HobbyPCB, LLC.
3373 E. Lake Shore Lane
Clearwater, Florida 33761

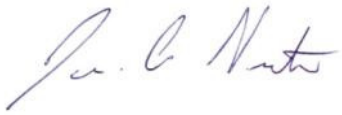
Document: Hardrock-50 Test Report

FCC Identifier: RHAHR50

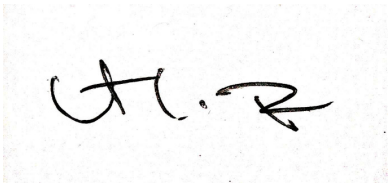
Date: July 16, 2013

Test Results: The HobbyPCB Hardrock-50 50W RF External Amplifier FCC ID RHAHR50 has been tested and passed and therefore meets the requirements of each applicable FCC section.

The following test report is submitted with the application for type acceptance of the HobbyPCB, LLC. Hardrock-50 amplifier, FCC ID RHAHR50. We certify that this information accurately represents the device presented in the application.



James C Veatch



Curtis Pope

HobbyPCB, LLC.
3373 E. Lake Shore Lane
Clearwater, Florida 33761

FCC Test Report
HobbyPCB Model Hardrock-50
50W RF External Power Amplifier

The following sections of CFR Title 47: Telecommunication apply to the DUT and are included in this report:

- **2.1033 Application for certification.**
- **2.1046(a) Measurements required: RF power output.**
- **2.815 External radio frequency power amplifiers.**
- **97.307(d) Emission standards.**
- **97.313 Transmitter power standards.**
- **97.315 Certification of external RF power amplifiers.**
- **97.317 Standards for certification of external RF power amplifiers.**

3373 E. Lake Shore Lane
Clearwater, Florida 33761

FCC ID: RHA-HR50

Tested by: James Veatch
Date: July 3, 2031

HobbyPCB, LLC.
3373 E. Lake Shore Lane
Clearwater, Florida 33761

Table of Contents

HobbyPCB, LLC.
3373 E. Lake Shore Lane
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1.0 General Information

Device Under Test: 50W HF Linear Power Amplifier

FCC ID: RHA-HR50

Model Number: Hardrock-50

Serial Number: N/A

Frequency Range:
160M - 1.8 – 2.0 MHz
80M - 3.5 – 4.0 MHz
40M - 7.0 – 7.3 MHz
30M - 10.1 – 10.15 MHz
20M - 14.0 – 14.35 MHz
17M - 18.068 – 18.168 MHz
15M - 21.0 – 21.45 MHz

Type of Emission: Determined by the device driving the HobbyPCB Hardrock-50.

Operating Power Level: 0 – 50W maximum

Power Source: DC Power Supply +13.8V @ 10A (typical)

Unit Tested: Prototype

Equipment Type: Fixed

Tune-up Procedure:
1 – Set power switch to 'ON' position
2 – Press the Band + or – button to select the frequency band
3 – Select CR (carrier operated) or PT (push to talk) keying mode

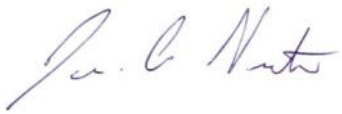
The HobbyPCB Hardrock-50 amplifier is supplied by the manufacturer in kit form only. The kit consists of three printed circuits boards with surface mount parts installed, all thru-hole parts required to complete each printed circuit assembly, an extruded aluminum chassis with machined and etched endplates, all chassis electrical and mechanical components and complete assembly and alignment instructions.

2.0 Attestation Statement

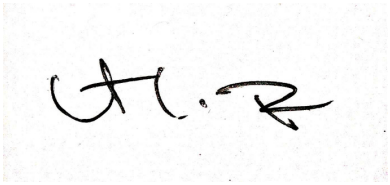
The HobbyPCB Hardrock-50 has been tested according to the requirements of CFR Title 47: Telecommunication. The HobbyPCB Hardrock-50 has met these requirements, and the results are documented in this report. The tests were performed according to the measurement procedures also shown in this report.

We attest that the Part 2 and Part 97 tests were completed at:

HobbyPCB RF Test Facility
1704 Bolton Street
Baltimore, MD 21217



James C Veatch



Curtis Pope

3.0 Other Information

The HobbyPCB Hardrock-50 operates only in the amateur radio bands below 22 MHz. The amplifier is not designed to operate on any frequency outside of the amateur bands below 25 MHz. Lowpass filtering on all bands reduced the gain of the HobbyPCB Hardrock-50 to 0 dB or below on all frequencies above 25 MHz including 26 to 28 MHz.

The HobbyPCB Hardrock-50 typically requires 5 Watts of drive to obtain full output power depending upon which transmit band it is on.

The gain of the HobbyPCB Hardrock-50 designed to be less than 13dB on all bands under all conditions and the maximum measured gain is less than 12 dB.

In 'off' or 'standby' positions, the HobbyPCB Hardrock-50 does NOT amplify. The exciter energy is simply passed on to the antenna at the same level in which it entered the amplifier. Since this switching is accomplished with an electromagnetic relay, not solid state components, the spurious emissions of the transceiver are unaffected.

4.0 PART 97.313

The HobbyPCB Hardrock-50 output power will not exceed 80 Watts into 50 Ohm resistive load. Therefore, it is impossible for the output power to reach or exceed 1500 Watts PEP specified in subparagraph (b) or the 200 Watts PEP specified in subparagraph (c).

5.0 PART 2.1033 (c) (8)

Final Amplifying Devices: Quantity 4, Toshiba RH16HHF1 power MOSFETs

Power into the drain of each device: 13.8V X 2.5A = 34.5 Watts

Total power input to the RF amplifier stage: 4 X 34.5 = 138 Watts

Note the power delivered by the bias supply is negligible.

6.0 PART 2.1033 (c) (11)

The following is a drawing of the equipment identification plate attached to an outer heatsink fin on the left side of each HobbyPCB Hardrock-50 amplifier:

7.0 PART 2.815 (b) (1) (2)

The HobbyPCB Hardrock-50 RF amplifier is not capable of amplification in the frequency band 26-28 MHz. Significant changes in the output filter bank and firmware would be required an therefore the HobbyPCB Hardrock-50 cannot be easily modified to operate in the 26-28 MHz frequency band. Driving the HobbyPCB Hardrock-50 in the 26-28 MHz frequency band results in -6 to -20 dB gain, depending on the actual frequency applied, from input to output of the amplifier when the Hardrock-50 amplifier is active and a gain of less than 0 dB when the Hardrock-50 is in stand-by mode or powered off.

8.0 Test Setup and Conditions

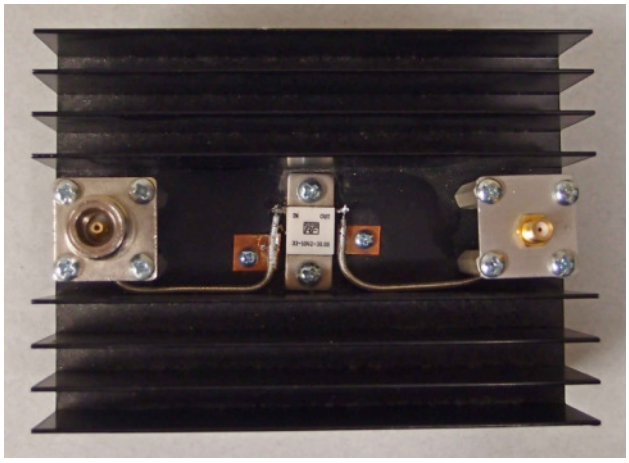
The data collected to verify conformity with Part 2.1046 (a), Part 2.1053, Part 97.307 (d) and Part 97.317 were taken at HobbyPCB Radio Test Facility located at 1704 Bolton Street, Baltimore, MD 21217.

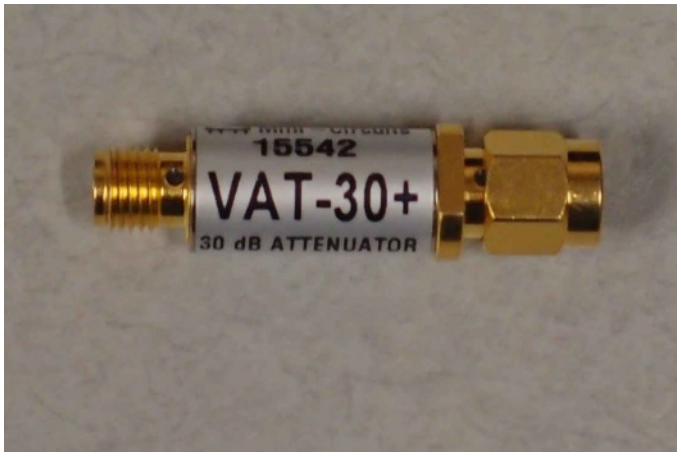
The temperature was 24 °C at the time of the test.

9.0 Test Equipment List

Elecraft Model K2 exciter (S/N 01671):

60 dB Attenuator consisting of a Florida RF Labs 33-1043-30.00, 350W, 30 dB, attenuator with heatsink cascaded with a Minicircuits Labs VAT-30, 30 dB attenuator (S/N 15542):





Jetstream JTPS28, 9 – 15 volt, 28 ampere, DC power supply, to power the DUT:

HobbyPCB, LLC.
3373 E. Lake Shore Lane
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B&K Precision Model 1550, 0 – 30 volt, 3 ampere, DC power supply (S/N 238G11561), to power the exciter:

Anritsu VNA Master, MS2035B, Network Analyzer/Spectrum Analyzer (S/N 1105056):

10.0 Test Procedures

The following sections outline the test procedures for calibrating the attenuator (required for all subsequent measurements); Gain measurements per paragraphs 2.815(1) and 97.317(2),(3) in accordance with paragraph 2.1046(a); Spurious emission measurements per paragraph 97.307(d) in accordance with paragraph 2.1046(a).

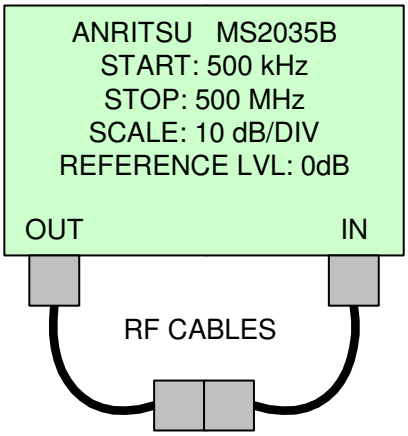
10.1 The Elecraft K2 Exciter

The Elecraft K2 S/N 01671 used during these tests is FCC Type Accepted for Amateur service. Since the device is mot certified or calibrated, the output spectrum was recorded at each of the test frequencies. Plots of the spectrum analyzer data are included as an attachment. The Elecraft K2 was determined to have a worst-case spurious attenuation of greater than 55 dB which exceeds the 43 dB required for the tests of the HobbyPCB Hardrock-50 amplifier.

10.2 Calibrating the Attenuator

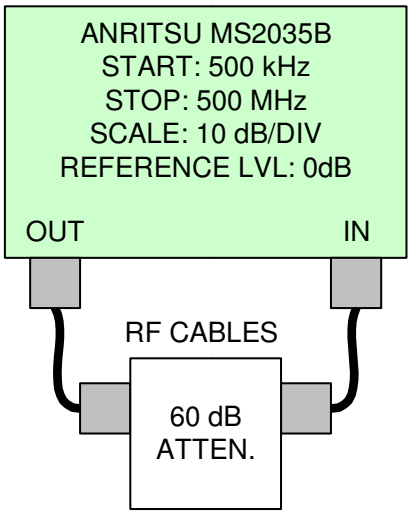
The Anritsu MS2035B used to make the required gain and spurious attenuation measurements should be limited to 0 dBm input power. To avoid damage to the instrument, 60 dB of attenuation is placed between the output of the DUT and the input of the spectrum analyzer.

Since the attenuation chain is not calibrated, we used the Network Analyzer (NA) function of the Anritsu MS2035B to measure actual attenuation using the following setup:



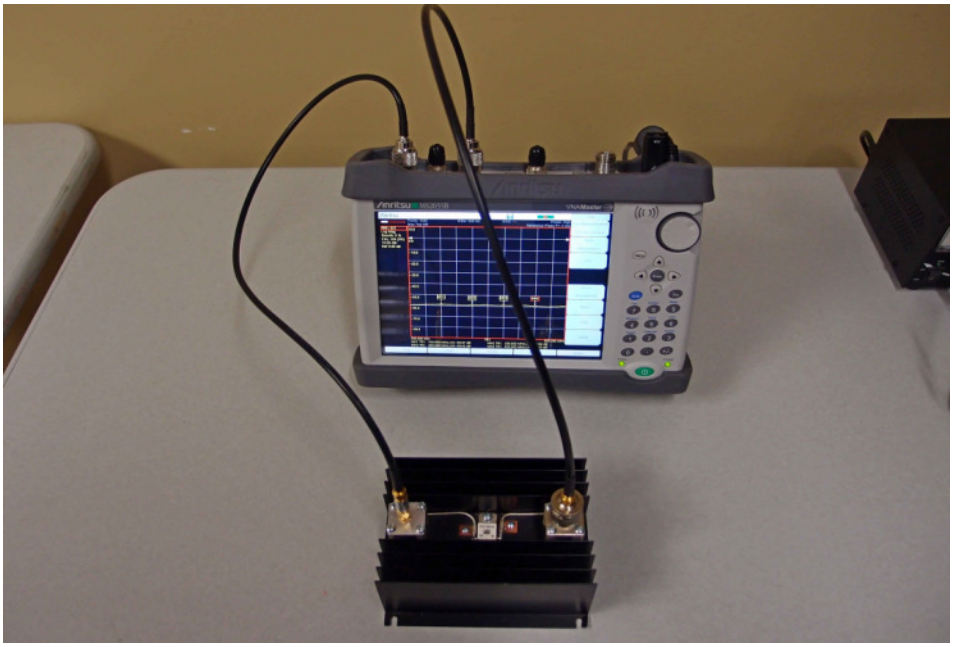
NETWORK ANALYZER CALIBRATION

The NA is then calibrated using the internal calibration routine and the attenuator is inserted at the reference plane:



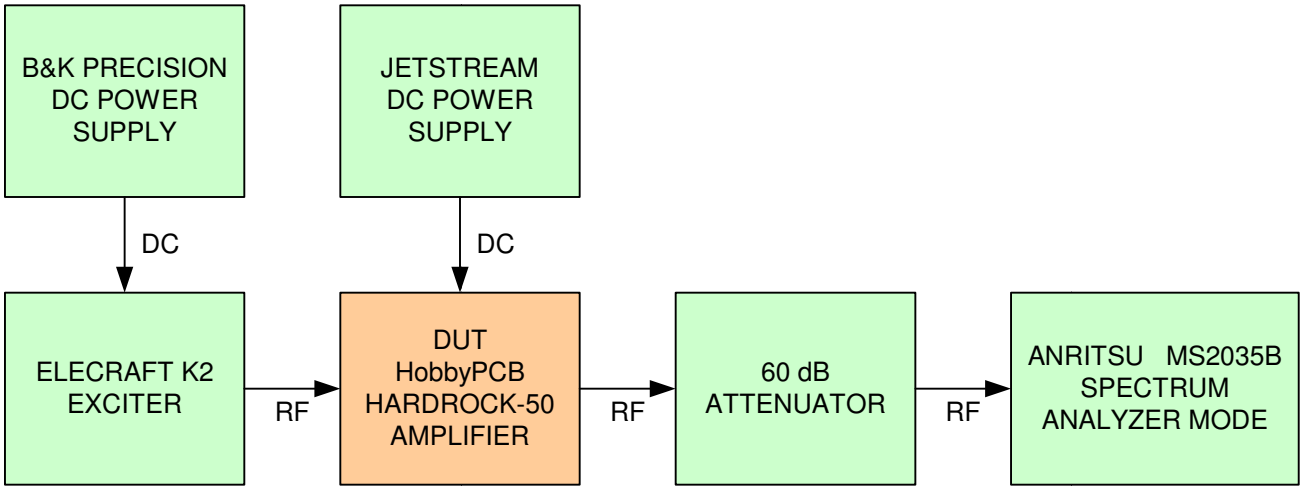
CALIBRATED ATTENUATOR MEASUREMENT

This photo shows the attenuator in the test setup:



10.3 Gain and Spurious Emissions Tests

The gain and spurious emissions test setups are identical:



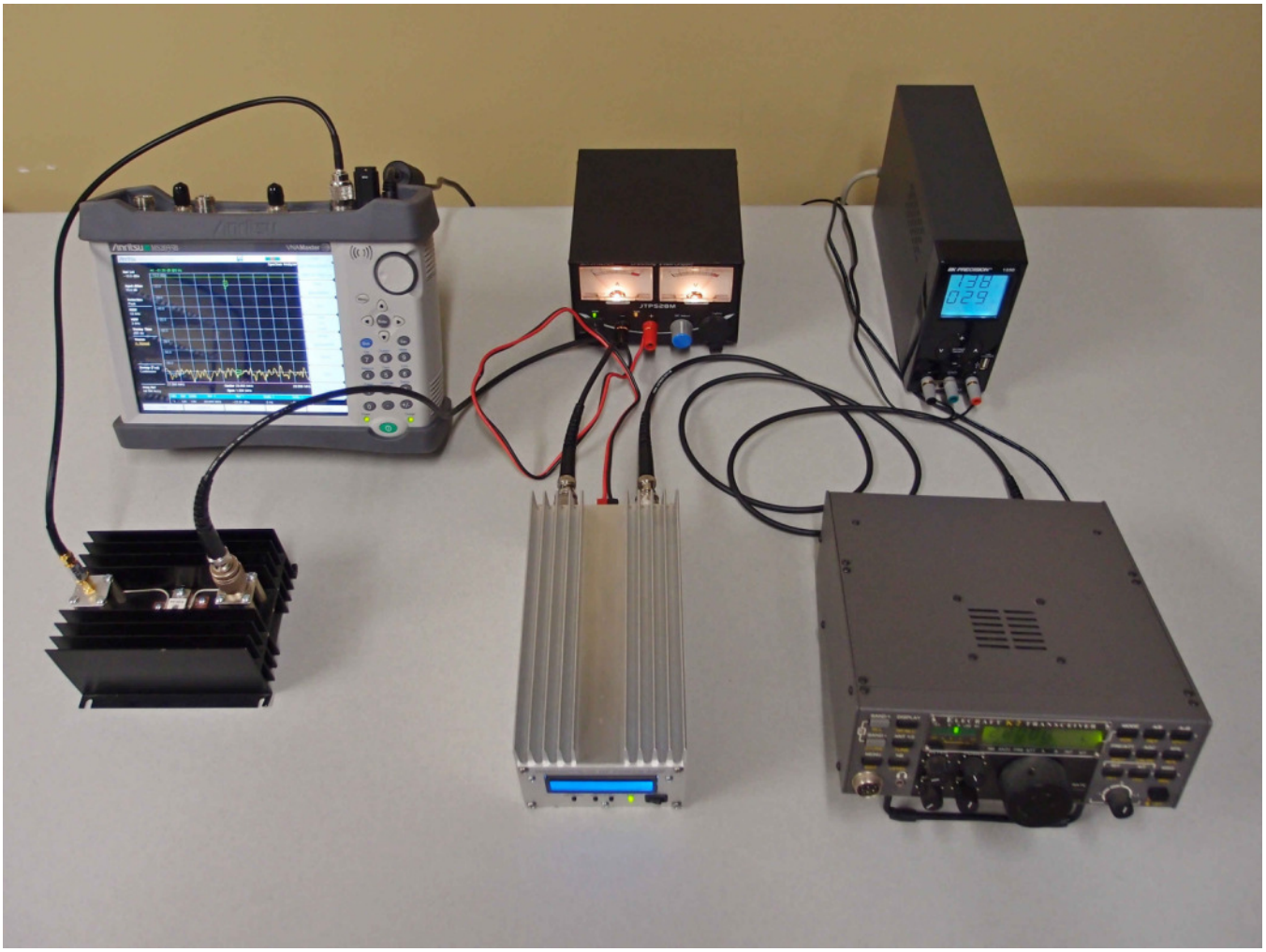
Gain measurements are made with the following procedure:

- Set exciter to test frequency, DUT in CR (carrier operated) mode
- Set the spectrum analyzer (SA) center to test frequency, span 1 MHz, reference level -10 dBm
- Adjust exciter power for 50 Watt output (-13 dBm +/- 0.5 dB on the spectrum analyzer)
- Place DUT in STBY (stand-by) mode
- Activate the exciter and place a reference marker at the peak of the exciter output
- Place the DUT in CR mode, activate the exciter
- Place a delta marker on the peak of the DUT output, record the gain

Spurious emissions measurements are made with the following procedure:

- Set exciter to test frequency, DUT in CR (carrier operated) mode
- Set the spectrum analyzer (SA) start frequency at below the test frequency, stop frequency at least 10 times the test frequency, reference level -10 dBm
- Adjust exciter power for 50 Watt output (-13 dBm +/- 0.5 dB on the spectrum analyzer)
- Place a reference at exciter frequency and a delta marker on the highest observed spurious response, record worst case spurious emission level

This photo shows the Hardrock-50 amplifier in the test setup:



10.4 Test Frequencies

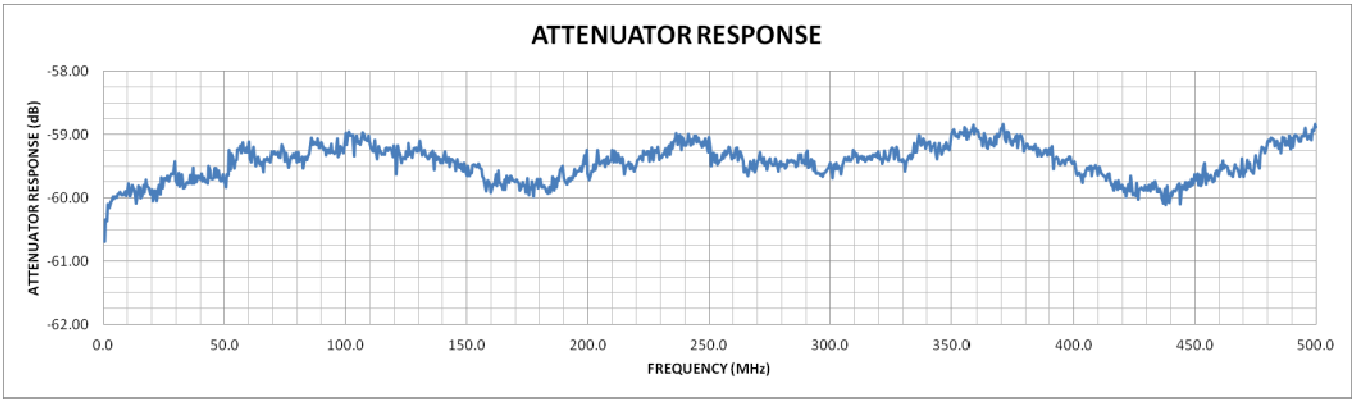
Gain and spurious emissions tests were conducted at the lowest, center and highest frequencies in the 160, 80, 40,30,20, 17 and 15 meter amateur frequency bands. On bands which are 100 kHz wide or less (30m and 17m) the center frequency was omitted. Additionally gain measurements were made at 26, 27 and 28 MHz to demonstrate compliance with paragraphs 2.815(1) and 97.317(3).

11.0 Test Results

This section contains the summarized results of the measurements taken during the testing. Raw data files will be included with the application.

11.1 Attenuator Test Results

This graph shows a graphical representation of the attenuator S21 value:



Frequency Range	1.5 – 22 MHz	1.5 – 500 MHz
Mean Value	-60.21 dB	-59.45
Maximum Value	-59.72 dB	-58.84 dB
Minimum Value	-60.36 dB	-60.36 dB
Range	0.65 dB	1.53 dB

The 1.5 – 22 MHz range is used to determine the DUT output power value which is SA reading minus the mean value with an accuracy of 0.65 dB

The 1.5-500 MHz range is used to determine the uncertainly in the spurious emissions measurements, which is 1.53 dB

Raw Data is in located in the ATTENUATOR Data.xls file.

11.2 Gain Test Results

The SA calculates the gain at a given frequency but the gain measurement is only considered valid when the exciter power is less then 5.5W and the DUT output is greater than 40W. The DUT is considered to have passed at a given frequency if the gain is less than 15dB the exciter power is less than 5.5W and the DUT output power is greater than 40W.

For measurements at 26, 27 and 28 MHz the DUT is considered to have passed the gain test as long as the gain is less than 0 dB.

The following table shows these criteria applied to the raw data.

BAND	FREQUENCY (MHz)	ATTEN VALUE (dB)	EXCITER SA (dBm)	GAIN (dB)	EXCITER Power (W)	DUT Power (W)	PASS/FAIL
160M	1.800	60.10	-23.40	10.93	4.7	57.9	PASS
	1.900	60.10	-23.04	10.69	5.1	59.6	PASS
	2.000	60.10	-23.35	10.72	4.7	55.8	PASS
80M	3.500	60.06	-23.48	10.72	4.5	53.7	PASS
	3.750	59.99	-23.36	11.00	4.6	57.9	PASS
	4.000	59.99	-24.57	11.95	3.5	54.6	PASS
40M	7.000	59.91	-23.16	9.62	4.7	43.4	PASS
	7.150	59.91	-23.23	9.87	4.7	45.2	PASS
	7.300	59.91	-23.00	9.69	4.9	45.7	PASS
30M	10.100	59.88	-23.48	10.10	4.4	44.7	PASS
	10.150	59.88	-23.62	10.03	4.2	42.6	PASS
20M	14.000	59.94	-23.43	10.35	4.5	48.5	PASS
	14.175	59.94	-23.46	10.56	4.4	50.6	PASS
	14.350	59.94	-23.59	10.70	4.3	50.7	PASS
17M	18.068	59.80	-23.90	10.15	3.9	40.3	PASS
	18.168	59.80	-23.70	9.99	4.1	40.6	PASS
15M	21.000	59.90	-23.32	9.85	4.5	44.0	PASS
	21.225	59.90	-23.63	9.91	4.2	41.5	PASS
	21.450	59.90	-23.64	9.86	4.2	40.9	PASS
NO GAIN	26.000	59.72	-34.10	-6.94	0.4	0.1	PASS
	27.000	59.74	-25.85	-11.22	2.4	0.2	PASS
	28.000	59.62	-23.34	-21.02	4.2	0.0	PASS

The HobbyPCB Hardrock-50 amplifier is compliant with CFR Title 47 paragraph 2.815(1) and paragraph 97.317(3) which require that the gain of an external amplifier for use in Amateur Radio service be 0dB of less from 26 to 28 MHz.

The HobbyPCB Hardrock-50 amplifier is compliant with CFR Title 47 paragraph 97.317(2) which limits the gain of an external amplifier for Amateur Radio service to 15 dB.

The actual spectrum analyzer plots are included as an attachment to this test report.

The HobbyPCB Hardrock-50 passes the gain test at all frequencies with a margin of 3 dB or greater.

11.2 Spurious Emissions Test Results

The SA calculates the level of the highest spurious emission relative to the desired signal but the level measurement is only considered valid when the DUT output is greater than 40W. The DUT is considered to have passed at a given frequency if the highest spurious level is attenuated more the 45 dB (43 dB per paragraph 97.307(d) plus 2 dB maximum measurement error) and the DUT output power is greater than 40W.

The following table shows these criteria applied to the raw data.

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Clearwater, Florida 33761

BAND	FREQUENCY (MHz)	SA RANGE (MHz)	ATTEN VALUE (dB)	DUT SA (dBm)	DUT Power (W)	Highest Spur (dB)	PASS/FAIL
160M	1.800	1 - 15	60.10	-13.05	50.7	-53.04	PASS
	1.900	1 - 15	60.10	-12.37	59.3	-52.84	PASS
	2.000	1 - 15	60.10	-12.69	55.1	-53.58	PASS
80M	3.500	3 - 40	60.06	-12.81	53.1	-56.40	PASS
	3.750	3 - 40	59.99	-12.38	57.7	-54.39	PASS
	4.000	3 - 40	59.99	-12.48	56.4	-54.22	PASS
40M	7.000	6 - 100	59.91	-13.17	47.2	-59.92	PASS
	7.150	6 - 100	59.91	-13.02	48.9	-60.18	PASS
	7.300	6 - 100	59.91	-13.02	48.9	-59.94	PASS
30M	10.100	9 - 100	59.88	-13.46	43.9	-61.85	PASS
	10.150	9 - 100	59.88	-13.53	43.2	-61.02	PASS
20M	14.000	13 - 150	59.94	-12.91	50.5	-56.83	PASS
	14.175	13 - 150	59.94	-12.90	50.6	-55.26	PASS
	14.350	13 - 150	59.94	-12.60	54.2	-55.68	PASS
17M	18.068	17-300	59.80	-13.64	41.3	-61.27	PASS
	18.168	17-300	59.80	-13.50	42.7	-52.88	PASS
15M	21.000	17-300	59.90	-13.58	42.9	-60.45	PASS
	21.225	17-300	59.90	-13.37	45.0	-52.88	PASS
	21.450	17-300	59.90	-13.68	41.9	-52.86	PASS

The HobbyPCB Hardrock-50 amplifier is compliant with CFR Title 47 paragraph 97.307(d) which limits the spurious emissions transmitter for Amateur Radio service to a maximum of 43 dB below the power of the carrier.

The actual spectrum analyzer plots are included as an attachment to this test report.

The HobbyPCB Hardrock-50 passes the spurious emissions test at all frequencies with a margin of 7.8 dB or greater.