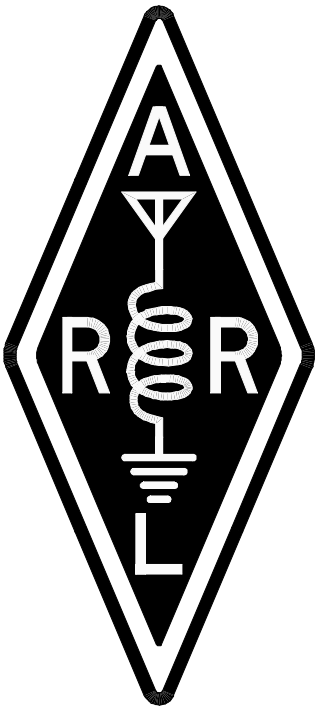
ARRL Laboratory
Expanded Test-Result Report
HF Amplifier Comparative Report

Prepared by:
American Radio Relay League, Inc.
Technical Department Laboratory
225 Main St.
Newington, CT 06111
Telephone: (860) 594-0210
Web Site: http://www.arrl.org/
Internet email: mgruber@arrl.org

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

Price:
$7.50 for ARRL Members, $12.50 for non-Members, postpaid.



Manufacturer:
Alpha/Power, Inc.
1440 Mead Court
Longmont, CO 80504
(970) 535-4173 FAX (970) 535-0281

Model: 91β Serial #: 961610296
QST "Product Review": September, 1997

Manufacturer:
Ameritron
116 Willow Rd
Starkville, MS 39759
Phone: 601-323-8211
Fax: 601-323-6551
WWW: http://www.ameritron.com/

Model: AL-800H Serial #: 00038
QST "Product Review": September, 1997

Manufacturer:
QRO Technologies
1117 West High Street
PO Box 939
Bryan, OH 43506
Phone: 419-636-2721
800-956-2721 (Orders and info)
Fax: 419-636-6039
Web Site: http://www.bright.net/~qrotec/

Model: HF-2500DX Serial #: 5450
QST "Product Review": September, 1997

Related ARRL Publications and Products:

Available from the ARRL Publications Sales Department:

The *ARRL Handbook for Radio Amateurs* (order # 1743) has a chapter on test equipment and measurements. It is available for $38.00 plus $6.00 shipping and handling. You can order it from our Web page, or contact the ARRL Publications Sales Department. It is also widely stocked by radio and electronic dealers. The ARRL Handbook is also now available in a convenient, easy to use CD-ROM format (order # 1751). In addition to the complete *Handbook* text and graphics, the CD-ROM includes a search engine, audio clips, zooming controls, bookmarks and clipboard support. The cost is $49.95 plus $4.00 shipping and handling.

QST "Product Reviews" have been reprinted in two 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. You can order these books from our Web page or contact the ARRL Publications Sales Department to order a copy.

QST is also available on CD ROM! The *1995 ARRL Periodicals CD ROM* (order #5579) contains a complete copy of all 1995 articles from *QST*, the *National Contest Journal* and *QEX*, ARRL's experimenter's magazine. The *1996 ARRL Periodicals CD ROM* (order #6109) covers all of the 1996 issues of the same magazines. They are 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* have also been scanned and put onto CD ROM. : *QST View CD-ROM 1990-1994* (order # 5749), *QST View CD-ROM 1985-1989* (order # 5757), *QST View CD-ROM 1980-1984* (order # 5765), *QSTView CD-ROM 1975-1979* (order # 5773) and *QSTView CD-ROM 1970-1974* (order #5781). The price 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 CD ROM ordered at the same time. (We are continuing to scan earlier years of *QST*, so check with ARRL Publications Sales Department to see what else may be available.)

You can order any of these publications from our Web page or contact our Publications Sales Department at:

ARRL Publications Sales Department
225 Main St.
Newington, CT 06111
(888) 277-5289 - toll free 8AM - 5PM Eastern time
(860) 594-0303 FAX
Internet: pubsales@arrl.org
World Wide Web: http://www.arrl.org/catalog/ (All ARRL Web orders are now secure!)
All major credit cards accepted. Dealer inquires welcome.

Available from the ARRL Technical Department Secretary:

Additional test result reports are available from the ARRL Technical Department Secretary. The cost is $7.50 for ARRL Members, $12.50 for non-Members for each report, postpaid. For ARRL Members, any 3 reports may be selected for $20.00, 4 or more for $6.50 each.

Manufacturer	Model	Issue
Alpha/Power	91β	Sep 97
Ameritron	AL-800H	Sep 97
ICOM	IC-706	Mar 96
	IC-756	May 97
	IC-775DSP	Jan 96
	IC-821H	Mar 97
JRC	NRD-535	May 97
Kenwood	TS-570D	Jan 97
	TS-870S	Feb 96
QRO Technologies	HF-2500DX	Sep 97
Ten Tec	411H	Jun 97
	Omni VI+	Nov 97
Yaesu	FT-1000MP	Apr 96
	FT-920	Oct 97

The ARRL Technical Information Service has prepared an information package, "What Rig Should I Buy?," (http://www.arrl.org/tis/info/bestrig.html) that discusses Product Review testing and the features of various types of equipment. Paper copies are available from the ARRL Technical Department Secretary. The cost for paper copies is $2.00 for ARRL Members, $4.00 for non-Members, postpaid.

Reprints of any *QST* article or Product Review are available from the ARRL Technical Department Secretary for $3.00 for ARRL Members, $5.00 for non-Members, postpaid (The QST CD ROMs usually represent a better value, however!).

Contact:

ARRL Technical Department Secretary
225 Main St.
Newington, CT 06111
(860) 594-0278 - voice
(860) 594-0259 FAX
Internet email: bdicosimo@arrl.org

Introduction:

This document is a summary of an extensive battery of tests performed by the ARRL Laboratory for each unit that is featured in *QST* "Product Review." We have expanded the series of tests we perform on each unit and we are offering the test results to those who are interested in learning more technical details about equipment than can be fit into the pages of *QST*. The proceeds from the sale of these reports is used to fund the additional staff time that goes into testing the equipment and preparing these reports, allowing us to do more testing than we have room to document in *QST*. Please help promote this valuable new service so we can continue to offer it and expand our testing program.

Each test section contains up to three components. For all tests, there is a discussion of the test and test method used in ARRL Laboratory testing. For most tests, critical test conditions are listed to enable other engineers to duplicate our test methods. For some of the tests, a block diagram of the test setup is included. The ARRL Laboratory has an internal document, the *ARRL Laboratory Test Procedures Manual.* This manual explains our specific test methods in detail, with a test description similar to the one in this report, a block diagram, showing the specific equipment currently in use for each test, along with all equipment settings and a specific step by step procedure used in the ARRL Laboratory. While this is not available as an ARRL publication, the ARRL Technical Department Secretary can supply a photocopy. The charge is $20.00 for ARRL Members, $25.00 for non-Members, postpaid.

Tests performed duruing ARRL product testing are derived from recognized standards and test methods. The test methods have sometimes been adapted to specific amateur needs. Other tests have been developed by the ARRL Lab. The ARRL Laboratory Test equipment is calibrated as required, with traceability to National Institute of Standards and Technology (NIST http://www.nist.gov/)). 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.

The units being tested are operated as specified by the equipment manufacturer. The ARRL screen room has an ac supply that is regulated to 117 or 234 volts. If possible, the equipment under test is operated from the ac supply. Mobile and portable equipment is operated at the voltage specified by the manufacturer, at 13.8 volts if not specified, or from a fully charged internal battery. Equipment that can be operated from 13.8 volts (nominal) is also tested for function, output power and frequency accuracy at the minimum specified voltage, or 11.5 volts if not specified. Units are tested at room temperature and humidity, both as determined by the ARRL HVAC system. In addition, units that are capable of mobile or portable operation are tested at their rated temperature range, or if not specified, at -10 to +60 degrees Celsius in a commercial temperature chamber.

ARRL "Product Review" testing represents a sample of only one unit. This is not necessarily representative of all units of the same model number. It is not uncommon that some 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. These problems are documented in the Product Review.

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* .

73 from ARRL Headquarters, Mike Tracy, KC1SX, ARRL Laboratory Engineer

Amplifier Output Power:

Test description: One of the first things an amateur wants to know about an amplifier is its RF output power. The ARRL Lab measures the CW output power for every band on which an amplifier can operate. The unit is tested across the entire amateur band and the worst-case number for each band is reported. Typically, the most popular band of operation for each mode is selected. Thus, on an HF amplifier, 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. 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.

Some amplifiers are derated from maximum output power on full-carrier AM and FM modes, even though they can often deliver more than this derated power for short periods 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 an amplifier decreases as output power increases. An amplifier rated at 1000 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 an amplifier is capable of delivering its rated PEP SSB output, the test-result table lists the power as being "as specified."

Key Test Conditions: Termination: 50 ohms resistive, or as specified by the manufacturer.

:

Spectral Purity Test:

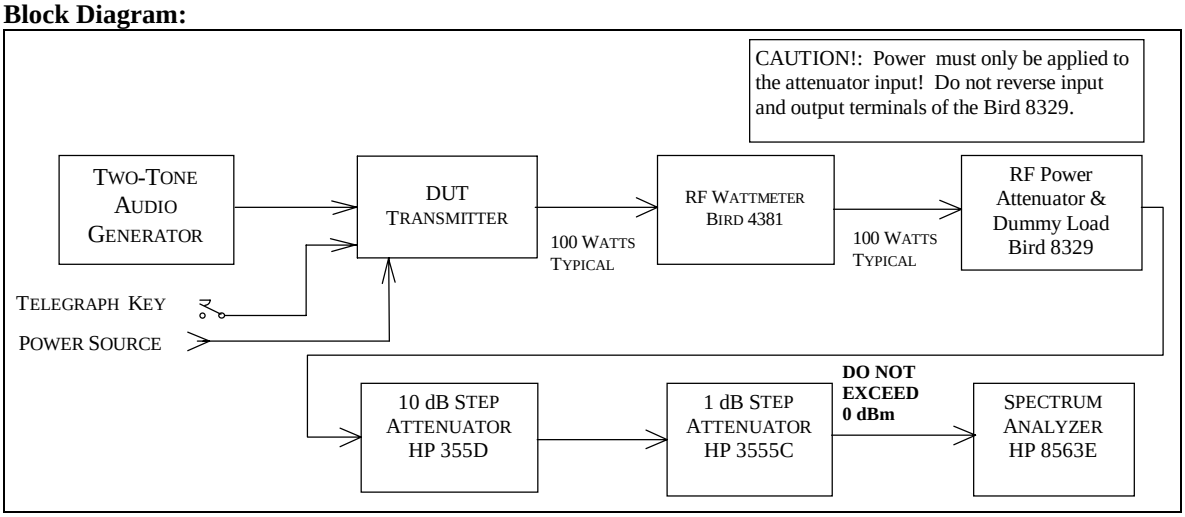
Test Description: All transmitters emit some signals outside their assigned frequency or frequency range. These signals are generally known as spurious emissions or "spurs." Part 97 of the FCC rules and regulations specify the amount of spurious emissions that can be emitted by a transmitter operating in the Amateur Radio Service. The ARRL Laboratory uses a spectrum analyzer to measure the spurious emission on each band on which an amplifier can operate. The amplifier is tested across the band and the worst-case spectral purity on each band is captured from the spectrum analyzer and stored on disk. 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 amplifier. The lower that level, expressed in dB relative to the output carrier, the cleaner the amplifier is. So an amplifier whose spurious emissions are -60 dBc is spectrally cleaner than is one whose spurious emissions are -30 dBc. FCC Part 97 regulations governing spectral purity are contained in 97.307 of the FCC rules. 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.*

Key Test Conditions:

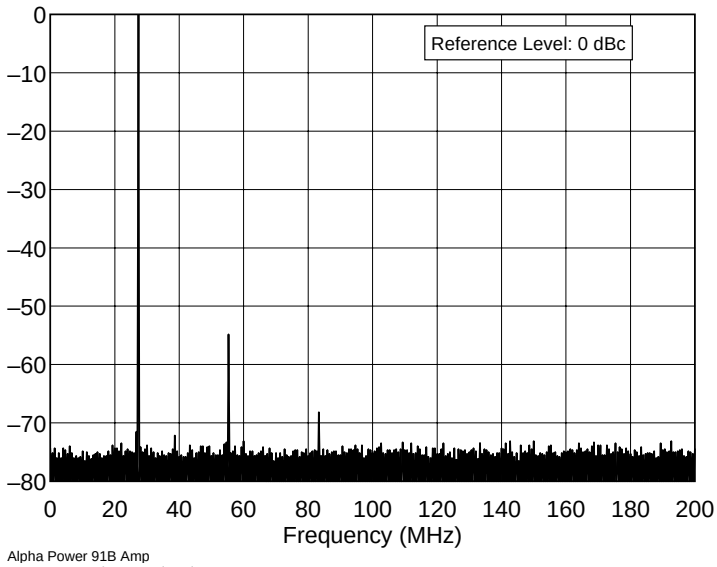
Unit is operated at nominal supply voltage and temperature.
Output power is adjusted to full power on each amateur band.
The level to the spectrum analyzer is - 10 dBm maximum.
The resolution bandwidth of the spectrum analyzer is 10 kHz on HF, 100 kHz on VHF, 1 MHz on UHF.

Block Diagram:

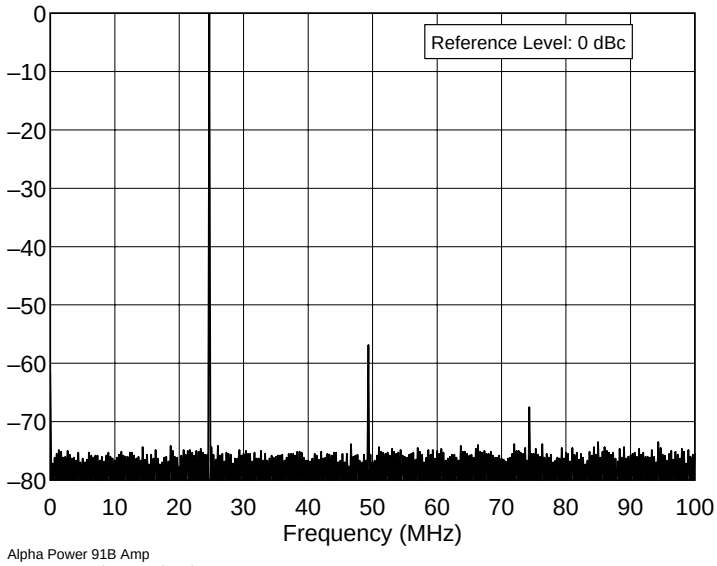


Notes:

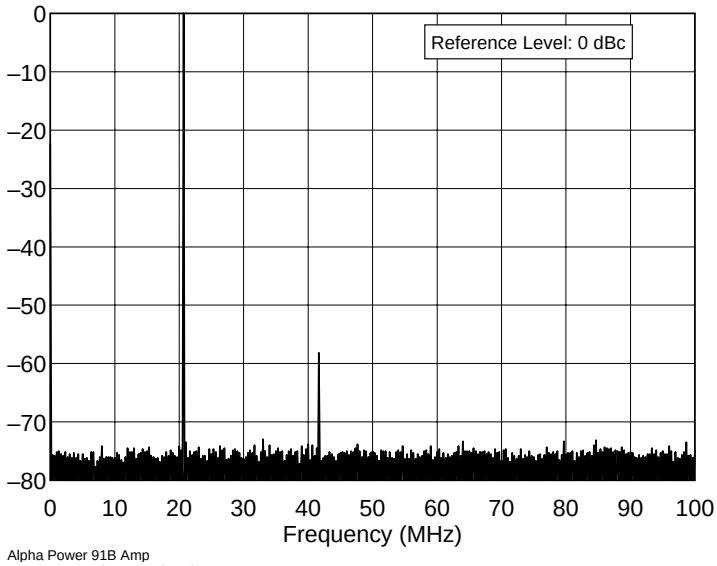
Spectral Purity Graph



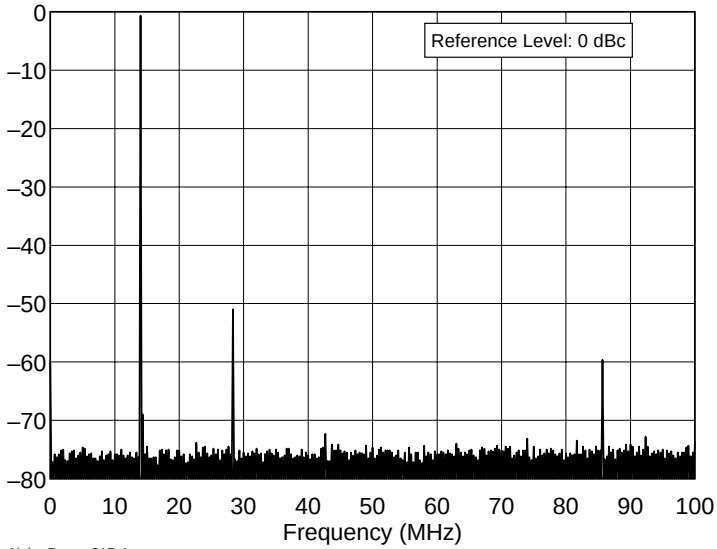
Alpha Power 91B Amp
28.0 MHz Band, Spectral Purity, 1500 W
P:\TESTS\ETO91B\ETO91S10.TXT



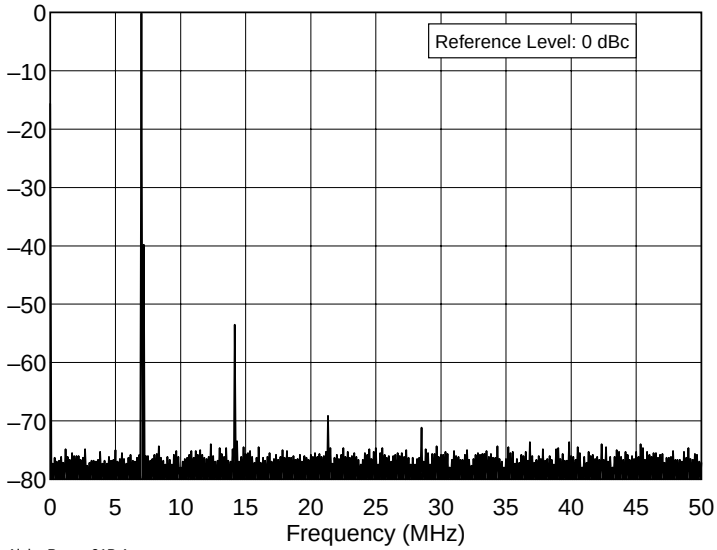
Alpha Power 91B Amp
24.9 MHz Band, Spectral Purity, 1500 W
P:\TESTS\ETO91B\ETO91S12.TXT



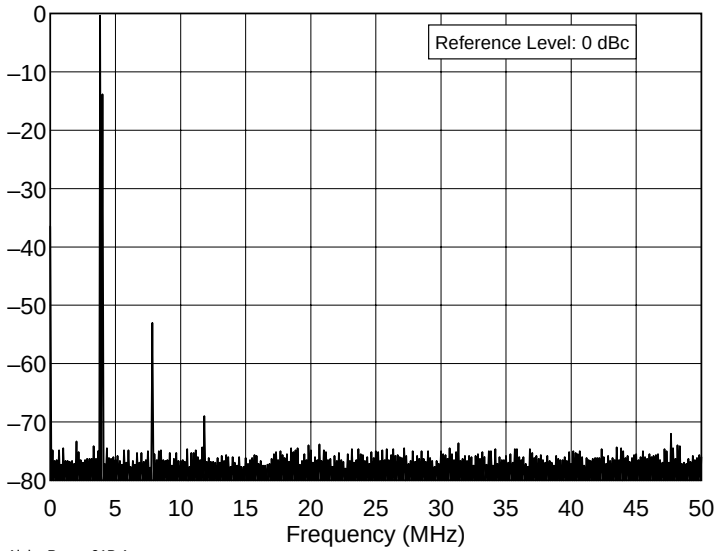
Alpha Power 91B Amp
21.0 MHz Band, Spectral Purity, 1500 W
P:\TESTS\ETO91B\ETO91S15.TXT



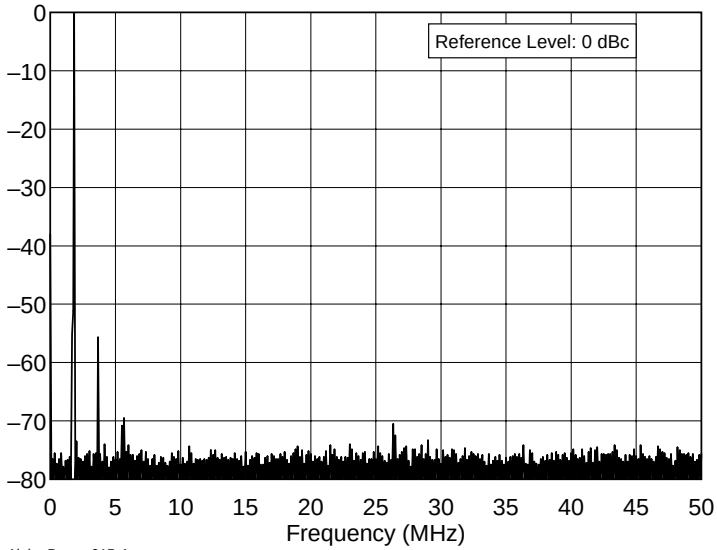
Alpha Power 91B Amp
14.0 MHz Band, Spectral Purity, 1500 W
P:\TESTS\ETO91B\ETO91S20.TXT



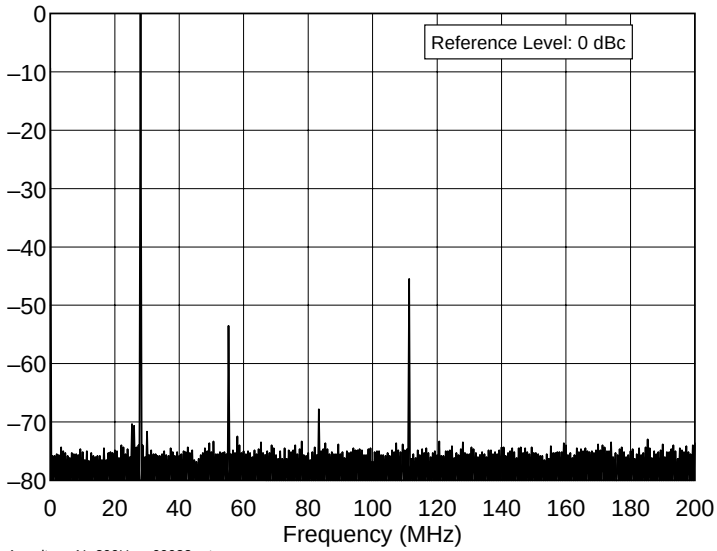
Alpha Power 91B Amp
7.0 MHz Band, Spectral Purity, 1500 W
P:\TESTS\ETO91B\ETO91S40.TXT



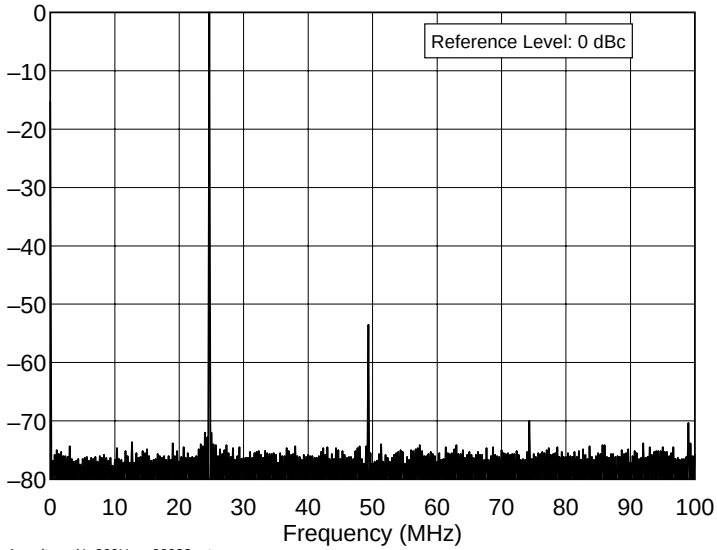
Alpha Power 91B Amp
3.5 MHz Band, Spectral Purity, 1500 W
P:\TESTS\ETO91B\ETO91S80.TXT



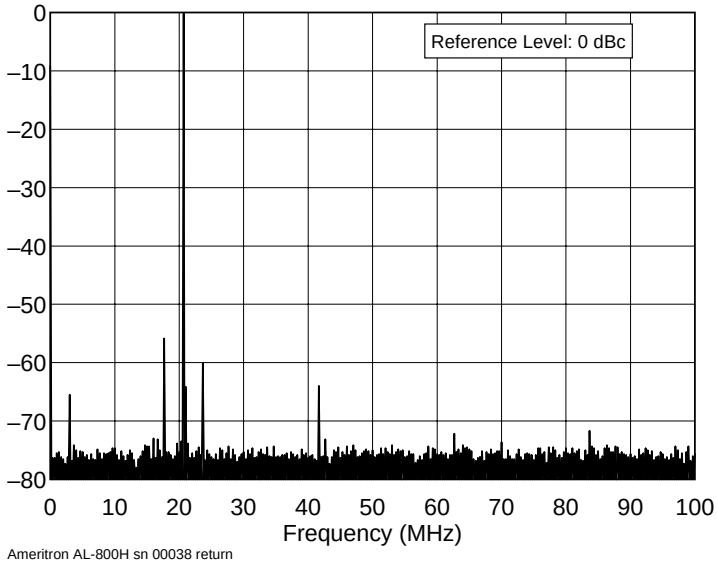
Alpha Power 91B Amp
1.8 MHz Band, Spectral Purity, 1500 W
P:\TESTS\ETO91B\ETO91SLO.TXT



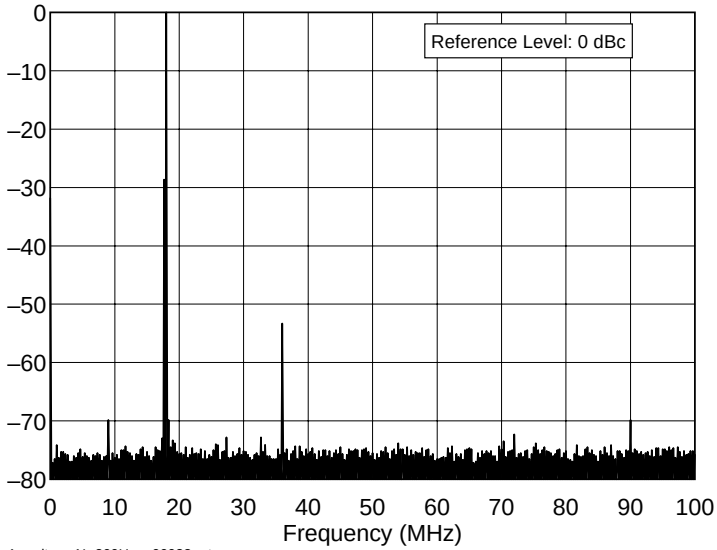
Ameritron AL-800H sn 00038 return
28.0 MHz Band, Spectral Purity, 1500 W
F:\SHARED\PROD_REV\TESTS\AL800H\AR800S10.TXT



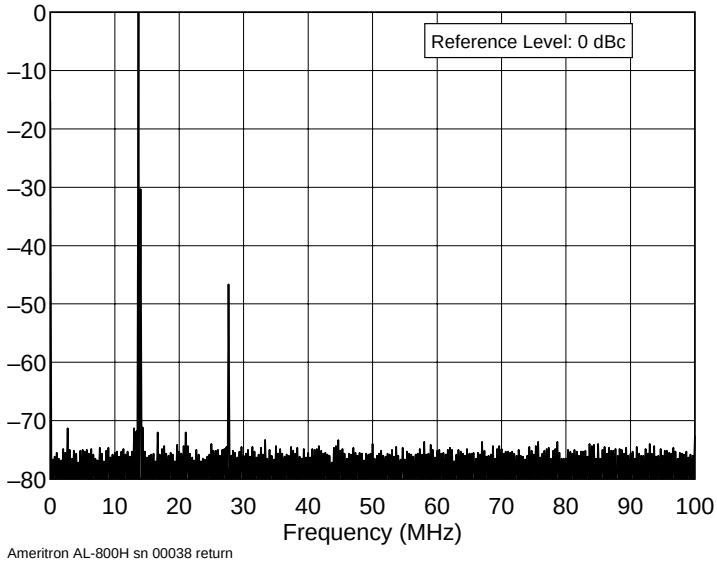
Ameritron AL-800H sn 00038 return
24.9 MHz Band, Spectral Purity, 1500 W
F:\SHARED\PROD_REV\TESTS\AL800H\AR800S12.TXT



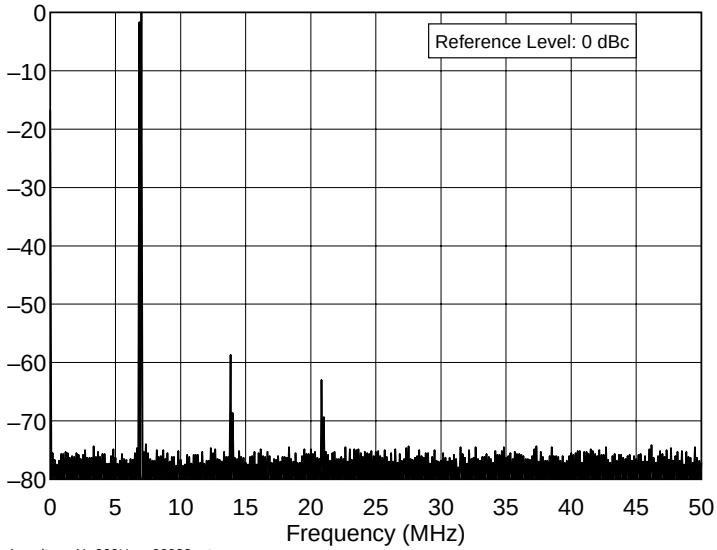
Ameritron AL-800H sn 00038 return
21.0 MHz Band, Spectral Purity, 1500 W
F:\SHARED\PROD_REV\TESTS\AL800H\AR800S15.TXT



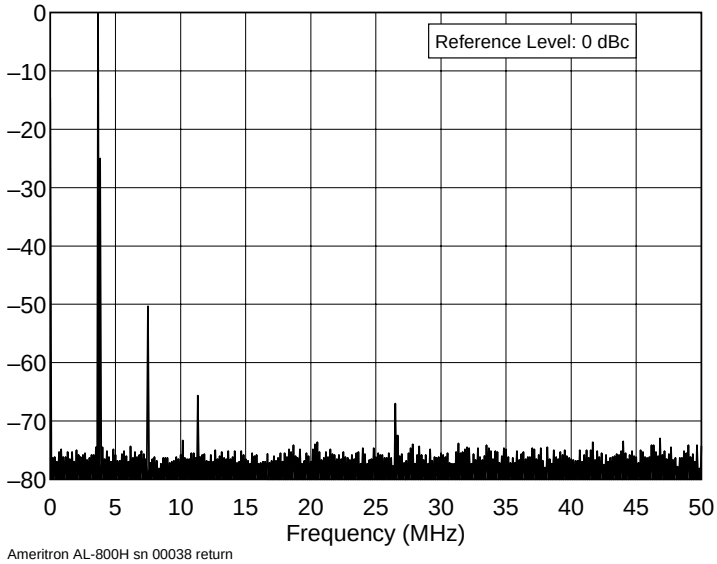
Ameritron AL-800H sn 00038 return
18.1 MHz Band, Spectral Purity, 1500 W
F:\SHARED\PROD_REV\TESTS\AL800H\AR800S17.TXT



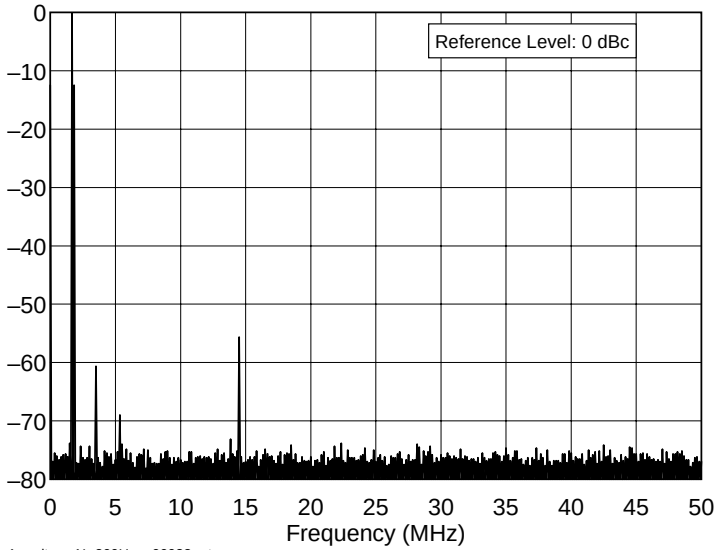
Ameritron AL-800H sn 00038 return
14.0 MHz Band, Spectral Purity, 1500 W
F:\SHARED\PROD_REV\TESTS\AL800H\AR800S20.TXT



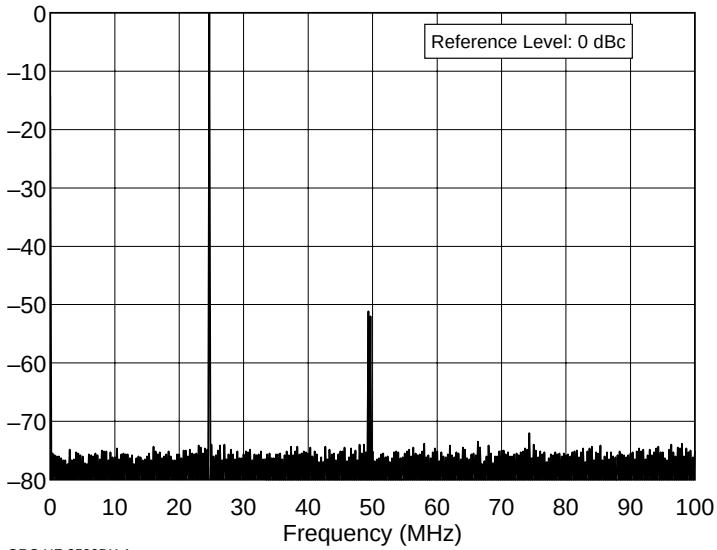
Ameritron AL-800H sn 00038 return
7.0 MHz Band, Spectral Purity, 1500 W
F:\SHARED\PROD_REV\TESTS\AL800H\AR800S40.TXT



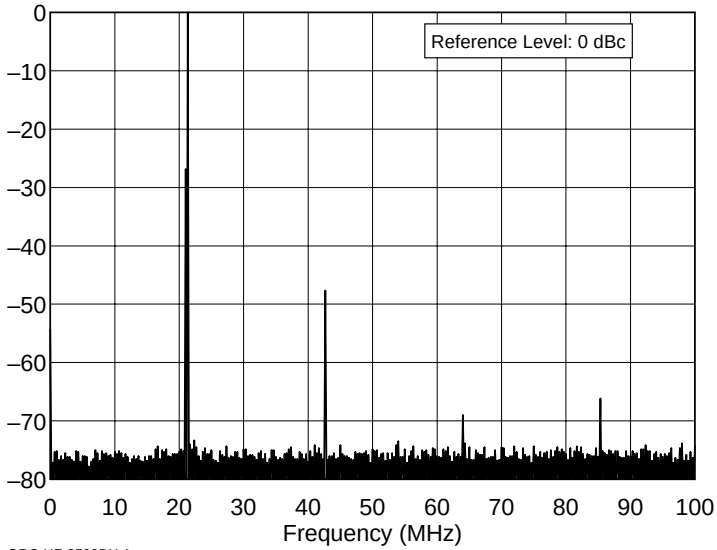
Ameritron AL-800H sn 00038 return
3.5 MHz Band, Spectral Purity, 1500 W
F:\SHARED\PROD_REV\TESTS\AL800H\AR800S80.TXT



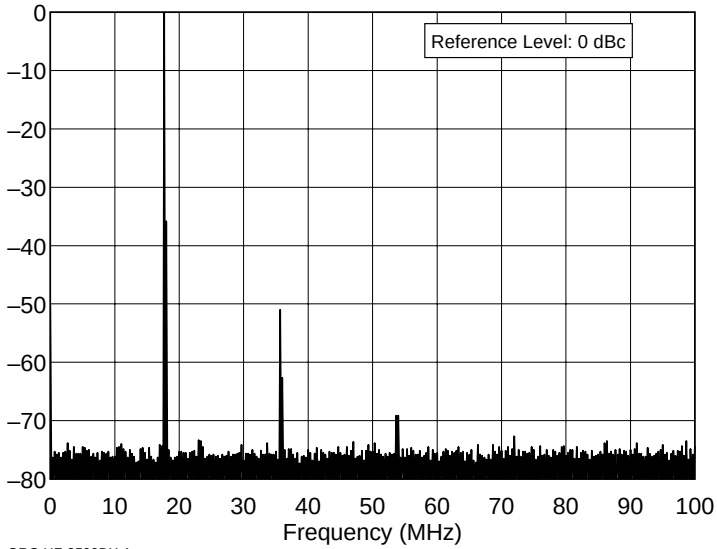
Ameritron AL-800H sn 00038 return
1.8 MHz Band, Spectral Purity, 100 W
F:\SHARED\PROD_REV\TESTS\AL800H\AR800SLO.TXT



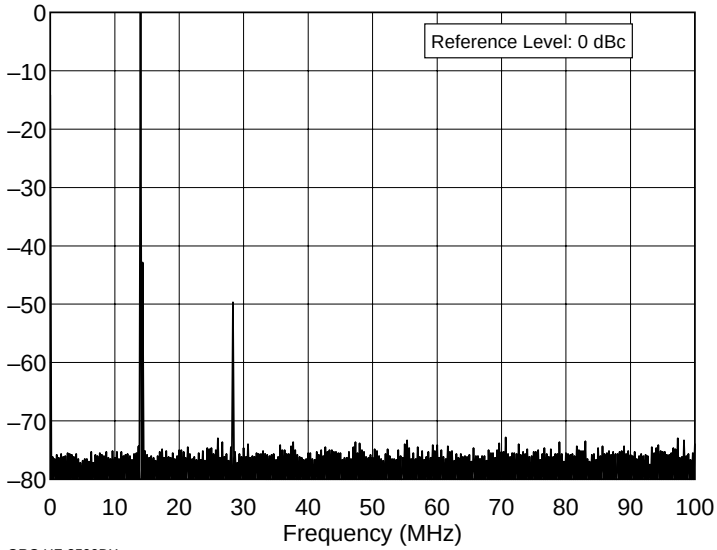
QRO HF-2500DX Amp
24.9 MHz Band, Spectral Purity, 1500 W
P:\TESTS\QROAMP\HF250S12.TXT



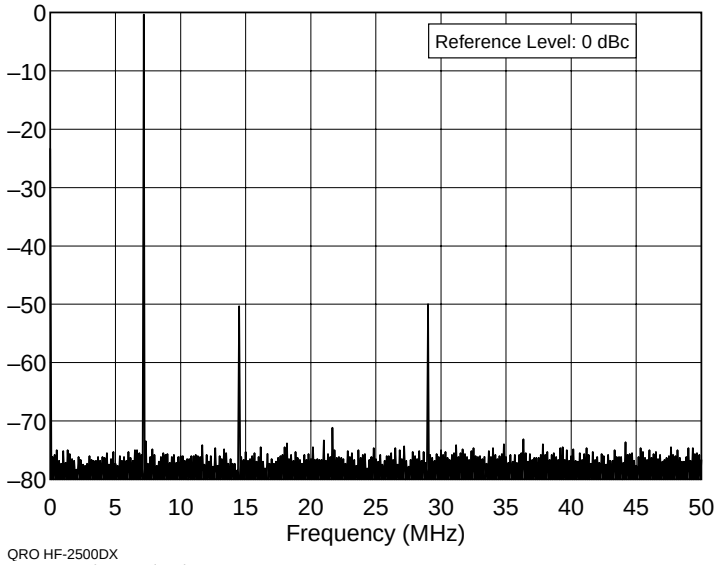
QRO HF-2500DX Amp
21.0 MHz Band, Spectral Purity, 1500 W
P:\TESTS\QROAMP\HF250S15.TXT



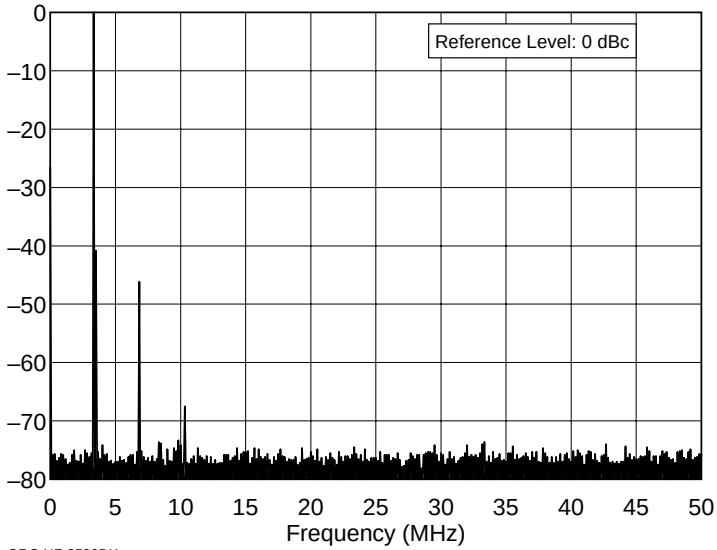
QRO HF-2500DX Amp
18.1 MHz Band, Spectral Purity, 1500 W
P:\TESTS\QROAMP\HF250S17.TXT



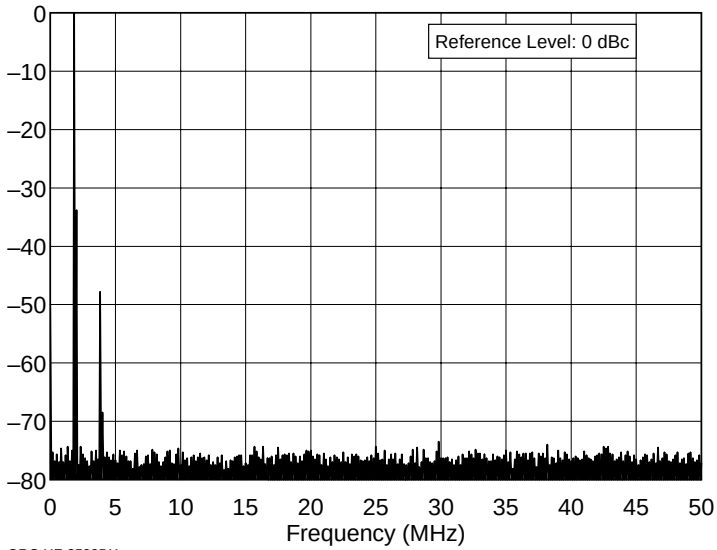
QRO HF-2500DX
14.0 MHz Band, Spectral Purity, 1500 W
P:\TESTS\QROAMP\HF250S20.TXT



QRO HF-2500DX
7.0 MHz Band, Spectral Purity, 1500 W
P:\TESTS\QROAMP\HF250S40.TXT



QRO HF-2500DX
3.5 MHz Band, Spectral Purity, 1500 W
P:\TESTS\QROAMP\HF250S80.TXT



QRO HF-2500DX
1.8 MHz Band, Spectral Purity, 1500 W
P:\TESTS\QROAMP\HF250SLO.TXT

Transmit Two-Tone IMD Test:

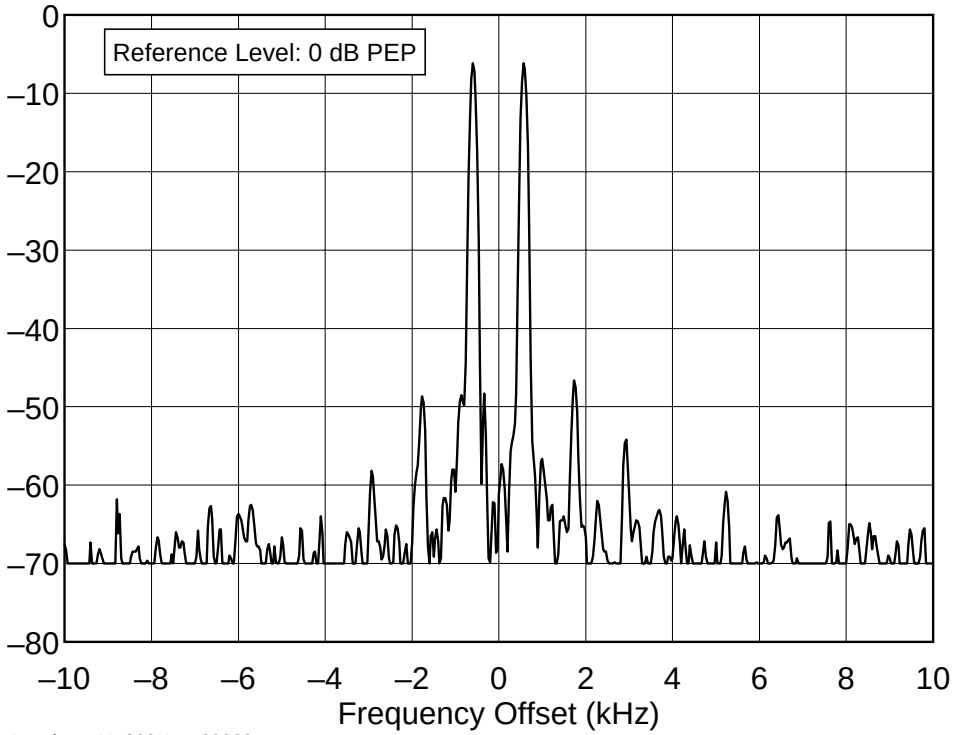
Test Description: Investigating the sidebands from a modulated transmitter requires a narrow-band spectrum analysis. In this test, a two-tone test signal is fed into the amplifier. The display shows the two test tones plus some of the IMD products produced by the SSB transmitter. In the ARRL Lab, we use a high-power, hybrid combiner made from coaxial cable. This hybrid combiner combines two 100-watt 14.2 MHz signals, with 3 dB of loss, to produce a two-tone test signal of 200 W PEP.

These frequencies were selected to give a meaningful display of ampflifier IMD. The intermodulation 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.

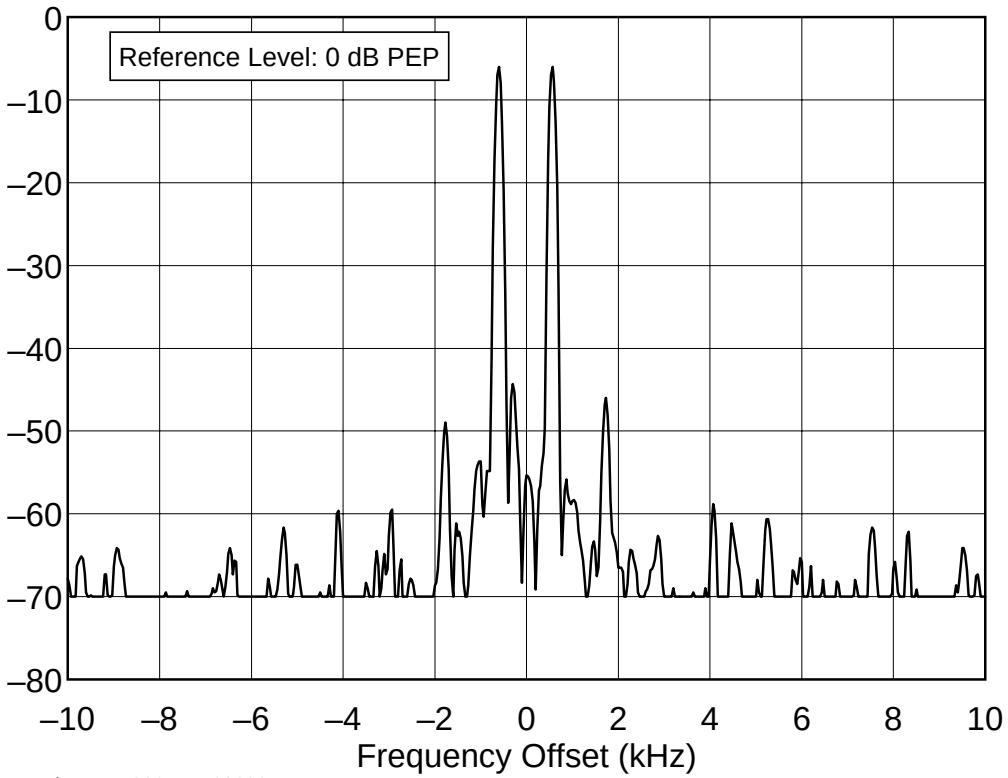
Key Test Conditions:
Transmitter operated at rated output power. Audio tones and drive level adjusted for best performance. Audio tones 700 and 1900 Hz. Both audio tones adjusted for equal RF output. Level to spectrum analyzer, - 10 dBm nominal, -10 dBm maximum. Resolution bandwidth, 10 Hz

Block Diagram:

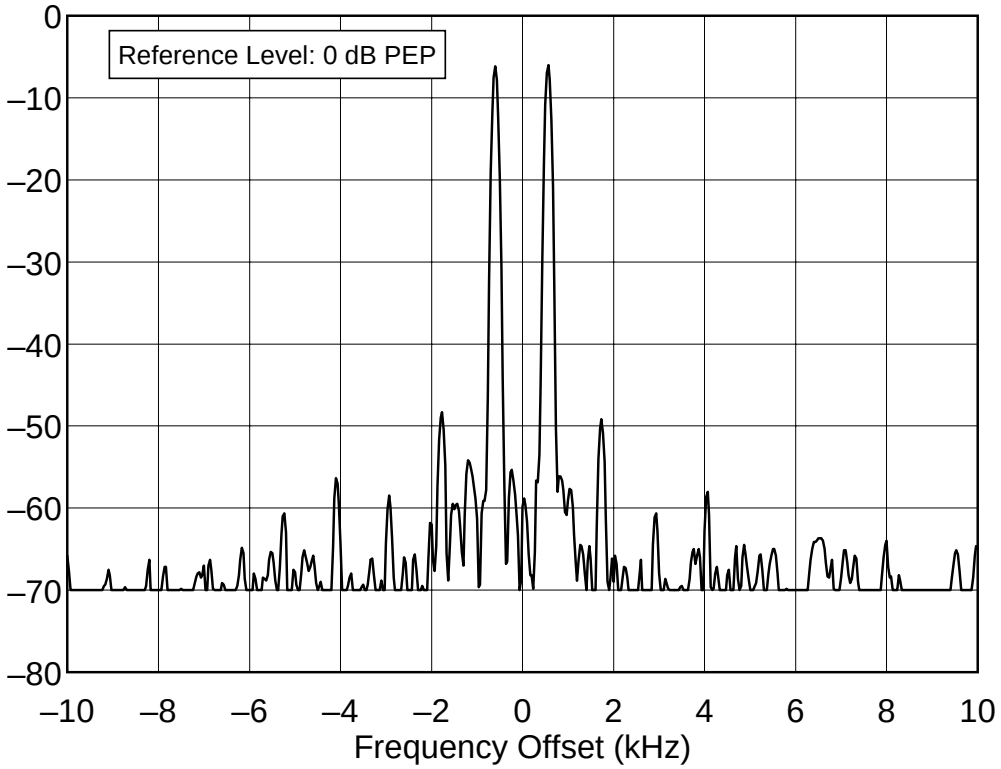
Notes:
1. The ARRL Lab's high-power IMD tests are done only on 20 meters. The two-port combiner is capable of operation only on 20 meters. The port-to-port isolation of the two-port coupler is critical to the accuracy of the test results. The baseline test-fixture IMD is about 55 dB below PEP for the third-order products, 65 dB for the fifth-order products and about 70 dB for higher-order products. A detailed setup and calibration procedure is used to enusre this level of isolation for each amplifier tested. This involves adjusting the "dummy load" matching network for maximum isolation when the coupper is terminated into 50 ohms, then adjusting the amplifier matching section for a 50-ohm load when the coupler is terminated into the amplifier under test, which is nominally 50 ohms, but can be significantly different enough that the coupler may not perform as desired unless it is matched.



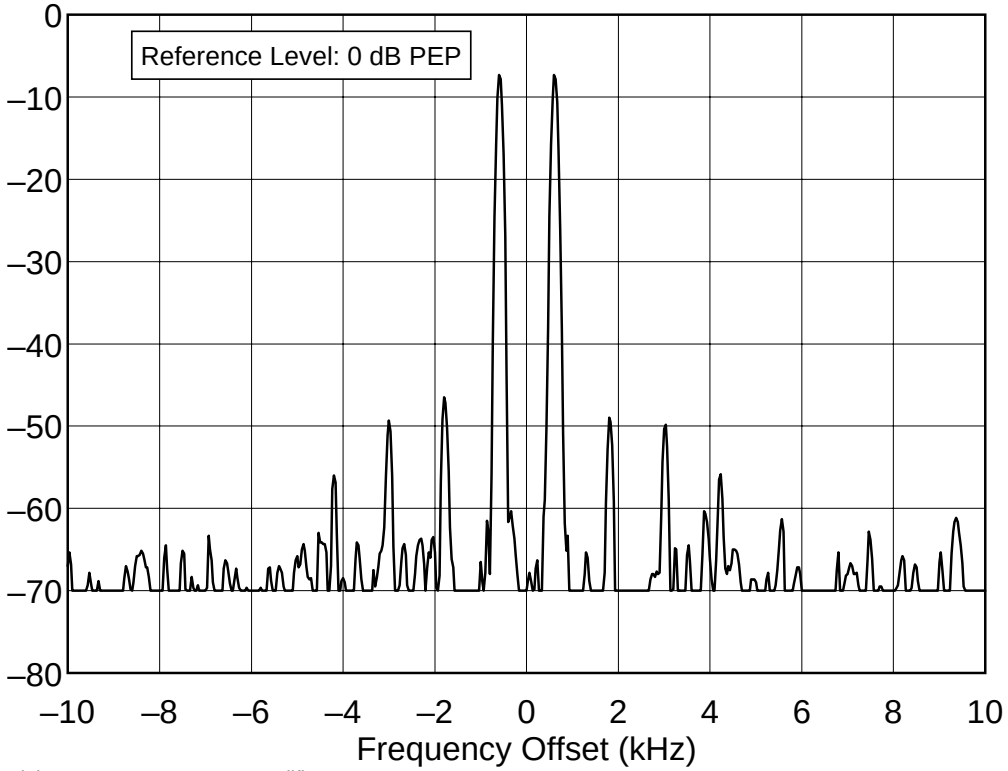
Ameritron AL-800H sn 00038 return
14.020 MHz, Transmit IMD, 1500 W
F:\SHARED\PROD_REV\TESTS\AL800H\AR800I20.TXT



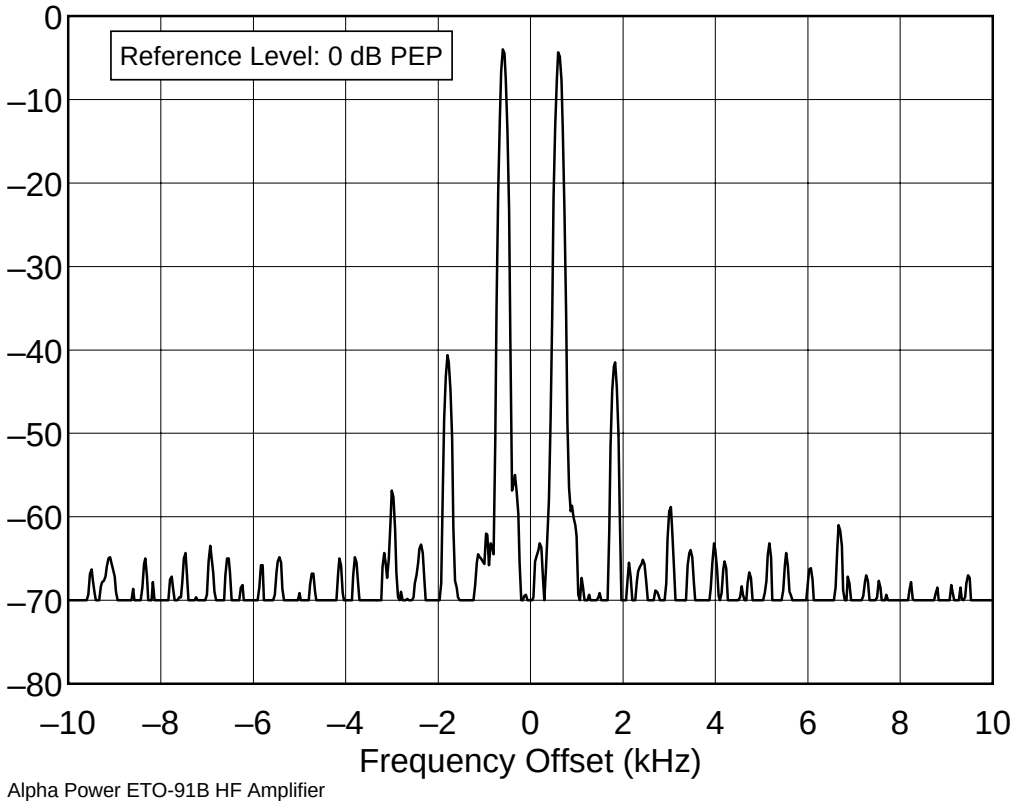
Ameritron AL-800H sn 00038 return
14.020 MHz, Transmit IMD, 1000 W
F:\SHARED\PROD_REV\TESTS\AL800H\AS800I20.TXT



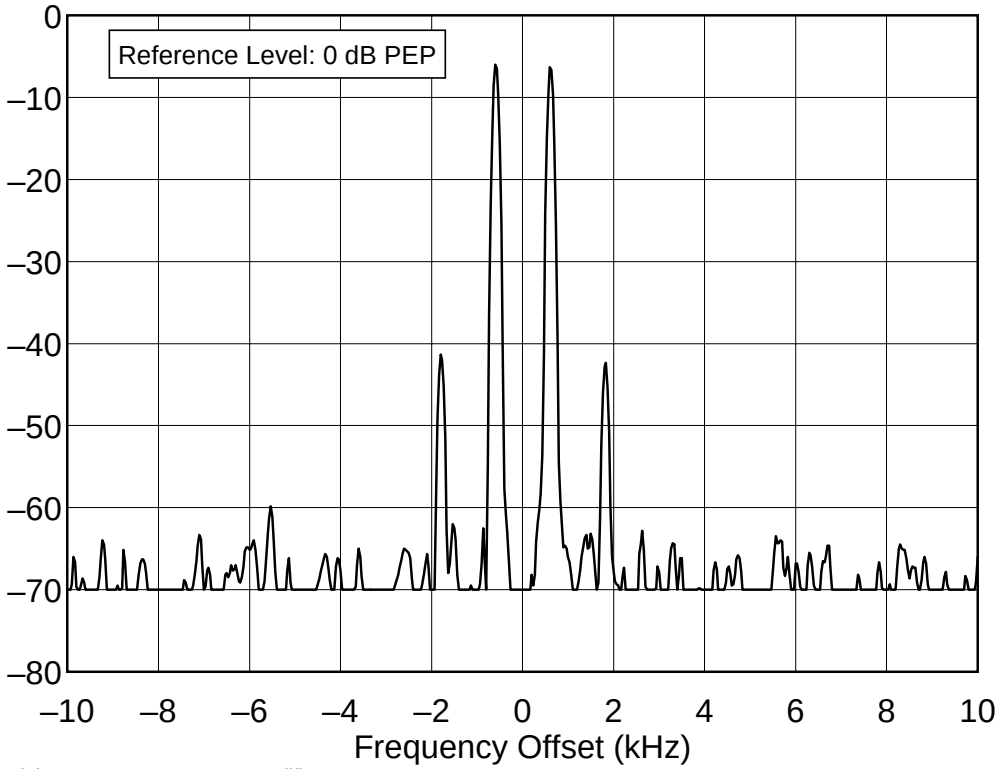
Ameritron AL-800H sn 00038 return
14.020 MHz, Transmit IMD, 750 W
F:\SHARED\PROD_REV\TESTS\AL800H\AT800I20.TXT



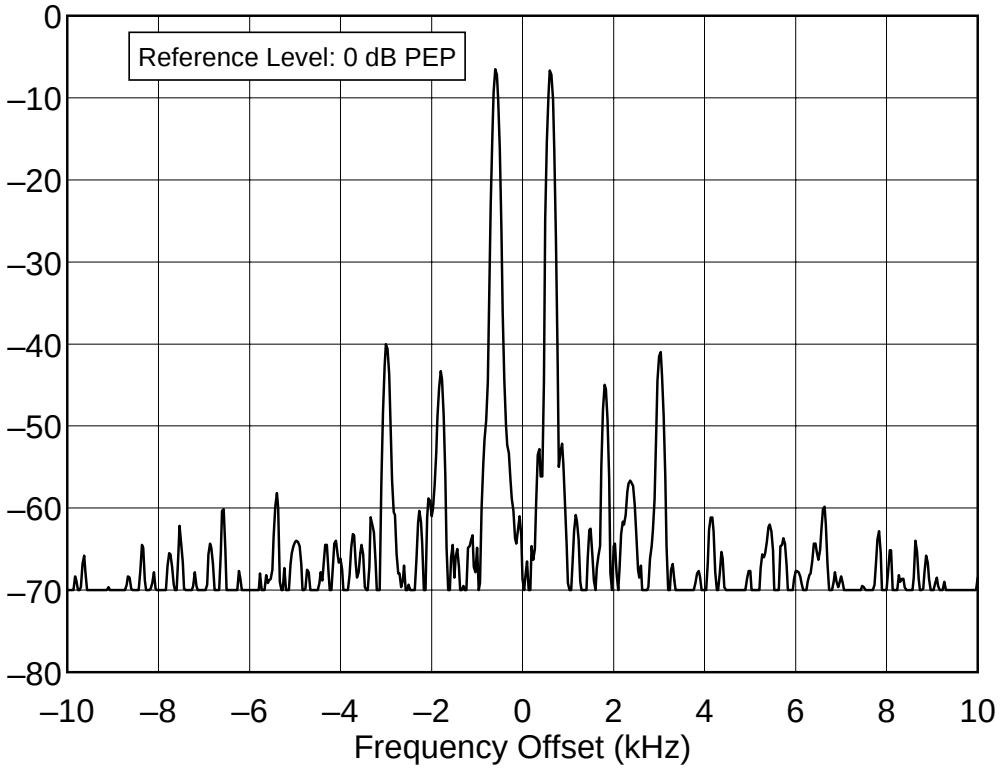
Alpha Power ETO-91B HF Amplifier
14.020 MHz, Transmit IMD, 1500 W
P:\TESTS\ETO91B\ETO-I20H.TXT



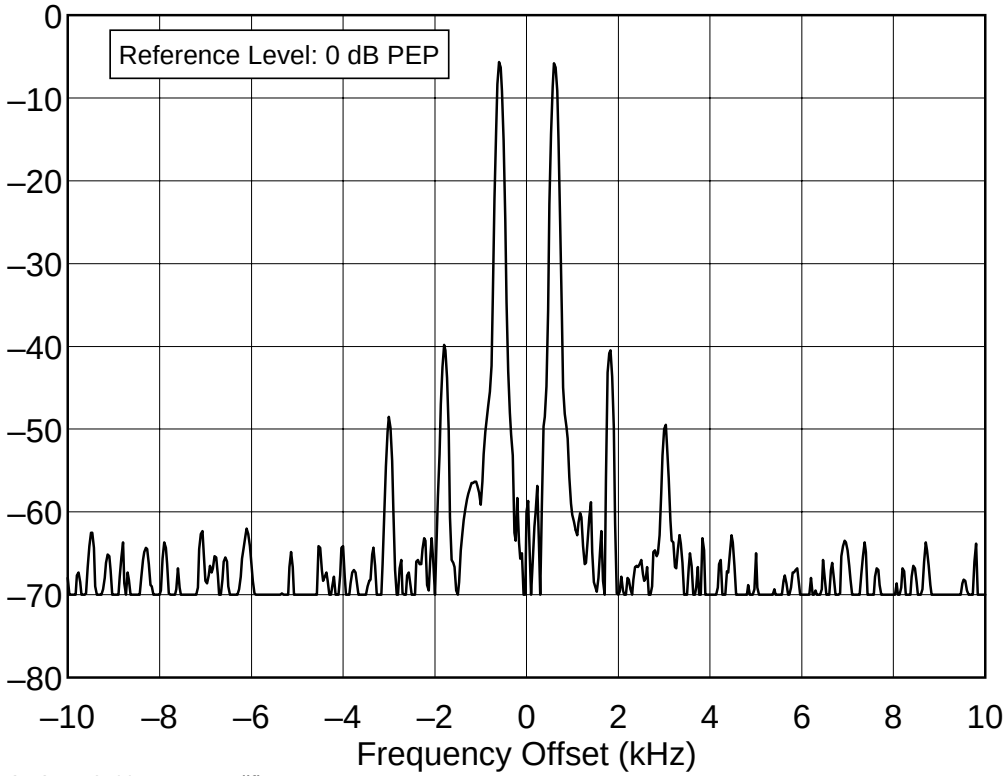
Alpha Power ETO-91B HF Amplifier
14.020 MHz, Transmit IMD, 750 W
P:\TESTS\ETO91B\ETO-I20L.TXT



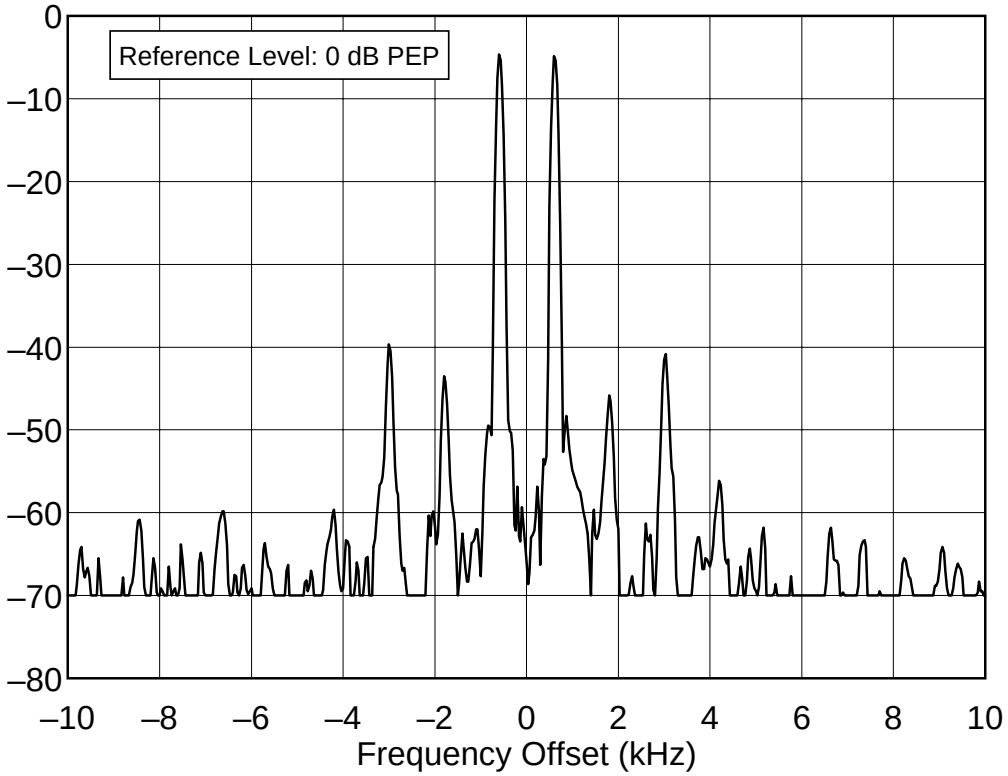
Alpha Power ETO-91B HF Amplifier
14.020 MHz, Transmit IMD, 1000 W
P:\TESTS\ETO91B\ETO-I20M.TXT



QRO HF-2500DX HF Amplifier
14.020 MHz, Transmit IMD, 1500 W
P:\TESTS\QROAMP\HF250I20.TXT



QRO HF-2500DX HF Amplifier
14.020 MHz, Transmit IMD, 750 W
P:\TESTS\QROAMP\HF25I20L.TXT



QRO HF-2500DX HF Amplifier
14.020 MHz, Transmit IMD, 1000 W
P:\TESTS\QROAMP\HF25I20M.TXT

