing from 100W to 79W.
- A 2 dB. weaker signal is the same as changing from 100W to 63W.
- A 3 dB. weaker signal is the same as changing from 100W to 50W.
- A 4 dB. weaker signal is the same as changing from 100W to 40W.
- A 5 dB. weaker signal is the same as changing from 100W to 32W.
- A 6 dB. weaker signal is the same as changing from 100W to 25W.
- A 7 dB. weaker signal is the same as changing from 100W to 20W.
- A 8 dB. weaker signal is the same as changing from 100W to 16W.

Msmt.#	Call	Test #	Freq.	Band	Pwr.	Combined/Corr. Signal				dB.		Comments
						Front	Pass	Rear	Drive	Avg.	F/B	
26	NN9K	10	50125	6	100	31.9	26.5	21.3		28.5	10.6	Chrysler Minivan, rear cent, tail gate, mast, 3 Hustler res.
62	W0QE	22	28050	10	100	34.5		30.1		32.9	4.4	Toyota 4Runner, off center left rear roof, 76" large dia. mast, 6 W9UCW res.
42	AJ5ZX	15	28336	10	25	28.9				28.9		Honda Ridgeline, behind cab center, 48" mast, 4H & 1V res.
55	KS5A	21	21050	15	100	34.8				34.8		Ford F350, toolbox, 76" mast, 3 Hustler
61	W0QE	22	21050	15	100	35.3		31.6		33.8	3.7	Toyota 4Runner, off center left rear roof, 76" large dia. mast, 6 W9UCW res.
48	AJ0C	17	21335	15	100	33.7		32.9	33.9	33.5	1.0	Ford Explorer, center roof, SGC 96" mast, SGC-230
14	W0GXQ	5	21010	15	100	33.4				33.4		Blazer, center roof, 72" mast, 5 W9UCW res.
41	AJ5ZX	15	21303	15	25	28.9				28.9		Honda Ridgeline, behind cab center, 48" mast, 4H & 1V res.
13	W0GXQ	5	18093	17	100	33.0				33.0		Blazer, center roof, 72" mast, 5 W9UCW res.
67	N0KV	23	18110	17	100	34.1	30.5	29.7	31.9	31.9	4.4	Chevy Silverado, 80" Mast & 4 Hustler res. on back pass. corner
16	W6TMD	6	14250	20	249*	35.7				35.7		Dodge PU, hitch 96" mast + 2 W9UCW res. (Amp. Used)
82	W0NAC	29	14339	20	380*	37.8	34.5	32.4	34.4	35.2	5.5	Toyota Tundra, trailer mt., HiSierra + 8 W9UCW res., 2 levels (Amp. Used)
54	KS5A	21	14075	20	100	33.2				33.2		Ford Ford F350, toolbox, 76" mast, 3 Hustler
60	W0QE	22	14055	20	100	33.2		31.8		32.6	1.4	Toyota 4Runner, off center left rear roof, 76" large dia. mast, 6 W9UCW res.
1	N0KV	1	14339	20	100	33.2	32.9	31.6	32.3	32.5	1.6	Chevy Silverado, Hamstick behind cab in stake hole on pass. side
5	HB9RG	3	14339	20	100	33.7	32.9	30.4	32.2	32.5	3.2	LeSabre, left rear QP, 96" mast, 2 W9UCW res.
3	AC0B	2	14305	20	100	32.2	32.5	32.2	32.5	32.3	0.4	Chevy van, mag mount, front center roof, Hamstick
7	NX4W	4	14339	20	100	32.4	32.7	31.4	32.5	32.3	1.3	GMC Envoy, center roof, 54" mast, 3 W9UCW
12	W0GXQ	5	14090	20	100	32.2				32.2		Blazer, center roof, 72" mast, 5 W9UCW res.
78	W0NAC	29	14339	20	100	32.0				32.0		Tundra, trailer mt., HiSierra + 8 W9UCW res., 2 levels
45	AJ0C	17	14326	20	100	31.7		30.8	31.5	31.3	1.0	Ford Explorer, center roof, SGC 96" mast, SGC-230
27	N4CD	11	14339	20	100	30.5				30.5		Buick LeSabre, center trunk, 72" mast, 3 W9UCW res.
31	KS5A	12	14075	20	100	30.7		29.7		30.2	0.9	Ford F350, across toolbox, 3 Hamsticks
66	N0KV	23	14338	20	100	32.1	29.1	26.6	30.9	30.1	5.5	Chevy Silverado, 80" Mast & 4 Hustler res. on back pass. corner
65	N0KV	23	14055	20	100	32.0	29.5	26.4	30.7	30.1	5.6	Chevy Silverado, 80" Mast & 4 Hustler res. on back pass. corner
15	W6TMD	6	14250	20	100	31.8		24.9		29.6	6.9	Dodge PU, hitch 96" mast + 2 W9UCW res.
50	K6KLL	19	14339	20	100	30.8	29.6	26.8		29.4	4.0	Buick LeSabre, trunk left, Outbacker + AT-180
19	N8KIE	7	14344	20	100	29.9		27.9		29.0	2.0	Magnum, rear roof, 44" mast, Hustler res.
71	WA3ZTY	25	14339	20	90	30.7	28.3	24.7	29.8	28.9	6.0	GMC Yukon, trailer mt., 84" mast, 2 Hustler res.
74	WQ7A	27	14339	20	100	30.4	29.0	25.3	28.7	28.7	5.1	GMC Denali, left rear bumper, HI-Q 2.5-80, 79" whip
37	NN9K	14	14062	20	100	28.3				28.3		Chrysler Minivan, cent. roof, 22" Hustler mast, 3 mag. mnt.
72	WY7LL	26	14339	20	100	30.7	28.4	25.0		28.6	5.7	LeSabre, left rear, 56" mast, 2 Hustler res.
24	NN9K	10	14062	20	100	28.8	28.1	25.3		27.7	3.5	Chrysler Minivan, rear cent, tail gate, mast, 3 Hustler res.
52	KA1YZV	20	14339	20	100	27.6				27.6		Toyota Camry, mag mt. center roof, ATAS-100
22	W9SUQ	9	14339	20	100	29.8		23.4	27.0	27.4	6.4	Camper, rear ladder, 96" mast, 2 W9UCW res.
49	W0GXQ	18	14054	20	100	28.4	27.5	25.1		27.2	3.3	Chevy Blazer, hitch mt., HS-1500, 54" whip
77	WQ7A	28	14339	20	100	29.0	27.7	23.5	27.1	27.2	5.4	GMC Denali, left rear bumper, HI-Q 2.5-80, 41" whip
43	W9GUY	16	14339	20	100	28.9		24.1		27.2	4.8	Dodge PU, rear bumper, 72" mast, 2 Hustler
38	AJ5ZX	15	14339	20	25	26.6				26.6		Honda Ridgeline, behind cab center, 48" mast, 4H & 1V res.
34	AB4YZ	13	14339	20	100	20.4		28.6	25.3	25.9	8.1	Dodge Sprinter motorhome, ATAS-120, left hood lip mt.

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						Front	Pass	Rear	Drive	Avg.	F/B	
59	W0QE	22	10120	30	100	32.5		31.1		31.9	1.4	Toyota 4Runner, off center left rear roof, 76" large dia. mast, 6 W9UCW res.
18	W6TMD	6	10125	30	100	31.9		31.5		31.7	0.4	Dodge PU, center roof 30m
30	N4CD	11	10123	30	100	30.8				30.8		Buick LeSabre, center trunk, 72" mast, 3 UCW res
33	KS5A	12	10120	30	100	30.5		28.5		29.7	2.0	Ford F350, across toolbox, 3 Hamsticks
79	W0NAC	29	10122	30	100	29.5				29.5		Toyota Tundra, trailer mt., HiSierra + 8 W9UCW res., 2 levels
9	NX4W	4	10138	30	100		29.3	28.0	29.0	28.8	1.3	GMC Envoy, center roof, 54" mast, 3 W9UCW
64	N0KV	23	10120	30	100	27.6	27.7	26.5	26.3	27.1	1.4	Chevy Silverado, 80" Mast & 4 Hustler res. on back pass. corner
21	AA8R	8	10121	30	100	27.3	26.5	25.4		26.5	1.9	Saturn Vue, hitch mt., 72" mast, 3 Hustler
36	AB4YZ	13	10125	30	100	19.7		23.8	22.4	22.3	4.1	Dodge Sprinter motorhome, ATAS-120, left hood lip mt.
81	W0NAC	29	7185	40	380*	33.3				33.3		Toyota Tundra, trailer mt., HiSierra + 8 W9UCW res., 2 levels (Amp. Used)
58	W0QE	22	7055	40	100	30.8		29.8		30.3	1.0	Toyota 4Runner, off center left rear roof, 76" large dia. mast, 6 W9UCW res.
56	KS5A	21	7050	40	100	29.4				29.4		Ford F350, toolbox, 76" mast, 3 Hustler
11	W0GXQ	5	7154	40	100	29.3				29.3		Blazer, center roof, 72" mast, 5 W9UCW res.
6	HB9RG	3	7188	40	100	29.5	29.3	28.5	29.0	29.1	0.9	LeSabre, left rear QP, 96" mast, 2 W9UCW res.
29	N4CD	11	7188	40	100	28.7				28.7		Buick LeSabre, center roof, Hamstick
10	W0GXQ	5	7053	40	100	28.5				28.5		Blazer, center roof, 72" mast, 5 W9UCW res.
28	N4CD	11	7057	40	100	28.3				28.3		Buick LeSabre, center trunk, 72" mast, 3 W9UCW res.
8	NX4W	4	7188	40	100	27.9	27.7	27.5	27.8	27.7	0.4	GMC Envoy, center roof, 54" mast, 3 W9UCW
2	N0KV	1	7188	40	100	27.7	27.5	27.4	27.4	27.5	0.3	Chevy Silverado, Hamstick behind cab in stake hole on drvr. side.
80	W0NAC	29	7185	40	100	26.5				26.5		Toyota Tundra, trailer mt., HiSierra + 8 W9UCW res., 2 levels
17	W6TMD	6	7165	40	100	25.3		27.3		26.4	2.0	Dodge PU, hitch 96" mast + 2 W9UCW res.
47	AJ0C	17	7195	40	100	26.5		26.5	25.8	26.3	0.7	Ford Explorer, center roof, SGC 96" mast, SGC-230
63	N0KV	23	7188	40	100	26.8	26.2	25.7	26.4	26.3	1.1	Chevy Silverado, 80" Mast & 4 Hustler res. on back pass. corner
20	N8KIE	7	7181	40	100	26.5		25.7		26.1	0.9	Magnum, left rear, Hamstick
68	N0KV	23	7055	40	100		26.2	25.7	26.3	26.1	0.6	Chevy Silverado, 80" Mast & 4 Hustler res. on back pass. corner
51	K6KLL	19	7188	40	100	25.4	25.1	24.4		25.0	1.0	Buick LeSabre, trunk left, Outbacker + AT-180
75	WQ7A	27	7188	40	100	25.2	24.7	24.2	24.5	24.7	1.0	GMC Denali, left rear bumper, HI-Q 2.5-80, 79" whip
70	WA3ZTY	25	7188	40	90	25.1	24.6	23.9	24.8	24.6	1.2	GMC Yukon, trailer mt., 84" mast, 2 Hustler res.
32	KS5A	12	7050	40	100	24.8		24.3		24.5	0.5	Ford F350, across toolbox, 3 Hamsticks
25	NN9K	10	7062	40	100	24.9	24.4	24.1		24.5	0.8	Chrysler Minivan, rear cent, tail gate, mast, 3 Hustler res.
53	KA1YZV	20	7188	40	100	23.3				23.3		Toyota Camry, mag mt. center roof, ATAS-100
73	WY7LL	26	7188	40	100	23.9	23.6	22.5	23.0	23.3	1.4	LeSabre, left rear, 56" mast, 2 Hustler res.
76	WQ7A	28	7188	40	100	22.3	21.9	21.0	21.4	21.7	1.3	GMC Denali, left rear bumper, HI-Q 2.5-80, 41" whip
23	W9SUQ	9	7188	40	100	20.6		18.8	21.2	20.3	2.4	Camper, rear ladder, 96" mast, 2 W9UCW res.
35	AB4YZ	13	7188	40	100	18.2		20.1	19.5	19.3	1.8	Dodge Sprinter motorhome, ATAS-120, left hood lip mt.
44	W9GUY	16	7188	40	100	18.5		17.9		18.2	0.6	Dodge PU, rear bumper, 72" mast, 2 Hustler
4	AC0B	2	7140	40	100	16.9	17.2	17.2	17.1	17.1	0.3	Chevy van, mag mount, rear center roof, Hamstick, very long ground
39	AJ5ZX	15	7188	40	25	11.4				11.4		Honda Ridgeline, behind cab center, 48" mast, 4H & 1V res.

Msmt.#	Call	Test #	Freq.	Band	Pwr.	Combined/Corr. Signal				dB.	dB.	Comments
						Front	Pass	Rear	Drive	Avg.	F/B	
57	W0QE	22	3550	80	100	21.5		21.3		21.4	0.2	Toyota 4Runner, off center left rear roof, 76" large dia. mast, 6 W9UCW res.
46	AJ0C	17	3909	80	100	18.1		16.9	17.0	17.4	1.1	Ford Explorer, center roof, SGC 96" mast, SGC-230
40	AJ5ZX	15	3902	80	25	-7.9				-7.9		Honda Ridgeline, behind cab center, 48" mast, 4H & 1V res.
69	N0KV	24	1810	160	100	17.2	17.2	16.9	17.2	17.1	0.3	Chevy Silverado, rt. Rear, HI-Q 160, 76" whip
Notes:												
Not all mobiles transmitted in all directions. The Avg. dB. Signal is the power average of all directions measured which may skew results slightly unless comparable directions are compared.												
AJ5ZX transmitted in AM mode, 25W is a power estimate, probably should add 6dB to numbers to equate to 100W.												





