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QST Magazine Product Reviews - Key Measurements Summary - HF-Transceivers or Receivers (page 1/6)

	Subject of measurement, band: 14 MHz	Receiver							Transmitter			Price in USD (2006-2016)	Company's site	
		20 kHz reciprocal mixing dynamic range	20 kHz blocking gain compression	20 kHz 3rd-order dynamic range	2 kHz reciprocal mixing dynamic range	2 kHz blocking gain compression	2 kHz 3rd-order dynamic range	20 kHz 3rd-order intercept	2 kHz 3rd-order intercept	Transmit 3rd-order IMD	Transmit 9th-order IMD			NEW: RX/TX turnaround time (TX delay) SSB
	Min/max of scale	-60/-140 dBc	70/140 dB	50/110 dB	-60/-140 dBc	70/140 dB	50/110 dB	-40/+35 dBm	-40/+35 dBm	-20/-35 dB	-20/-70 dB			
Transceivers/receivers sorted by 2 kHz 3rd-order dynamic range and if equal by 20 kHz 3rd-order dynamic range														
1	Yaesu FTdx5000D, December 2010	-109 dBc	136 dB *	114 dB **	-102 dBc	136 dB *	114 dB **	+41 dBm **	+40 dBm **	Class AB: -30 dB, Class A: -43 dB **	Class AB: -47 dB, Class A: -72 dB **	37 ms	\$5,399	www.yaesu.com
2	WINRADIO WR-G31DDC, January 2012	N/M	128 dB	107 dB	N/M	128 dB	107 dB	+32 dBm	+32dBm	N/A	N/A	N/A	\$899	www.winradio.com
3	Kenwood TS-590SG, July 2015	-118 dBc	139 dB	106 dB	-94 dBc	130 dB	106 dB	+29 dBm	+29 dBm	-42 dB ~**	-58 dB ~	17 ms	\$1,609	www.kenwood.com
4	Elecraft K3 %, after Synthesizer Upgrade, November 2015	-119 dBc	143 dB **	106 dB	-115 dBc	143 dB **	103 dB	N/M	N/M	N/M	N/M	N/M	\$2,200	www.elecraft.com
5	Elecraft K3 %, January 2009 with update, November 2015	-115 dBc	143 dB **	106 dB	-93 dBc	135 dB	103 dB	+29 dBm	+28 dBm	-29 dB	-51 dB	12 ms	\$2,200	www.elecraft.com
6	FlexRadio FLEX-6700, April 2015	-124 dBc	128 dB	103 dB	-116 dBc	128 dB	103 dB	+46 dBm **	+46 dBm **	-41 dB ~**	-55 dB ~	140 ms	\$7,499	www.flexradio.com
7	Elecraft K3, April 2008	N/M	139 dB	103 dB	N/M	139 dB	102 dB	+26 dBm	+26 dBm	-27 dB	-53 dB	22 ms	\$2,200	www.elecraft.com
8	Kenwood TS-990S, February 2014	-117 dBc	138 dB	112 dB **	-87 dBc	133 dB	101 dB	+44 dBm **	+35 dBm	-31 dB	-57 dB	18 ms	\$8,000	www.kenwood.com
9	Yaesu FTdx3000, April 2013	-106 dBc	137 dB *	110 dB	-82 dBc	127 dB	100 dB	+40 dBm **	+23 dBm	-27 dB	-52 dB	34 ms	\$2,699	www.yaesu.com
10	SSB Electronic ZEUS ZS-1, June 2014	-128 dBc	129 dB	105 dB	-120 dBc	129 dB	100 dB	+31 dBm	+31 dB	-34 dB	-60 dB	68 ms	\$1,700	www.ssb.de
11	Hilberling PT-8000A, November 2014	-118 dBc	138 dB	104 dB	-111 dBc	138 dB	100 dB	+35 dBm	+30 dBm	-35 dB ~	-59 dB ~	43 ms	\$17,500	www.hilberling.de
12	Elecraft KX3, December 2012	-120 dBc	130 dB	103 dB	-114 dBc	128 dB	100 dB	+34 dBm	+34 dBm	-30 dB	-55 dB	30 ms	\$999	www.elecraft.com
13	FlexRadio FLEX-5000A, July 2008	N/M	123 dB	99 dB	N/M	123 dB	99 dB	+35 dBm	+30 dBm	-34 dB	-54 dB	29 ms	\$2,799	www.flexradio.com
14	TenTec 599AT Eagle, August 2011	N/M	136 dB	98 dB	N/M	126 dB	98 dB	+22 dBm	+22 dBm	-28 dB	-48 dB	16 ms	\$1,795	www.tentec.com
15	Kenwood TS-590S, May 2011	N/M	141 dB **	106 dB	N/M	121 dB	97 dB	+26 dBm	+22 dBm	-29 dB	-52 dB	14 ms	\$1,649	www.kenwood.com
16	Perseus SDR, December 2008	N/M	129 dB	100 dB	N/M	129 dB	97 dB	+35 dBm	+35 dBm	N/A	N/A	N/A	\$999	www.microtelecom.it
17	Apache Labs ANAN-100D, October 2015	-117 dBc	124 dB	97 dB	-105 dBc	122 dB	96 dB	+22 dBm	+22 dBm	Pure Signal OFF: -29 dB, Pure Signal ON: -49 dB **	Pure Signal OFF: -49 dB, Pure Signal ON: -60 dB	142 ms	\$3,489	www.apache-labs.com
18	TEN-TEC 539 Argonaut VI, August 2013	N/M	N/M	96 dB	N/M	N/M	96 dB	+20 dBm	+20 dBm	-30 dB	-51 dB	20 ms	\$995	www.tentec.com
19	Icom IC-7700, October 2008	N/M	125 dB	106 dB	N/M	102 dB	95 dB	+35 dBm	+24 dBm	-28 dB	-53 dB	15 ms	\$7,179	www.icomamerica.com
20	Flex-3000, Oct/Nov 2009	N/M	113 dB	99 dB	N/M	113 dB	95 dB	+28 dBm	+26 dBm	-30 dB	-45 dB	48 ms	\$1,699	www.flexradio.com
21	TenTec Orion-II, September 2006	N/M	136 dB	92 dB	N/M	136 dB	95 dB	+20 dBm	+21 dBm	-28 dB	-52 dB	30 ms	\$4,295	www.tentec.com
22	FlexRadio FLEX-6300, April 2015	-121 dBc	127 dB	92 dB	-116 dBc	126 dB	92 dB	+43 dBm **	+43 dBm **	-41 dB ~**	-54 dB ~	136 ms	\$2,499	www.flexradio.com
23	Icom IC-7410, October 2011	N/M	143 dB **	106 dB	N/M	111 dB	88 dB	+29 dBm	+5 dBm	-30 dB	-61 dB	45 ms	\$1,949	www.icomamerica.com

QST Magazine Product Reviews - Key Measurements Summary - HF-Transceivers or Receivers (page 2/6)

Subject of measurement, band: 14 MHz	Receiver								Transmitter			Price in USD (2006-2016)	Company's site	
	20 kHz reciprocal mixing dynamic range	20 kHz blocking gain compression	20 kHz 3rd-order dynamic range	2 kHz reciprocal mixing dynamic range	2 kHz blocking gain compression	2 kHz 3rd-order dynamic range	20 kHz 3rd-order intercept	2 kHz 3rd-order intercept	Transmit 3rd-order IMD	Transmit 9th-order IMD	NEW: RX/TX turnaround time (TX delay) SSB			
Min/max of scale	-60/-140 dBc	70/140 dB	50/110 dB	-60/-140 dBc	70/140 dB	50/110 dB	-40/+35 dBm	-40/+35 dBm	-20/-35 dB	-20/-70 dB				
Transceivers/receivers sorted by 2 kHz 3rd-order dynamic range and if equal by 20 kHz 3rd-order dynamic range														
24	Icom IC-7600, November 2009	N/M	122 dB	106 dB	N/M	102 dB	88 dB	+31 dBm	+13 dBm	-31 dB	-48 dB	13 ms	\$4,976	www.icomamerica.com
25	Icom IC-9100, April 2012	-101 dBc	142 dB **	108 dB	-77 dBc	111 dB	87 dB	+29 dBm	+2 dBm	-29 dB	-64 dB	61 ms	\$3,650	www.icomamerica.com
26	Icom IC-7800 V2, March 2007	N/M	144 dB **	108 dB	N/M	117 dB	86 dB	+38 dBm **	+22 dBm	-32 dB	-52 dB	15 ms	\$12,499	www.icomamerica.com
27	FlexRadio FLEX-1500, December 2011	N/M	107 dB	100 dB	N/M	107 dB	86 dB	+31 dBm	+13 dBm	-22 dB	-48 dB	200 ms	\$649	www.flexradio.com
28	Yaesu FTdx9000MP, July 2010	N/M	137 dB	99 dB	N/M	102 dB	85 dB	+28 dBm	+7 dBm	Class AB: -22 dB, Class A: -37 dB **	Class AB: -47 dB, Class A: -75 dB **	32 ms	\$11,629	www.yaesu.com
29	TenTec R4020 QRP, February 2011	N/M	N/M	84 dB	N/M	N/M	84 dB	-10 dB	-10 dBm	N/M	N/M	116 ms	\$249	www.tentec.com
30	Yaesu FTdx1200, January 2014	-104 dBc	132 dB	101 dB	-81 dBc	123 dB	83 dB	+31 dBm	+4 dBm	-32 dB	-50 dB	38 ms	\$1,600	www.yaesu.com
31	Yaesu FT-991, November 2015	-103 dBc	134 dB	100 dB	-75 dBc	99 dB	82 dB	+31 dBm	-1 dBm	-26 dB ~	-46 dB ~	34 ms	\$1,550	www.yaesu.com
32	TenTec Omni-VII, July 2007	N/M	137 dB	91 dB	N/M	134 dB	82 dB	+11 dBm	+6,5 dBm	-27 dB	-55 dB	20 ms	\$2,695	www.tentec.com
33	Icom IC-R9500, January 2008	N/M	144 dB **	5kHz/92 dB	N/M	109 dB	81 dB	+32 dBm	-4dBm	N/A	N/A	N/A	\$17,000	www.icomamerica.com
34	Yaesu FTdx9000C, March 2006	N/M	128 dB	101 dB	N/M	97 dB	78 dB	+35 dBm	+1 dBm	Class AB: -34 dB, Class A: -43 dB **	-80 dB **	35 ms	\$5,779	www.yaesu.com
35	Yaesu FT-450D, November 2011	N/M	134 dB	97 dB	N/M	88 dB	76 dB	+16 dBm	-21 dBm	-25 dB	-50 dB	26 ms	\$999	www.yaesu.com
36	Yaesu FT-950, March 2008	N/M	128 dB	95 dB	N/M	98 dB	71 dB	+21 dBm	-4 dBm	-35 dB	-56 dB	25 ms	\$1,449	www.yaesu.com
37	Alinco DX-SR8T, June 2011	N/M	100 dB	94 dB	N/M	83 dB	70 dB	+1 dB	-30 dBm	-28dB	-53 dB	50 ms	\$519	www.alinco.com
38	Yaesu FT-2000D, October 2007	N/M	136 dB	98 dB	N/M	87 dB	69 dB	+26 dBm	-16 dBm	Class AB: -31 dB, Class A: -41 dB **	Class AB: -47 dB, Class A: -65 dB	27 ms	\$3,549	www.yaesu.com
39	Icom IC-7100, July 2014	-103 dBc	120 dB	95 dB	-84 dBc	89 dB	68 dB	+13 dBm	-25 dBm	-34 dB	-49 dB	22 ms	\$1,370	www.icomamerica.com
40	Icom IC-7200, June 2009	N/M	140 dB	99 dB	N/M	83 dB	67 dB	+23 dBm	-11 dBm	-32 dB	-58 dB	13 ms	\$1,396	www.icomamerica.com
41	Yaesu FT-450, December 2007	N/M	134 dB	97 dB	N/M	90 dB	67 dB	+13 dBm	-31 dBm	-30 dB	-48 dB	20 ms	N/A	www.yaesu.com
42	Yaesu FT-2000, February 2007	N/M	126 dB	95 dB	N/M	92 dB	64 dB	+16 dBm	-22 dBm	-32 dB	-60 dB	35 ms	\$2,819	www.yaesu.com
43	Icom IC-7000, May 2006	N/M	112 dB	89 dB	N/M	86 dB	63 dB	+6 dBm	-27 dBm	-33 dB	-58 dB	12 ms	\$1,299	www.icomamerica.com
44	Alinco DX-SR9T, October 2014	-88 dBc	114 dB	87 dB	-72 dBc	91 dB	60 dB	+17 dBm	-25 dBm	-28dB	-47 dB	60 ms	\$770	www.alinco.com

QST Magazine Product Reviews - Key Measurements Summary - HF Power Amplifiers (page 3/6)

	Subject of measurement, HF	Driving Power	Output Power, CW	Spurious and harmonic suppression 3rd harmonic worst case	Transmit 3rd-order IMD	Transmit 5th-order IMD	Transmit 7th-order IMD	Transmit 9th-order IMD	TR switching time key to RF	TR switching time un-key to power off	Listprice in USD (1997-2016)	Company's site
HF Power Amplifiers sorted by 3rd-order IMD and if equal by 9th-order IMD												
1	Alpha 8100, April 2007	50-55 W	1500 W	-55 dBc	-52 dB	-48 dB	-53 dB	-61 dB	N/M	N/M	\$4,850	www.rfconcepts.com
2	Ameritron AL-800H, September 1997	41-61 W	1500 W	-50 dBc	-49 dB	-55 dB	N/M	N/M	N/M	N/M	\$2,295	www.ameritron.com
3	AlphaPower 91b, September 1997	45-80 W	1500 W	-52 dBc	-45 dB	-49 dB	N/M	N/M	N/M	N/M	\$2,798	www.rfconcepts.com
4	Acom 1000, November 2002	70 W ~	1000 W	-53 dBc	-44 dB	-55 dB	N/M	N/M	N/M	N/M	\$2,750	www.acom-bg.com
5	OM Power OM2500A, November 2014	48-60 W ~	1500 W	-49 dBc	-43 dB	-44 dB	>-60 dB	-56 dB	10 ms	10 ms	\$7,995	www.om-power.com
6	QRO Technologies HF-2500DX, September 1997	40-80 W	1500 W	-46 dBc	-43 dB	-40 dB	N/M	N/M	N/M	N/M	\$2,895	www.qrotec.com
7	SPE Expert 1K-FA, September 2009	28-32 W ~	900 W	-51 dBc	-42 dB	-43 dB	-49 dB	-56 dB	N/M	N/M	\$3,850	www.radio-ham.eu
8	Acom 600S, August 2015	22-28 W ~	600 W	>-60 dBc	-42 dB	-39 dB	-49 dB	-55 dB	12 ms	23 ms	\$2,800	www.acom-bg.com
9	Ten-Tec Centaur Model 411, June 1997	90-100 W	600 W	-48 dBc	-39 dB	-45 dB	N/M	N/M	N/M	N/M	\$750	www.tentec.com
10	Ameritron ALS-1300, September 2011	65-100 W ~	1200 W @	-49 dBc	-38 dB	-43 dB	-54 dB	-49 dB	N/M	N/M	\$2,400	www.ameritron.com
11	Hardrock 50, December 2014	2,4-5 W	50 W	-48 dBc	-38 dB	-33 dB	-38 dB	-46 dB	3,2 ms	3,8 ms	\$299	www.hobbypcb.com
12	Acom 2000A, May 2000	50-60 W	1500 W	-50 dBc	-37 dB	-60 dB	N/M	N/M	N/M	N/M	\$5,500	www.acom-bg.com
13	Acom 1010, December 2006	60 W ~	500 W	-53 dBc	-37 dB	-53 dB	-56 dB	-62 dB	N/M	N/M	\$2,340	www.acom-bg.com
14	Emtron DX-1d, December 2004	40-60 W	750 W	-45 dBc	-37 dB	-46 dB	N/M	N/M	N/M	N/M	\$2,184	www.emtron.com.au
15	Ameritron ALS-600, August 2001	100 W ~	400 W	-49 dBc	-37 dB	-40 dB	N/M	N/M	N/M	N/M	\$1,130	www.ameritron.com

QST Magazine Product Reviews - Key Measurements Summary - HF Power Amplifiers (page 4/6)

	Subject of measurement, HF	Driving Power	Output Power, CW	Spurious and harmonic suppression 3rd harmonic worst case	Transmit 3rd-order IMD	Transmit 5th-order IMD	Transmit 7th-order IMD	Transmit 9th-order IMD	TR switching time key to RF	TR switching time un-key to power off	Listprice in USD (1997-2016)	Company's site		
HF Power Amplifiers sorted by 3rd-order IMD and if equal by 9th-order IMD														
	16	Ten-Tec 418, February 2013	1-20 W	100 W	-52 dBc	-37 dB	-38 dB	-47 dB	-57 dB	N/M	N/M	\$785	www.tentec.com	
NEW	17	Ameritron ALS-1306, January 2016	60-100 W	1100 W	-60 dBc	-37 dB	-40 dB	-54 dB	-56 dB	12 ms	29 ms	\$3,000	www.ameritron.com	NEW
	18	Icom IC-PW1, February 2001	40 W ~	1000 W @	-60 dBc	-36 dB	-41 dB	N/M	N/M	N/M	N/M	\$5,400	www.icomamerica.com	
	19	Tokyo Hy-Power HL-1.2KFX, June 2008	75-95 W	630 W	-55 dBc	-36 dB	-39 dB	-50 dB	-68 dB	N/M	N/M	\$2,350	None	
	20	Tokyo Hy-Power HL-1.5KFX, September 2007	85 W	900 W	-52 dBc	-36 dB	-39 dB	-50 dB	-57 dB	N/M	N/M	\$3,000	None	
	21	Elecraft KPA500, February 2012	30-40 W	500 W	-51 dBc	-34 dB	-53 dB	-46 dB	-54 dB	N/M	N/M	\$2,400	www.elecraft.com	
	22	Acom 1500, June 2013	53-73 W ~	1500 W @	>-50 dBc	-33 dB	-39 dB	-50 dB	-55 dB	N/M	N/M	\$4,750	www.acom-bg.com	
	23	Yaesu VL-1000, January 2002	40 W ~	1000 W @	-60 dBc	-32 dB	-44 dB	N/M	N/M	N/M	N/M	\$4,000	www.yaesu.com	
	24	SPE Expert 2K-FA, November 2013	36-48 W ~	1500 W	-49 dBc	-32 dB	-39 dB	-49 dB	<-60 dB	7 ms	17 ms	\$7,300	www.radio-ham.eu	
	25	Elecraft KXPA100, October 2014	4-6 W ~	100 W	-42/-65 dBc	-32 dB	-34 dB	-42 dB	-52 dB	3 ms	8 ms	\$750	www.elecraft.com	
	26	Tokyo Hy-Power HL-550KFX, March 2013	50-80 W ~	550 W ~	-55 dBc	-30 dB	-43 dB	-50 dB	-57 dB	N/M	N/M	\$3,000	None	
	27	Ameritron ALS-600, March 2005	100 W ~	400 W	-49 dBc	-30 dB	-40 dB	N/M	N/M	N/M	N/M	\$1,428	www.ameritron.com	
	28	Ten-Tec Titan III, March 2004	75 W ~	1500 W	-43 dBc	-30 dB	-37 dB	N/M	N/M	N/M	N/M	\$3,565	www.tentec.com	
	29	TenTec Titan II, September 2001	60 W ~	1500 W	-43 dBc	-29 dB	-31 dB	N/M	N/M	N/M	N/M	\$2,990	www.tentec.com	
	30	SGC SG-500, February 2006	50 W ~	500 W	-49 dBc	-28 dB !	-48 dB !	-49 dB !	-53 dB !	N/M	N/M	\$1,395	www.sgcworld.com	

Notes (page 5/6)

* = Blocking exceeded the levels indicated
** = Below/above measurable levels
~ = Typical
% = Preamp off
! = vs. carrier
@ = PEP
\$ = Listprice in US according to Elecraft, FlexRadio, TenTec and Universal Radio
N/A = Not applicable
N/M = Not measured

Please take into account that there might be a difference in the numbers when comparing the older product reviews (before February 2007) compared to the later product reviews, due to changes in the testing methodology, measurements filters, etcetera.

Dark green = awesome
Green = excellent
Light green = good
Yellow = average
Orange = moderate
Red = poor
Dark red = bad

Blocking gain compression:

When a very strong off channel signal appears at the input to a receiver it is often found that the sensitivity is reduced. The effect arises because the front end amplifiers run into compression as a result of the off channel signal. This often arises when a receiver and transmitter are run from the same site and the transmitter signal is exceedingly strong. When this occurs it has the effect of suppressing all the other signals trying to pass through the amplifier, giving the effect of a reduction in gain.

Blocking is generally specified as the level of the unwanted signal at a given offset (normally 20 kHz) which will give a 3 dB reduction in gain. A good receiver may be able to withstand signals of about ten milliwatts before this happens. The blocking specification is now more important than it was many years ago. With the increase in radio communications systems in use, it is quite likely that a radio transmitter will be operating in the close vicinity to a receiver. If the radio receiver is blocked by the neighbouring transmitter then it can seriously degrade the performance of the overall radio communications system.

Reciprocal mixing dynamic range:

ARRL Lab reports three dynamic range measurements that determine a transceiver's overall performance.

Along with blocking gain compression dynamic range and two tone third order dynamic range, we must consider RMDR while evaluating how well a receiver hears.

Which of these measurements is the most important factor in comparing receivers depends a lot on how you plan to use that receiver. For hearing weak signals at or near the receiver's noise floor, receiver noise typically is the limiting factor. For the reception of stronger signals under crowded band conditions, two tone third order DR is the most important number.

To assess a receiver's ability to perform well in the presence of a single, strong off-channel signal (common within geographical ham radio "clusters" or with another ham on the same block), blocking gain compression DR is usually the dominant factor.

Reciprocal mixing is noise generated in a superheterodyne receiver when noise from the local oscillator (LO) mixes with strong, adjacent signals. All LOs generate some noise on each sideband, and some LOs produce more noise than others. This sideband noise mixes with the strong, adjacent off-channel signal, and this generates noise at the output of the mixer. This noise can degrade a receiver's sensitivity and is most notable when a strong signal is just outside the IF passband. RMDR at 2 kHz spacing is almost always the worst of the dynamic range measurements at 2 kHz spacing that we report in the "Product Review" data table.

3rd order dynamic range:

The difference in decibels between the weakest signal the receiver can handle and the strongest signal the same receiver can handle simultaneously,
- without the need of using additional controls of the receiver, manually carried out by the operator - within 20 kHz (wide spaced) and 2 kHz (close in) within the receiver's passband.
For more information on this important item, written by Rob Sherwood NC0B, please use this link: <http://www.sherweng.com/documents/Barc2008.pdf>

3rd order intercept:

This more or less theoretical point, gives a good indication of a receiver's overall strong signal performance. Third order intercept is related to two-tone third order IMD.

When receiver's response on desired and undesired signals (within the passband) were plotted in the same graph, the two lines would intersect at a point called the third-order intercept.

ARRL Product Review testing includes Two-Tone IMD results at several signal levels. Two-tone, Third-order Dynamic Range figures comparable to previous reviews are shown on the first line in each group.

The "IP3" column is the calculated Third-order Intercept Point. Second-order intercept points were determined using -97 dBm reference.

Third order two-tone dynamic range values shown are best case. IMD DR depends on band activity and signal strengths. See text and February 2010 QST, page 52, for an explanation.

RX/TX turnaround time (TX delay) SSB:

The delay between receive and transmit, important for digital modes. A transmit-to-receive delay of 35 ms or less in SSB indicates that the rig is suitable for digital operation.

Transmit 3rd and 9th order IMD:

All measurements in dB are below PEP output, except note !.

Transmit two-tone intermodulation distortion, or two-tone IMD, is a measure of spurious output close to the desired audio of a transmitter being operated in SSB mode. This spurious output is often created in the audio stages of a transceiver, but any amplification stage can contribute**

If you have ever heard someone causing "splatter", the noisy audio that extends beyond a normal 3 kHz nominal SSB bandwidth, then you have heard the effects of transmit IMD.

Frequencies close to the transmit signal are affected the most, but depending on the amount of IMD, large portions of the band can suffer from one poor transmitter**

Pure Signal = Pre Distortion

For more information (including what the numbers really mean) please read ARRL's QST Magazine August 2004 and January 2006 very interesting articles, and the ARRL Lab Test Procedures Manual which is available at the ARRL.

Version, Website and Disclaimer (page 6/6)

Version January 11, 2016

Please send me an e-mail (to: hans at pa1hr dot nl) if you have corrections, remarks, etc.

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The measurement figures in this overview are from the ARRL Laboratory and published in QST Magazine.

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