ONE WORLD ○ OUR APPROVAL

Test report

267266-10TRFWL

Date of issue: March 5, 2015

Applicant:

Andrew Wireless Innovations Group

Product:

ION-E

Model:

UAP

FCC ID:

BCR-IONEUAP

Specification:

FCC 47 CFR Part 27

Miscellaneous wireless communications 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	March 5, 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

Nemko Canada Inc. authorizes the applicant to reproduce this report provided it is reproduced in its entirety and for use by the company's employees only.
Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties.
Nemko Canada Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.
© Nemko Canada Inc.

Table of contents

Table of contents **3**

Section 1. Report summary **4**

1.1 Applicant and manufacturer 4

1.2 Test specifications 4

1.3 Statement of compliance 4

1.4 Exclusions 4

1.5 Test report revision history 4

Section 2. Summary of test results **5**

2.1 FCC Part 27 test results 5

Section 3. Equipment under test (EUT) details **6**

3.1 Sample information 6

3.2 EUT information 6

3.3 Technical information 6

3.4 Product description and theory of operation 6

3.5 EUT exercise details 6

3.6 EUT setup diagram 7

Section 4. Engineering considerations **8**

4.1 Modifications incorporated in the EUT 8

4.2 Technical judgment 8

4.3 Deviations from laboratory tests procedures 8

Section 5. Test conditions **9**

5.1 Atmospheric conditions 9

5.2 Power supply range 9

Section 6. Measurement uncertainty **10**

6.1 Uncertainty of measurement 10

Section 7. Test equipment **11**

7.1 Test equipment list 11

Section 8. Testing data **12**

8.1 FCC 27.50(a) Peak output power at RF antenna connector 12

8.2 FCC 27.53(a) Spurious emissions at RF antenna connector 14

8.3 FCC 27.53(a) Radiated spurious emissions 22

8.4 FCC 27.54 Frequency stability 24

8.5 Part 2.1049 Occupied bandwidth 25

Section 9. Setup Photos **28**

9.1 Set-up 28

Section 10. Block diagrams of test set-ups **29**

10.1 Radiated emissions set-up 29

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 27	Miscellaneous wireless communications services
935210 D02 Signal Boosters Certification v02r01	Appendix D booster, amplifier, and repeater interim basic authorization procedures
KDB 935210 D04	Provider Specific Booster Measurements v01

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 27 test results

Part	Test description	Verdict
§27.50(a)	Peak output power at RF antenna connector	Pass
§27.53(a)	Spurious emissions at RF antenna connector	Pass
§27.53(a)	Radiated spurious emissions	Pass
§27.54	Frequency stability	Pass
§2.1049	Occupied bandwidth	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	2350-2360 MHz (LTE)
Modulation type	LTE (QPSK and QAM) 10 MHz
Power requirements	110 V_{AC}, ~3 A for entire system tested
Emission designator	D7W
Gain	20 dB
Antenna information	External Antenna is not provided EUT used a 50 Ω termination.

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

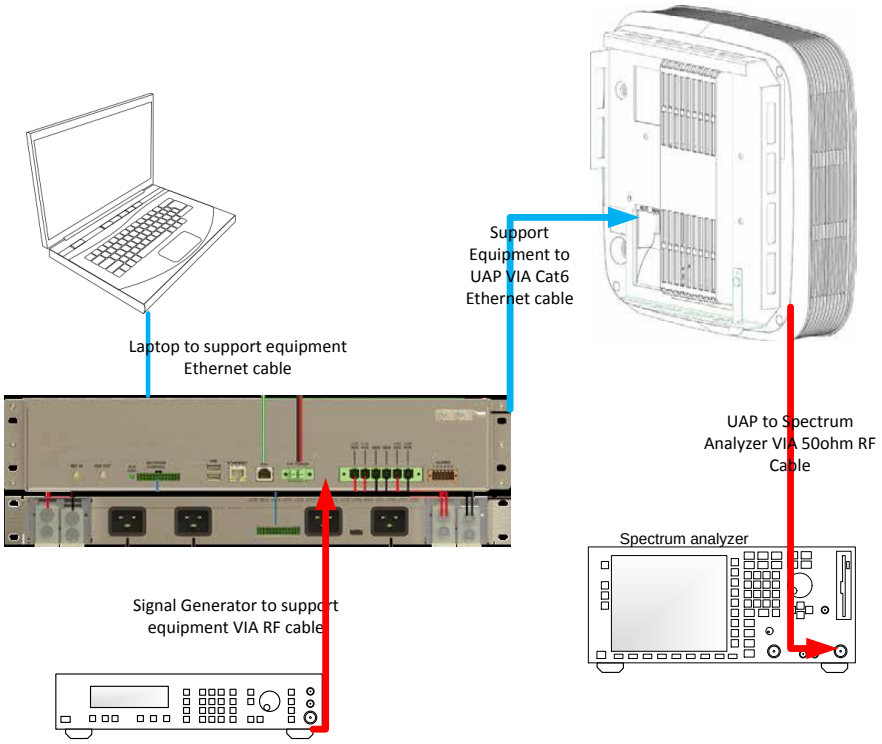


Figure 3.6-1: *Setup diagram*

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

This report covers only 2350-2360 MHz LTE band.

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
AC power line conducted emissions	3.55

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	Mar. 18/15
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
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	Mar. 20/15
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	Mar. 12/15
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	Mar. 10/15
Horn antenna (1–18 GHz)	EMCO	3115	FA000649	1 year	Mar. 25/15
Horn antenna (18–26.5 GHz)	Electro-metrics	SH-50/60-1	FA000479	—	VOU
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	June 23/15
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
Signal generator	Rohde & Schwarz	SMIQ03E	FA001269	1 year	Feb 27/15
Signal generator	Rohde & Schwarz	SMIQ06B	FA001878	1 year	Feb 24/15
50 Ω coax cable	C.C.A.	None	FA002555	1 year	June 23/15
50 Ω coax cable	Huber + Suhner	None	FA002074	1 year	June 23/15
Temperature chamber	Thermotron	SM-16C	FA001030	1 year	NCR
Multimeter	Fluke	16	FA001831	1 year	Feb. 04/15

Note: NCR - no calibration required, VOU - verify on use

Section 8. Testing data

8.1 FCC 27.50(a) Peak output power at RF antenna connector

8.1.1 Definitions and limits

(1) Base and fixed stations. (i) For base and fixed stations transmitting in the 2305-2315 MHz band or the 2350-2360 MHz band:

(A) The average equivalent isotropically radiated power (EIRP) must not exceed 2,000 watts within any 5 megahertz of authorized bandwidth and must not exceed 400 watts within any 1 megahertz of authorized bandwidth.

(B) The peak-to-average power ratio (PAPR) of the transmitter output power must not exceed 13 dB. The PAPR measurements should be made using either an instrument with complementary cumulative distribution function (CCDF) capabilities to determine that PAPR will not exceed 13 dB for more than 0.1 percent of the time or other Commission approved procedure. The measurement must be performed using a signal corresponding to the highest PAPR expected during periods of continuous transmission

8.1.2 Test summary

Test date	February 4, 2015	Temperature	23 °C
Test engineer	Kevin Rose	Air pressure	1002 mbar
Verdict	Pass	Relative humidity	32 %

8.1.3 Observations, settings and special notes

Test receiver settings:

Detector mode	RMS (for average), Peak (for peak)
Resolution bandwidth	100 kHz
Integration bandwidth	>OBW
Video bandwidth	>RBW
Trace mode	Power Average (for average), Max Hold (for peak)
Measurement time	Auto

8.1.4 Test data

Table 8.1-1: *Peak to average ratio results.*

Modulation	Frequency, MHz	RF output power AVG, dBm	RF output power Peak, dBm	Peak to Average Ratio, dB	Peak to Average Ratio Limit, dBm	Peak to Average Margin, dB
10 MHz LTE QAM	2355	18.37	27.62	9.25	13	3.75
10 MHz LTE QPSK	2355	18.24	27.71	9.47	13	3.53

Table 8.1-2: *Conducted Power 5 MHz authorized bandwidth results.*

Modulation	Frequency, MHz	RF output power AVG, dBm	Antenna Gain, dBi	EIRP, dBm	Limit, dBm/5 MHz	Margin, dBm
10 MHz LTE QAM	2355	18.37	5	23.37	63	39.63
10 MHz LTE QPSK	2355	18.24	5	23.24	63	39.76

Note: The results were measured using a higher resolution bandwidth integrated power. 5MHz limit is the lowest limit
The actual limit may be increased by(60+10*LOG (actual bandwidth/5MHz)

Table 8.1-3: *Conducted Power 1 MHz authorized bandwidth results.*

Modulation	Frequency, MHz	RF output power AVG, dBm	Antenna Gain, dBi	EIRP, dBm	Limit, dBm/1 MHz	Margin, dBm
10 MHz LTE QAM	2355	18.37	5	23.37	56	32.63
10 MHz LTE QPSK	2355	18.24	5	23.24	56	32.76

Note: The results were measured using a higher resolution bandwidth integrated power. 1MHz limit is the lowest limit
The actual limit may be increased by(60+10*LOG (actual bandwidth/1MHz)

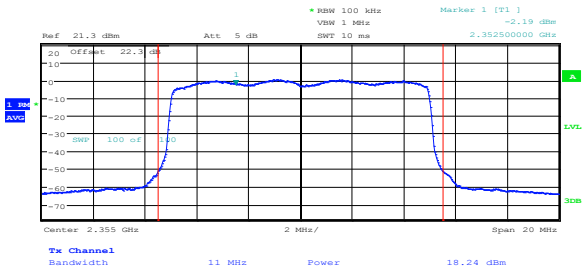


Figure 8.1-1: *Conducted Average power example*

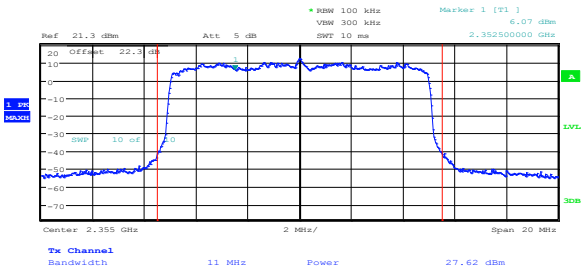


Figure 8.1-2: *Conducted Peak power example*

8.2 FCC 27.53(a) Spurious emissions at RF antenna connector

8.2.1 Definitions and limits

(a) For operations in the 2305-2320 MHz band and the 2345-2360 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power P (with averaging performed only during periods of transmission) within the licensed band(s) of operation, in watts, by the following amounts:

(1) For base and fixed stations' operations in the 2305-2320 MHz band and the 2345-2360 MHz band:

(i) By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2305 and 2320 MHz and on all frequencies between 2345 and 2360 MHz that are outside the licensed band(s) of operation, and not less than 75 + 10 log (P) dB on all frequencies between 2320 and 2345 MHz;

(ii) By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2300 and 2305 MHz, 70 + 10 log (P) dB on all frequencies between 2287.5 and 2300 MHz, 72 + 10 log (P) dB on all frequencies between 2285 and 2287.5 MHz, and 75 + 10 log (P) dB below 2285 MHz;

(iii) By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2360 and 2362.5 MHz, 55 + 10 log (P) dB on all frequencies between 2362.5 and 2365 MHz, 70 + 10 log (P) dB on all frequencies between 2365 and 2367.5 MHz, 72 + 10 log (P) dB on all frequencies between 2367.5 and 2370 MHz, and 75 + 10 log (P) dB above 2370 MHz.

(5) Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the channel blocks at 2305, 2310, 2315, 2320, 2345, 2350, 2355, and 2360 MHz, a resolution bandwidth of at least 1 percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e., 1 MHz). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

(7) The measurements of emission power can be expressed in peak or average values, provided they are expressed in the same parameters as the transmitter power;

8.2.2 Test summary

Test date	February 4, 2015	Temperature	23 °C
Test engineer	Kevin Rose	Air pressure	1002 mbar
Verdict	Pass	Relative humidity	32 %

8.2.3 Observations, settings and special notes

KDB 935210 D04 Provider Specific Booster Measurements used to perform the testing.

Frequency range	30 MHz to 10th harmonic
Detector mode	RMS
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	Average
Measurement time	Auto

8.2.4 Test data

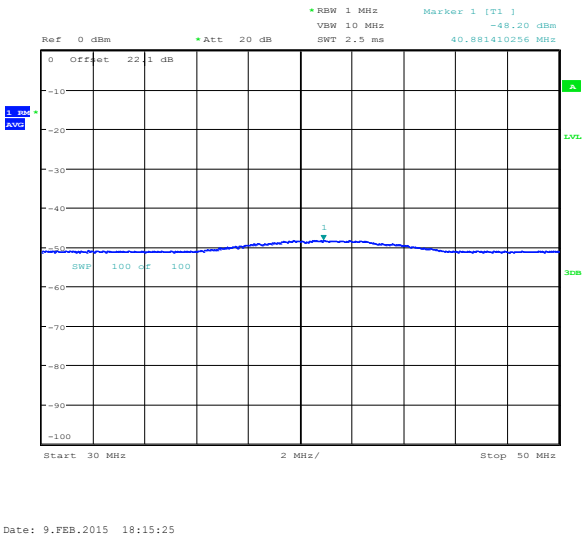


Figure 8.2-1: *10 MHz LTE QAM 30–50 MHz*

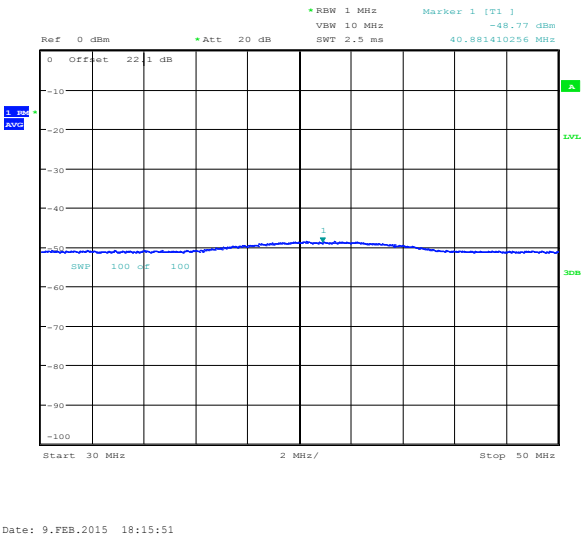


Figure 8.2-2: *10 MHz LTE QPSK 30–50 MHz*

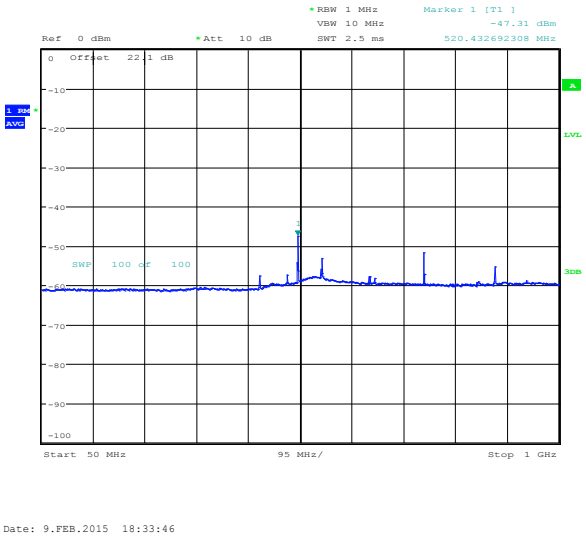


Figure 8.2-3: *10 MHz LTE QAM 50 MHz-1GHz*

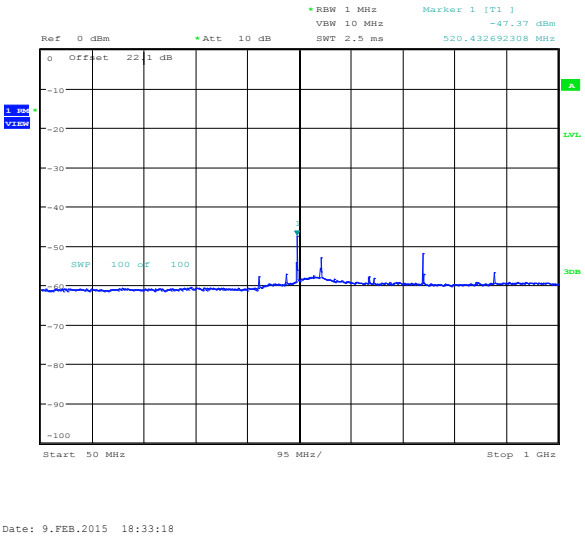


Figure 8.2-4: *10 MHz LTE QPSK 50 MHz-1GHz*

8.2.1 Test data

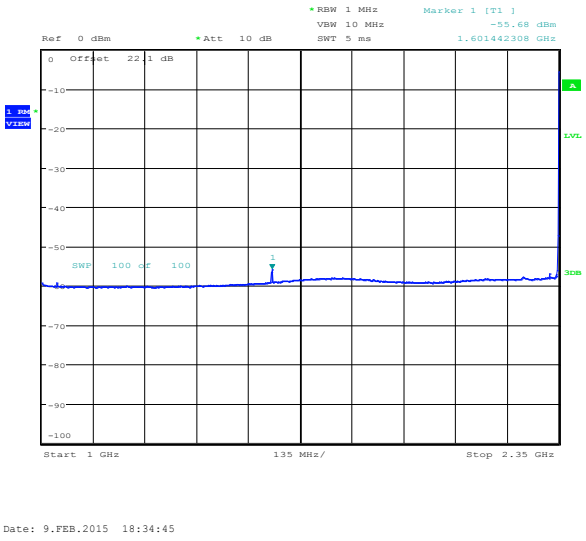


Figure 8.2-5: *10 MHz LTE QAM 1–2.35 GHz*

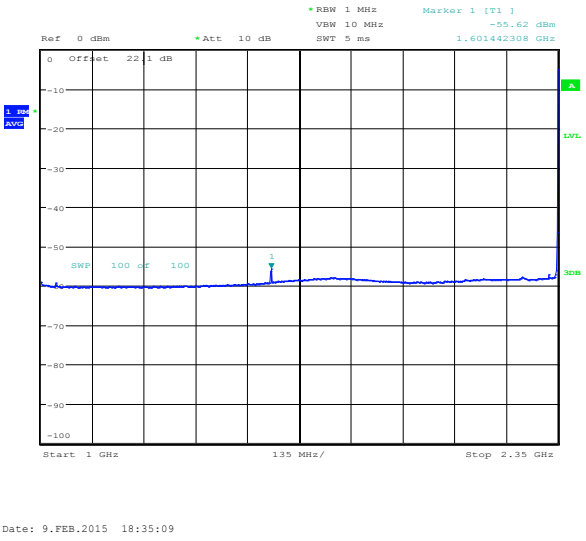


Figure 8.2-6: *10 MHz LTE QPSK 1–2.35 GHz*

8.2.1 Test data

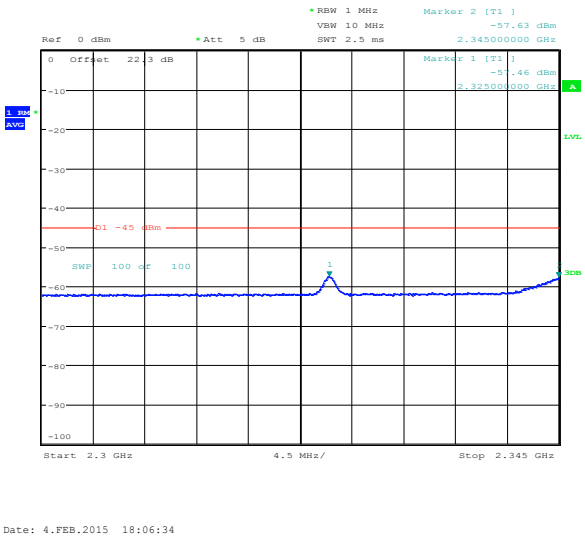


Figure 8.2-7: *10 MHz LTE QAM 2.3 – 2.345 GHz*

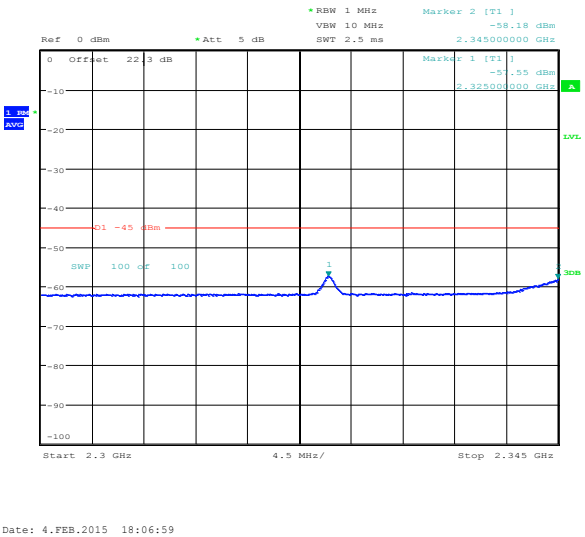


Figure 8.2-8: *10 MHz LTE QPSK 2.3 – 2.345 GHz*

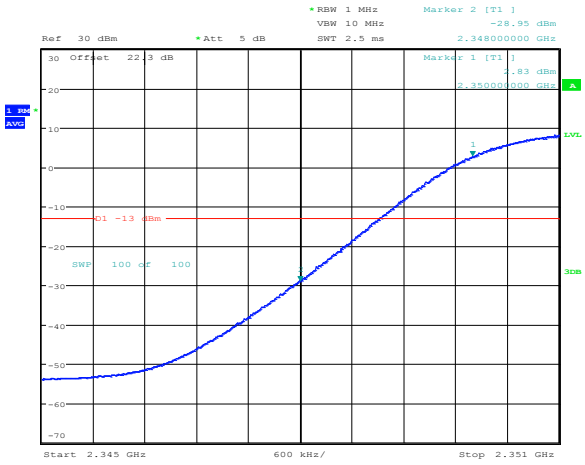


Figure 8.2-9: *10 MHz LTE QAM 2.345-2.351 GHz*

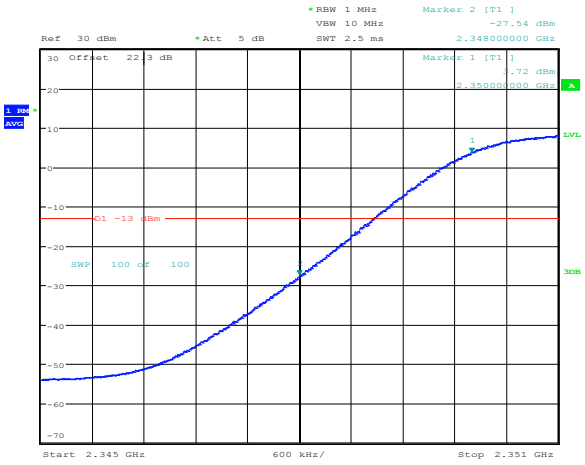


Figure 8.2-10: *10 MHz LTE QPSK 2.345-2.351 GHz*

8.2.1 Test data

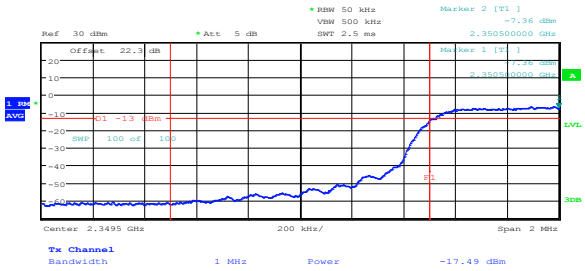


Figure 8.2-11: *10 MHz LTE QAM 2350 MHz*

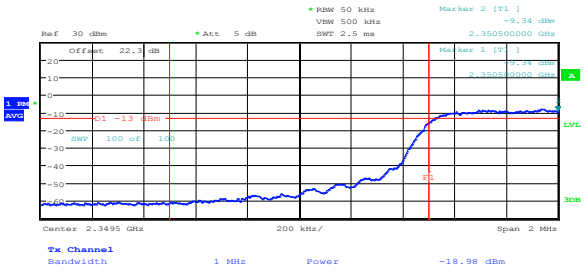


Figure 8.2-12: *10 MHz LTE QPSK 2350 MHz*

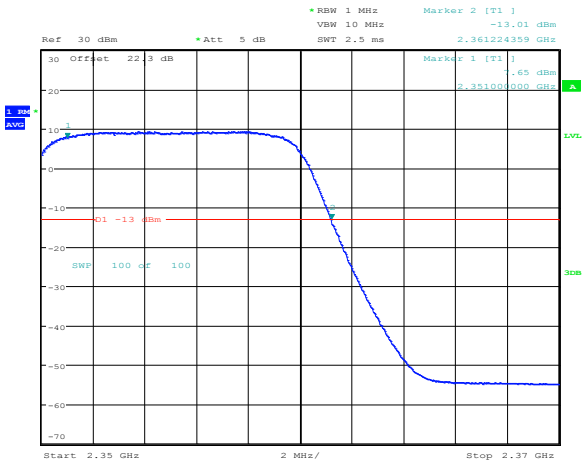


Figure 8.2-13: *10 MHz LTE QPSK 2.352.37 GHz*

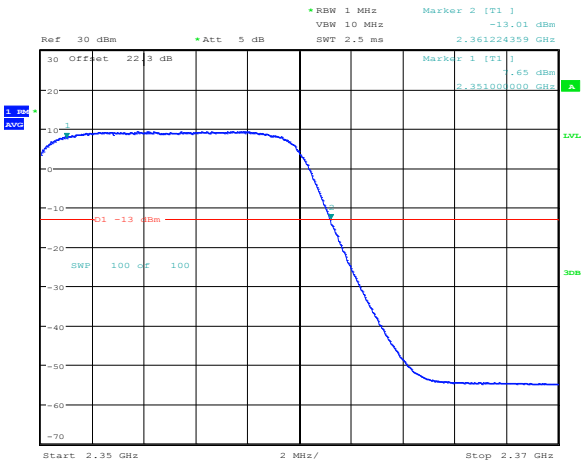


Figure 8.2-14: *10 MHz LTE QPSK 2.352.37 GHz*

8.2.1 Test data

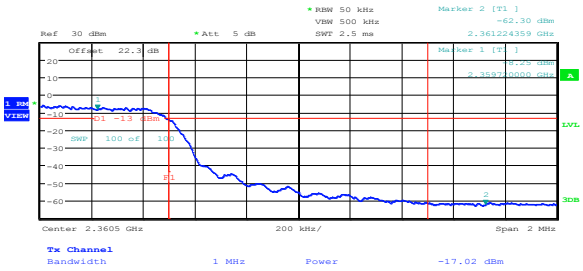


Figure 8.2-15: *10 MHz LTE QAM 2360 MHz*

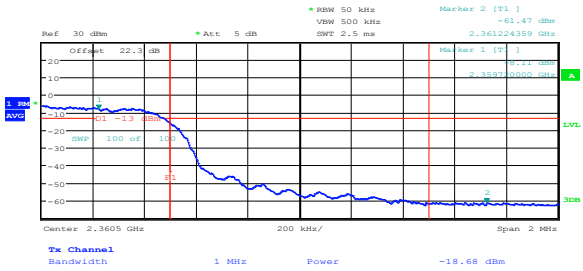


Figure 8.2-16: *10 MHz LTE QPSK 2360 MHz*

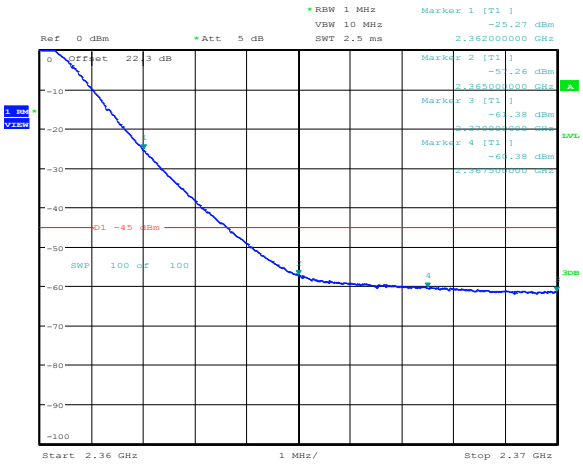


Figure 8.2-17: *10 MHz LTE QAM 2.36 –2.37 GHz*

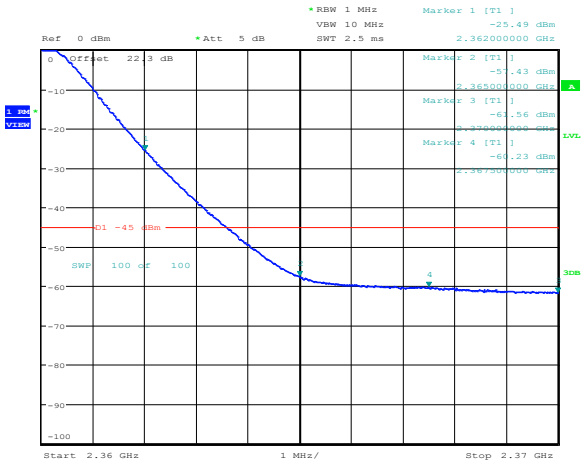


Figure 8.2-18: *10 MHz LTE QPSK 2.36 –2.37 GHz*

8.2.1 Test data

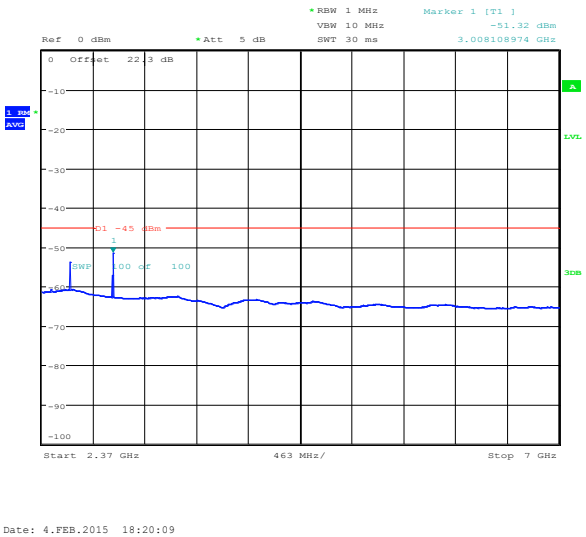


Figure 8.2-19: *10 MHz LTE QAM 2.37-7 GHz*

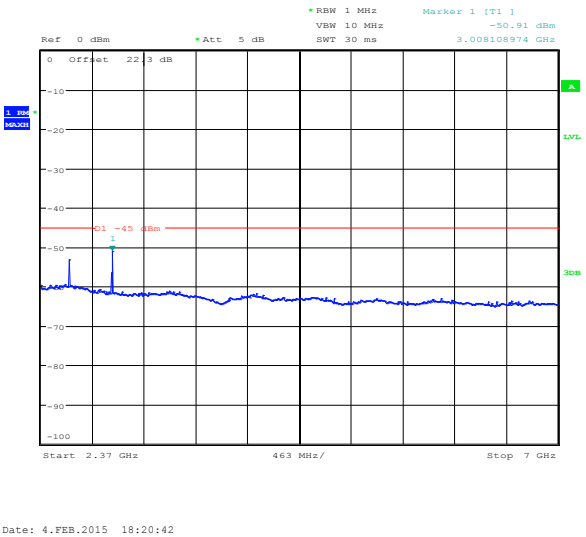


Figure 8.2-20: *10 MHz LTE QPSK 2.37-7 GHz*

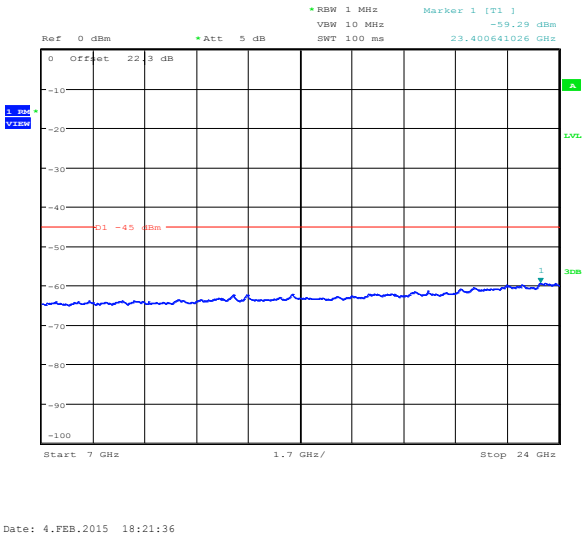


Figure 8.2-21: *10 MHz LTE QPSK 7-24 GHz*

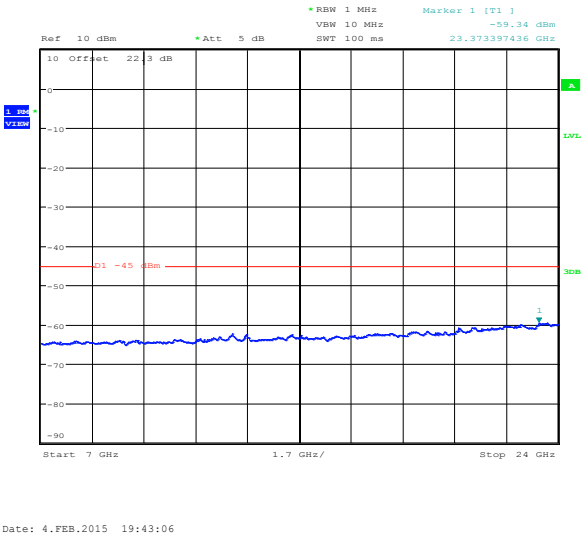


Figure 8.2-22: *10 MHz LTE QPSK 7-24 GHz*

8.2.4 Test data continued

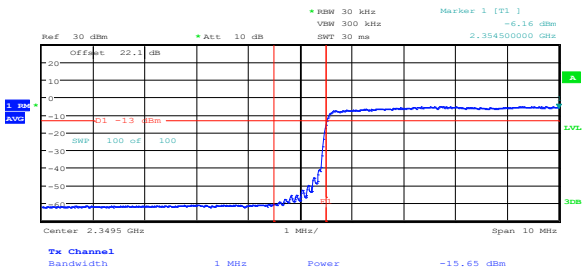


Figure 8.2-23: *10 MHz Lower Band edge QPSK*

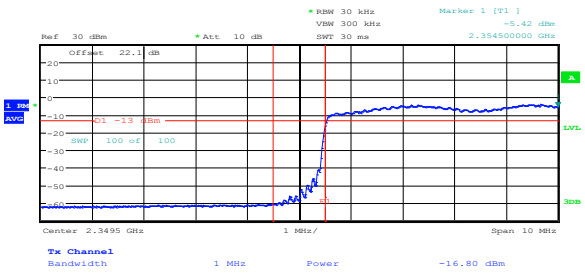


Figure 8.2-24: *10 MHz Lower Band edge QAM*

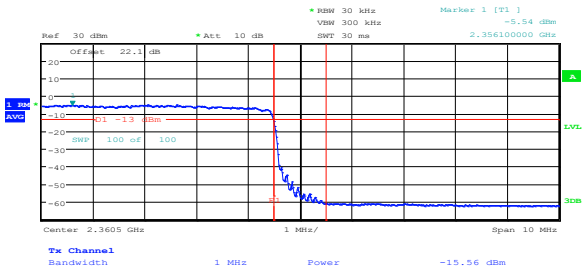


Figure 8.2-25: *10 MHz Upper Band edge QPSK*

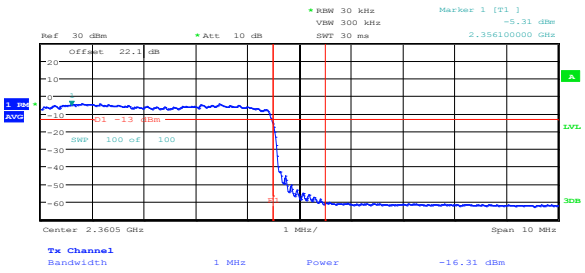


Figure 8.2-26: *10 MHz Upper Band edge QAM*

8.3 FCC 27.53(a) Radiated spurious emissions

8.3.1 Definitions and limits

(a) For operations in the 2305-2320 MHz band and the 2345-2360 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power P (with averaging performed only during periods of transmission) within the licensed band(s) of operation, in watts, by the following amounts:

(1) For base and fixed stations' operations in the 2305-2320 MHz band and the 2345-2360 MHz band:

(i) By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2305 and 2320 MHz and on all frequencies between 2345 and 2360 MHz that are outside the licensed band(s) of operation, and not less than 75 + 10 log (P) dB on all frequencies between 2320 and 2345 MHz;

(ii) By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2300 and 2305 MHz, 70 + 10 log (P) dB on all frequencies between 2287.5 and 2300 MHz, 72 + 10 log (P) dB on all frequencies between 2285 and 2287.5 MHz, and 75 + 10 log (P) dB below 2285 MHz;

(iii) By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2360 and 2362.5 MHz, 55 + 10 log (P) dB on all frequencies between 2362.5 and 2365 MHz, 70 + 10 log (P) dB on all frequencies between 2365 and 2367.5 MHz, 72 + 10 log (P) dB on all frequencies between 2367.5 and 2370 MHz, and 75 + 10 log (P) dB above 2370 MHz.

8.3.2 Test summary

Test date	February 11, 2015	Temperature	22 °C
Test engineer	Kevin Rose	Air pressure	1003 mbar
Verdict	Pass	Relative humidity	46 %

8.3.3 Observations, settings and special notes

Low, Mid, and High channels of all modulations were investigated. Worst case examples are provided.
935210 D02 Signal Boosters Certification v02r01 was used for Radiated Emissions

Receiver settings were:

Frequency range	30 MHz to 10th harmonic
Detector mode	Peak
Resolution bandwidth	100 kHz (below 1 GHz), 1000 kHz (above 1 GHz)
Video bandwidth	>RBW
Trace mode	Max Hold

8.3.4 Test data

Table 8.3-1: *Radiated spurious results*

Frequency, MHz	Field strength, dBµv/m	Substitution factor, dB	Calculated EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
32.4	24.5	-73.4	-48.9	-45	3.9
63.4	26	-91.2	-65.2	-45	20.2
445.2	34	-83.5	-49.5	-45	4.5
1400	3.7	-70.5	-66.8	-45	21.8
1600	13.6	-70.8	-57.2	-45	12.2
2000	2.4	-68.7	-66.3	-45	21.3
2600	5.4	-67.3	-61.9	-45	16.9
2800	2.1	-65.5	-63.4	-45	18.4
4297	4.4	-61.2	-56.8	-45	11.8
6012.4	5.8	-56.7	-50.9	-45	5.9
16000	-25.1	-26.1	-51.2	-45	6.2

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, Substitution factor, and attenuators where applicable. Emissions above 10 GHz the measuring antenna was moved to 30 cm of the unit.

8.4 FCC 27.54 Frequency stability

8.4.1 Definitions and limits

The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

8.4.2 Test summary

Test date	September 4, 2014	Temperature	22 °C
Test engineer	Kevin Rose	Air pressure	1003 mbar
Verdict	Pass	Relative humidity	46 %

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, Hz	Offset, Hz
+50 °C, Nominal	2355098412	0
+40 °C, Nominal	2355098412	0
+30 °C, Nominal	2355098412	0
+20 °C, +15 %	2355098412	0
+20 °C, Nominal	2355098412	Reference
+20 °C, −15 %	2355098412	0
+10 °C, Nominal	2355098412	0
0 °C, Nominal	2355098412	0
-10 °C, Nominal	2355098412	0
-20 °C, Nominal	2355098412	0
-30 °C, Nominal	2355098412	0

8.5 Part 2.1049 Occupied bandwidth

8.5.1 Definitions and limits

The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

8.5.2 Test summary

Test date	February 3, 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

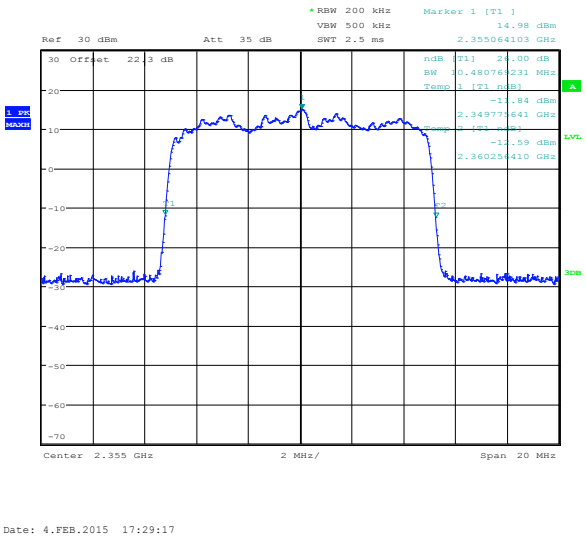


Figure 8.5-1: *10 MHz QAM output*

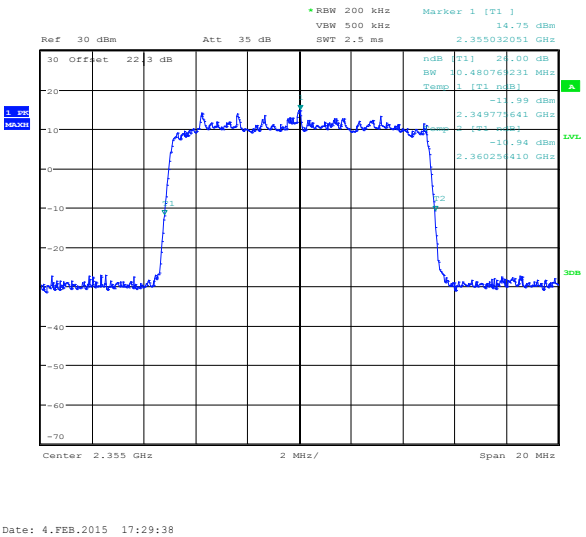


Figure 8.5-2: *10 MHz QPSK output*

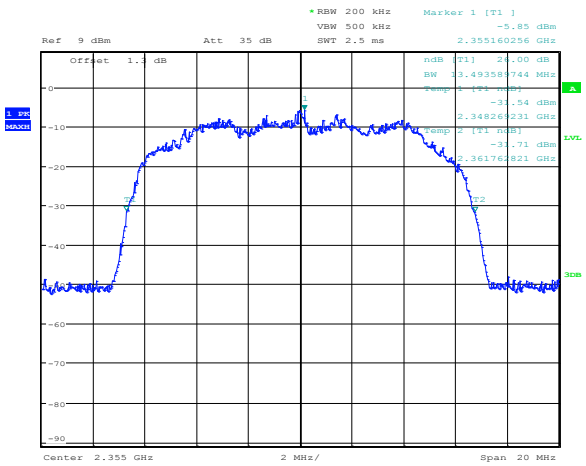


Figure 8.5-3: *10 MHz QAM input*

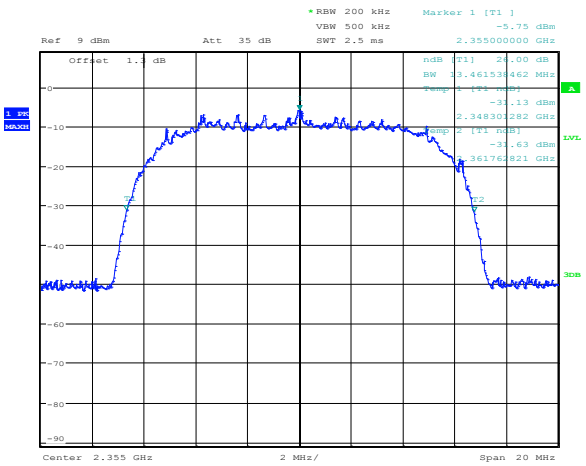


Figure 8.5-4: *10 MHz QPSK input*

8.5.4 Test data continued

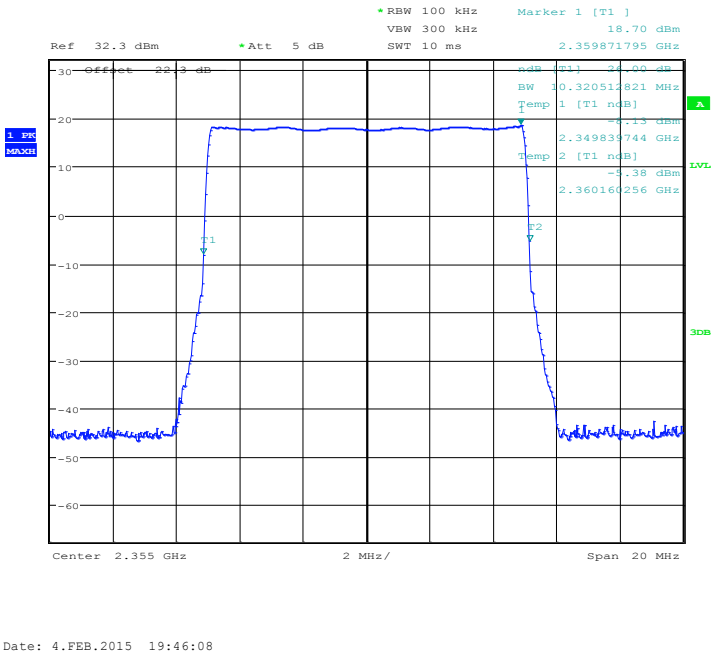


Figure 8.5-5: *Filter response*

Section 9. Setup Photos

9.1 Set-up

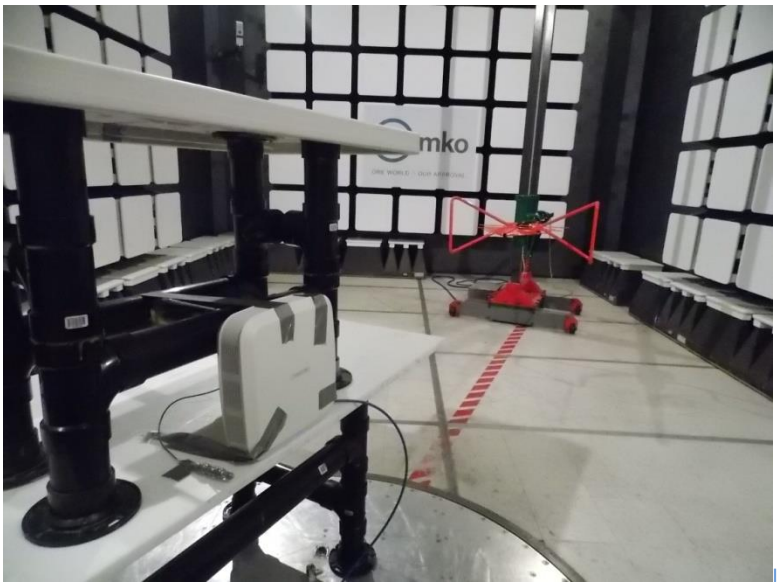


Figure 9.1-1: *Radiated setup photo*

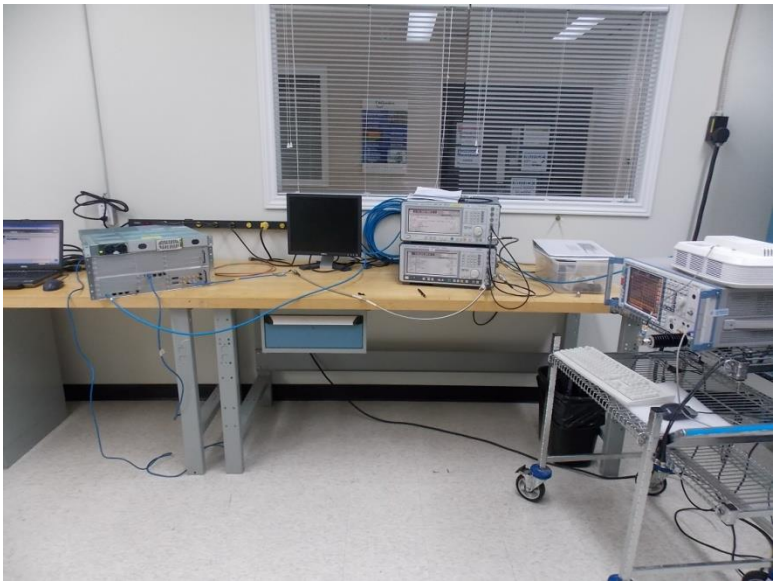
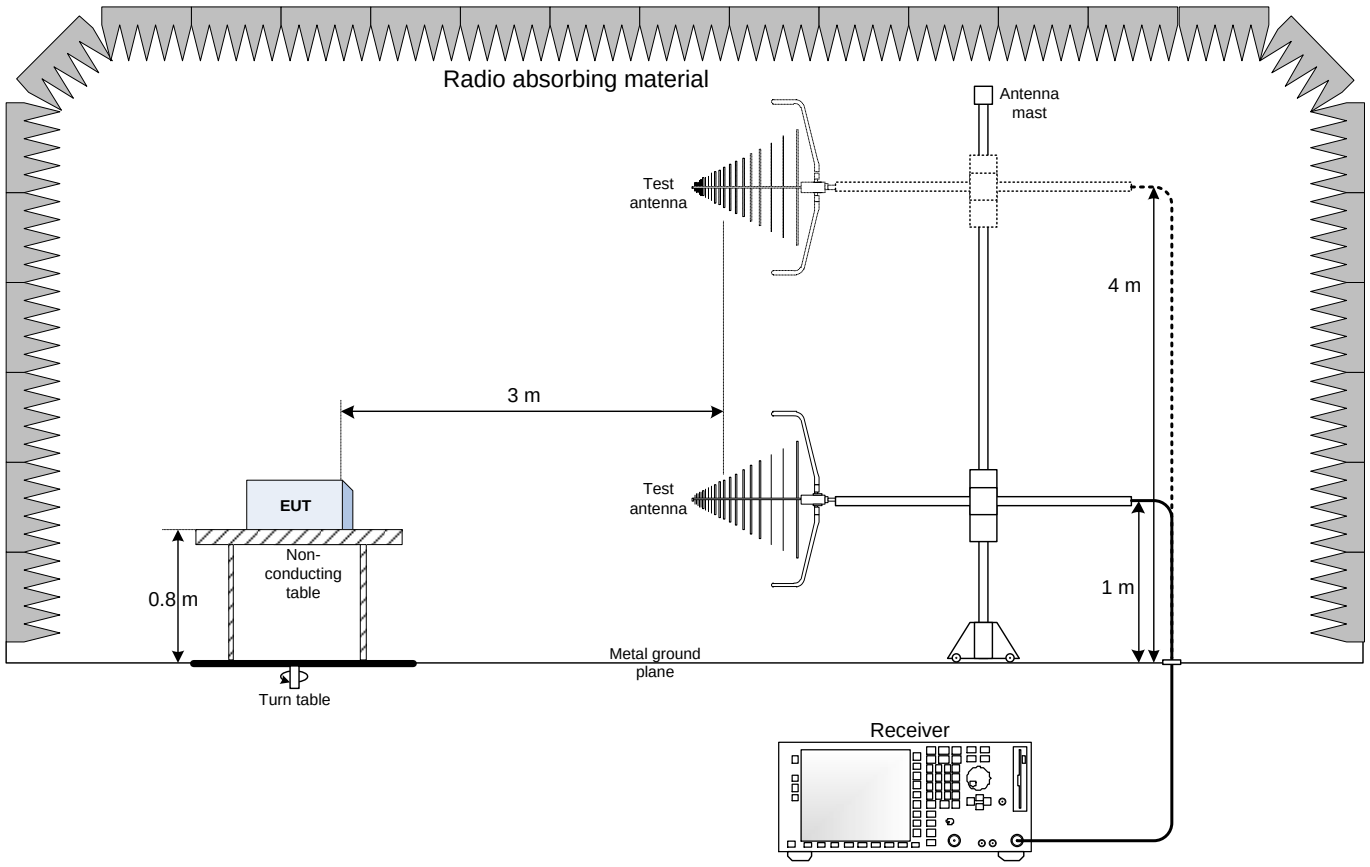


Figure 9.1-2: *Conducted setup photo*

Section 10. Block diagrams of test set-ups

10.1 Radiated emissions set-up