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Test report

282376-2TRFWL

Date of issue: June 18, 2015

Applicant:

Andrew Wireless Innovations Group

Product:

ION-E

Model:

UAP

FCC ID:

BCR-IONEUAP

Specification:

FCC 47 CFR Part 90

Private Land Mobile Radio Services

Test location

Company name	Nemko Canada Inc.
Address	303 River Road
City	Ottawa
Province	Ontario
Postal code	K1V 1H2
Country	Canada
Telephone	+1 613 737 9680
Facsimile	+1 613 737 9691
Toll free	+1 800 563 6336
Website	www.nemko.com
Site number	FCC test site registration number: 176392, IC: 2040A-4 (3 m semi anechoic chamber)

Tested by	Kevin Rose, Wireless/EMC Specialist
Reviewed by	Andrey Adelberg, Senior Wireless/EMC Specialist
Date	June 18, 2015
Signature	

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Copyright notification

Table of contents

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Andrew Wireless Innovations Group
Address	620 N Greenfield Parkway
City	Garner
Province/State	NC
Postal/Zip code	27529
Country	USA

1.2 Test specifications

FCC 47 CFR Part 90	Private Land Mobile Radio Services
935210 D02 Signal Boosters Certification v02r01	Appendix D booster, amplifier, and repeater interim basic authorization procedures

1.3 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See “Summary of test results” for full details.

1.4 Exclusions

None

1.5 Test report revision history

Revision #	Details of changes made to test report
TRF	Original report issued

Section 2. Summary of test results

2.1 FCC Part 90 test results

Part	Test description	Verdict
§90.541/90.543	RF Output Power	Pass
§90.543	Conducted Spurious	Pass
§90.543	Radiated Spurious	Pass
§90.539	Frequency stability	Pass
§90.543	Input vs Output	Pass
§90.219 (e)(2)	Noise figure	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	August 18, 2014
Nemko sample ID number	1

3.2 EUT information

Product name	ION-E
Model	UAP
Serial number	18

3.3 Technical information

Operating band	758–775 MHz
Modulation type	LTE in 758 – 768 MHz frequency band and P25, FM in 763 – 775 MHz frequency band
Power requirements	110 V_{AC}, ~3 A for entire system tested
Emission designator	D7W in 758 – 868 MHz frequency band and F1D, F1E, F3E in 763 – 775 MHz frequency band
Gain	20 dB
Antenna information	Antenna Gain is 6.85 dBd

3.4 Product description and theory of operation

The UAP amplifier is a multi-band, multi-operator remote unit configuration used in conjunction with a master unit in the ION-E optical distribution antenna system.

3.5 EUT exercise details

The UAP was controlled via a Laptop interface with control software to configure the system.

3.6 EUT setup diagram

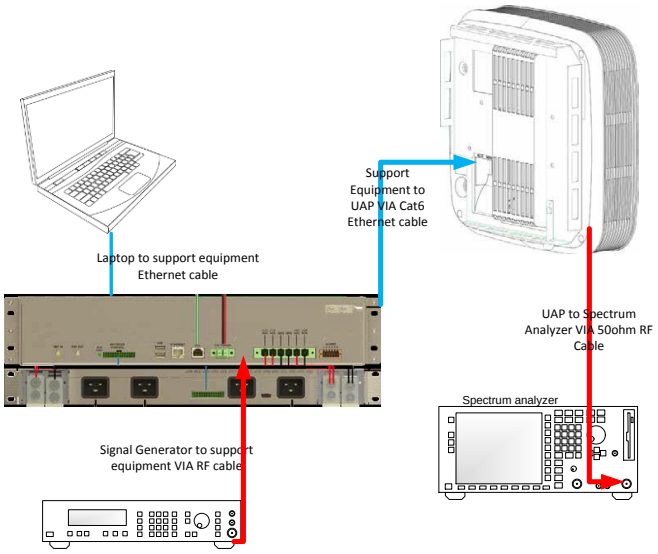


Figure 3.6-1: *Setup diagram*

Table 3.6-1: *Support equipment*

Description	Manufacturer	Model/Part number	Serial number	Rev.
Power Supply	GE	SP800XXXXXXZ0P3	14CS1227006	1
WCS rack	Commscope	WCS4	47	-

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 mbar

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Feb. 25/16
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Jan. 7/16
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	Mar. 27/16
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	Apr. 12/16
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	Apr. 01/16
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	June 23/15
50 Ω coax cable	C.C.A.	None	FA002555	1 year	June 23/15
Signal generator	Rohde & Schwarz	SMIQ03E	FA001269	1 year	June 15/15
Signal generator	Rohde & Schwarz	SMIQ06B	FA001878	1 year	June 15/15
Noise Source	HP	346A	Rental	2 year	Mar 20/17
50 Ω coax cable	Huber + Suhner	None	FA002074	1 year	June 23/15
Temperature chamber	Thermotron	SM-16C	FA001030	1 year	NCR

Note: NCR - no calibration required

Section 8. Testing data

8.1 FCC §90.541(a)/542 (a)(1) RF Output Power

8.1.1 Definitions and limits

90.541
The transmitting power and antenna height of base, mobile, portable and control stations operating in the 769-775 MHz and 799-805 MHz frequency bands must not exceed the maximum limits in this section. Power limits are listed in effective radiated power (ERP).

(b) The transmitting power of a control station must not exceed 200 watts ERP.

90.542
(a) The following power limits apply to the 758-768/788-798 MHz band:

(1) Fixed and base stations transmitting a signal in the 758-768 MHz band with an emission bandwidth of 1 MHz or less must not exceed an ERP of 1000 watts and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 1000 watts ERP in accordance with Table 1 of 90.542

8.1.2 Test summary

Test date	April 30, 2015	Temperature	24 °C
Test engineer	Kevin Rose	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	47 %

8.1.3 Observations, settings and special notes

Worst case limit is used. Test receiver settings:

Detector mode	Peak
Resolution bandwidth	1 MHz
Intergration bandwidth	>OBW
Video bandwidth	>RBW
Trace mode	Max Hold
Measurement time	Auto

8.1.4 Test data

Table 8.1-1: *RF Output power results*

Modulation	Frequency, MHz	Conducted Power , dBm	Antenna Gain, dBd	ERP, W	Limit, W
Analog	774.5	18.43	6.85	0.33	200
P25	768.0	18.07	6.85	0.32	200
1.4 MHz OFDM	763.0	18.46	6.85	0.34	1000
3 MHz OFDM	763.0	18.29	6.85	0.33	1000
5 MHz OFDM	763.0	18.52	6.85	0.34	1000
10 MHz OFDM	763.0	18.38	6.85	0.33	1000

8.2 FCC §90.543(c)(e)(1-5) Conducted Spurious

8.2.1 Definitions and limits

Transmitters designed to operate in 769-775 MHz and 799-805 MHz frequency bands must meet the emission limitations in paragraphs (a) through (d) of this section. Class A and Class B signal boosters retransmitting signals in the 769-775 MHz and 799-805 MHz frequency bands are exempt from the limits listed in paragraph (a) of this section when simultaneously retransmitting multiple signals and instead shall be subject to the limit listed in paragraph (c) of this section when operating in this manner. Transmitters operating in 758-768 MHz and 788-798 MHz bands must meet the emission limitations in (e) of this section.Spurious emissions from a signal booster must not exceed −13 dBm within any 100 kHz measurement bandwidth.

(e) For operations in the 758-768 MHz and the 788-798 MHz bands, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

(1) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than 76 + 10 log (P) dB in a 6.25 kHz band segment, for base and fixed stations.

(2) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations.

(3) On any frequency between 775-788 MHz, above 805 MHz, and below 758 MHz, by at least 43 + 10 log (P) dB.

(4) Compliance with the provisions of paragraphs (e)(1) and (2) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

8.2.2 Test summary

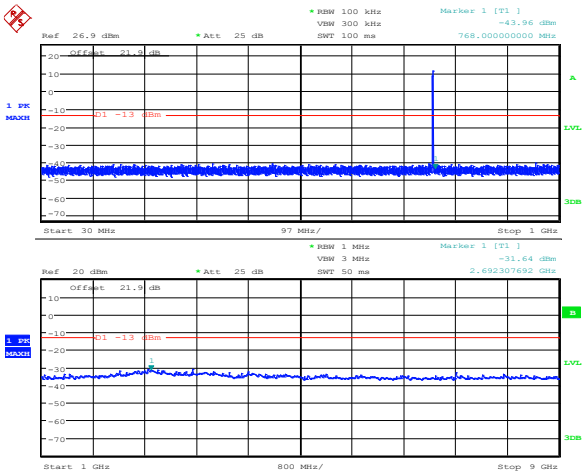
Test date	April 28, 2015	Temperature	23 °C
Test engineer	Kevin Rose	Air pressure	1007 mbar
Verdict	Pass	Relative humidity	32 %

8.2.3 Observations, settings and special notes

Notes: Based on discussions in PS Docket No. 13-87 (FCC 13-40 NPRM at 132) we have omitted 90.543(a) (ACP requirements) and have applied the less restrictive out-of-band emission limits of 90.543(c) when multiple signals are transmitted simultaneously.

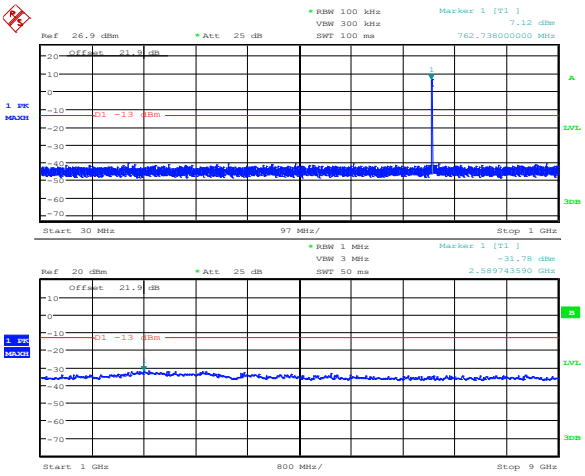
Frequency range	30 MHz to 10th harmonic
Detector mode	Peak
Resolution bandwidth sweep	100 kHz (below 1 GHz), 1000 kHz (above 1 GHz)
Resolution bandwidth band edge	> 1 % of OBW
Video bandwidth	>RBW
Trace mode	Max Hold
Measurement time	Auto

8.2.4 Test data



High channel
Date: 30.APR.2015 18:16:58

Figure 8.2-1: *30MHz to 9 GHz 1.4 MHz OFDM*



High channel
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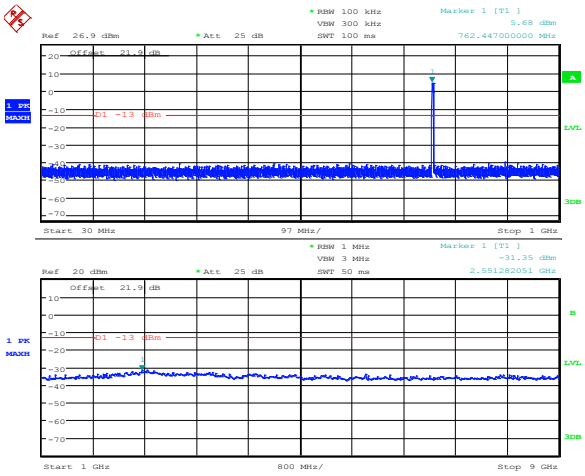
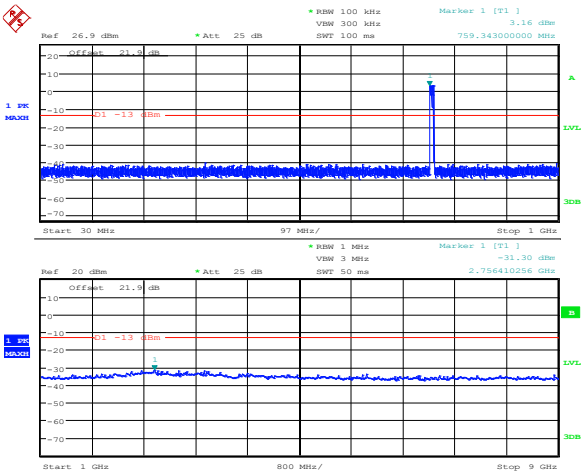
Figure 8.2-2: *30MHz to 9 GHz 3 MHz OFDM*



High channel
Date: 30.APR.2015 18:18:22

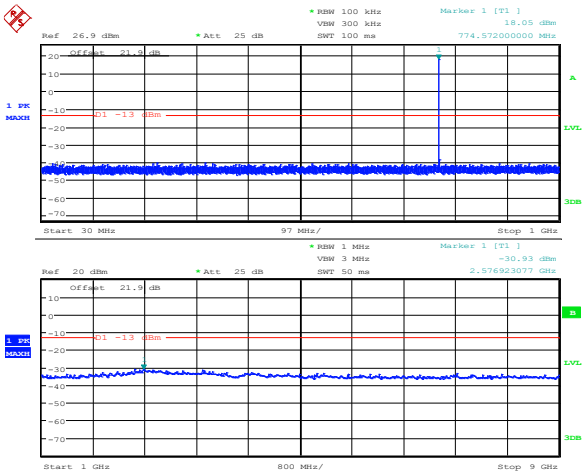
Figure 8.2-3: *30MHz to 9 GHz 5 MHz OFDM*



High channel
Date: 30.APR.2015 18:18:42

Figure 8.2-4: *30MHz to 9 GHz 10 MHz OFDM*

8.2.4 Test data continued



High channel
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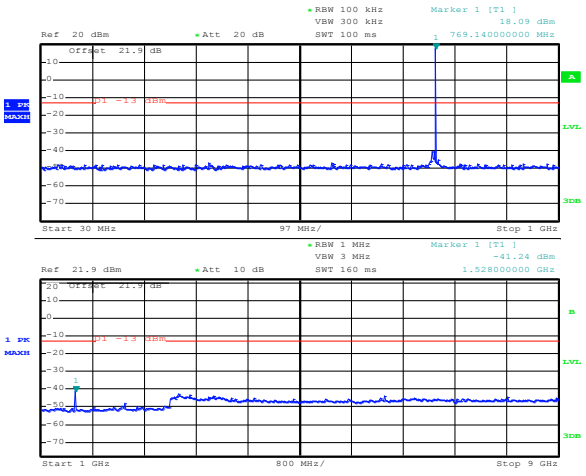
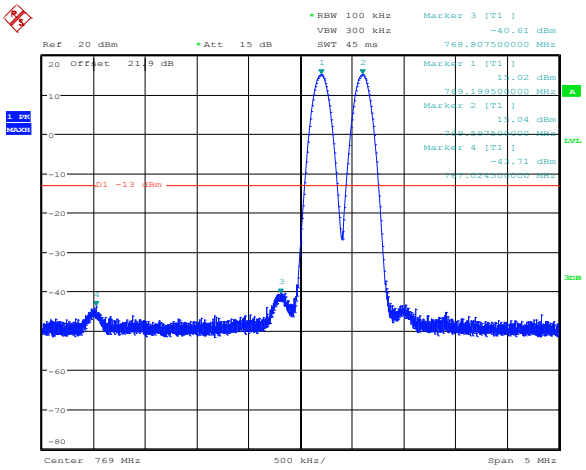
Figure 8.2-5: *30MHz to 9 GHz Analog*



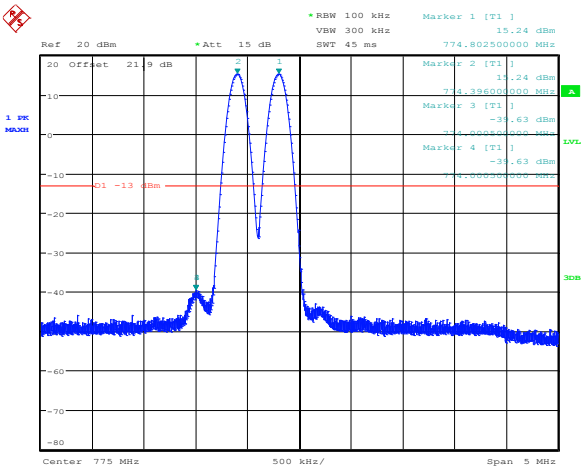
Date: 26.MAY.2015 16:08:42

Figure 8.2-6: *30MHz to 9 GHz P25*



High channel
Date: 30.APR.2015 18:59:51

Figure 8.2-7: *Analog Intermodulation*



High channel
Date: 30.APR.2015 19:03:46

Figure 8.2-8: *Analog Intermodulation*

8.2.4 Test data continued

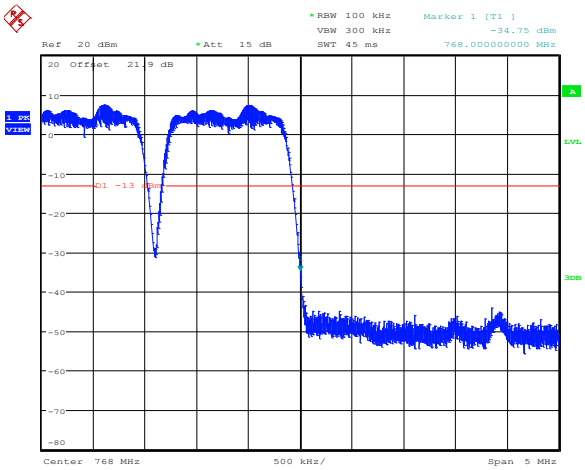


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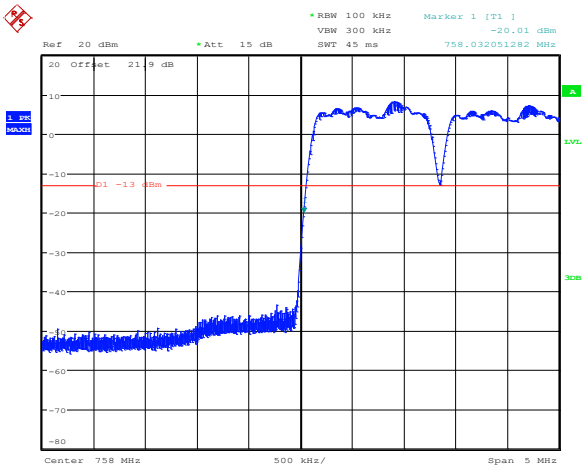
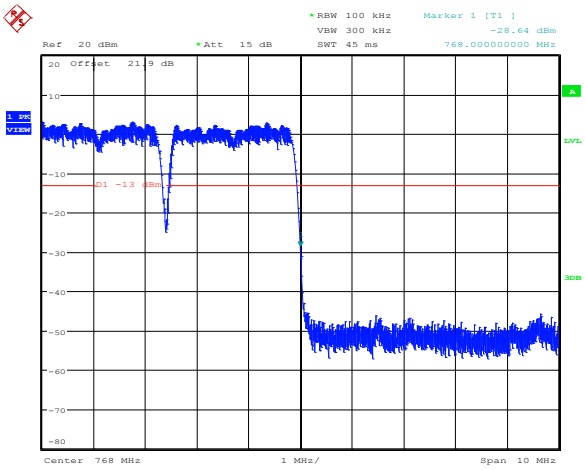
Figure 8.2-9: *1.4 MHz Intermodulation*



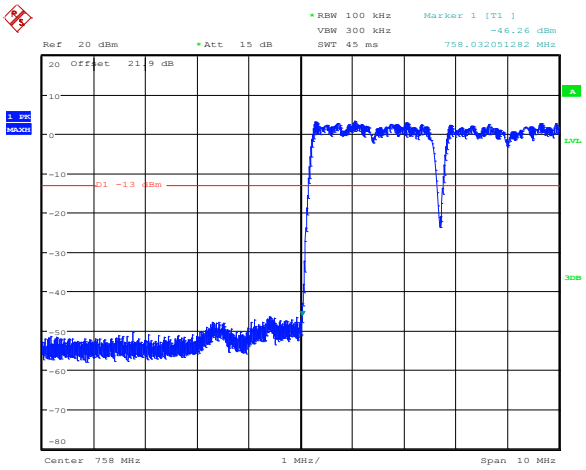
High channel
Date: 30.APR.2015 18:50:01

Figure 8.2-10: *1.4 MHz Intermodulation*



High channel
Date: 30.APR.2015 18:44:31

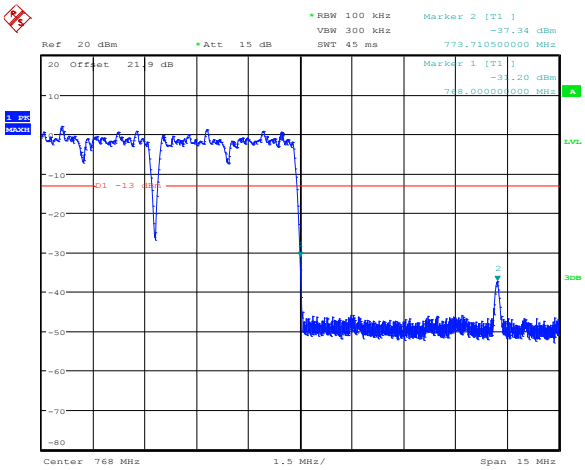
Figure 8.2-11: *3 MHz Intermodulation*



High channel
Date: 30.APR.2015 18:48:56

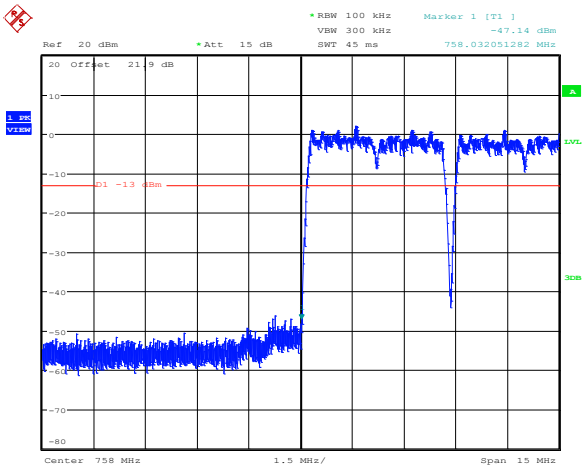
Figure 8.2-12: *3 MHz Intermodulation*

8.2.4 Test data continued



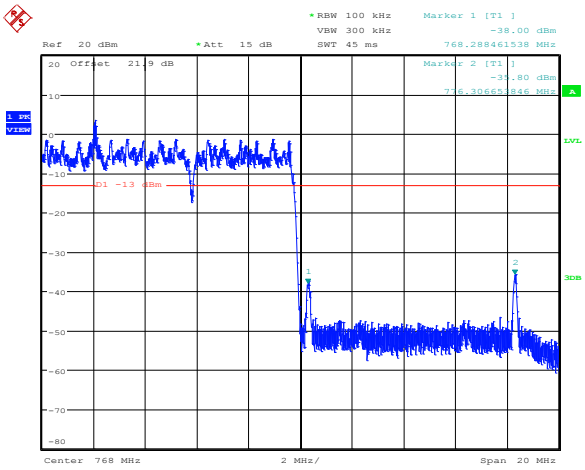
High channel
Date: 30.APR.2015 18:45:32

Figure 8.2-13: *5 MHz Intermodulation*



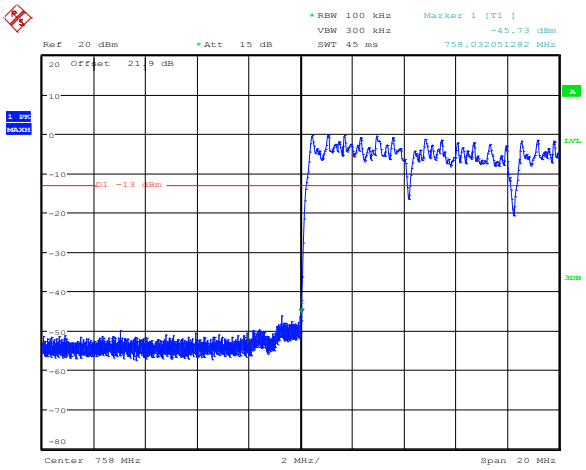
High channel
Date: 30.APR.2015 18:48:18

Figure 8.2-14: *5 MHz Intermodulation*



High channel
Date: 30.APR.2015 18:46:35

Figure 8.2-15: *10 MHz Intermodulation*



High channel
Date: 30.APR.2015 18:47:36

Figure 8.2-16: *10 MHz Intermodulation*

8.2.4 Test data continued

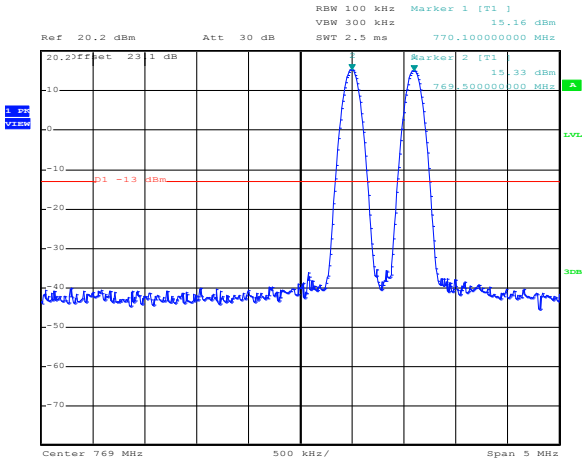


Figure 8.2-17: *P25 Intermodulation*

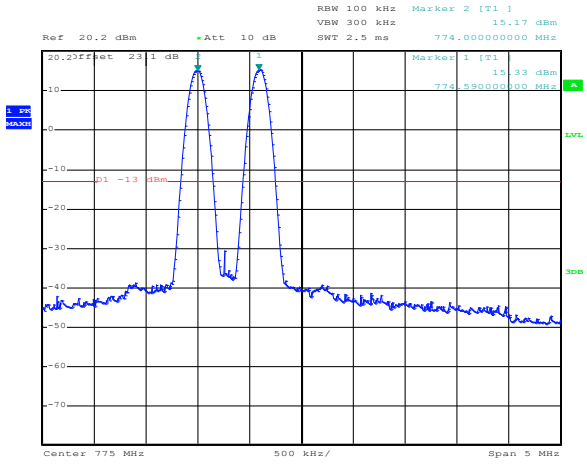


Figure 8.2-18: *P25 Intermodulation*

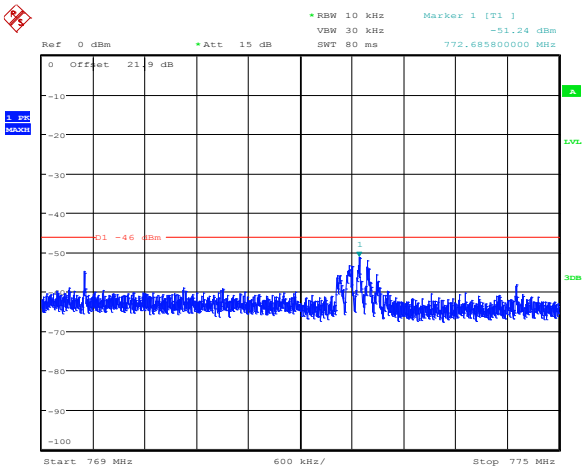


Figure 8.2-19: *769–775 MHz Spurious*

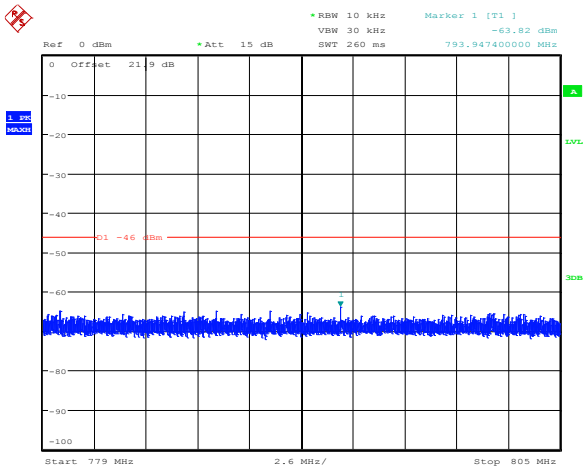


Figure 8.2-20: *779–805 MHz Spurious*

8.3 FCC §90.543(c)(e)(f); Radiated Spurious

8.3.1 Definitions and limits

Spurious emissions from a signal booster must not exceed −13 dBm within any 100 kHz measurement bandwidth.

(f) For operations in the 758-775 MHz and 788-805 MHz bands, all emissions including harmonics in the band 1559-1610 MHz shall be limited to −70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and −80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

8.3.2 Test summary

Test date	May 3, 2015	Temperature	23 °C
Test engineer	Kevin Rose	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	35 %

8.3.3 Observations, settings and special notes

Low, Mid, and High channels were investigated.

No emissions were detected within 20 dB of the −13 dBm limit.

Receiver settings were:

Frequency range	30 MHz to 10th harmonic
Detector mode	Peak
Resolution bandwidth	100 kHz (below 1 GHz), 1 MHz (above 1 GHz)
Video bandwidth	>RBW
Trace mode	Max Hold

8.3.4 Test data

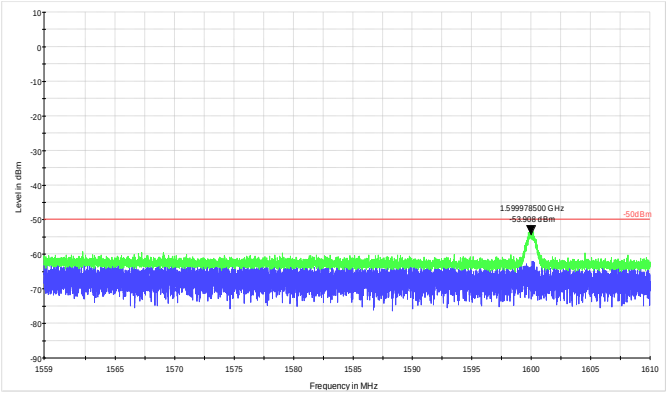


Figure 8.3-1: *1559–1610 MHz Spurious*

8.4 FCC §90.539(b)(d) Frequency stability

8.4.1 Definitions

Transmitters designed to operate in 769-775 MHz and 799-805 MHz frequency bands must meet the frequency stability requirements in this section.

(a) Mobile, portable and control transmitters must normally use automatic frequency control (AFC) to lock on to the base station signal.

(b) The frequency stability of base transmitters operating in the narrowband segment must be 100 parts per billion or better.

(c) The frequency stability of mobile, portable, and control transmitters operating in the narrowband segment must be 400 parts per billion or better when AFC is locked to the base station. When AFC is not locked to the base station, the frequency stability must be at least 1.0 ppm for 6.25 kHz, 1.5 ppm for 12.5 kHz (2 channel aggregate), and 2.5 ppm for 25 kHz (4 channel aggregate).

(d) The frequency stability of base transmitters operating in the wideband segment must be 1 part per million or better.

(e) The frequency stability of mobile, portable and control transmitters operating in the wideband segment must be 1.25 parts per million or better when AFC is locked to a base station, and 5 parts per million or better when AFC is not locked.

8.4.2 Test summary

Test date	March 24, 2015	Temperature	22 °C
Test engineer	Kevin Rose	Air pressure	1001 mbar
Verdict	Pass	Relative humidity	34 %

8.4.3 Observations, settings and special notes

Assessed to remain within assigned band. Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	20 Hz
Video bandwidth	RBW × 3
Trace mode	Max Hold

8.4.4 Test data

Table 8.4-1: *Frequency Stability result*

Test conditions	Frequency, MHz	Offset, Hz
+50 °C, Nominal	764.998389	0
+40 °C, Nominal	764.998389	0
+30 °C, Nominal	764.998389	0
+20 °C, +15 %	764.998389	0
+20 °C, Nominal	764.998389	Reference
+20 °C, −15 %	764.998389	0
+10 °C, Nominal	764.998389	0
0 °C, Nominal	764.998389	0
-10 °C, Nominal	764.998389	0
-20 °C, Nominal	764.998389	0
-30 °C, Nominal	764.998389	0

8.5 FCC §90.543 Input vs Output

8.5.1 Definitions and limits

(4) A signal booster must be designed such that all signals that it retransmits meet the following requirements:

(i) The signals are retransmitted on the same channels as received. Minor departures from the exact provider or reference frequencies of the input signals are allowed, provided that the retransmitted signals meet the requirements of §90.213.

(ii) There is no change in the occupied bandwidth of the retransmitted signals.

(iii) The retransmitted signals continue to meet the unwanted emissions limits of §90.210 applicable to the corresponding received signals (assuming that these received signals meet the applicable unwanted emissions limits by a reasonable margin)

8.5.2 Test summary

Test date	April 29, 2015	Temperature	22 °C
Test engineer	Kevin Rose	Air pressure	1003 mbar
Verdict	Pass	Relative humidity	46 %

8.5.3 Observations, settings and special notes

Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	≥1 % of OBW
Video bandwidth	≥ RBW
Trace mode	Max Hold

8.5.4 Test data

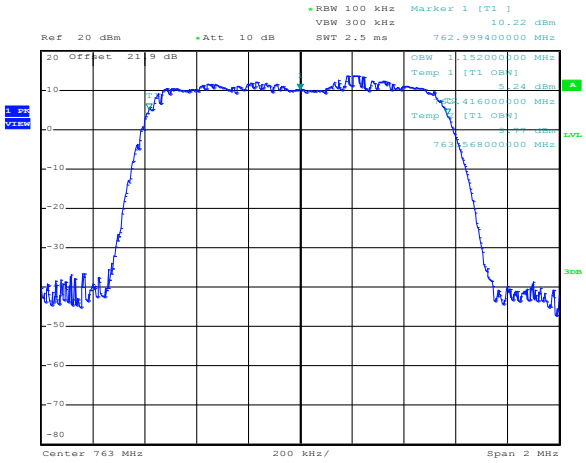


Figure 8.5-1: *1.4 MHz OFDM output*

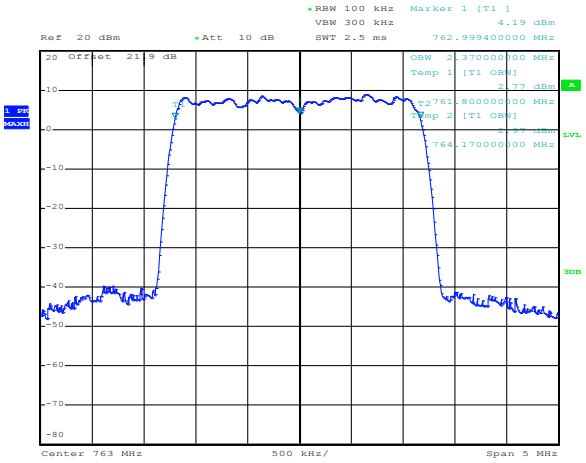


Figure 8.5-2: *3 MHz OFDM output*

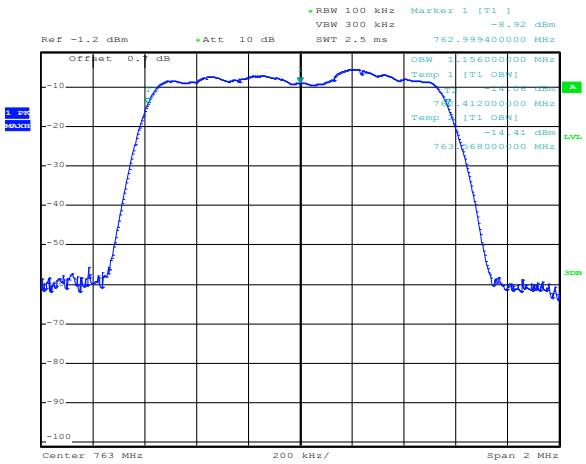


Figure 8.5-3: *1.4 MHz OFDM input*

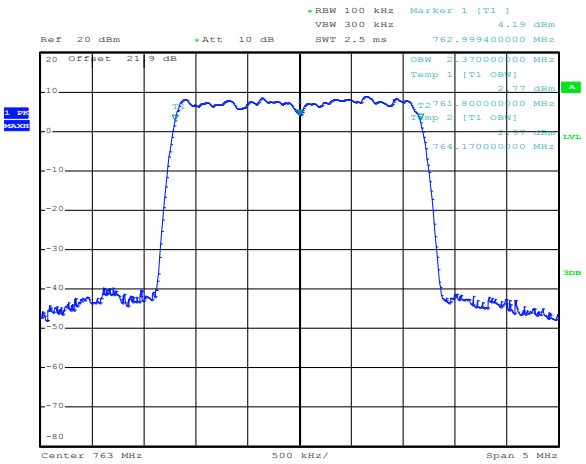


Figure 8.5-4: *3 MHz OFDM input*

8.5.4 Test data continued

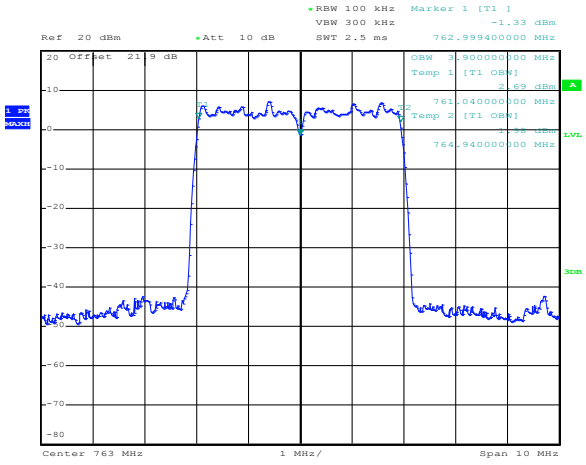


Figure 8.5-5: *5 MHz OFDM output*

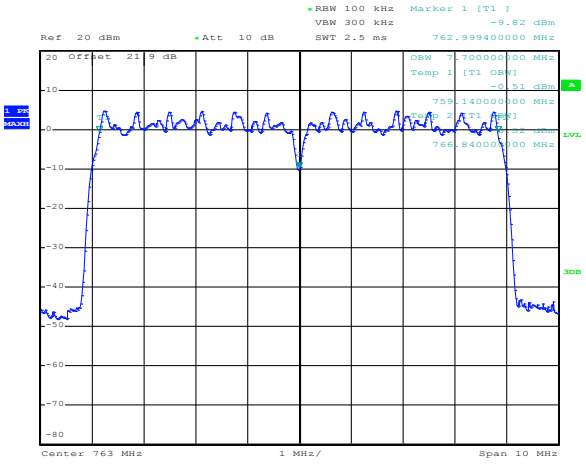


Figure 8.5-6: *10 MHz OFDM output*

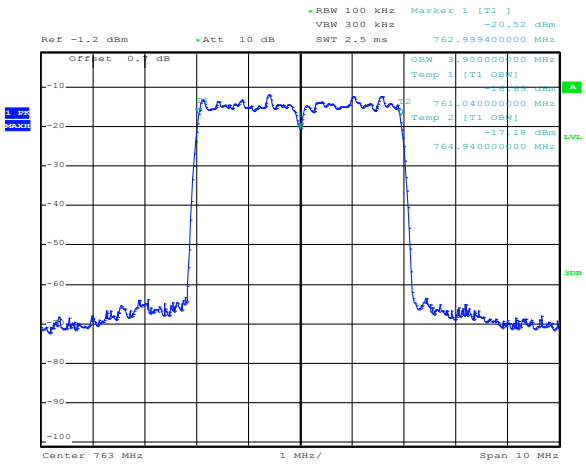


Figure 8.5-7: *5 MHz OFDM input*

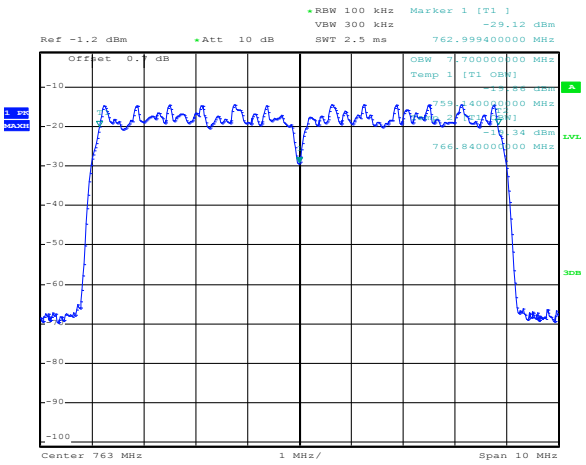


Figure 8.5-8: *10 MHz OFDM input*

8.5.4 Test data continued

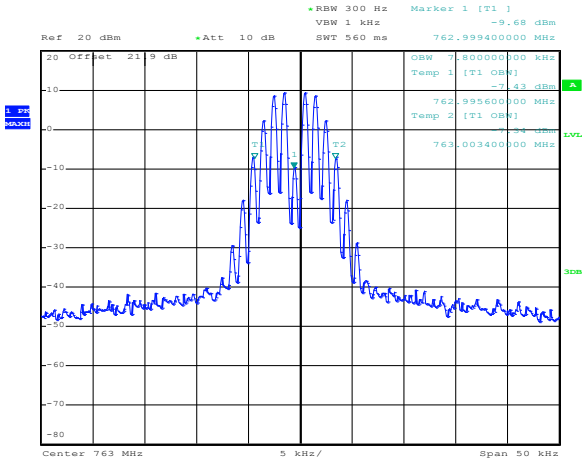


Figure 8.5-9: *Analog output*

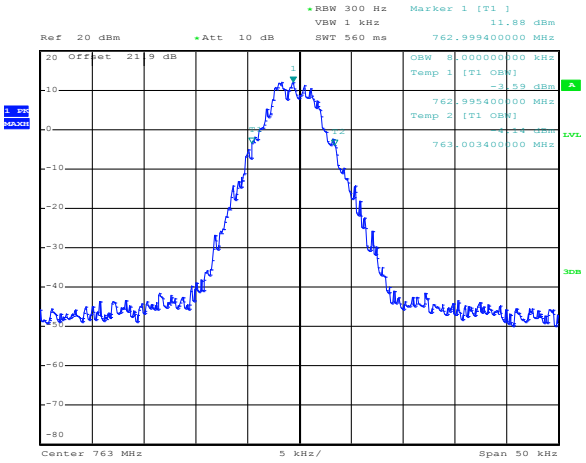


Figure 8.5-10: *P25 output*

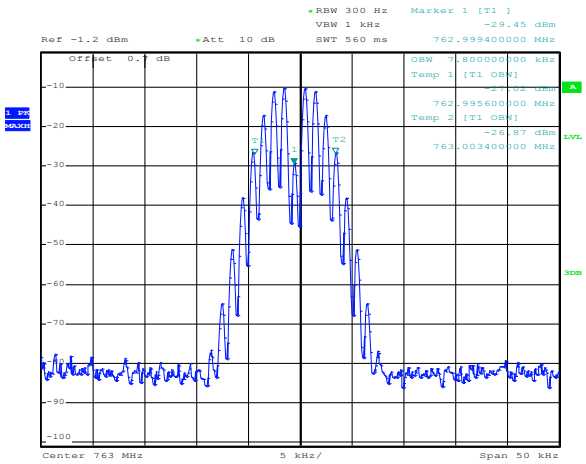


Figure 8.5-11: *Analog input*

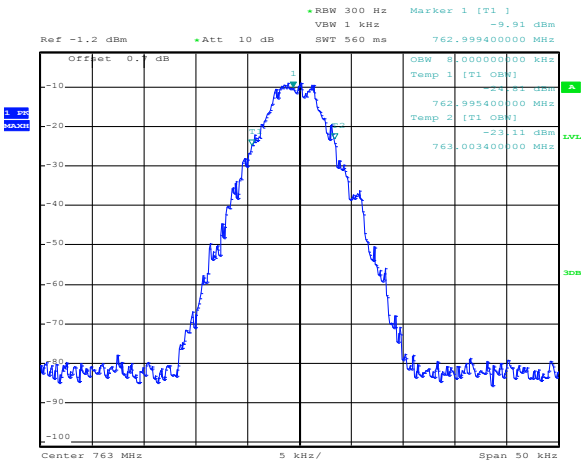


Figure 8.5-12: *P25 input*

8.5.4 Test data continued

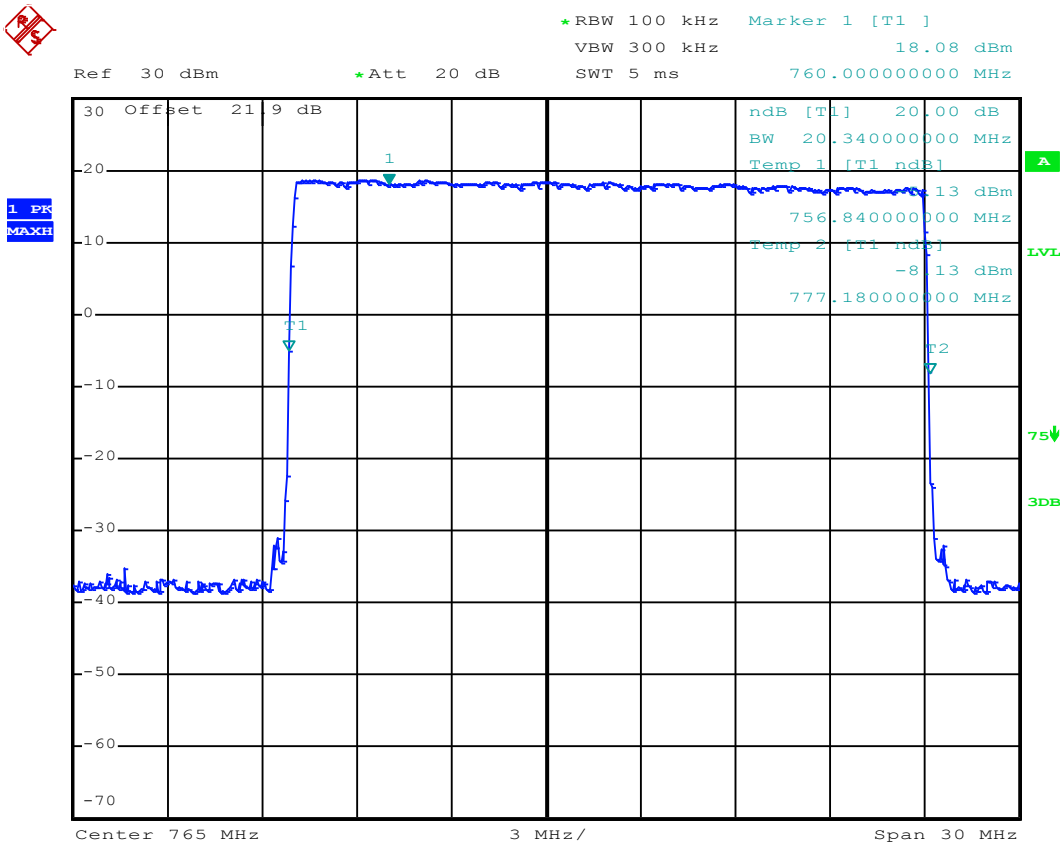


Figure 8.5-13: *Filter response*

8.6 FCC §90.219 (e)(2) Noise figure

8.6.1 Definitions and limits

T The noise figure of a signal booster must not exceed 9 dB in either direction.

8.6.2 Test summary

Test date	May 3, 2015	Temperature	22 °C
Test engineer	Kevin Rose	Air pressure	1003 mbar
Verdict	Pass	Relative humidity	46 %

8.6.3 Observations, settings and special notes

Assessed to remain within assigned band. Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	1 MHz
Video bandwidth	RBW × 3
Trace mode	Average

8.6.4 Test data

Table 8.6-1: *Noise figure result*

Noise Source OFF, dBm	Noise Source ON, dBm	ENR, dB	NF Result, dB	Limit, dB	Margin, dB
-100.56	-99.55	5.04	4.81	9	4.19

Noise Figure (NF) = $10*\log_{10}$ $(10^{(ENR/10)}/10^{(Y/10)}-1)$

Y= Noise Source OFF - Noise Source ON

ENR= Noise level above Thermal noise

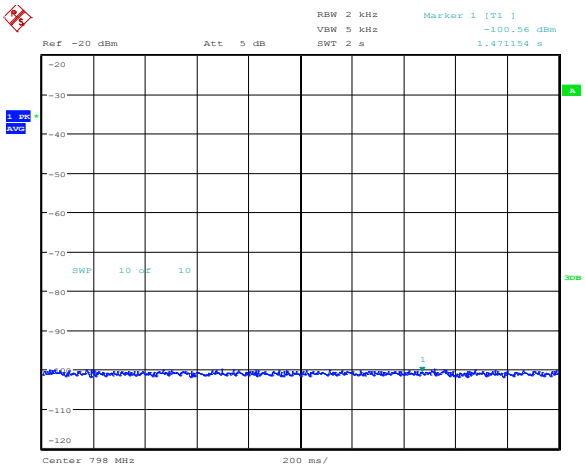


Figure 8.6-1: *5 Noise off*

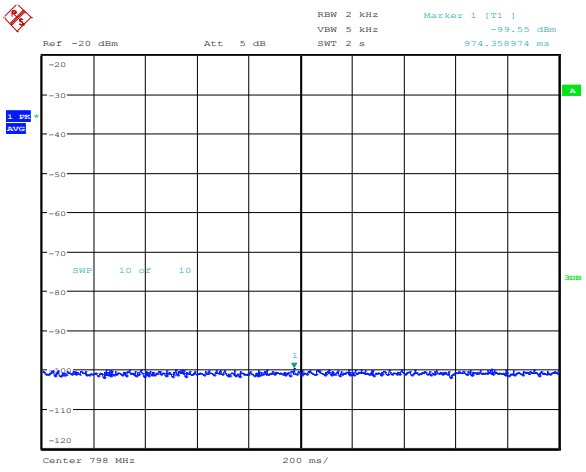


Figure 8.6-2: *Noise on*

Section 9. Setup Photos

9.1 Set-up

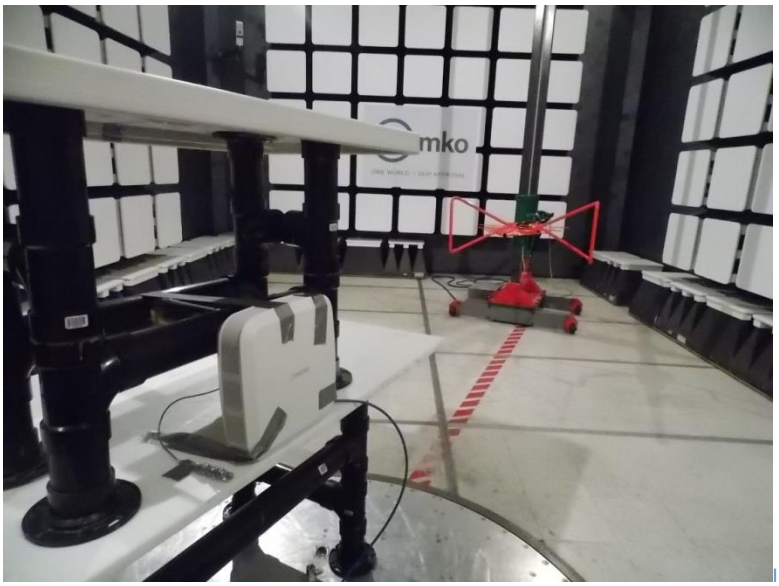


Figure 9.1-1: *Radiated setup photo*

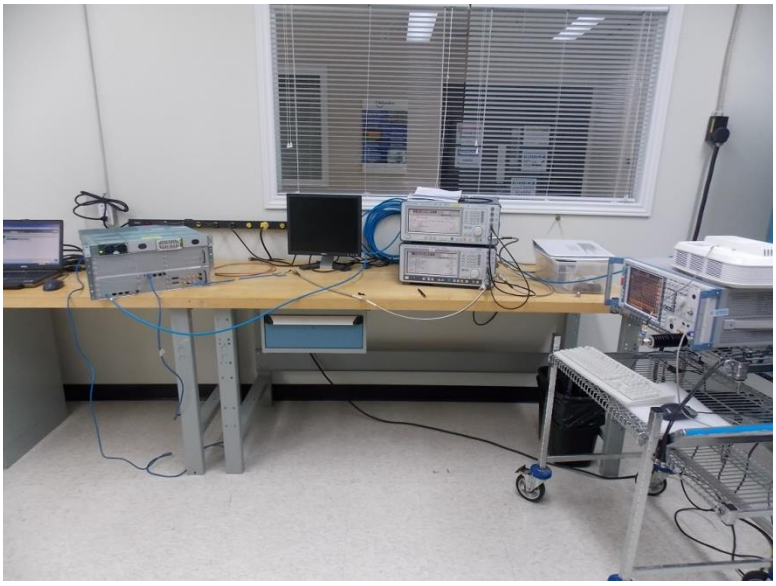
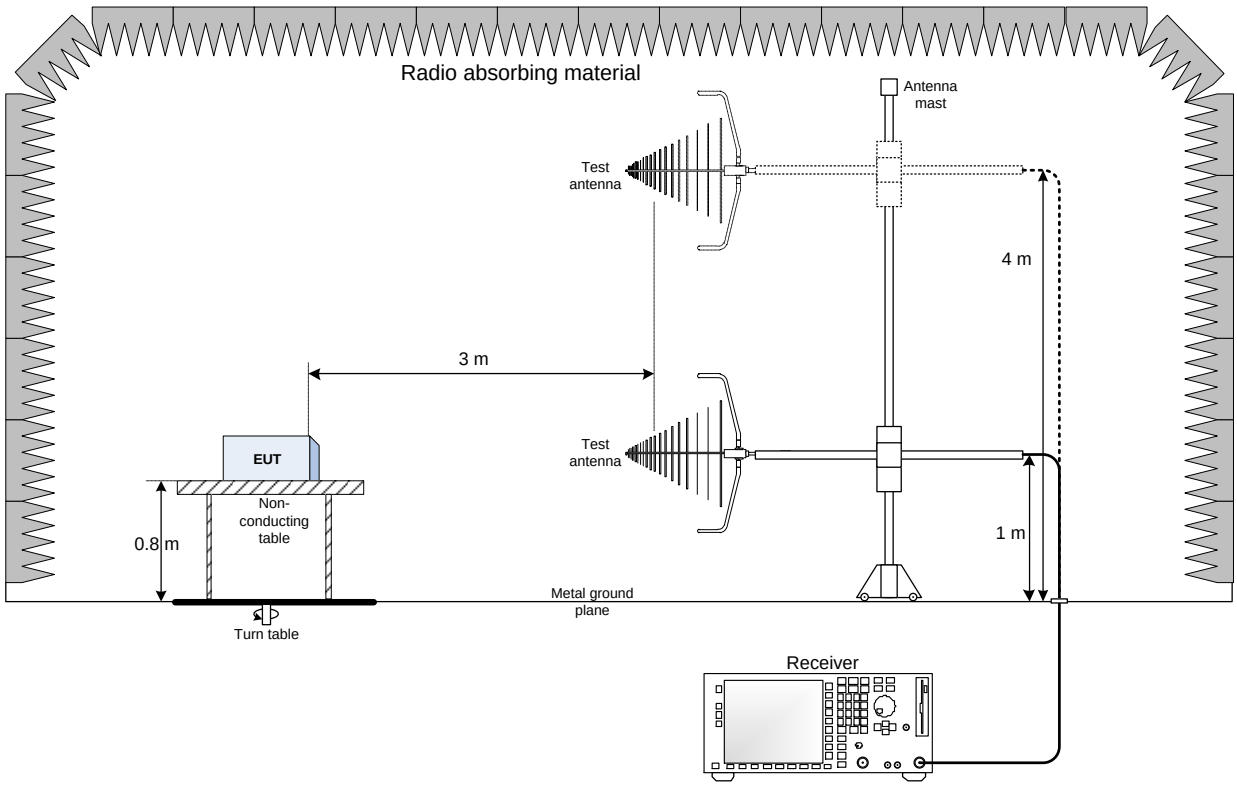


Figure 9.1-2: *Conducted setup photo*

Section 10. Block diagrams of test set-ups

10.1 Radiated emissions set-up



10.2 Noise figure set-up