ARRL Laboratory
Expanded Test-Result Report
Elecraft K2

Prepared by:
American Radio Relay League, Inc.
Technical Department Laboratory
225 Main St.
Newington, CT 06111
Telephone: (860) 594-0214
Internet: mtracy@arrl.org

Order From:
American Radio Relay League, Inc.
Technical Department Secretary
225 Main St.
Newington, CT 06111
Telephone: (860) 594-0278
Internet: reprints@arrl.org

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Model Information:
K2 Serial #: 00495
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Manufacturer:
Elecraft
PO Box 69
Aptos, CA 95001-0069
Telephone: 831-662-8345
Email: radios@elecraft.com
http://www.elecraft.com/

List of Tests:
(Page numbers are omitted because the length of the report varies from unit to unit.)

Transmitter Tests:
Transmit Output Power
Current Consumption
Transmit Frequency Range
Spectral Purity
Transmit Two-Tone IMD
Carrier and Sideband Suppression
CW Keying Waveform
Transmit Keyer Speed
SSB Transmit Delay
Transmit/Receive Turnaround
Transmit Composite Noise

Receiver Tests:
Noise Floor (Minimum Discernible Signal)
Receive Frequency Range
Blocking Dynamic Range
Two-Tone, Third-Order Dynamic Range and Intercept Point
Two-Tone, Second-Order Intercept Point
In-Band Receiver IMD

Introduction:

This document summarizes the extended battery of tests performed by the ARRL Laboratory for some of the units that are featured in *QST* "Product Review." For all tests, there is a discussion of the test and test method used in ARRL Laboratory testing. For those seeking more detail on our test methods and connection diagrams, the *ARRL Laboratory Test Procedures Manual* is available from the ARRL Technical Department Secretary at a cost of $20.00 for ARRL Members, $25.00 for non-Members, postpaid. It is also available for download from our Member's web page.

Most of the tests used in ARRL product testing are derived from recognized standards and test methods. Other tests have been developed by the ARRL Lab. The ARRL Laboratory test equipment is calibrated annually, with traceability to National Institute of Standards and Technology (NIST). Most of the equipment is calibrated by a contracted calibration laboratory. Other equipment, especially the custom test fixtures, is calibrated by the ARRL Laboratory Engineers, using calibrated equipment and standard techniques.

Units used in Product Review testing are purchased off the shelf from major distributors. We take all necessary steps to ensure that we do not use units that have been specially selected by the manufacturer. When the review is complete, the unit is offered for sale in an open mail bid, announced regularly in *QST*. The units being tested are operated as specified by the equipment manufacturer. Units are tested at room temperature and humidity as determined by the ARRL HVAC system. Equipment is operated at the voltage specified by the manufacturer or from a fully charged internal battery. Equipment that is intended for mobile or portable operation from a dc power source (supply or battery) is also tested for function, output power and frequency accuracy at the minimum specified voltage (11.5 volts if not specified). Also, units that are capable of mobile or portable operation are tested at their rated temperature range (–10 to +60 degrees Celsius if not specified) in a commercial temperature chamber.

ARRL Product Review testing typically represents a sample of only one unit (although we sometimes obtain an extra unit or two for comparison purposes). This is not necessarily representative of all units of the same model number. It is not uncommon that some test parameters will vary significantly from unit to unit. The ARRL Laboratory and Product Review editor work with manufacturers to resolve any deviation from specifications or other problems encountered in the review process and these problems are documented in the Product Review.

Related ARRL Publications and Products:
The *2000 ARRL Handbook for Radio Amateurs* has a chapter on test equipment and measurements. The book is available for $32.00 plus $6 shipping and handling. The *Handbook* is also now available in a convenient, easy to use CD-ROM format. You can order both versions of the *Handbook* from our web page at http://www.arrl.org, or contact the ARRL Publications Sales Department at 888-277-5289 (toll free). It is also widely stocked by radio and electronic dealers and a few large bookstores.

The ARRL Technical Information Service has prepared an information package that discusses Product Review testing and the features of various types of equipment. Request the "What is the Best Rig To Buy" package from the ARRL Technical Department Secretary. The cost is $2.00 for ARRL Members, $4.00 for non-Members, postpaid.

Many *QST* "Product Reviews" have been reprinted in three ARRL publications: The *ARRL Radio Buyers Sourcebook* (order #3452) covers selected Product Reviews from 1970 to 1990. The cost is $15.00 plus $4.00 shipping and handling. The *ARRL Radio Buyers Sourcebook Volume II* (order #4211) contains reprints of all of the Product Reviews from 1991 and 1992. The cost is $15.00 plus $4.00 shipping and handling. The *VHF/UHF Radio Buyer's Sourcebook* (order #6184) contains nearly 100 reviews of transceivers, antennas, amplifiers and accessories for VHF and above.

The *1995*, *1996*, *1997* and *1998 ARRL Periodicals CD ROMs* (order #5579, #6109, #6729, #7377) each contain a complete copy of all articles from a year's worth of *QST*, the *National Contest Journal* and *QEX* (ARRL's experimenter's magazine). Each CD is available for $19.95 plus $4.00 for shipping and handling. Contact the ARRL Publications Sales Department to order a copy.

Older issues of *QST* are also available: *QST View CD-ROMs* come in sets covering either five years each (*1960-1964 through 1990-1994)*, ten years each (*1930-1939, 1940-1949* and *1950-59*) or more (*1915-1929)*. The price for each set is $39.95. Shipping and handling for all ARRL CD ROM products is $4.00 for the first one ordered, $1.00 for each additional set ordered at the same time.

Additional test result reports are available for most transceivers and amplifiers reviewed since 1996. The ARRL Member's Only web page offers these reports for downloading and online viewing in Adobe Portable Document Format (PDF) at no cost to current ARRL members.

The cost for printed copies by mail is $7.50 for ARRL Members, $12.50 for non-Members for each report, postpaid. ARRL Members can obtain any three reports for $20.00, postpaid.

Transmitter Output Power:

Test description: One of the first things an amateur wants to know about a transmitter or transceiver is its RF output power. The ARRL Lab measures the CW output power for every band on which a transmitter can operate. The unit is tested across the entire amateur band and the worst-case number for each band is reported. The equipment is also tested on one or more bands for any other mode of operation for which the transmitter is capable. Typically, the most popular band of operation for each mode is selected. Thus, on an HF transmitter, the SSB tests are done on 75 meters for lower sideband, 20 meters for upper sideband, and AM tests are done on 75 meters, FM tests are done on 10 meters, etc (if applicable). This test also compares the accuracy of the unit's internal output-power metering against the ARRL Laboratory's calibrated test equipment.

A two-tone audio input, at a level within the manufacturer's microphone-input specifications, is used for the SSB mode. No modulation is used in the AM and FM modes.

Many transmitters are de-rated from maximum output power on full-carrier AM and FM modes. In most cases, a 100-watt CW/SSB transmitter may be rated at 25 watts carrier power on AM. The radio may actually deliver 100 watts PEP in AM or FM but is not specified to deliver that power level for any period of time. In these cases, the published test-result table will list the AM or FM power as being "as specified." In almost all cases, the linearity of a transmitter decreases as output power increases. A transmitter rated at 100 watts PEP on single sideband may actually be able to deliver more power, but as the power is increased beyond the rated RF output power, adjacent channel splatter (IMD) usually increases dramatically. If the ARRL Lab determines that a transmitter is capable of delivering its rated PEP SSB output, the test-result table lists the power as being "as specified."

In addition to measuring the RF output power of the unit under test, the Transmitter Output-Power Test also measures the dc current consumption at the manufacturer's specified dc-supply voltage (if applicable).

Transmitter Output Power Test Results:

Frequency Band	Mode	Unit Minimum Power (W)	Measured Minimum Power (mW	Unit Maximum Power (W)	Measured Maximum Power (W)	Notes
3.5 MHz	CW	0.1	3.6	15.2	13.6	1
7.0 MHz	CW	0.1	123	15.2	14.0	
10.1 MHz	CW	0.1	57	15.2	13.5	
14 MHz	CW	0.1	105	15.2	15.3	
14 MHz	USB	0.1	–	15.2	10.0	2
18 MHz	CW	0.1	107	15.2	13.8	
21 MHz	CW	0.1	102	15.2	12.3	
24 MHz	CW	0.1	129	15.2	12.8	
28 MHz	CW	0.1	140	15.2	12.7	3

Notes:

1. Unit does not have a power meter, but does have a power requested value.
   This is not meant to be an accurate readout of actual power output, however.
2. Per standard test procedure, audio input levels are adjusted for manufacturer's rated power.
3. Output power on 10M decreases above 28.8 MHz due to the alignment of the filter.

Current Consumption Test: (DC-powered units only)

Test Description: Current consumption can be a important to the success of mobile and portable operation. While it is most important for QRP rigs, the ARRL Lab tests the current consumption of all equipment that can be operated from a battery or 12-14 v dc source. The equipment is tested in transmit at maximum output power. On receive, it is tested at maximum volume, with no input signal, using the receiver's broadband noise. Any display lights are turned on to maximum brightness, if applicable. This test is not performed on equipment that can be powered only from the ac mains.

Current Consumption:

Voltage	Transmit Current	Output Power	Receive Current	Lights?	Notes
13.8 V	2.5 A	10.0 W	0.3 A	ON	1

Note:

1. Receive current can be reduced by turning off the display back-light ("day mode"), changing the S-meter to "dot mode" (or off altogether) and by enabling the K2's battery mode. In doing all of the above, the measured receive current was reduced to 153 mA.

Transmit Frequency Range Test:

Test Description: Many transmitters can transmit outside the amateur bands, either intentionally (to accommodate MARS operation, for example) or unintentionally as the result of the design and internal software. The ARRL Lab tests the transmit frequency range inside the screen room. The purpose of the Transmit Frequency Range Test is to determine the range of frequencies, including those outside amateur bands, for which the transmitter may be used. The key test conditions are to test it at rated power, using nominal supply voltages. Frequencies are as indicated on the transmitter frequency indicator or display. Most modern synthesized transmitters are capable of operation outside the ham bands. However, spectral purity is not always legal outside the hams bands, so caution must be used. In addition, most other radio services require that transmitting equipment be type accepted for that service. Amateur equipment is not legal for use on other than amateur and MARS frequencies.

Test Results:

Frequency	Low-Frequency Limit	High-Frequency Limit	Notes
80 M – 10M	–	–	1

Notes:

1. Transmit bandwidth is limited only by the filter adjustments. The radio will go into transmit mode on all receive frequencies, but output is reduced by the filters increasingly as you move away from each ham band. See Receive Frequency Range Test Results for more information on VFO tuning range.

CW Transmit Frequency Accuracy Test:

Test Description: Most modern amateur equipment is surprisingly accurate in frequency. It is not uncommon to find equipment operating within a few Hz of the frequency indicated on the frequency display. However, some units, notably "analog" units, not using a phase-lock loop in the VFO design, can be off by a considerable amount. This test measures the output frequency. Unit is operated into a 50-ohm resistive load at nominal temperature and supply voltage.

Test Results:

Unit Frequency	Supply Voltage	Temperature	Measured Frequency Full Output Power	Notes
14.000 00 MHz	13.8 V	25 C	14.001.067 MHz	1

Notes:
1. Output frequency is dependent upon the K2's frequency counter calibration and BFO adjustments, so "your mileage may vary" (could be better or worse than the above).

Spectral Purity Test:

Test Description: All transmitters emit some signals outside their assigned frequency or frequency range. These signals are known as spurious emissions or "spurs." Part 97.307 of the FCC rules and regulations specify the amount of spurious emissions that can be emitted by a transmitter operating in the Amateur Radio Service. The ARRL Laboratory uses a spectrum analyzer to measure the spurious emission on each band on which a transmitter can operate. The transmitter is tested across the band and the worst-case spectral purity on each band is recorded. Spectral purity is reported in dBc, meaning dB relative to the transmitted carrier.

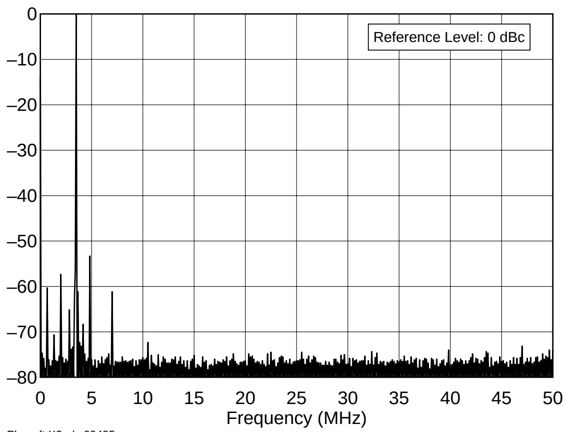
The graphs and tables indicate the relative level of any spurious emissions from the transmitter. The lower that level, expressed in dB relative to the output carrier, the better the transmitter is. So a transmitter whose spurious emissions are –60 dBc is spectrally cleaner than is one whose spurious emissions are –30 dBc. Information about all amateur rules and regulations is found in the *ARRL FCC Rule Book.* Additional information about the decibel is found in the *ARRL Handbook.*

Test Results - summary:

Frequency	Spurs (dBc)	Notes
3.5 MHz	–55 dBc	
7 MHz	–62	
10.1 MHz	–53	
14 MHz	–50	
18 MHz	–46	
21 MHz	–48	
24 MHz	–43	
28 MHz	–38	1

Notes:
1. Measured at 28.8 MHz.

Spectral-Purity Graphs:



Elecraft K2 s/n 00495
3.5 MHz Band, Spectral Purity, 10 W
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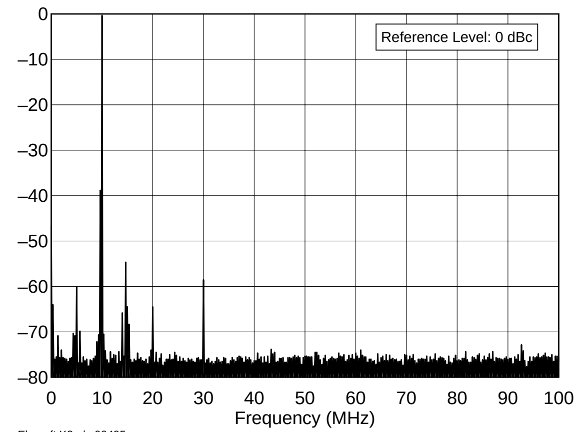

Elecraft K2 s/n 00495
10.1 MHz Band, Spectral Purity, 10 W
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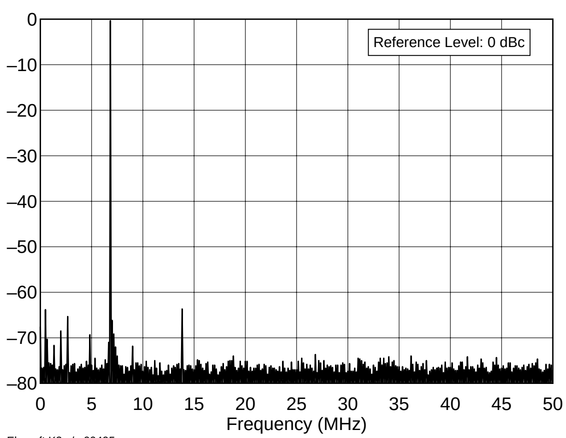

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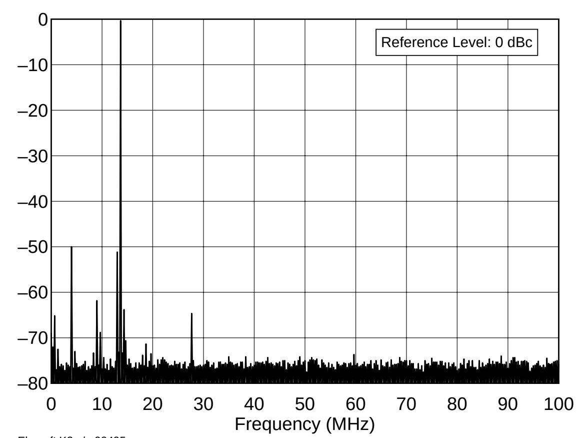

Elecraft K2 s/n 00495
14.0 MHz Band, Spectral Purity, 10 W
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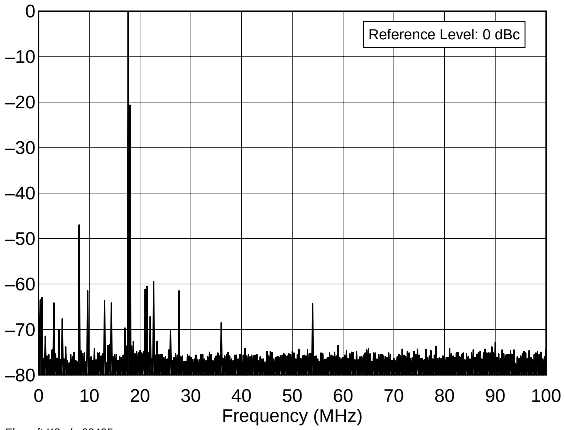

Elecraft K2 s/n 00495
18.1 MHz Band, Spectral Purity, 10 W
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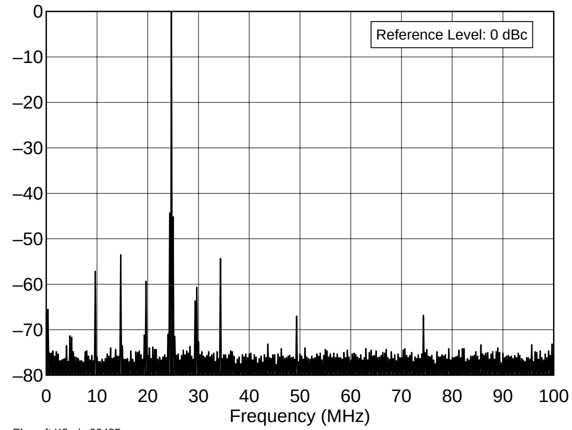

Elecraft K2 s/n 00495
24.9 MHz Band, Spectral Purity, 10 W
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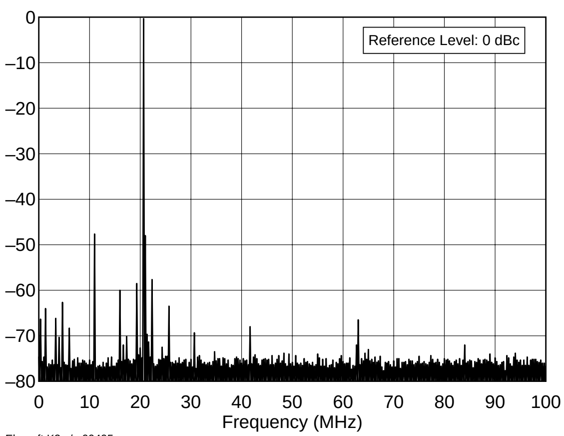

Elecraft K2 s/n 00495
21.0 MHz Band, Spectral Purity, 10 W
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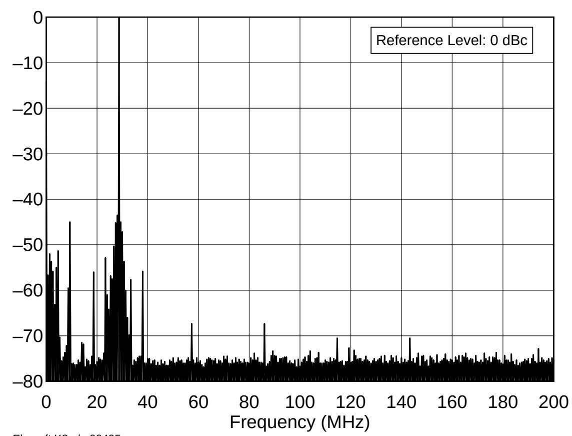


Elecraft K2 s/n 00495
28.0 MHz Band, Spectral Purity, 10 W
C:\TESTS\K2MOD\K2S10.TXT

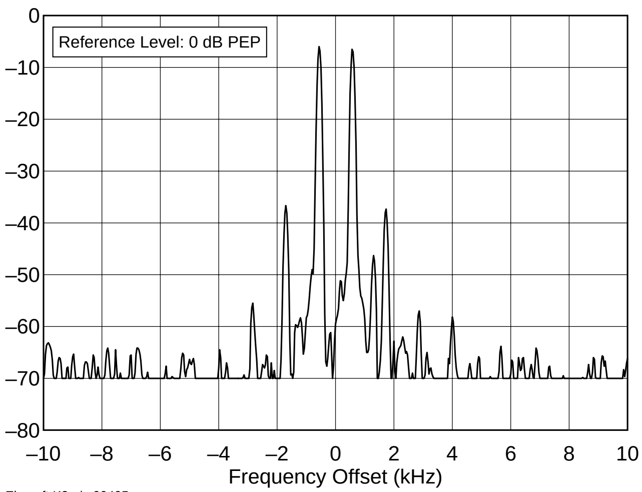
Transmit Two-Tone IMD Test:

Test Description: Investigating the sidebands from a modulated transmitter requires a narrow-band spectrum analysis. In this test, a two-tone test signal is used to modulate the transmitter. The display shows the two test tones plus some of the intermodulation distortion (IMD) products produced by the SSB transmitter. In the ARRL Lab, frequencies of 700 and 1900 Hz are used to modulate the transmitter. These frequencies were selected to be within the audio passband of the typical transmitter, resulting in a meaningful display of transmitter IMD. The IMD products appear on the spectral plot above and below the two tones. The lower the intermodulation products, the better the transmitter. In general, it is the products that are farthest removed from the two tones (typically > 3 kHz away) that cause the most problems. These can cause splatter up and down the band from strong signals.

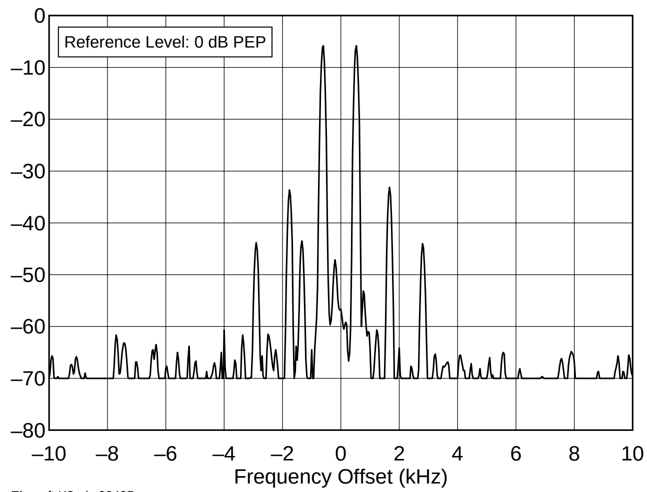
Test Result Summary:

Frequency	Worst-case 3rd-order dB PEP	Worst-case 5th-order dB PEP	Notes
3.9 MHz	–39	–53	
7.25 MHz	–37	–45	
10.12 MHz	–35	–44	
14.2 5 MHz	–42	–50	
18.12 MHz	–42	–45	
21.25 MHz	–35	–43	
24.95 MHz	–35	–44	
28.35 MHz	–29	–44	

Transmit IMD Graphs



Elecraft K2 s/n 00495
3.900 MHz, Transmit IMD, 10 W
C:\!TESTS\K2MOD\K2I80.TXT



Elecraft K2 s/n 00495
10.120 MHz, Transmit IMD, 10 W
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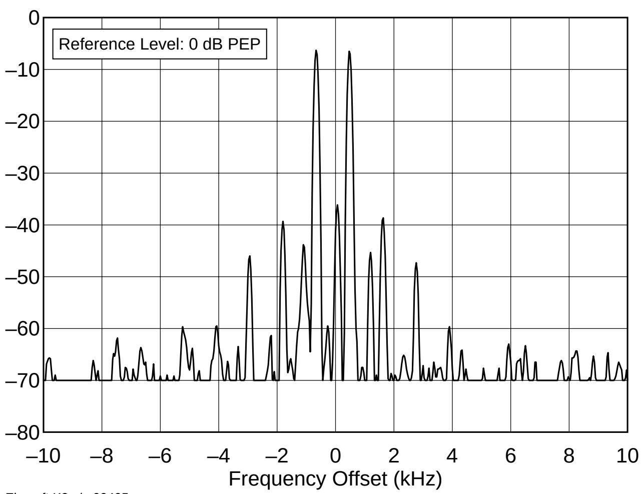

Elecraft K2 s/n 00495
7.250 MHz, Transmit IMD, 10 W
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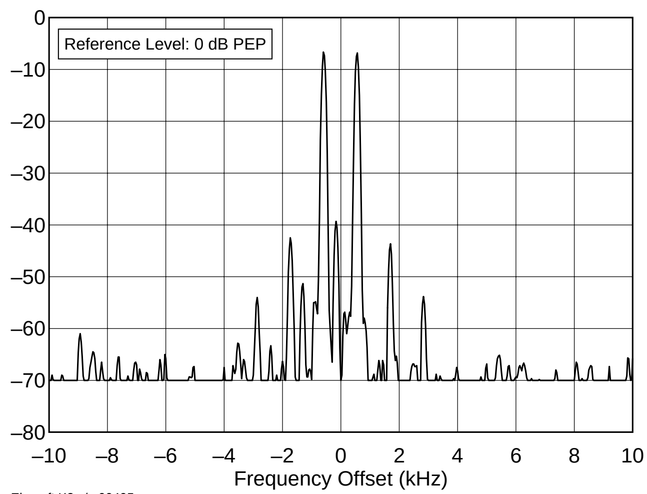
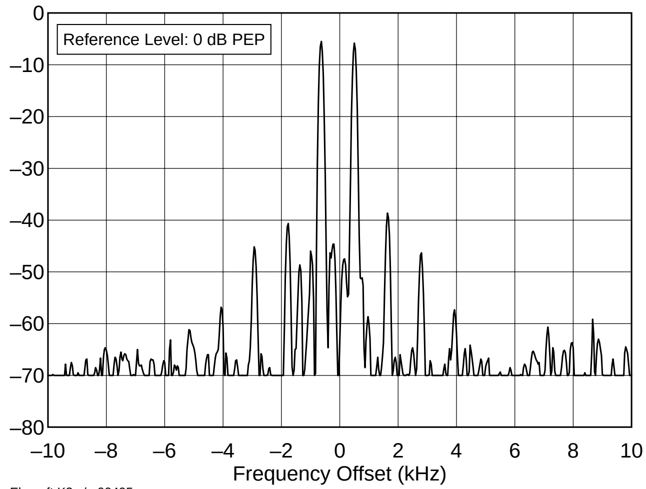
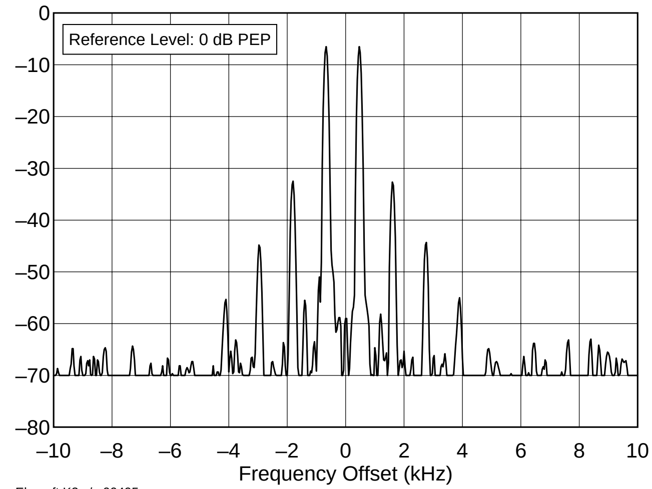


Elecraft K2 s/n 00495
14.250 MHz, Transmit IMD, 10 W
C:\!TESTS\K2MOD\K2I20.TXT



Elecraft K2 s/n 00495
18.120 MHz, Transmit IMD, 10 W
C:\!TESTS\K2MOD\K2I17.TXT



Elecraft K2 s/n 00495
24.950 MHz, Transmit IMD, 10 W
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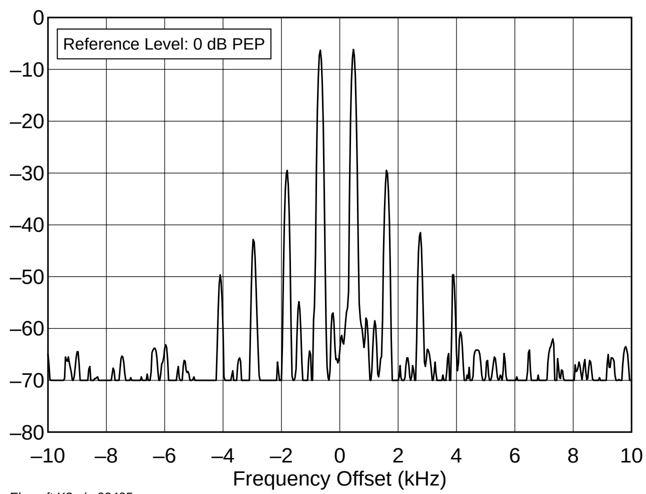
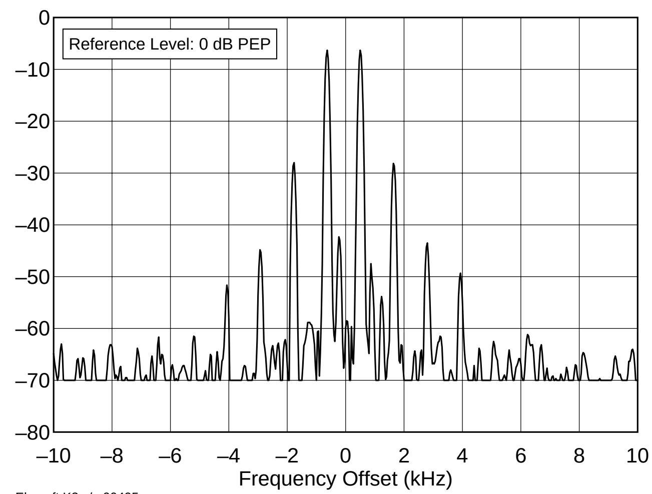


Elecraft K2 s/n 00495
21.250 MHz, Transmit IMD, 10 W
C:\!TESTS\K2MOD\K2I15.TXT



Elecraft K2 s/n 00495
28.350 MHz, Transmit IMD, 10 W
C:\!TESTS\K2MOD\K2I10.TXT

SSB Carrier and Unwanted Sideband Suppression Test:

Test Description: The purpose of the SSB Carrier and Opposite-Sideband Suppression test is to determine the level of carrier and unwanted sideband suppression relative to Peak Envelope Power (PEP). The transmitter output is observed on the spectrum analyzer and the unwanted components are compared to the desired sideband. The greater the amount of suppression, the better the transmitter. For example, opposite sideband suppression of 60 dB is better than suppression of 50 dB.

Test Results:

Frequency	Carrier Suppression	Opposite Sideband Suppression	Notes
14.2 MHz USB 14.2 MHz LSB	–51 dB PEP –45 dB PEP	< –65 dB PEP < –65 dB PEP	

CW Keying Waveform Test:

Test Description: The purpose of the CW Keying Waveform Test is to determine the rise and fall times for the 10% to the 90% point of the device under test's RF output envelope in the CW mode. The on and off delay times from key closure to RF output are also measured. If the transmitter under test has several CW modes, (i.e. VOX, QSK) these measurements is made at rated output power for each mode. A picture of the oscilloscope screen is taken of the results with the QSK off, and in the VOX mode showing the first dit, and any other test conditions that result in a waveshape that is significantly different from the others (more than 10% difference, spikes, etc.). The first and second dits are shown in all modes.

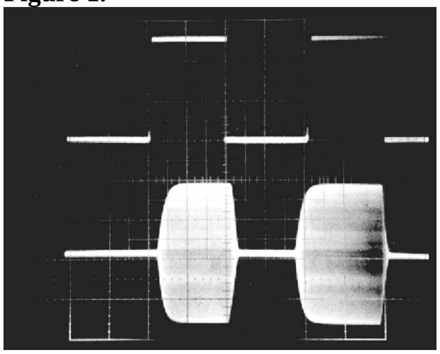
If the risetime or falltime become too short, the transmitter will generate key clicks. Most click-free transmitters have a rise and fall time between 1 ms and 5 ms. The absolute value of the on delay and off delay are not critical, but it is important that they be approximately the same so that CW weighting will not be affected.

Some transmitters used in the VOX mode exhibit a first dit that is shorter than subsequent dits. Other transmitters can show significant shortening of all dits when used in the QSK mode. The latter will cause keying to sound choppy.
The first dit foreshortening is expressed as a "weighting" number. In perfect keying, the weighting is 50%, meaning that the carrier is ON for 50% of the time.

Test Result Summary:

Frequency	Mode	First Dit Risetime	First Dit Falltime	Subsequent Dits Risetime	Subsequent Dits Falltime	On Delay 1st/2nd	Off Delay 1st/2nd	Weighting %	First Dit Weighting %
14.02 MHz	–	4.0 ms	4.0 ms	4.0 ms	4.0 ms	23.5/18.5 ms	24.0/20.0 ms	55%	45%

Figure 1.



First and second dits (horizontal scale is 10 ms/division).

Transmit Keyer Speed Test:

Test Description: This test measures the speed of the internal keyer on transmitters so equipped. The keyer is tests at minimum, midrange and maximum speeds and the time from dit to dit is measured using an oscilloscope and used to calculate the speed using the "Paris" method of code speed calculation. (In the Paris method, the word "Paris" is used as the standard word to calculate words per minute.)

Test Results:

Min WPM	Max WPM	Mid WPM	Notes
8.9 wpm	41 wpm	29 wpm	1

Notes:
1. Specified keyer range = 9 to 50 wpm.

Keying sidetone test:

Test Description: This test measures the audio frequency of the keyer sidetone.

Test Result:

Default pitch	Minimum	Maximum	Notes
700 Hz	400 Hz	800 Hz	1

Notes:
1. Transmit offset tracks sidetone.

Transmit/Receive Turnaround Test:

Test Description: The purpose of the Transmit/Receive turnaround test is to measure the delay required to switch from the transmit to the receive mode of a transceiver.

Test Results:

Frequency	Conditions	T/R Delay AGC Fast	T/R Delay AGC Slow	Notes
14.2 MHz	50% audio	38 ms	35 ms	1

Notes:
1. T/R delay less than or equal to 35 ms is suitable for use on AMTOR. This unit just meets the requirement.

Transmit Delay Test

Test Description: The purpose of the Transmit Delay test is to measure the time between PTT closure and 50% RF output. It is measured on SSB, modulated with a single tone.

Test Results:

Frequency	Mode	On delay	Notes
14.2 MHz	SSB	23 ms	

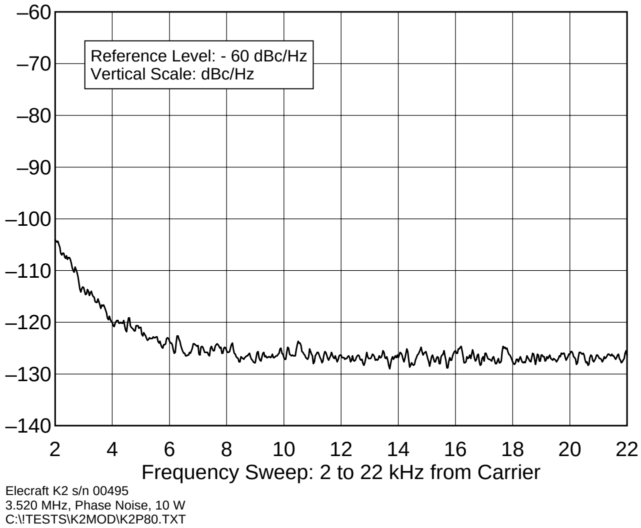
Transmit Composite Noise Test:

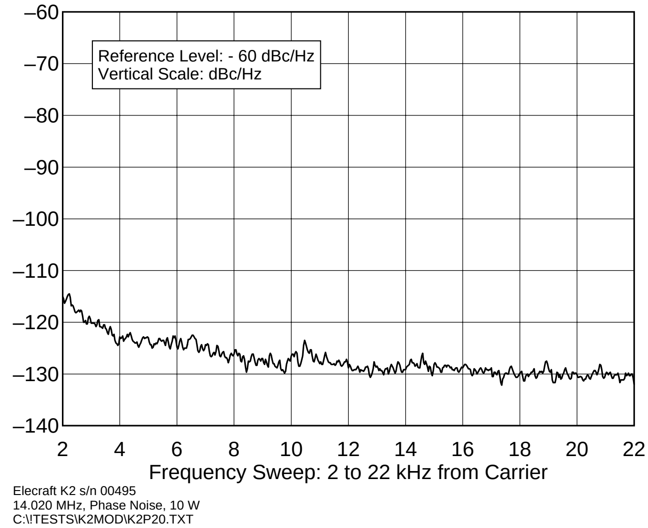
Test Description: The purpose of the Composite-Noise Test is to observe and measure the phase and amplitude noise, as well as any spurious signals generated by the device under test transmitter. Since phase noise is the primary noise component in any well-designed transmitter, it can be assumed, therefore, that almost all the noise observed during this test is phase noise. This measurement is accomplished by converting the output of the transmitter down to a frequency about 10 or 20 Hz above baseband. A mixer and a signal generator used as a local oscillator are used to perform this conversion. Filters remove the 0 Hz component as well as the unwanted heterodyne components. The remaining noise and spurious signals are then observed on the spectrum analyzer. The lower the noise as seen on the plot, the better the transmitter.

Test Results:

Frequency	2 kHz offset (dBc/Hz)	20 kHz offset (dBc/Hz)	Notes
3.520 MHz	–105	–126	
14.02 MHz	–115	–130	

Transmit Composite Noise Graphs:





Receiver Noise Floor (Minimum Discernible Signal) Test:

Test Description: The noise floor of a receiver is the level of input signal that gives a desired audio output level that is equal to the noise output level. This is sometimes called “minimum discernible signal” (MDS), although a skilled operator can detect a signal up to 10 dB or so below the noise floor. Most modern receivers have a noise floor within a few dB of “perfect.” A perfect receiver would hear only the noise of a resistor at room temperature. However, especially for HF receiving systems, the system noise is rarely determined by the receiver. In most cases, external noise is many dB higher than the receiver’s internal noise. In this case, it is the external factors that determine the system noise performance. Making the receiver more sensitive will only allow it to hear more noise. It will also be more prone to overload. In many cases, especially in the lower HF bands, receiver performance can be improved by sacrificing unneeded sensitivity by placing an attenuator in front of the receiver. The more negative the sensitivity number expressed in dBm, or the smaller the number expressed in voltage, the better the receiver.

Noise Floor Summary:

Frequency	Preamp OFF MDS dBm	Preamp ON MDS dBm	Notes
3.52 MHz	–132.9	–136.5	1
14.02 MHz	–131.0	–137.6	

Notes:

1. The crystal filter option selected was 700 Hz nominal bandwidth. However, the actual bandwidth of the filter was considerably narrower (about 350 Hz), making this option closer to the desired 500 Hz width than the 400 Hz option.

Receive Frequency Range:

Test Description: This test measures the tuning range of the receiver. The range expressed is the range over which the receiver can be tuned. Most receivers exhibit some degradation of sensitivity near the limits of their tuning range. In cases where this degradation renders the receiver unusable, we report both the actual and useful tuning range.

Test Results:

Minimum Frequency	Minimum Frequency MDS dBm	Maximum Frequency	Maximum Frequency MDS	Notes
2.900 MHz	–120.6	4.100 MHz	–126.1	1
6.500	–115.2	7.350	–128.5	
10.000	–123.2	10.500	–131.4	
13.200	–115.0	14.700	–117.4	
17.100	–115.9	20.100	–116.8	
20.100	–116.8	22.000	–123.1	2
23.200	–116.8	25.700	–126.2	
25.700	–121.4	30.400	–115.0	3

Notes:

1. Each row in this table represents one of the “band” memories. Ranges given represent useful reception range, but the VFO can be tuned over a considerably larger range than the unit will receive over. For example, on the 80M “band” position, the VFO can be tuned from 0.00 (dc) to 16.0 MHz and on the 10M “band” position, the VFO can be tuned as high as 100 MHz. This is only the display frequency, however; the unit does not actually receive or transmit on these extremes.
2. Actual coverage on the higher “bands” overlaps. The 15M “band” will usefully receive below 20.1 MHz.
3. The 10M “band” will usefully receive below 25.700 MHz. These overlap areas were not tested.

Blocking Dynamic Range Test:

Test Description: Dynamic range is a measurement of a receiver's ability to function well on one frequency in the presence of one or more unwanted signals on other frequency. It is essentially a measurement of the difference between a receiver's noise floor and the loudest off-channel signal that can be accommodated without measurable degradation of the receiver's response to a relatively weak signal to which it is tuned. This difference is usually expressed in dB. Thus, a receiver with a dynamic range of 100 dB would be able to tolerate an off-channel signal 100 dB stronger than the receiver's noise floor.
In the case of blocking dynamic range, the degradation criterion is receiver desense. Blocking dynamic range (BDR) is the difference, in dB, between the noise floor and an off-channel signal that causes 1 dB of gain compression in the receiver. It indicates the signal level, above the noise floor, that begins to cause desensitization. BDR is calculated by subtracting the noise floor from the level of undesired signal that produces a 1-dB decrease in a weak desired signal. It is expressed in dB. The greater the dynamic range, expressed in dB, the better the receiver performance. It is usual for the dynamic range to vary with frequency spacing.

Test Result Summary:

Band	Preamp	Spacing	BDR (dB)	Notes
3.52 MHz	OFF	20 kHz	136	
3.52 MHz	ON	20 kHz	127	
14.02 MHz	OFF	20 kHz	136	
14.02 MHz	ON	20 kHz	128	
14.02 MHz	ON	50 kHz	126	1
14.02 MHz	ON	100 kHz	126	

Notes:
1. Tests for greater spacing than 20 kHz were only performed as part of the swept testing.

Two-Tone 3rd-Order Dynamic Range Test:

Test Description: Intermodulation distortion dynamic range (IMD DR) measures the impact of two-tone IMD on a receiver. IMD is the production of spurious responses resulting from the mixing of desired and undesired signals in a receiver. IMD occurs in any receiver when signals of sufficient magnitude are present. IMD DR is the difference, in dB, between the noise floor and the strength of two equal off-channel signals that produce a third-order product equal to the noise floor.

In the case of two-tone, third-order dynamic range, the degradation criterion is a receiver spurious response. If the receiver generates a third-order response equal to the receiver's noise floor to two off-channel signals, the difference between the noise floor and the level of one of the off-channel signals is the blocking dynamic range.

This test determines the range of signals that can be tolerated by the device under test while producing essentially no undesired spurious responses. To perform the 3rd Order test, two signals of equal amplitude and spaced 20 kHz apart, are injected into the input of the receiver. If we call these frequencies f_1 and f_2, the third-order products will appear at frequencies of $(2f_1-f_2)$ and $(2f_2-f_1)$.

The greater the dynamic range, expressed in dB, or the higher the intercept point, the better the performance.

Test Result Summary:

Band	Spacing	Preamp OFF IMD DR (dB)	Preamp ON IMD DR	Notes
3.52 MHz	20 kHz	100	95	
14.02 MHz	20 kHz	97	98	
14.02 MHz	50 kHz	N/A	96	
14.02 MHz	100 kHz	N/A	96	

Dynamic Range Graphs:

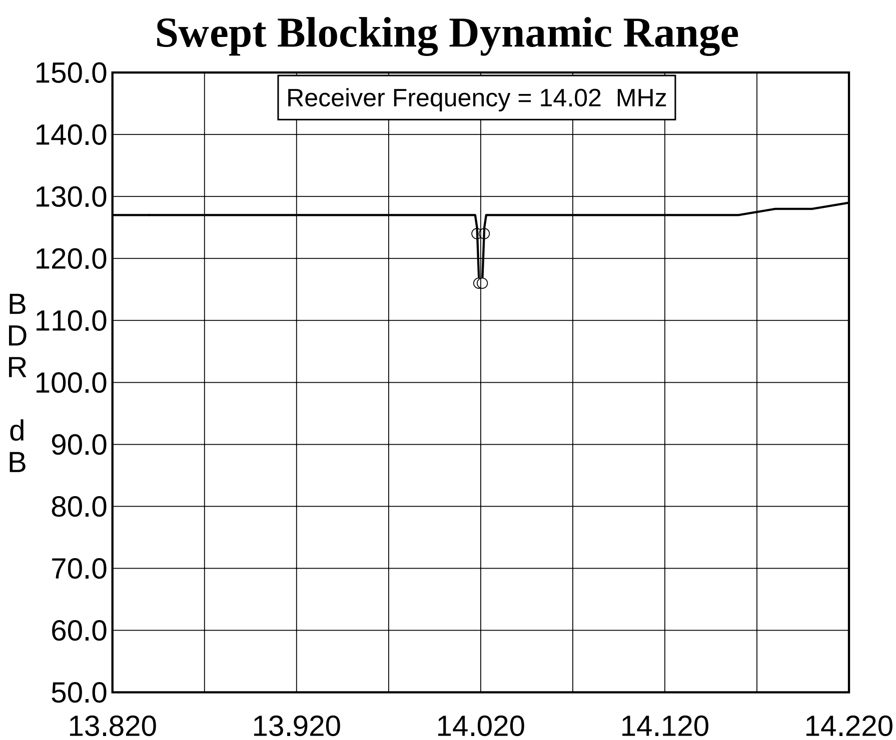
The following graphs are one of the highlights of ARRL test result reports -- swept plots of receiver two-tone, third-order IMD dynamic range and blocking dynamic range.

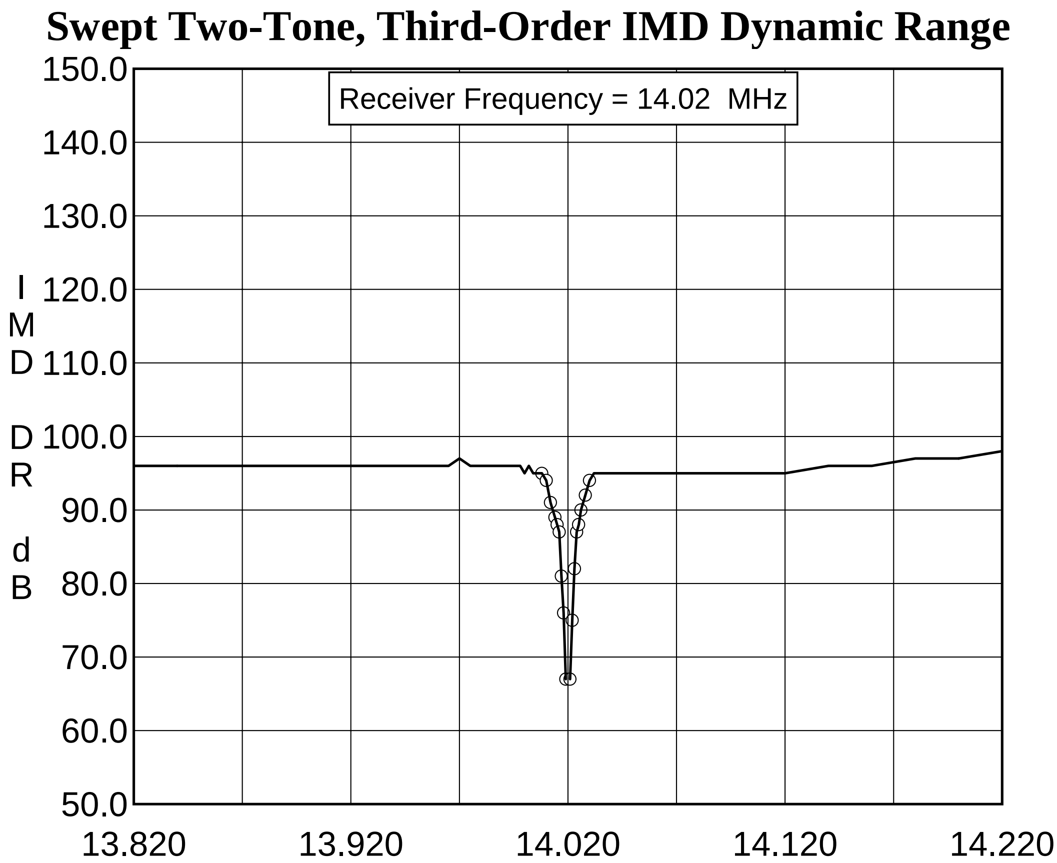
Dynamic range measures the difference between a receiver's noise floor and the receiver's degradation in the presence of strong signals. In some cases, the receiver's noise performance causes receiver degradation before blocking or a spurious response is seen. In either case, if the noise floor is degraded by 1 dB due to the presence of receiver noise during the test, the dynamic range is said to be noise limited by the level of signal that caused the receiver noise response. A noise-limited condition is indicated on the test-result graphs by a circle marking the points that were noise limited.

Being "noise limited" is not necessarily a bad thing. A receiver noise limited at a high level is better than a receiver whose dynamic range is lower than the noise-limited level. In essence, a receiver that is noise limited has a dynamic range that is better than its local-oscillator noise. Most of the best receivers are noise limited at rather high levels.

The ARRL Laboratory has traditionally used off-channel signals spaced 20 kHz from the desired signal. While this does allow easy comparisons between different receivers, there is nothing magical about the 20-kHz spacing. In nearly all receivers, the dynamic range varies with signal spacing, due to the specific design of the receiver. Most receivers have filter combinations that do some coarse filtering at RF and in the first IF, with additional filtering taking place in later IF or AF stages. As the signals get "inside" different filters in the receiver, the dynamic range decreases as the attenuation of the filter is no longer applied to the signal. Interestingly, the different filter shapes can sometimes be seen in the graphs of dynamic range of different receivers. In the case of the ARRL graphs, one can often see that the 20-kHz spacing falls on the slope of the curve. Many manufacturers specify dynamic range at 50 or 100 kHz.

The graphs that follow show swept blocking and two-tone dynamic range. In the blocking test, the receiver is tuned to a signal on 14.020 MHz, the center of the graph. The X axis is the frequency (MHz) of the undesired, off-channel signal. In the two-tone test, the receiver is tuned to a signal on 14.020 MHz, the center of the graph. The X-axis is the frequency of the closer of the two tones that are creating intermodulation.





Second-Order IMD Test:

Test Description: This test measures the amount of 2nd-order mixing that takes place in the receiver. Signals at 6 and 8 MHz are presented to the receiver and the resultant output at 14 MHz is measured.

Test Results:

Frequency	Preamplifier	Mode	Dynamic Range (dB)	IP2	Notes
14.02 MHz	OFF	CW	129	+75 dBm	
14.02 MHz	ON	CW	127	+76 dBm	

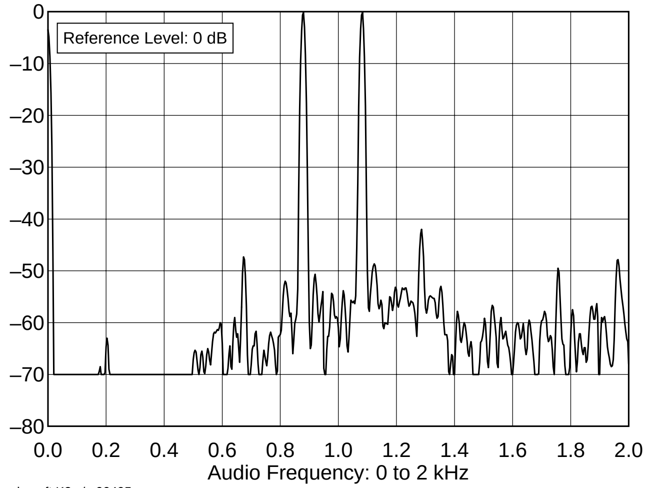
In-Band Receiver IMD Test:

Test Description: This test measures the intermodulation that occurs between two signals that are simultaneously present in the passband of a receiver. Two signals, at levels of 50 µV (nominally S9), spaced 200 Hz apart are used. The receiver AGC is set to FAST. The receiver is tuned so the two signals appear at 900 Hz and 1100 Hz in the receiver audio. The output of the receiver is viewed on a spectrum analyzer and the 3rd- and 5th order products are measured directly from the screen. The smaller the products as seen on the graph, the better the receiver. Generally, products that are less than 30 dB below the desired tones will not be cause objectionable receiver intermodulation distortion.

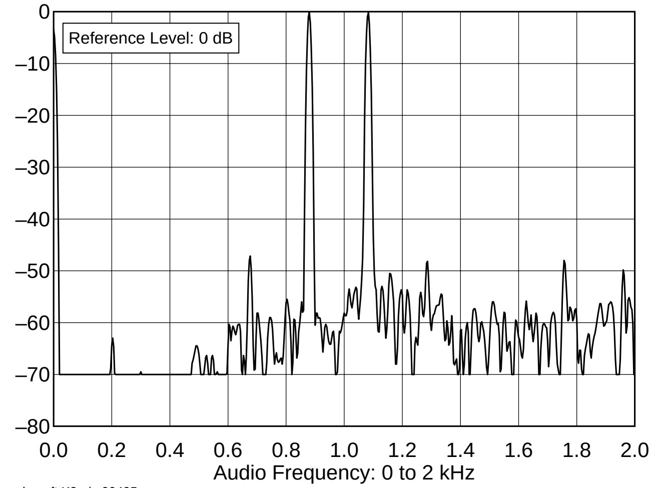
Test Result Summary:

Frequency	Preamplifier	AGC	3rd-order dB PEP	5th-order dB PEP	Notes
14.02 MHz	ON	FAST	–43	–57	
14.02 MHz	ON	SLOW	–47	–56	

In-Band Receiver IMD Graphs:



elecraft K2 s/n 00495
14.020 MHz, AGC Fast, In-Band Receiver IMD
C:\!TESTS\K2MOD\K2IBF.TXT



elecraft K2 s/n 00495
14.020 MHz, AGC Slow, In-Band Receiver IMD
C:\!TESTS\K2MOD\K2IBS.TXT