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Test report

267266-5TRFWL

Date of issue: March 5, 2015

Applicant:

Andrew Wireless Innovations Group

Product:

ION-E

Model:

UAP

FCC ID:

BCR-IONEUAP

Specifications:

FCC 47 CFR Part 24

Personal communications services

Subpart E – Broadband PCS

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

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 24	Personal communications services Subpart E – Broadband PCS
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 24 Subpart E test results

Part	Test description	Verdict
§24.232(a)(d)	EIRP limits	Pass
§24.238(a)(b)	Spurious emissions at the antenna terminal	Pass
§24.238(a)(b)	Field strength of spurious radiation	Pass
§24.235	Frequency stability	Pass
§2.0149	Occupied bandwidth	Pass

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	Block A: 1930–1945 MHz, Block D: 1945–1950 MHz, Block B: 1950–1965 MHz, Block C: 1975–1990 MHz, Block E: 1965–1970 MHz, Block F: 1970–1975 MHz and 1990–1995 MHz
Modulation type	LTE 1.4, 3, 5, 10 MHz, GSM 200 kHz, CDMA 1.25 MHz, UMTS 4.1 MHz
Channel Spacing	Standard
Power requirements	110 V_{AC}, ~3 A for entire system tested
Emission designator	LTE, D7W CDMA, F9W, GSM, GXW UMTS, F9W
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

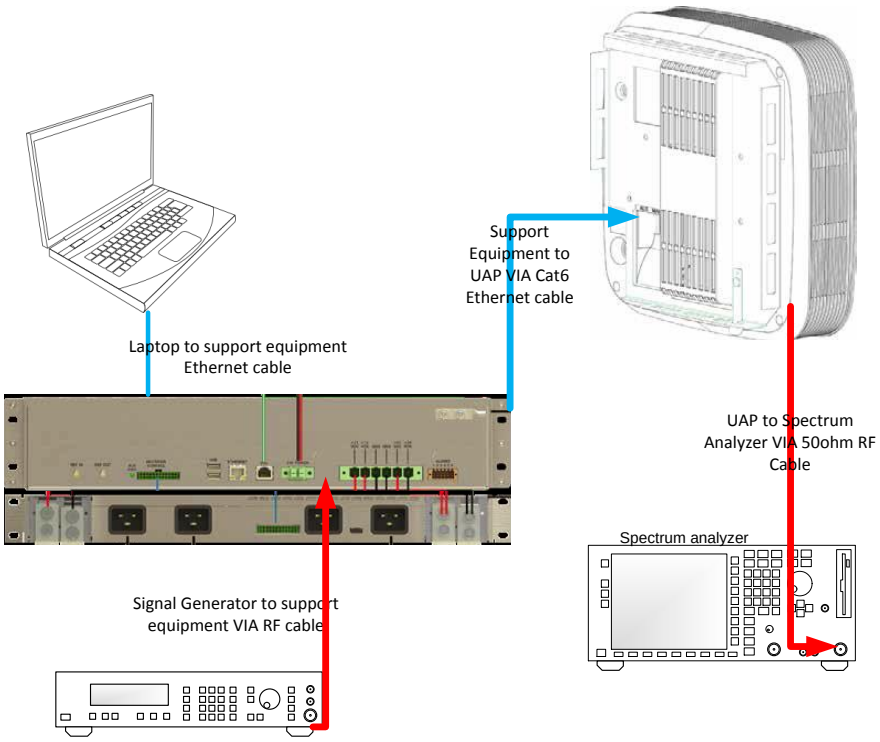

Figure 3.6-1: *Setup diagram*

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

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
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. 07/16
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 Clause 24.232(a) (d) Equivalent isotropically radiated power limits

8.1.1 Definitions and limits

(a)(1) Base stations with an emission bandwidth of 1 MHz or less are limited to 1640 watts equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT, except as described in paragraph (b) below.

(2) Base stations with an emission bandwidth greater than 1 MHz are limited to 1640 watts/MHz equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT.

(d) Power measurements for transmissions by stations authorized under this section may be made either in accordance with a Commission-approved average power technique or in compliance with paragraph (e) of this section. In both instances, equipment employed must be authorized in accordance with the provisions of §24.51. In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

8.1.2 Test summary

Test date	February 4, 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

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
1.4 MHz LTE QAM	1960	18.35	27.95	9.6	13	3.4
1.4 MHz LTE QPSK	1960	18.52	27.9	9.38	13	3.62
3 MHz LTE QAM	1960	18.07	28.25	10.18	13	2.82
3 MHz LTE QPSK	1960	18.13	28.1	9.97	13	3.03
5 MHz LTE QAM	1960	18.67	28.53	9.86	13	3.14
5 MHz LTE QPSK	1960	18.7	28.32	9.62	13	3.38
10 MHz LTE QAM	1960	18.64	28.16	9.52	13	3.48
10 MHz LTE QPSK	1960	18.77	28.12	9.35	13	3.65
CDMA	1960	18.28	29.3	11.02	13	1.98
UMTS	1960	18.28	28.4	10.12	13	2.88
GSM	1960	18.05	24.89	6.84	13	6.16

Table 8.1-2: *EIRP results*

Modulation	Frequency, MHz	RF output power AVG, dBm	Antenna Gain, dBi	EIRP, dBm	Limit, dBm/MHz	Margin, dBm
1.4 MHz LTE QAM	1960	18.35	5	23.35	62.15	38.80
1.4 MHz LTE QPSK	1960	18.52	5	23.52	62.15	38.63
3 MHz LTE QAM	1960	18.07	5	23.07	62.15	39.08
3 MHz LTE QPSK	1960	18.13	5	23.13	62.15	39.02
5 MHz LTE QAM	1960	18.67	5	23.67	62.15	38.48
5 MHz LTE QPSK	1960	18.70	5	23.70	62.15	38.45
10 MHz LTE QAM	1960	18.64	5	23.64	62.15	38.51
10 MHz LTE QPSK	1960	18.77	5	23.77	62.15	38.38
CDMA	1960	18.28	5	23.28	62.15	38.87
UMTS	1960	18.28	5	23.28	62.15	38.87
GSM	1960	18.05	5	23.05	62.15	39.10

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)

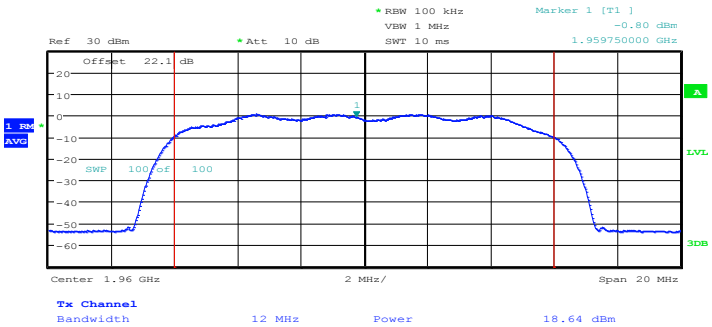

Figure 8.1-1: *Conducted Average power example*

8.2 Clause 24.238(a) (b) Spurious emissions at antenna terminal

8.2.1 Definitions and limits

(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 Log (P) dB.

(b) 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 frequency block a resolution bandwidth of at least one 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 or 1 percent of emission bandwidth, as specified). 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.

8.2.2 Test summary

Test date	February 5, 2015	Temperature	24 °C
Test engineer	Kevin Rose	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	47 %

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	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

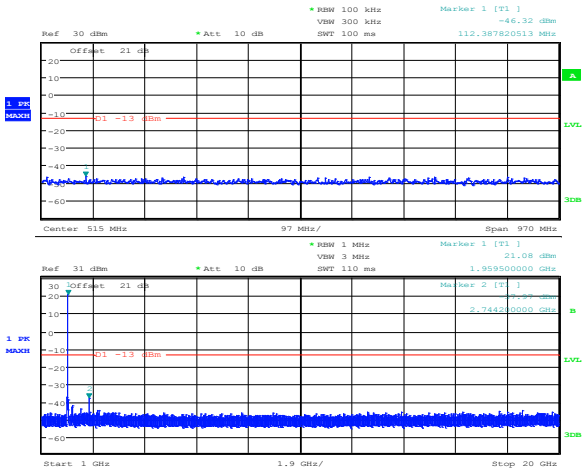

Figure 8.2-1: *1.4 MHz LTE QAM 30 MHz – 20 GHz*

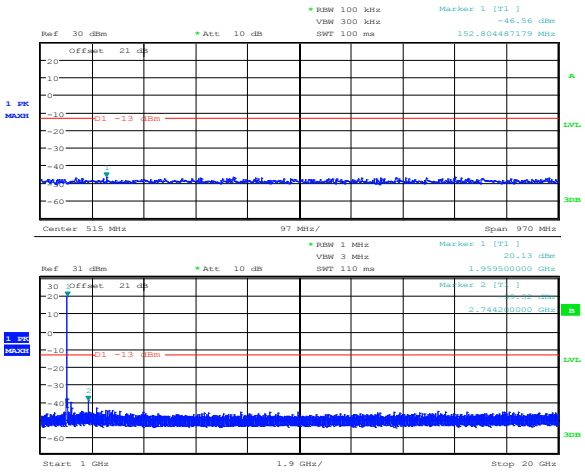

Figure 8.2-2: *1.4 MHz LTE QPSK 30 MHz – 20 GHz*

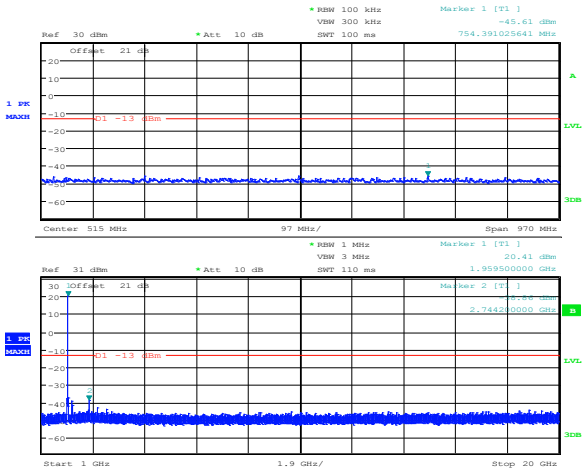

Figure 8.2-3: *3 MHz LTE QAM 30 MHz – 20 GHz*

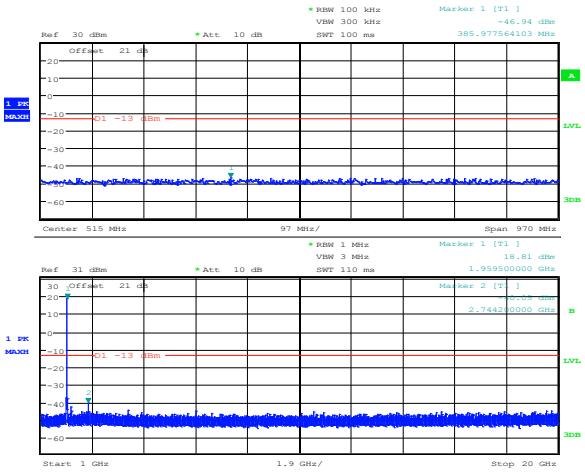

Figure 8.2-4: *3 MHz LTE QPSK 30 MHz – 20 GHz*

8.2.4 Test data continued

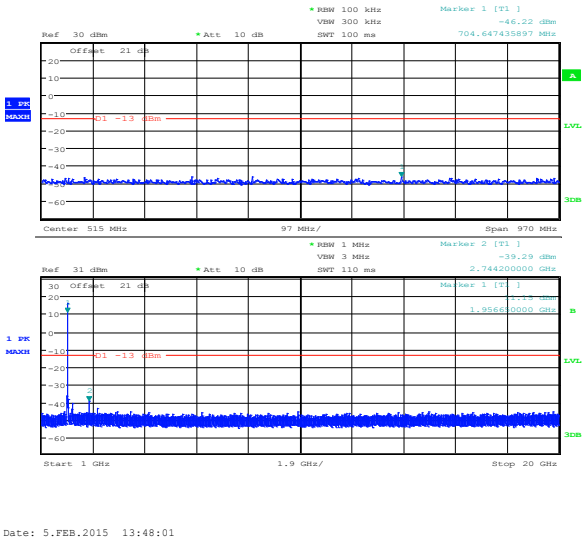

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Figure 8.2-5: *5 MHz LTE QAM 30 MHz – 20 GHz*

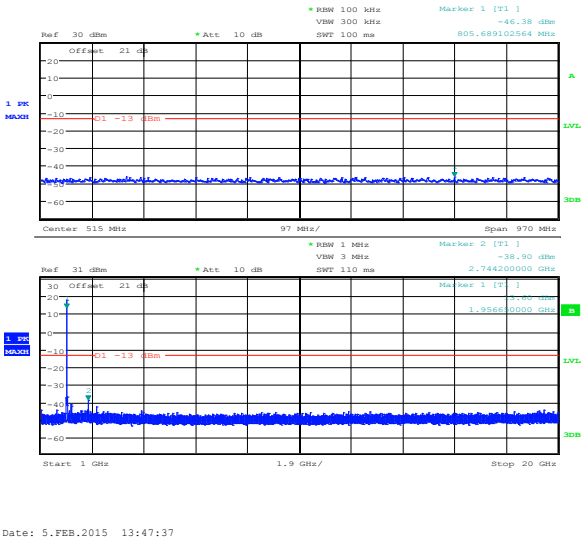

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Figure 8.2-6: *5 MHz LTE QPSK 30 MHz – 20 GHz*

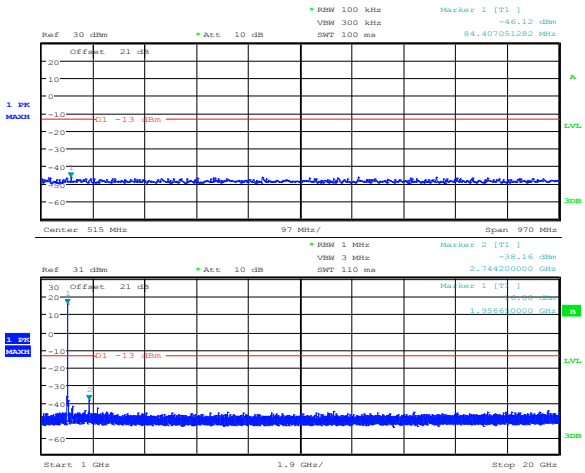

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Figure 8.2-7: *10 MHz LTE QAM 30 MHz – 20 GHz*

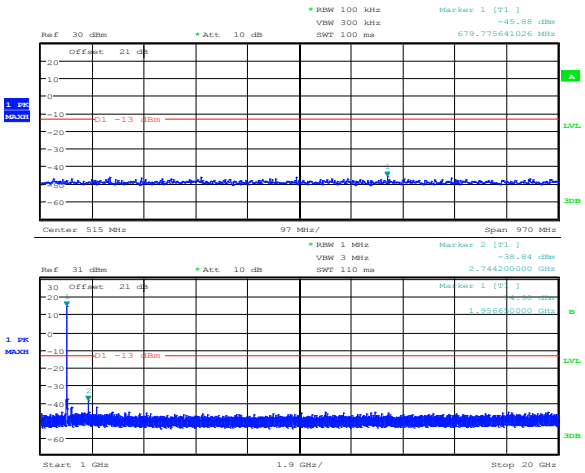

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Figure 8.2-8: *10 MHz LTE QPSK 30 MHz – 20 GHz*

8.2.4 Test data continued

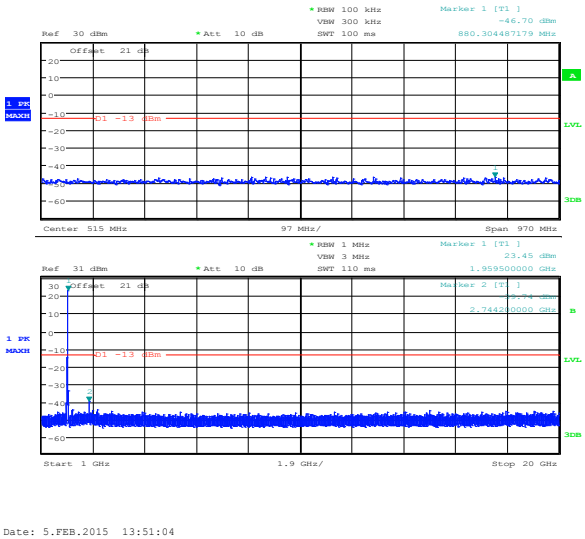

Figure 8.2-9: *CDMA 30 MHz – 20 GHz*

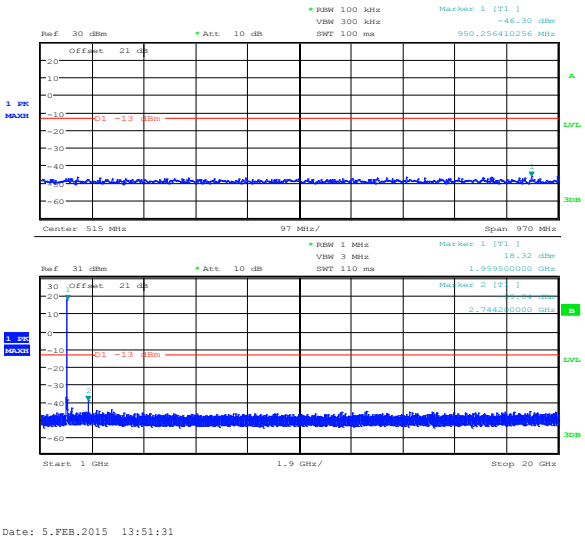

Figure 8.2-10: *10 MHz GSM 30 MHz – 20 GHz*

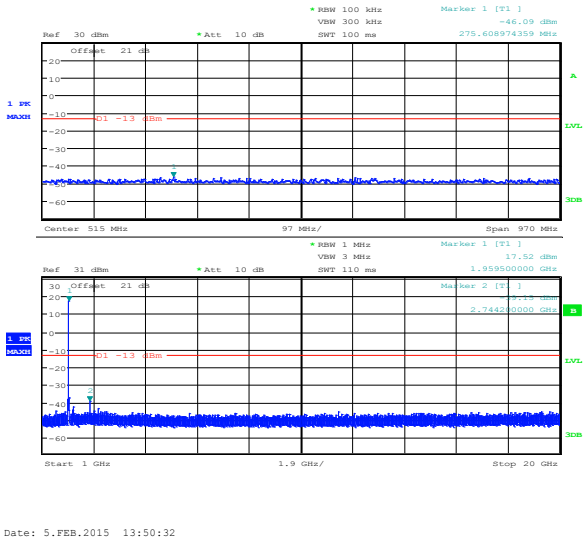

Figure 8.2-11: *UMTS 30 MHz – 20 GHz*

8.2.4 Test data continued

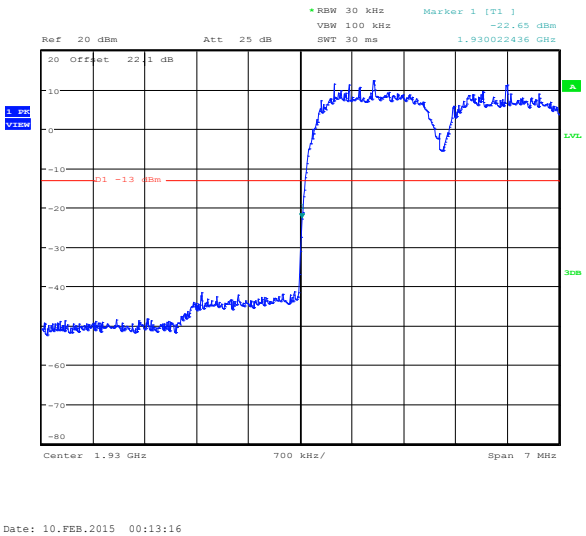

Figure 8.2-12: *1.4 MHz Lower Bandedge QPSK*

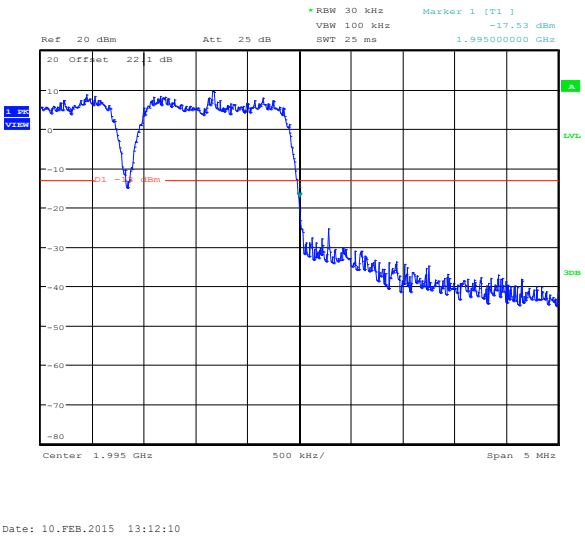

Figure 8.2-13: *1.4 MHz Upper Bandedge QPSK*

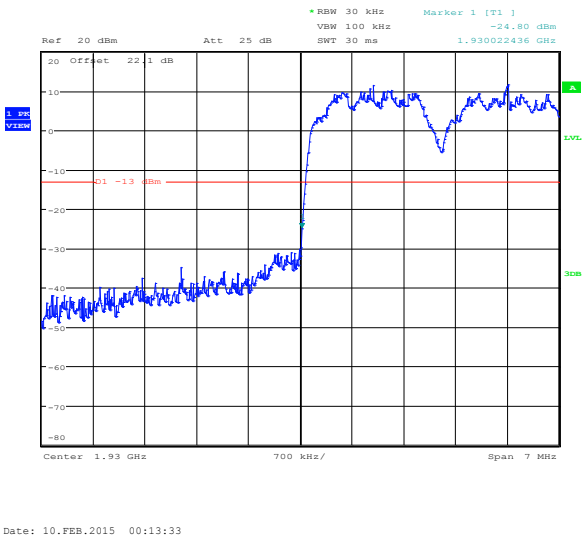

Figure 8.2-14: *1.4 MHz Lower Bandedge QAM*

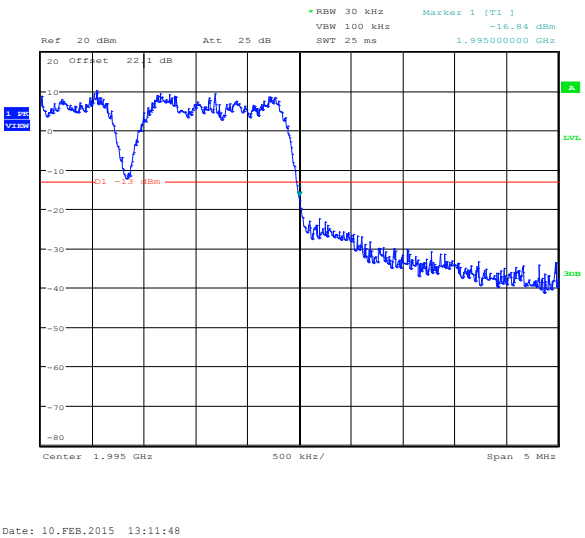

Figure 8.2-15: *1.4 MHz Upper Bandedge QAM*

8.2.5 Test data continued

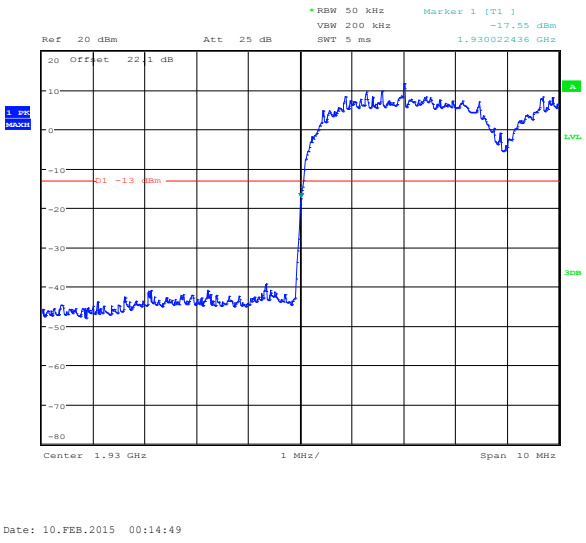

Figure 8.2-16: *3 MHz Lower Bandedge QPSK*

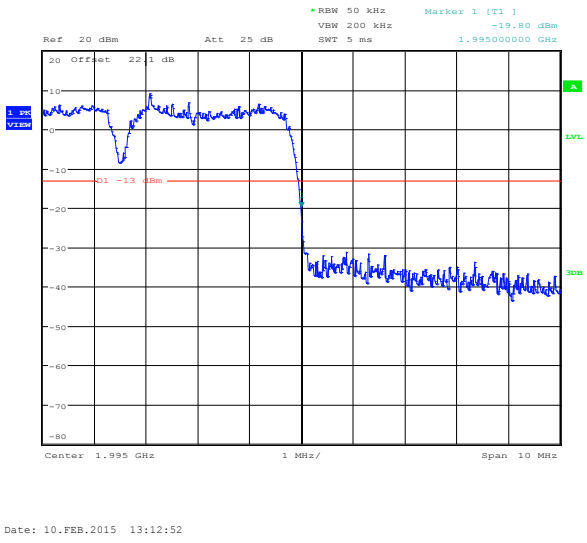

Figure 8.2-17: *3 MHz Upper Bandedge QPSK*

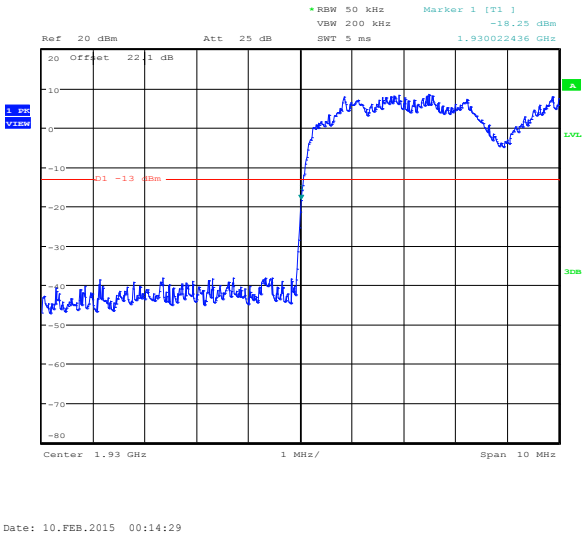

Figure 8.2-18: *3 MHz Lower Bandedge QAM*

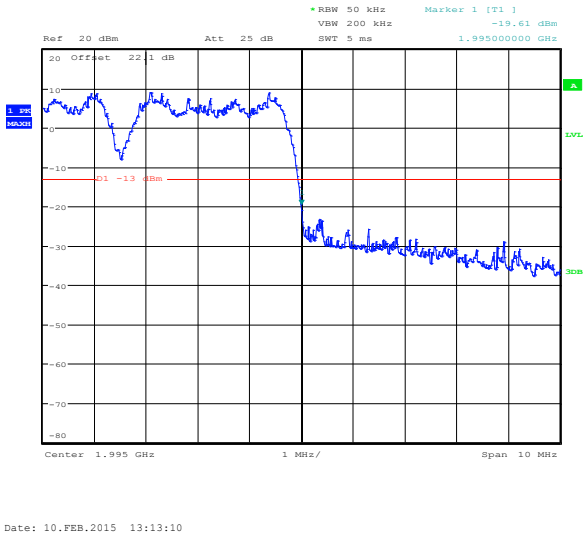

Figure 8.2-19: *3 MHz Upper Bandedge QAM*

8.2.4 Test data continued

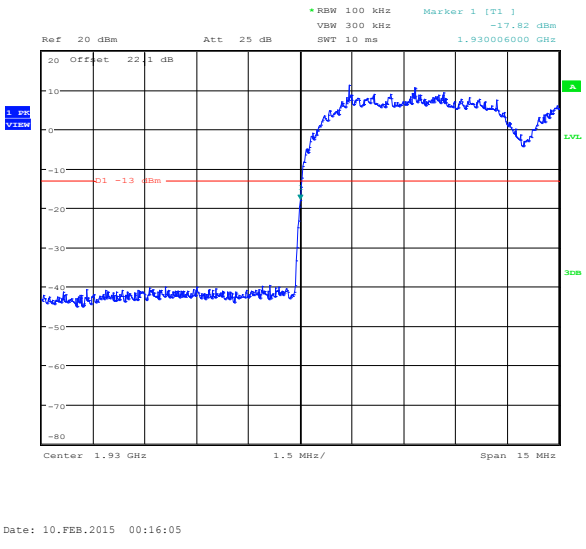

***Figure 8.2-20: 5** MHz Lower Bandedge QPSK*

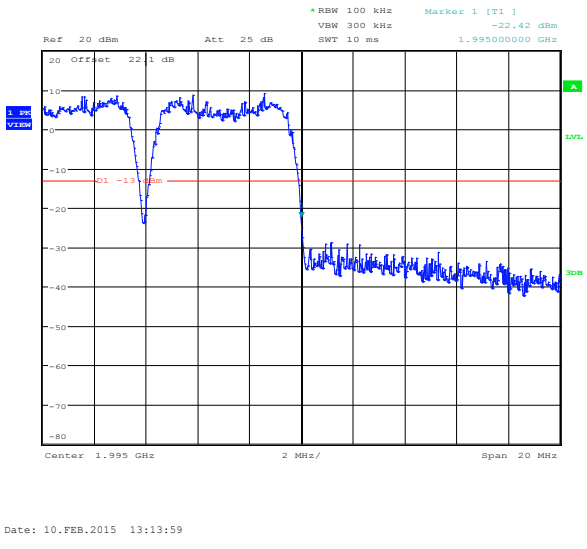

***Figure 8.2-21: 5** MHz Upper Bandedge QPSK*

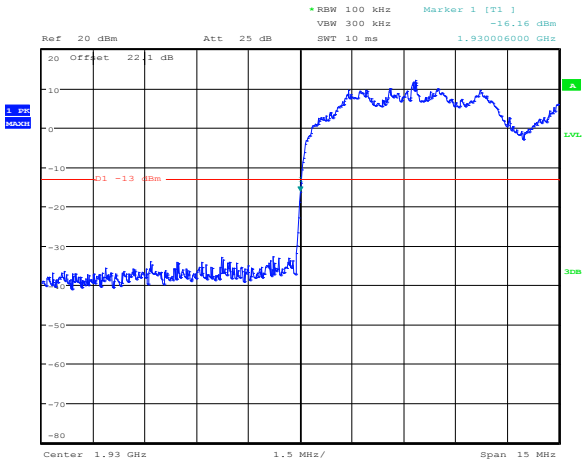

***Figure 8.2-22: 5** MHz Lower Bandedge QAM*

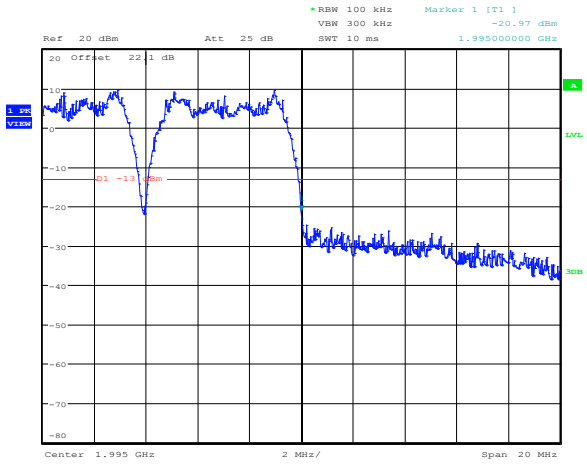

***Figure 8.2-23: 5** MHz Upper Bandedge QAM*

8.2.4 Test data continued

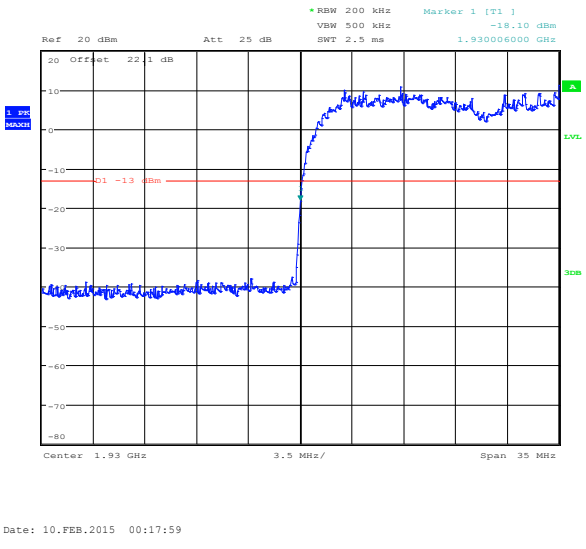

***Figure 8.2-24: 10** MHz Lower Bandedge QPSK*

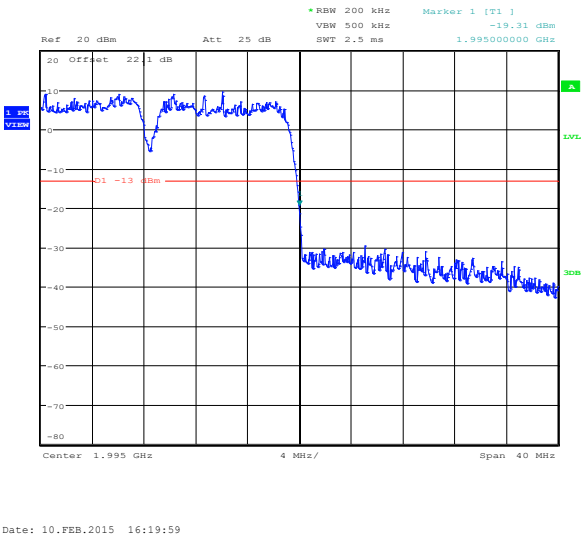

***Figure 8.2-25: 10** MHz Upper Bandedge QPSK*

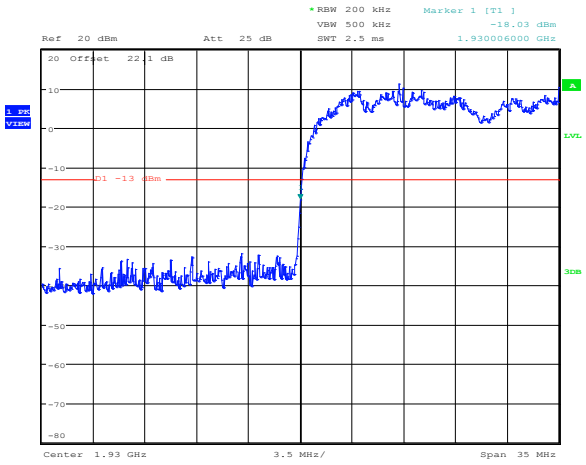

***Figure 8.2-26: 10** MHz Lower Bandedge QAM*

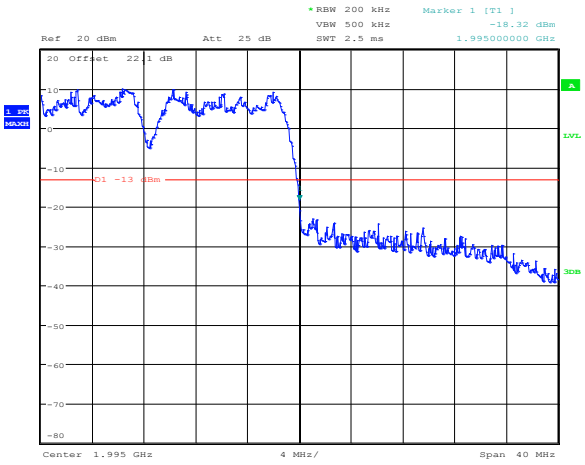

***Figure 8.2-27: 10** MHz Upper Bandedge QAM*

8.2.4 Test data continued

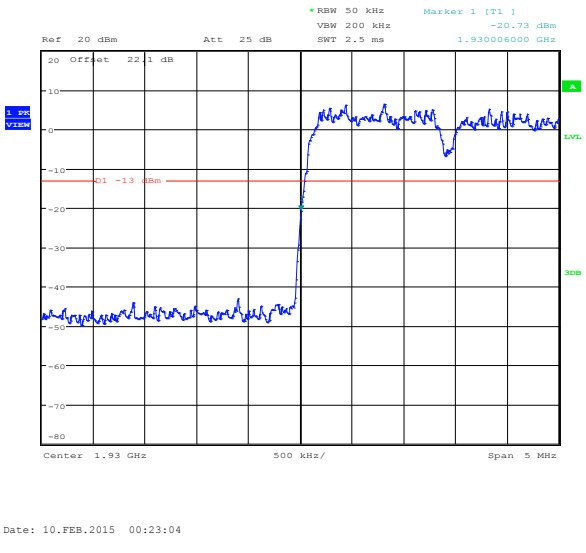

Figure 8.2-28: *CDMA Lower Bandedge*

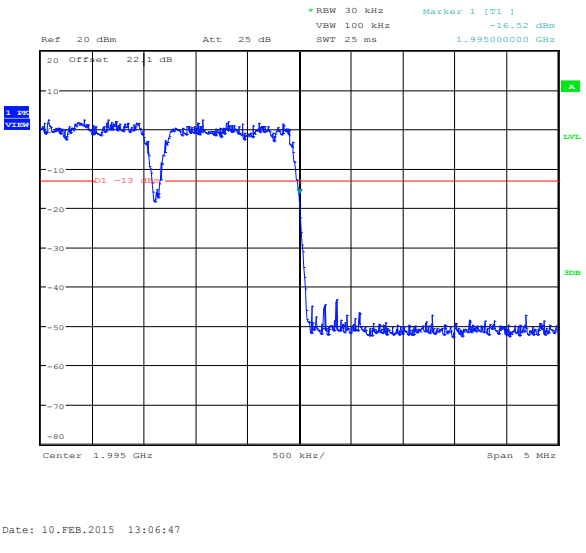

Figure 8.2-29: *CDMA Upper Bandedge*

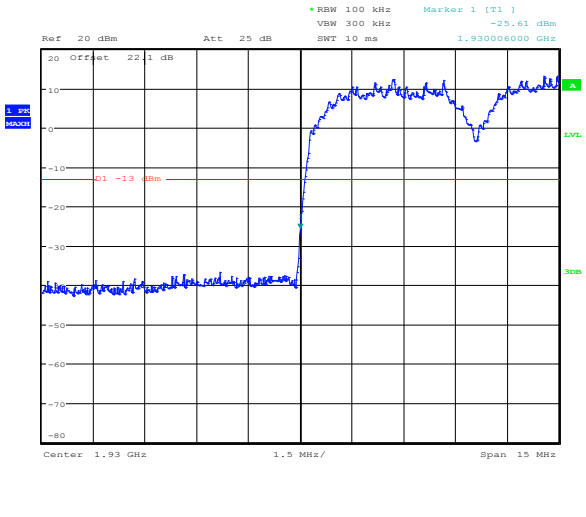

Figure 8.2-30: *UMTS Lower Bandedge*

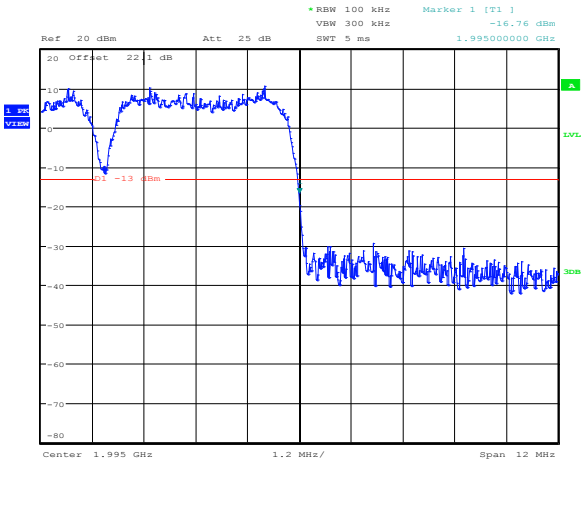

Figure 8.2-31: *UMTS Upper Bandedge*

8.2.4 Test data continued

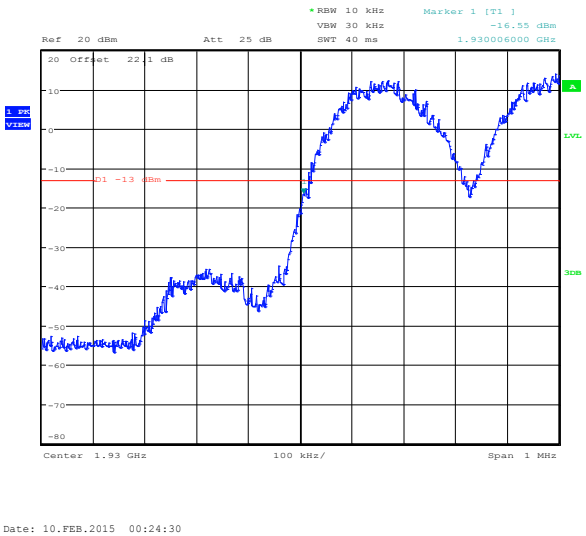

Figure 8.2-32: 20 *GSM Lower Bandedge*

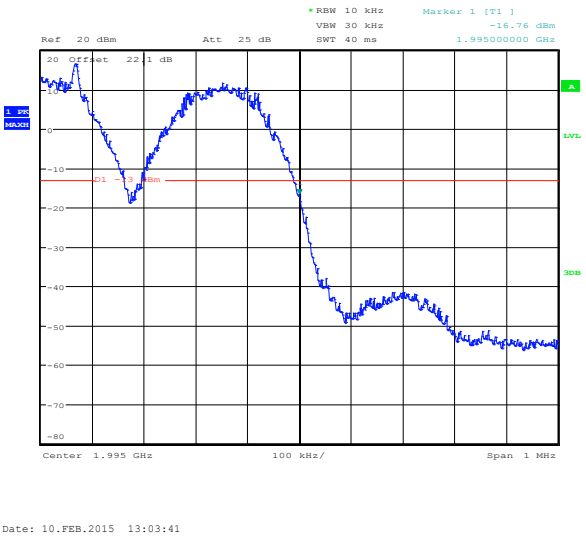

Figure 8.2-33: *GSM Upper Bandedge*

8.3 Clause 24.238(a) (b) Field strength of spurious radiation

8.3.1 Definitions and limits

(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 Log (P) dB.

(b) 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 frequency block a resolution bandwidth of at least one 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 or 1 percent of emission bandwidth, as specified). 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.

8.3.2 Test summary

Test date	February 11, 2015	Temperature	25 °C
Test engineer	Kevin Rose	Air pressure	1002 mbar
Verdict	Pass	Relative humidity	50 %

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

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
33	37.87	-73.37	-35.5	-13	22.5
63.7	21.83	-91.23	-69.4	-13	56.4
445.1	27.82	-83.52	-55.7	-13	42.7
3200	16.12	-63.42	-47.3	-13	34.3
3920	17.36	-61.06	-43.7	-13	30.7

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.
Substitution factor includes signal generator, cable loss, and antenna factor.

8.4 Clause 24.235 Frequency stability

8.4.1 Definitions and limits

The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

8.4.2 Test summary

Test date	August 26, 2014	Temperature	24 °C
Test engineer	Kevin Rose	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	47 %

8.4.3 Observations, settings and special notes

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	1.979999866	0
+40 °C, Nominal	1.979999866	0
+30 °C, Nominal	1.979999866	0
+20 °C, +15 %	1.979999866	0
+20 °C, Nominal	1.979999866	Reference
+20 °C, -15 %	1.979999866	0
+10 °C, Nominal	1.979999866	0
0 °C, Nominal	1.979999866	0
-10 °C, Nominal	1.979999866	0
-20 °C, Nominal	1.979999866	0
-30 °C, Nominal	1.979999866	0

8.5 Clause 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 23, 2015	Temperature	24 °C
Test engineer	Kevin Rose	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	47 %

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

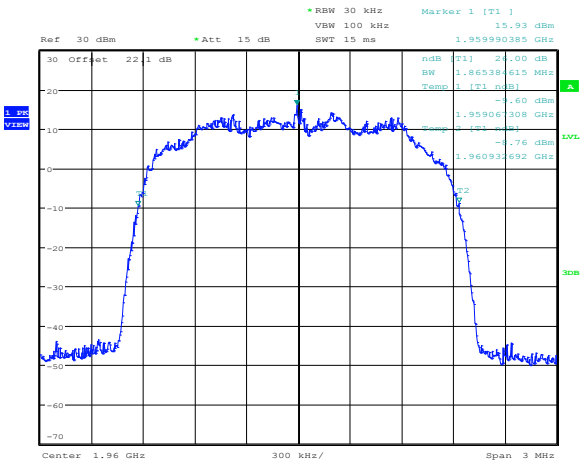

Figure 8.5-1: *1.4 MHz QAM output*

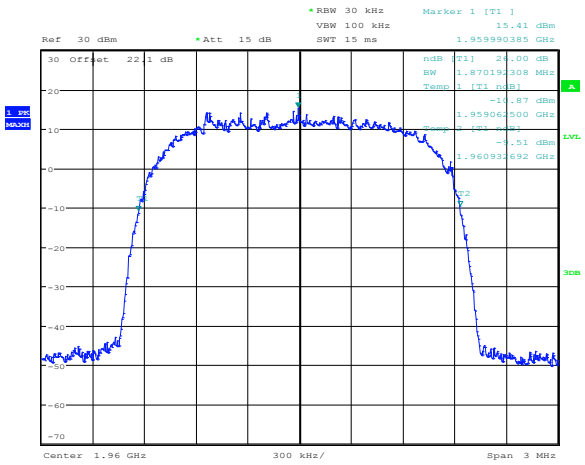

Figure 8.5-2: *1.4 MHz QPSK output*

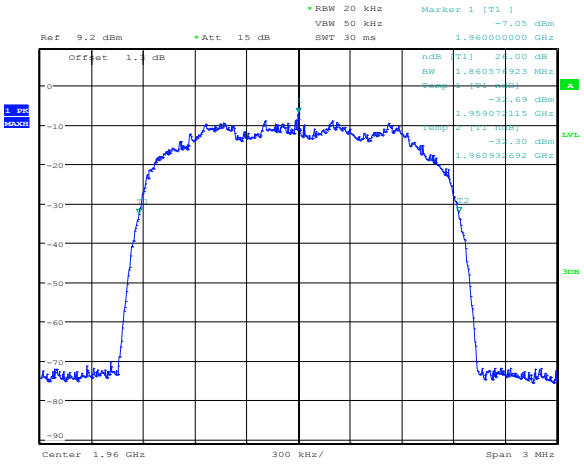

Figure 8.5-3: *1.4 MHz QAM input*

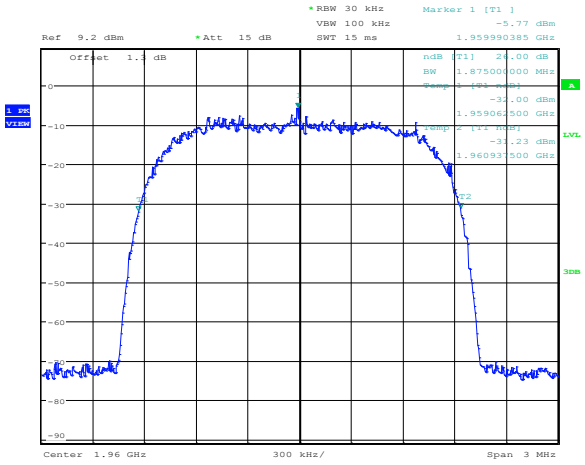

Figure 8.5-4: *1.4 MHz QPSK input*

8.5.4 Test data continued

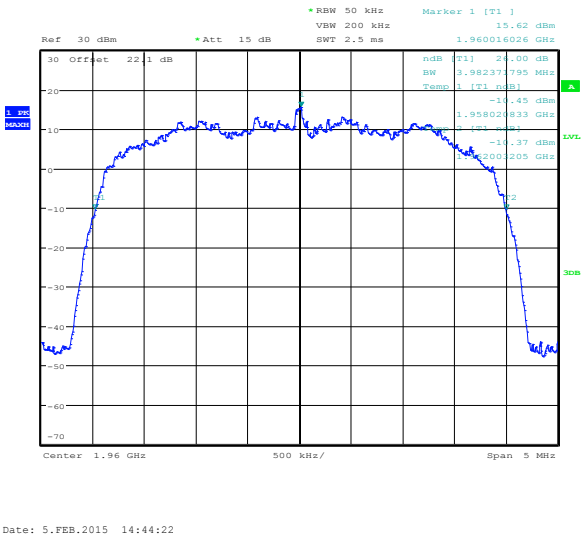

Figure 8.5-5: *3 MHz QAM output*

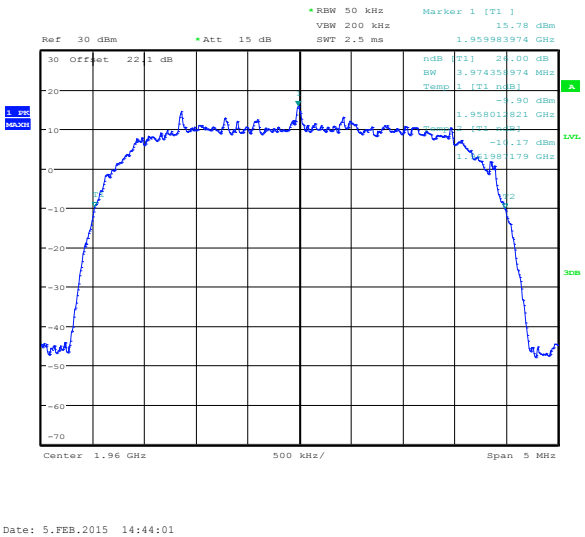

Figure 8.5-6: *3 MHz QPSK output*

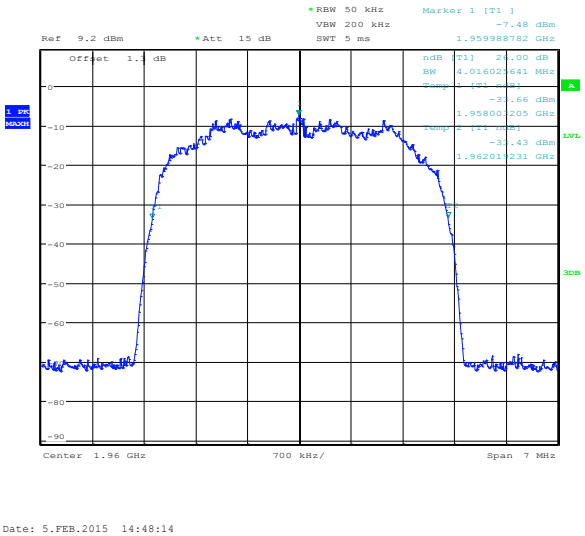

Figure 8.5-7: *3 MHz QAM input*

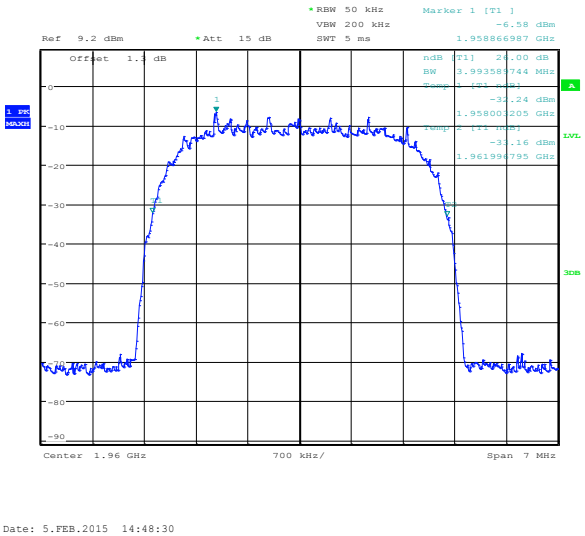

Figure 8.5-8: *3 MHz QPSK input*

8.5.5 Test data continued

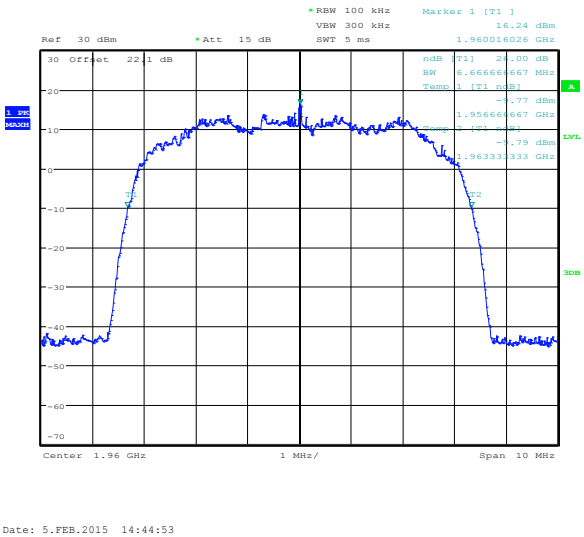

Figure 8.5-9: *5 MHz QAM output*

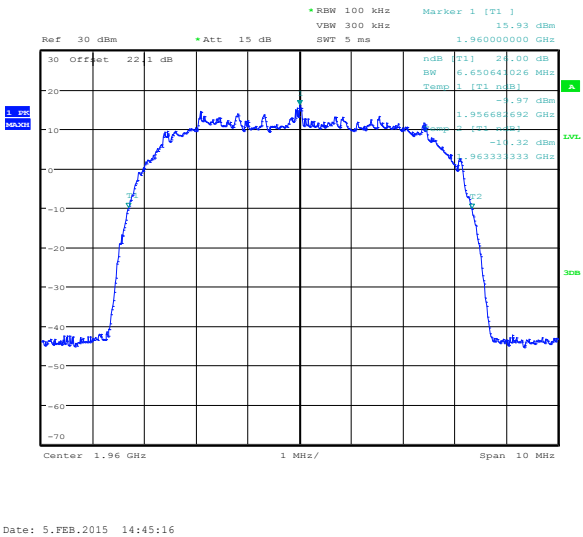

Figure 8.5-10: *5 MHz QPSK output*

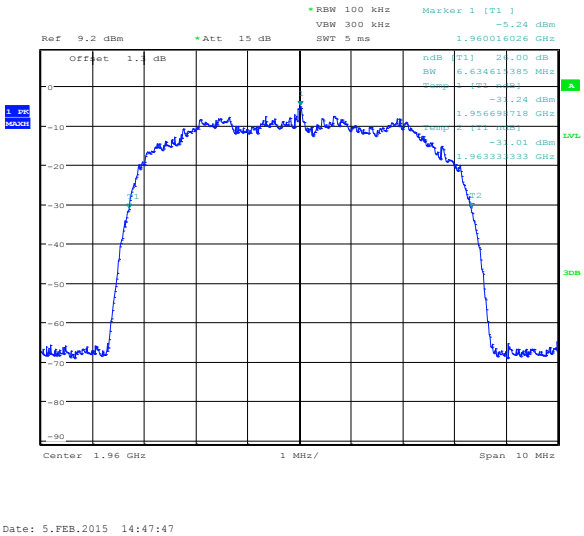

Figure 8.5-11: 5 *MHz QAM input*

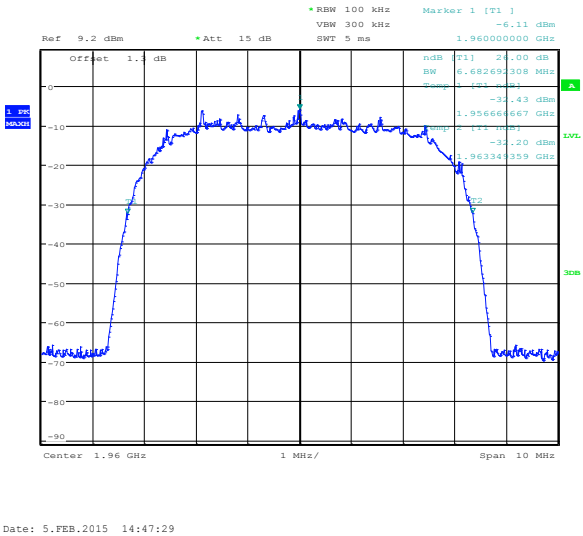

Figure 8.5-12: *5 MHz QPSK input*

8.5.4 Test data continued

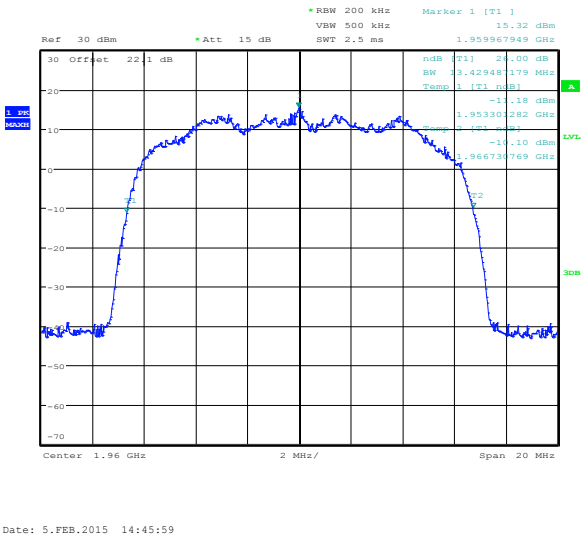

Figure 8.5-13: *10 MHz QAM output*

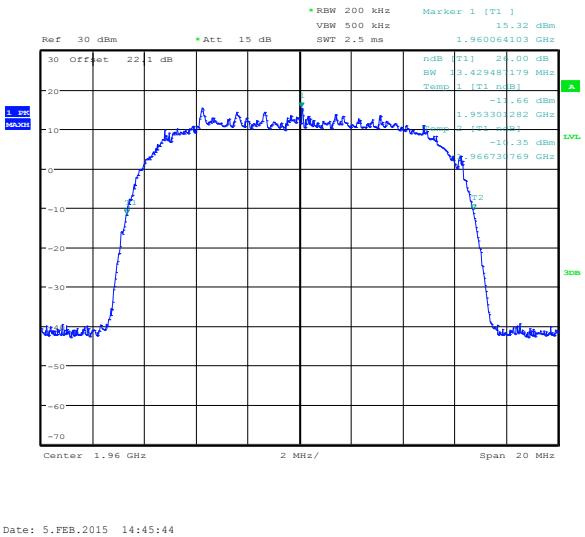

Figure 8.5-14: *10 MHz QPSK output*

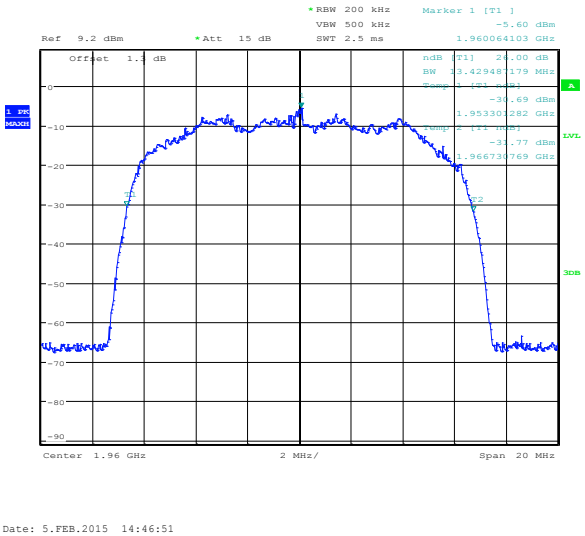

Figure 8.5-15: *10 MHz QAM input*

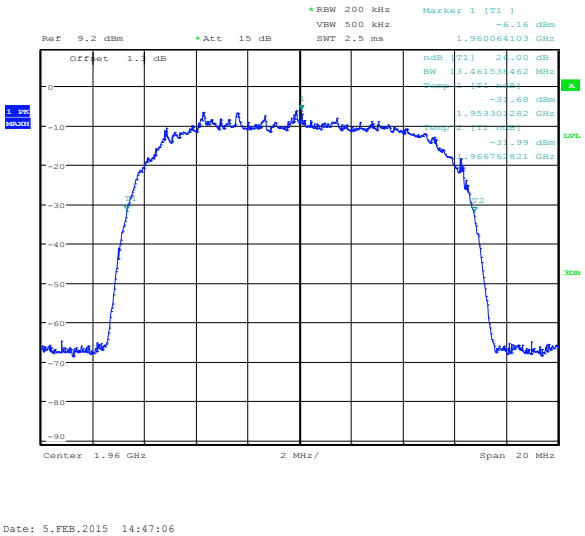

Figure 8.5-16: *10 MHz QPSK input*

8.5.4 Test data continued

8.5.4 Test data continued

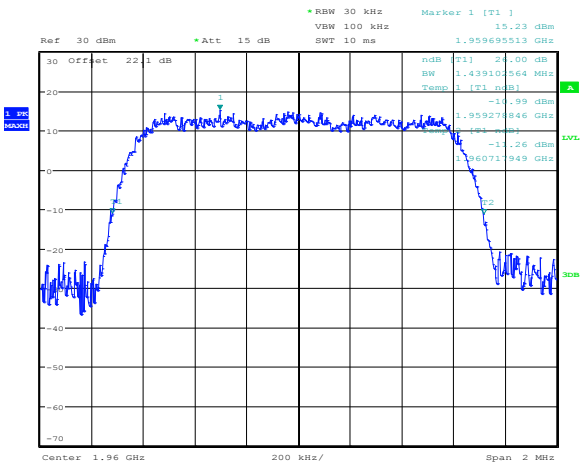

Figure 8.5-17: *CDMA output*

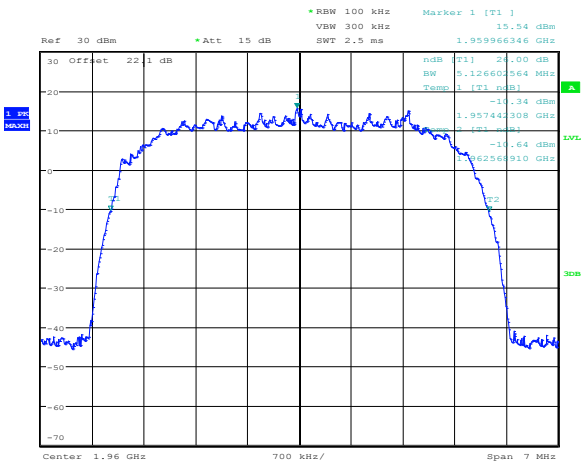

Figure 8.5-18: *UMTS output*

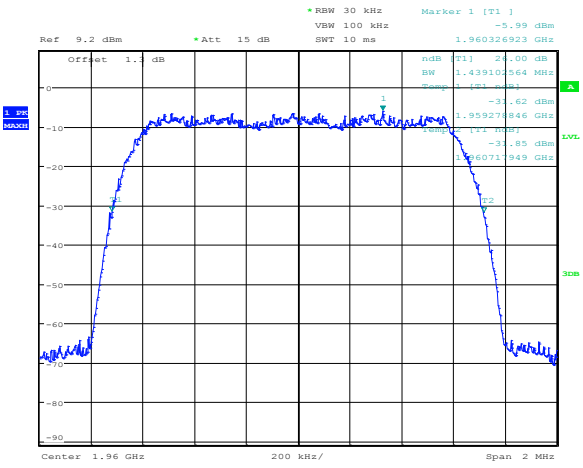

Figure 8.5-19: *CDMA input*

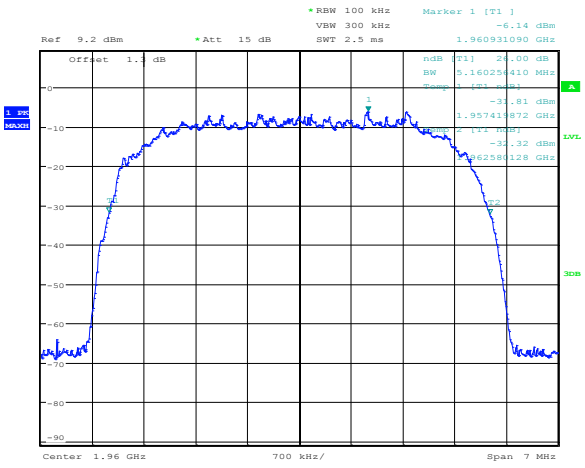

Figure 8.5-20: *UMTS input*

8.5.4 Test data continued

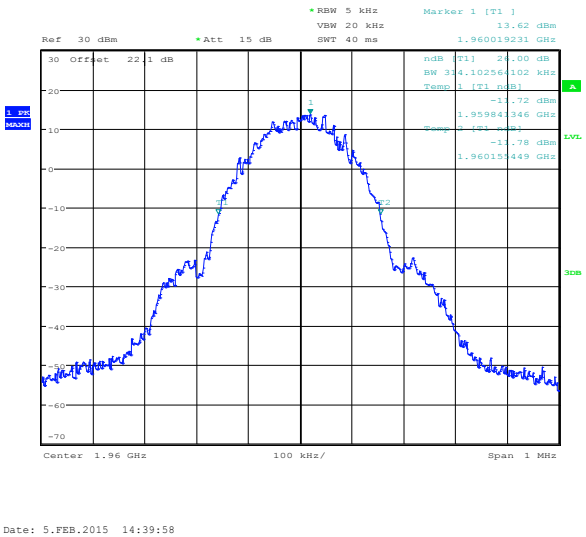

Figure 8.5-21: *GSM output*

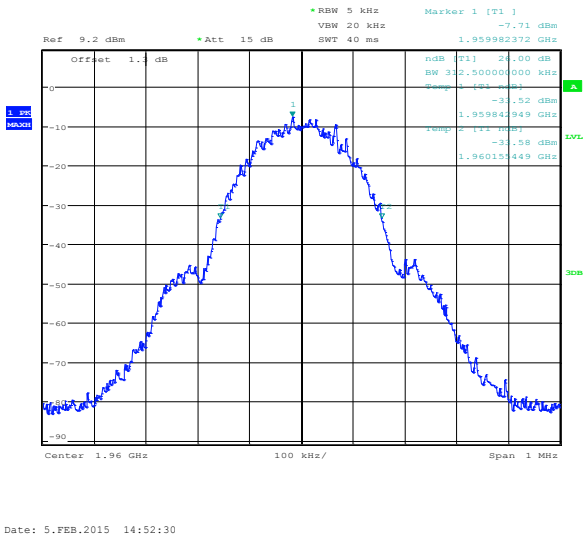

Figure 8.5-22: *GSM input*

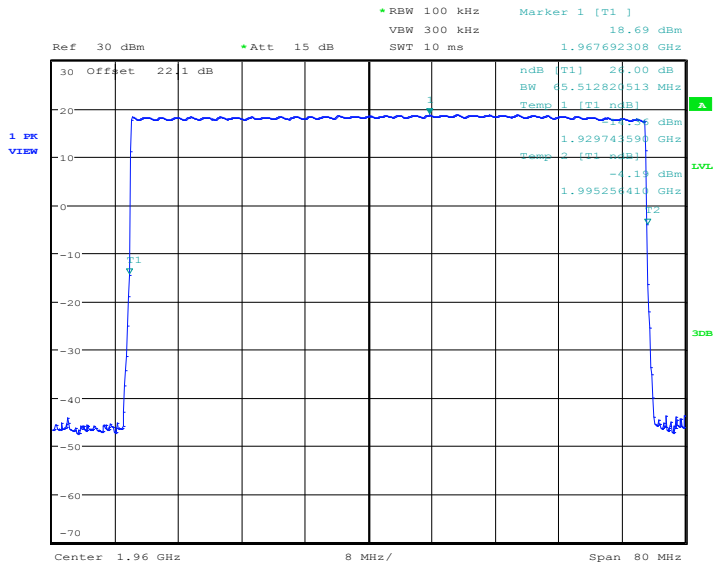

Figure 8.5-23: *Filter response*

Section 9. Setup Photos

9.1 Set-up

Figure 9.1-1: *Radiated setup photo*

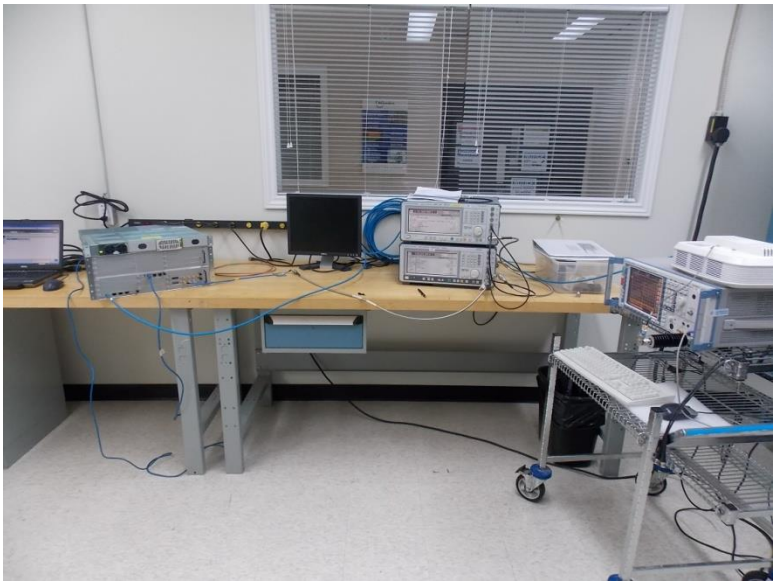

Figure 9.1-2: *Conducted setup photo*

Section 10. Block diagrams of test set-ups

10.1 Radiated emissions set-up