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Test report

300304-1TRFWL

Date of issue: March 1, 2016

Applicant:

6harmonics Inc.

Product:

Television Band Device (TVBD)

Model:

GWS-4012-23

FCC ID:

2AASTGWS-4012-23

IC Registration Number:

20750A-GWS-4012-23

Specifications:

FCC 47 CFR Part 15 Subpart H

Television Band Devices

RSS-222 February 5, 2015; Issue 1

White Space Devices (WSDs)

Nemko Canada Inc., a testing laboratory, is accredited by the Standards Council of Canada. The tests included in this report are within the scope of this accreditation

SCC Accredited LAB
LAB Accrédité CCN

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: 176392; IC: 2040A-4 (3 m semi anechoic chamber)

Tested by	Andrey Adelberg, Senior Wireless/EMC Specialist
Reviewed by	Kevin Rose, Wireless/EMC Specialist
Date	March 1, 2016
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	6harmonics Inc.
Address	Suite 10 - 21 Concourse Gate
City	Ottawa
Province/State	ON
Postal/Zip code	K2E 7S4
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 15, Subpart H	Television Band Devices
RSS-222 February 5, 2015; Issue 1	White Space Devices (WSDs)

1.3 Test procedures

416721 D01 White Space Test Procedures v02	Certification Test Procedures for TV Band (White Space) Devices Authorized Under Subpart H of the Part 15 Rules
ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.4 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.

1.5 Exclusions

None

1.6 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 15, general requirements test results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.31(e)	Variation of power source	Pass[1]
§15.203	Antenna requirement	Pass[2]

Notes: [1] Measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, was performed with the supply voltage varied between 85 % and 115 % of the nominal rated supply voltage. No noticeable output power variation was observed

[2]The Antennas are professionally installed.

2.2 FCC Part 15 Subpart H, test results

Part	Test description	Verdict
§15.709(a)(1)	Maximum conducted output power for fixed TVBDs	Pass
§15.709(a)(5)(i)	Power spectral density for fixed TVBDs	Pass
§15.709(c)(1)(i)	Adjacent channel power for fixed TVBDs	Pass
§15.709(c)(3)	Radiated spurious emissions from TVBDs	Pass
§15.709(c)(4)	Emissions in the band 602–620 MHz	Pass
§15.709(c)(5)	AC power line conducted limits	Pass

Note: none

2.3 IC RSS-GEN, Issue 4, test results

Part	Test description	Verdict
7.1.2	Receiver radiated emission limits	Not applicable
7.1.3	Receiver conducted emission limits	Not applicable
8.8	Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus	Pass

Notes: [1] According to sections 5.2 and 5.3 of RSS-Gen, Issue 4 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

2.4 RSS-222, test results

Section	Test description	Verdict
6.2.1	Transmitter power, power spectral density (PSD) and transmit power control for Fixed WSDs	Pass
6.3.2	Transmitter band edge and adjacent channel power limits	Pass
6.3.3	Spurious emissions measurements and limits	Pass
6.4	Field strength emissions in the band 602-620 MHz	Pass

Note: none

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	December 21, 2015
Nemko sample ID number	133-00753

3.2 EUT information

Product name	Television Band Device (TVBD)
Model	GWS-4012-23
Serial number	720000001

3.3 Technical information

Operating band	470–698 MHz
Operating frequency	476–596 MHz and 626–692 MHz
Modulation type	BPSK, QPSK, 16-QAM, and 64-QAM
Channel bandwidth	12 MHz
Emission designator	W7D
Power requirements	120 V_{AC} 60 Hz
Antenna information	Shenglu Omnidirectional antenna, MN#: SL13319A, gain 2.5 dBi, SN#: 2015090004 Shenglu Directional antenna, MN#: SL14174A, gain 8 dBi, SN#: 2014120041

3.4 Product description and theory of operation

The 6Harmonics Inc. GWS radios are a new class of radios designed for the global white space radio market. The GWS-4012-23 is designed to provide up to 23 dBm of transmit power, offer a sensitivity of up to −100 dBm, and provide 16.5 Mbps of UDP throughput in a 12 MHz television channel. The product can be used for Point to Point or Point to Multi-point operation.

3.5 EUT exercise details

The GWS-4012-23 is powered from a POE Midspan. During the tests a laptop was used to connect to the GWS-4012-23 and configure the device to transmit continuously with the desired modulation and power.

3.6 EUT setup diagram

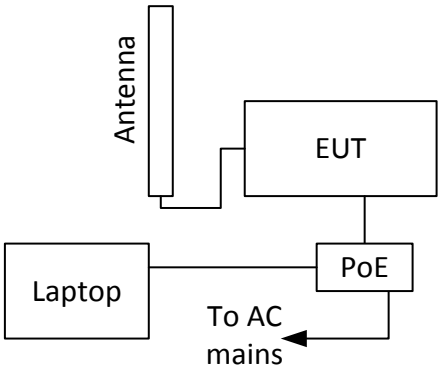


Figure 3.6-1: *Setup diagram*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
PoE Power supply	PowerDsine	PD-9501G/SP/AC	N15036517007500A03
Omnidirectional antenna 2.5 dBi	Shenglu	SL13319A	2015090004
Directional antenna 8 dBi	Shenglu	SL14174A	2014120041

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	Feb. 25/16
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Power source	California Instruments	5001ix	FA002494	1 year	Jan. 22 /16
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Jan. 07/16
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	May 05/16
LISN	Rohde & Schwarz	ENV216	FA002023	1 year	Jan. 09/16
Tunable Notch Filter	K&L	3TNF-500/1000-N/N	FA001330	–	VOU
Tunable Band Pass Filter	K&L	3BT-500/1000-5-N/N	FA001506	–	VOU

Note: NCR - no calibration required

Section 8. Testing data

8.1 FCC 15.207(a) and RSS-Gen 8.8 AC power line conducted emissions limits

8.1.1 Definitions and limits

FCC:
Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

IC:
A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in table below.

Unless the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in table below. The more stringent limit applies at the frequency range boundaries.

Table 8.1-1: *Conducted emissions limit*

Frequency of emission, MHz	Conducted limit, dBµV	
	Quasi-peak	Average**
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

Note: * - The level decreases linearly with the logarithm of the frequency.
** - A linear average detector is required.

8.1.2 Test summary

Test date	December 21, 2015	Temperature	23 °C
Test engineer	Andrey Adelberg	Air pressure	1015 mbar
Verdict	Pass	Relative humidity	34 %

8.1.3 Observations, settings and special notes

The EUT was set up as tabletop configuration.

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Receiver settings for preview measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

Receiver settings for final measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Quasi-Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

8.1.4 Test data

Plot 8.1-1: *Conducted emissions on phase line*

Table 8.1-2: *Average conducted emissions results on phase line*

Frequency, MHz	Average result, dBµV	Meas. Time, ms	Bandwidth, kHz	Filter	Correction, dB	Margin, dB	Limit, dBµV
18.244000	45.27	1000	9	On	10.45	4.70	50.00
19.634500	45.53	1000	9	On	10.50	4.50	50.00
19.708750	45.04	1000	9	On	10.50	5.00	50.00
19.985500	45.64	1000	9	On	10.52	4.40	50.00
20.685250	44.88	1000	9	On	10.53	5.10	50.00

Plot 8.1-2: *Conducted emissions on neutral line*

Table 8.1-3: *Average conducted emissions results on neutral line*

Frequency, MHz	Average result, dBµV	Meas. Time, ms	Bandwidth, kHz	Filter	Correction, dB	Margin, dB	Limit, dBµV
18.2440000	44.82	1000	9	On	10.60	5.20	50.00
19.6300000	45.47	1000	9	On	10.67	4.50	50.00
19.7087500	45.32	1000	9	On	10.68	4.70	50.00
19.9810000	45.80	1000	9	On	10.70	4.20	50.00
20.6830000	45.08	1000	9	On	10.75	4.90	50.00

8.2 FCC 15.709(a)(1) and RSS-222 6.2.1.2 Maximum conducted output power for fixed TVBDs

8.2.1 Definitions and limits

FCC:
For fixed TVBDs, the maximum power delivered to the transmitting antenna shall not exceed one watt per 6 megahertz of bandwidth on which the device operates. The power delivered to the transmitting antenna is the maximum conducted output power reduced by the signal loss experienced in the cable used to connect the transmitter to the transmit antenna. If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
IC:
Fixed WSD conducted power level per 6 MHz of bandwidth on which the devices operate shall not exceed the level of 30 dBm (1 W) during any time of continuous transmission.
Fixed WSD with a transmitting antenna of directional gain greater than 6 dBi shall reduce the maximum conducted output power and PSD by the amount in decibels that the directional gain of the antenna exceeds 6 dBi.

8.2.2 Test summary

Test date	December 21, 2015	Temperature	23 °C
Test engineer	Andrey Adelberg	Air pressure	1015 mbar
Verdict	Pass	Relative humidity	34 %

8.2.3 Observations, settings and special notes

Since channel bandwidth is 12 MHz instead of 6 MHz, the power integration was performed over 12 MHz channel.
Spectrum analyser settings for output power:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	RMS
Sweep time:	5 s
Trace mode:	Power Averaging over 10 traces

8.2.4 Test data

Table 8.2-1: *Conducted output power and EIRP measurements for Omnidirectional antenna*

Channel	Frequency, MHz	Power, dBm/12 MHz	Power limit, dBm/12 MHz	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	Margin, dB
Low	476.00	22.39	30.00	7.61	2.50	24.89	36.00	11.11
Mid	590.00	23.59	30.00	6.41	2.50	26.09	36.00	9.91
High	692.00	22.38	30.00	7.62	2.50	24.88	36.00	11.12

Note: Antenna gain is equal and lower than 6 dBi, therefore no reduction in power limit was required.

Table 8.2-2: *Conducted output power and EIRP measurements for Directional antenna*

Channel	Frequency, MHz	Power, dBm/12 MHz	Power limit, dBm/12 MHz	Margin, dB	Antenna gain, dBi*	EIRP, dBm	EIRP limit, dBm	Margin, dB
Low	476.00	17.18	29.00	11.82	7.00	24.18	36.00	11.82
Mid	590.00	17.16	29.00	11.84	7.00	24.16	36.00	11.84
High	692.00	17.07	29.00	11.93	7.00	24.07	36.00	11.93

Note: Antenna gain is 8 dBi and cable loss is 1 dB, total system antenna gain is 7 dBi, therefore 1 dB reduction in power limit was required.

8.3 FCC 15.709(a)(5)(i) and RSS-222 6.2.1.2 The power spectral density from the TVBD

8.3.1 Definitions and limits

FCC:
The power spectral density from the TVBD shall not be greater than the following values when measured in any 100 kHz band during any time interval of continuous transmission:
(i) Fixed devices: 12.6 dBm conducted power. If transmitting antennas of directional gain greater than 6 dBi are used, this conducted power level shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
IC:
Fixed WSD conducted PSD per 100 kHz band within a 6 MHz wide channel shall not exceed the 12.6 dBm/100 kHz level during any time of continuous transmission.
Fixed WSD with a transmitting antenna of directional gain greater than 6 dBi shall reduce the maximum conducted output power and PSD by the amount in decibels that the directional gain of the antenna exceeds 6 dBi.

8.3.2 Test summary

Test date	December 21, 2015	Temperature	23 °C
Test engineer	Andrey Adelberg	Air pressure	1015 mbar
Verdict	Pass	Relative humidity	34 %

8.3.3 Observations, settings and special notes

Spectrum analyser settings for output power:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	RMS
Sweep time:	5 s
Trace mode:	Power Averaging over 10 traces

8.3.4 Test data

Table 8.3-1: *Conducted PSD measurements for Omnidirectional antenna*

Channel	Frequency, MHz	PSD, dBm/100 kHz	PSD limit, dBm/100 kHz	Margin, dB	Antenna gain, dBi	EIRP PSD, dBm/100 kHz	EIRP limit, dBm/100 kHz	Margin, dB
Low	476.00	5.42	12.60	7.18	2.50	7.92	18.60	10.68
Mid	590.00	6.87	12.60	5.73	2.50	9.37	18.60	9.23
High	692.00	5.77	12.60	6.83	2.50	8.27	18.60	10.33

Note: Antenna gain is equal and lower than 6 dBi, therefore no reduction in PSD limit was required.

Table 8.3-2: *Conducted PSD measurements for Directional antenna*

Channel	Frequency, MHz	PSD, dBm/100 kHz	PSD limit, dBm/100 kHz	Margin, dB	Antenna gain, dBi*	EIRP PSD, dBm/100 kHz	EIRP limit, dBm/100 kHz	Margin, dB
Low	476.00	5.97	11.60	5.63	7.00	12.97	17.60	4.63
Mid	590.00	5.65	11.60	5.95	7.00	12.65	17.60	4.95
High	692.00	5.00	11.60	6.60	7.00	12.00	17.60	5.60

Note: Antenna gain is 8 dBi and cable loss is 1 dB, total system antenna gain is 7 dBi, therefore 1 dB reduction in PSD limit was required.

8.4 FCC 15.709(c)(1)(i) and RSS-222 6.3.2 Transmitter band edge for fixed TVBDs

8.4.1 Definitions and limits

FCC:
(1) In the television channels immediately adjacent to the channel in which the TVBD is operating, emissions from the TVBD shall not exceed the following levels:
(i) Fixed devices: −42.8 dBm conducted power.
Emission measurements in the adjacent channels shall be performed using a minimum resolution bandwidth of 100 kHz with an average detector. A narrower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 100 kHz.
IC:
WSDs band edge and adjacent channel power shall not exceed the conducted levels of −42.8 dBm/100 kHz

8.4.2 Test summary

Test date	December 22, 2015	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	31 %

8.4.3 Observations, settings and special notes

Spectrum analyser settings for output power:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	RMS
Sweep time:	5 s
Trace mode:	Power Averaging over 10 traces

8.4.4 Test data

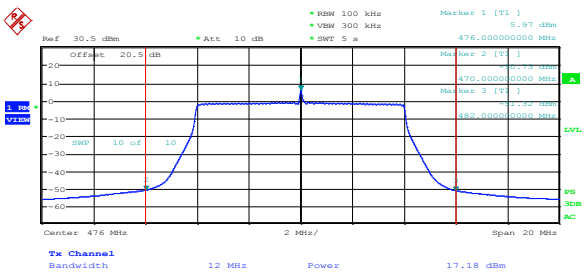


Figure 8.4-1: *Band edges (and ACP) for low channel, directional antenna*

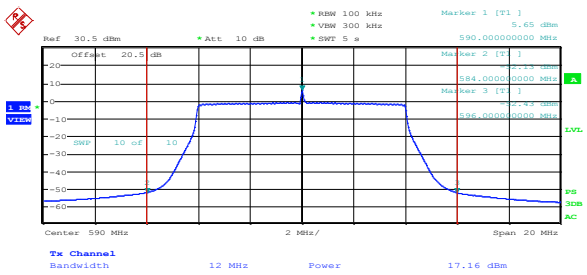


Figure 8.4-2: *Band edges (and ACP) for mid channel, directional antenna*

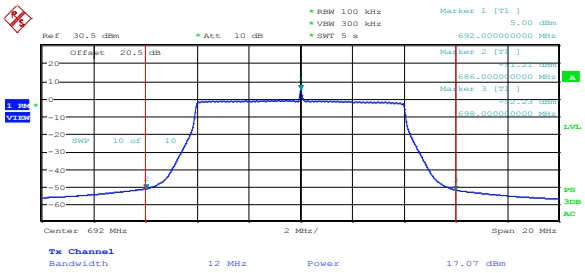


Figure 8.4-3: *Band edges (and ACP) for high channel, directional antenna*

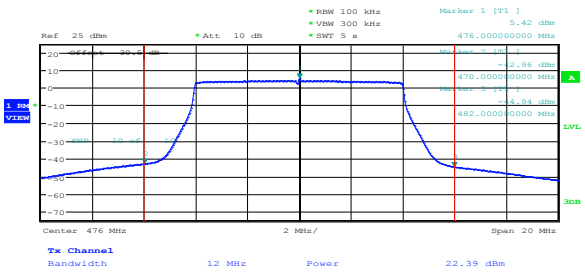


Figure 8.4-4: *Band edges (and ACP) for low channel, omnidirectional antenna*

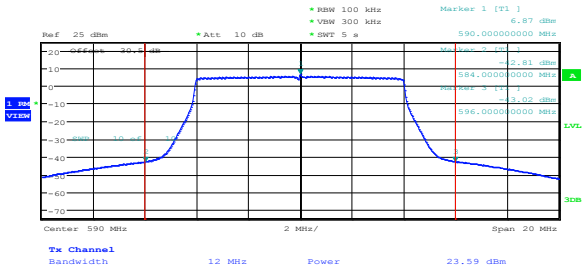


Figure 8.4-5: *Band edges (and ACP) for mid channel, omnidirectional antenna*

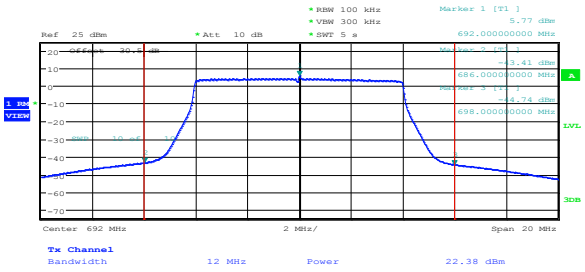


Figure 8.4-6: *Band edges (and ACP) for high channel, omnidirectional antenna*

Table 8.4-1: *Band edge measurements for Omnidirectional antenna*

Channel	Frequency, MHz	Band edge level, dBm/100 kHz	Band edge limit, dBm/100 kHz	Margin, dB
Low	470	-42.96	-42.80	0.16
Low	482	-44.94	-42.80	2.14
Mid	584	-42.81	-42.80	0.01
Mid	596	-43.02	-42.80	0.22
High	686	-43.41	-42.80	0.61
High	698	-44.74	-42.80	1.94

Note: Antenna gains are equal and lower than 6 dBi, therefore no reduction in band edge limit was required.

Table 8.4-2: *Band edge measurements for Directional antenna*

Channel	Frequency, MHz	Band edge level, dBm/100 kHz	Band edge limit, dBm/100 kHz	Margin, dB
Low	470	-50.73	-43.80	6.93
Low	482	-51.32	-43.80	7.52
Mid	584	-52.13	-43.80	8.33
Mid	596	-52.43	-43.80	8.63
High	686	-51.21	-43.80	7.41
High	698	-52.23	-43.80	8.43

Note: Antenna gain is 8 dBi and cable loss is 1 dB, total system antenna gain is 7 dBi, therefore 1 dB reduction in band edge limit was required.

8.5 FCC 15.709(c)(3) and RSS-222 6.3.3 Radiated spurious emissions beyond the television channels

8.5.1 Definitions and limits

FCC:
At frequencies beyond the television channels immediately adjacent to the channel in which the TVBD is operating, the radiated emissions from TVBDs shall meet the requirements of § 15.209.
IC:
Beyond the adjacent channel emissions, the emission limits of RSS-Gen apply. See RSS-Gen for guidance on performing those measurements

Table 8.5-1: *FCC §15.209 and RSS-Gen Radiated emission limits*

Frequency, MHz	Field strength of emissions		Measurement distance
	µV/m	dBµV/m	m
0.009–0.490	2400/F	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 - 20 \times \log_{10}(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges.
For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test

8.5.2 Test summary

Test date	September 29, 2015	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	34 %

8.5.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
Radiated measurements were performed at a distance of 3 m.

Spectrum analyser settings for radiated measurements below 1 GHz:

Resolution bandwidth:	120 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak or Quasi-peak
Trace mode:	Max Hold

Spectrum analyser settings for peak radiated measurements above 1 GHz:

Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for average radiated measurements above 1 GHz:

Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	Average
Trace mode:	Max Hold

8.5.4 Test data

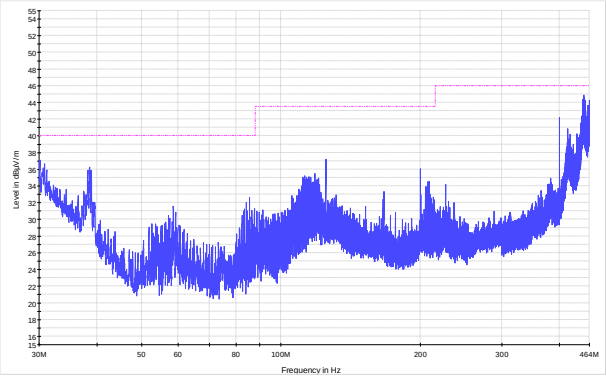


Figure 8.5-1: *Radiated spurious emissions within 30–464 MHz for low channel for Omnidirectional antenna*

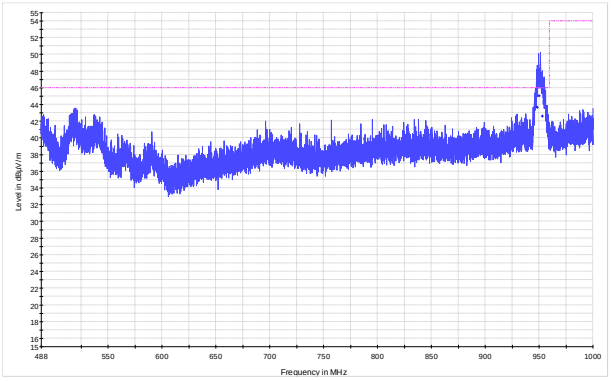


Figure 8.5-2: *Radiated spurious emissions within 488–1000 MHz for low channel for Omnidirectional antenna*

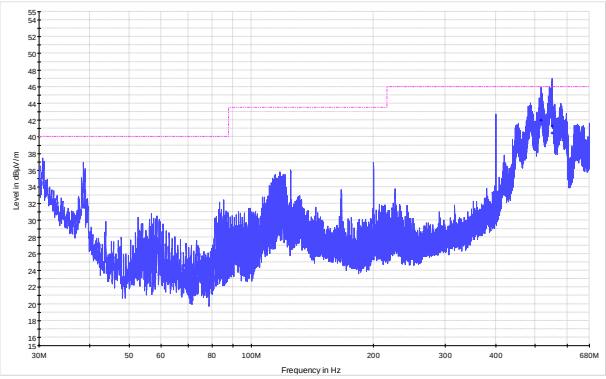


Figure 8.5-3: *Radiated spurious emissions within 30–680 MHz for high channel for Omnidirectional antenna*

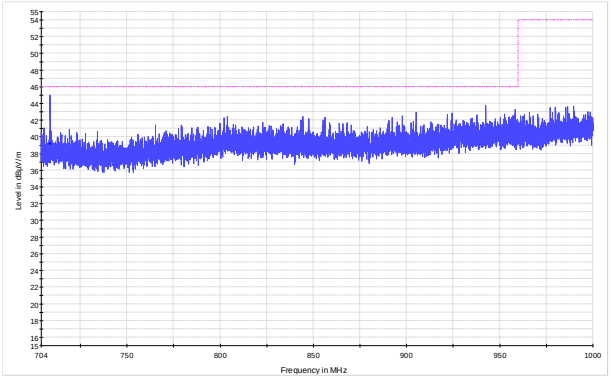


Figure 8.5-4: *Radiated spurious emissions within 704–1000 MHz for high channel for Omnidirectional antenna*

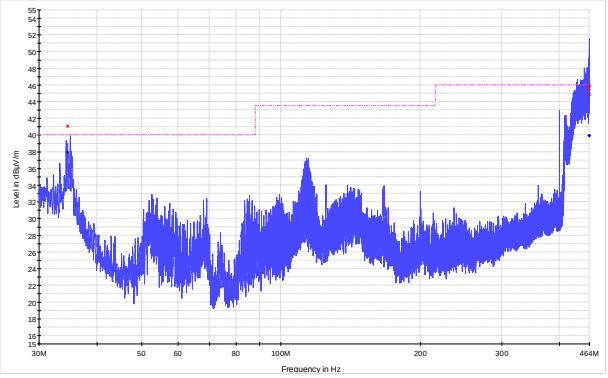


Figure 8.5-5: *Radiated spurious emissions within 30–464 MHz for low channel for Directional antenna*

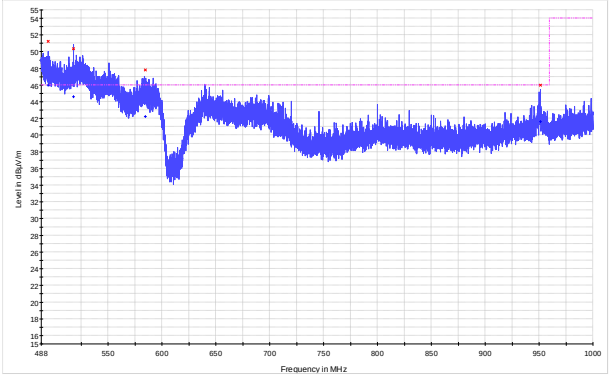


Figure 8.5-6: *Radiated spurious emissions within 488–1000 MHz for low channel for Directional antenna*

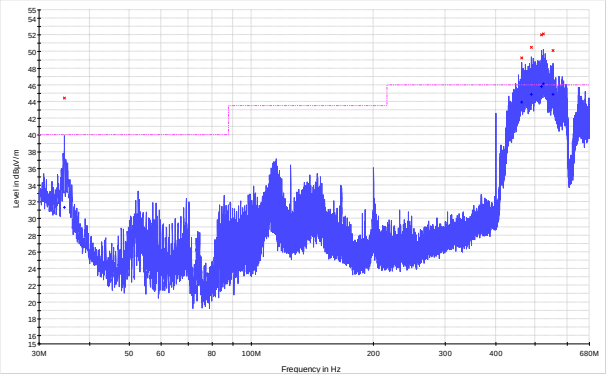


Figure 8.5-7: *Radiated spurious emissions within 30–680 MHz for high channel for Directional antenna*

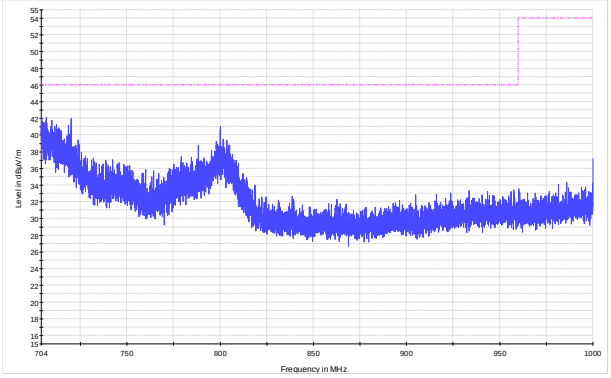


Figure 8.5-8: *Radiated spurious emissions within 704–1000 MHz for high channel for Directional antenna*

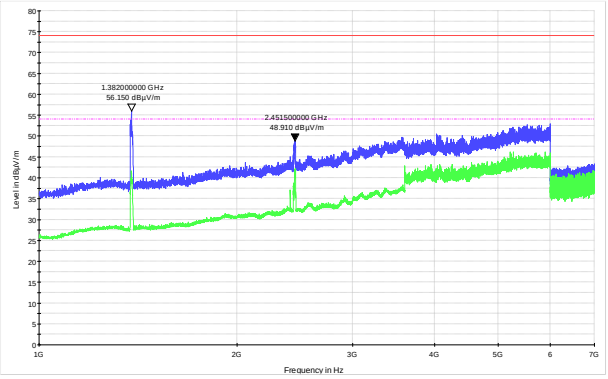


Figure 8.5-9: *Radiated spurious emissions within 1–7 GHz for low channel for Omnidirectional antenna*

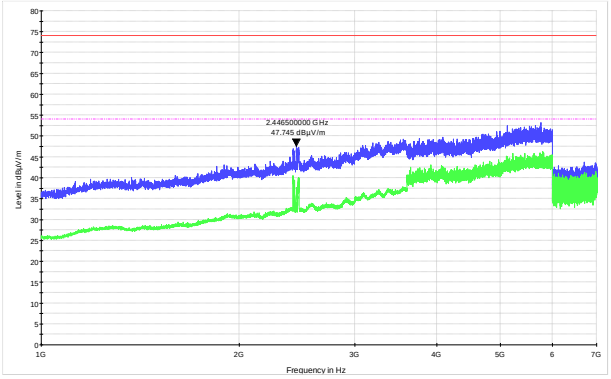


Figure 8.5-10: *Radiated spurious emissions within 1–7 GHz for high channel for Omnidirectional antenna*

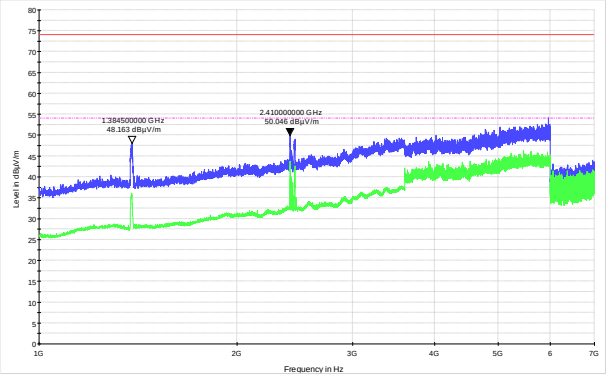


Figure 8.5-11: *Radiated spurious emissions within 1–7 GHz for low channel for Directional antenna*

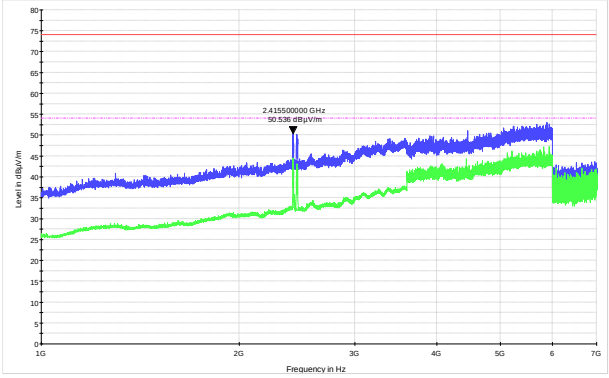


Figure 8.5-12: *Radiated spurious emissions within 1–7 GHz for high channel for Directional antenna*

Table 8.5-2: *Radiated spurious emissions measurements beyond band edges for Omnidirectional antenna below 1 GHz*

Channel	Frequency, MHz	Quasi-Peak field strength, dBµV/m	Limit, dBµV/m	Margin, dB
Low	949.96	45.06	46.00	0.94
Low	948.44	43.65	46.00	2.35
Low	952.88	42.62	46.00	3.38
High	550.00	40.47	46.00	5.53
High	550.00	41.31	46.00	4.69
High	516.96	42.00	46.00	4.00
High	708.76	39.19	46.00	6.81

Table 8.5-3: *Radiated spurious emissions measurements beyond band edges for Omnidirectional antenna above 1 GHz*

Channel	Frequency, MHz	Peak field strength, dBµV/m	Average limit, dBµV/m	Margin, dB
Low	1382.0	42.90*	54.00	11.1
Low	2451.5	49.91	54.00	4.09
High	2446.5	47.75	54.00	6.25

Note: * - Average field strength result. Peak field strength was measured at 56.15 dBµV/m with 74 dBµV/m limit.

Table 8.5-4: *Radiated spurious emissions measurements beyond band edges for Directional antenna below 1 GHz*

Channel	Frequency, MHz	Quasi-Peak field strength, dBµV/m	Limit, dBµV/m	Margin, dB
Low	34.60	38.00	40.00	2.00
Low	463.52	39.93	46.00	6.07
Low	463.72	39.96	46.00	6.04
Low	463.08	39.98	46.00	6.02
Low	517.92	44.62	46.00	1.38
Low	494.40	45.97	46.00	0.03
Low	584.48	42.25	46.00	3.76
Low	951.24	41.65	46.00	4.36
High	518.36	45.82	46.00	0.18
High	523.48	45.17	46.00	0.83
High	463.28	43.97	46.00	2.03
High	489.88	44.89	46.00	1.11
High	553.44	44.87	46.00	1.13
High	34.64	31.38	40.00	8.62

Table 8.5-5: *Radiated spurious emissions measurements beyond band edges for Directional antenna above 1 GHz*

Channel	Frequency, MHz	Peak field strength, dBµV/m	Average limit, dBµV/m	Margin, dB
Low	1384.5	48.16	54.00	5.84
Low	2410.0	50.05	54.00	3.95
High	2415.0	50.54	54.00	3.46

8.6 FCC 15.709(c)(4) and RSS-222 6.4 Field Strength Emissions in the band 602–620 MHz

8.6.1 Definitions and limits

FCC:
Emissions in the band 602–620 MHz must also comply with the following field strength limits at a distance of one meter:
IC:
Transmitter field strength emissions must comply with the following field strength limits at a distance of one metre.

Table 8.6-1: *602–620 MHz band field strength limits*

Frequency, MHz	Field strength, dBµV/m/120 kHz
602–607	120 – 5 × (F – 602)
607–608	95
608–614	30
614–615	95
615–620	120 – 5 × (620 – F)

Notes: F is frequency in MHz

8.6.2 Test summary

Test date	December 21, 2015	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1010 mbar
Verdict	Pass	Relative humidity	33 %

8.6.3 Observations, settings and special notes

The spectrum was searched from 602 MHz to the 620 MHz.
Radiated measurements were performed at a distance of 1 m.
In order to eliminate the Spectrum analyzer overloading, notch filter tuned to the fundamental frequency was used:

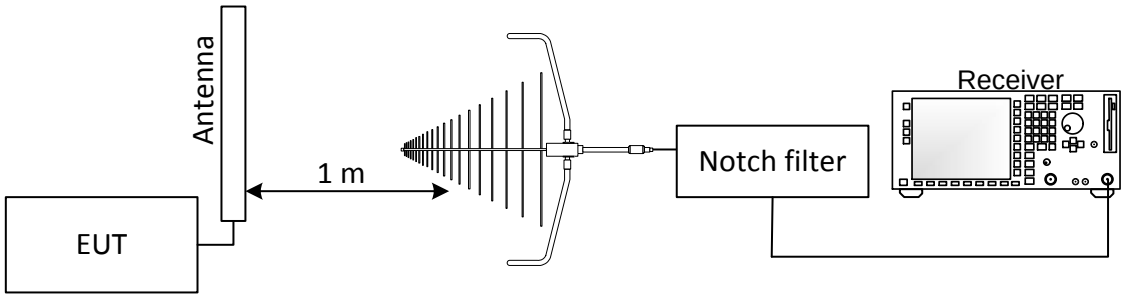


Figure 8.6-1: *Setup diagram for 602–620 MHz radiated emissions measurements*

Spectrum analyser settings:

Resolution bandwidth:	120 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

8.6.4 Test data

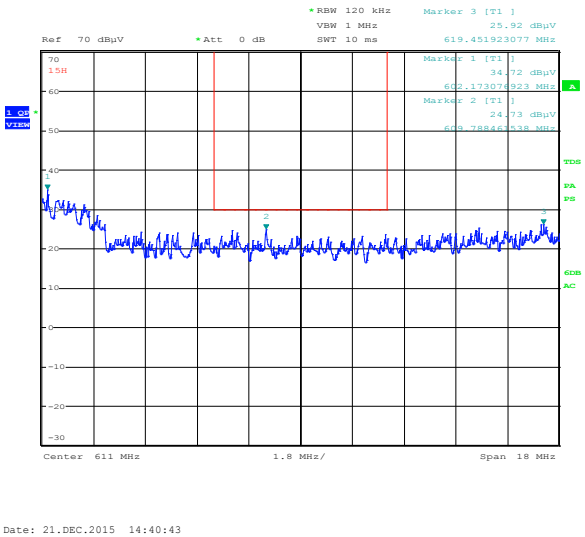


Figure 8.6-2: *Radiated spurious emissions within 602–620 MHz for lower adjacent channel to the restricted band (596 MHz), Omnidirectional antenna*

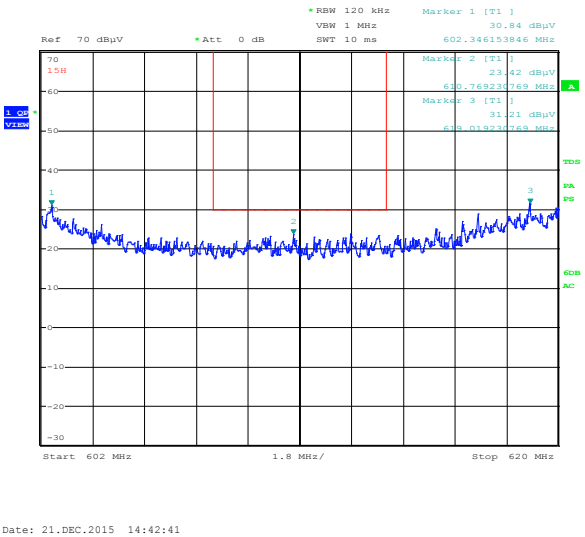


Figure 8.6-3: *Radiated spurious emissions within 602–620 MHz for upper adjacent channel to the restricted band (626 MHz), Omnidirectional antenna*

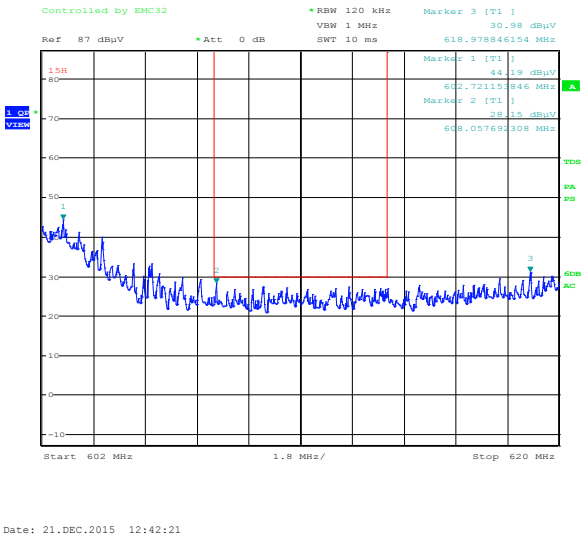


Figure 8.6-4: *Radiated spurious emissions within 602–620 MHz for lower adjacent channel to the restricted band (596 MHz), Directional antenna*

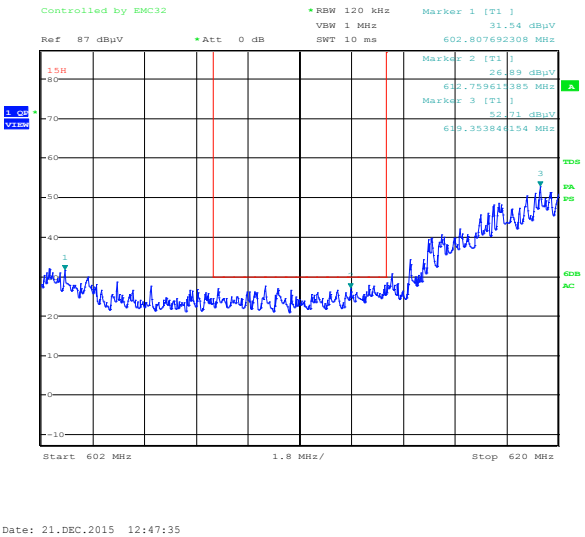
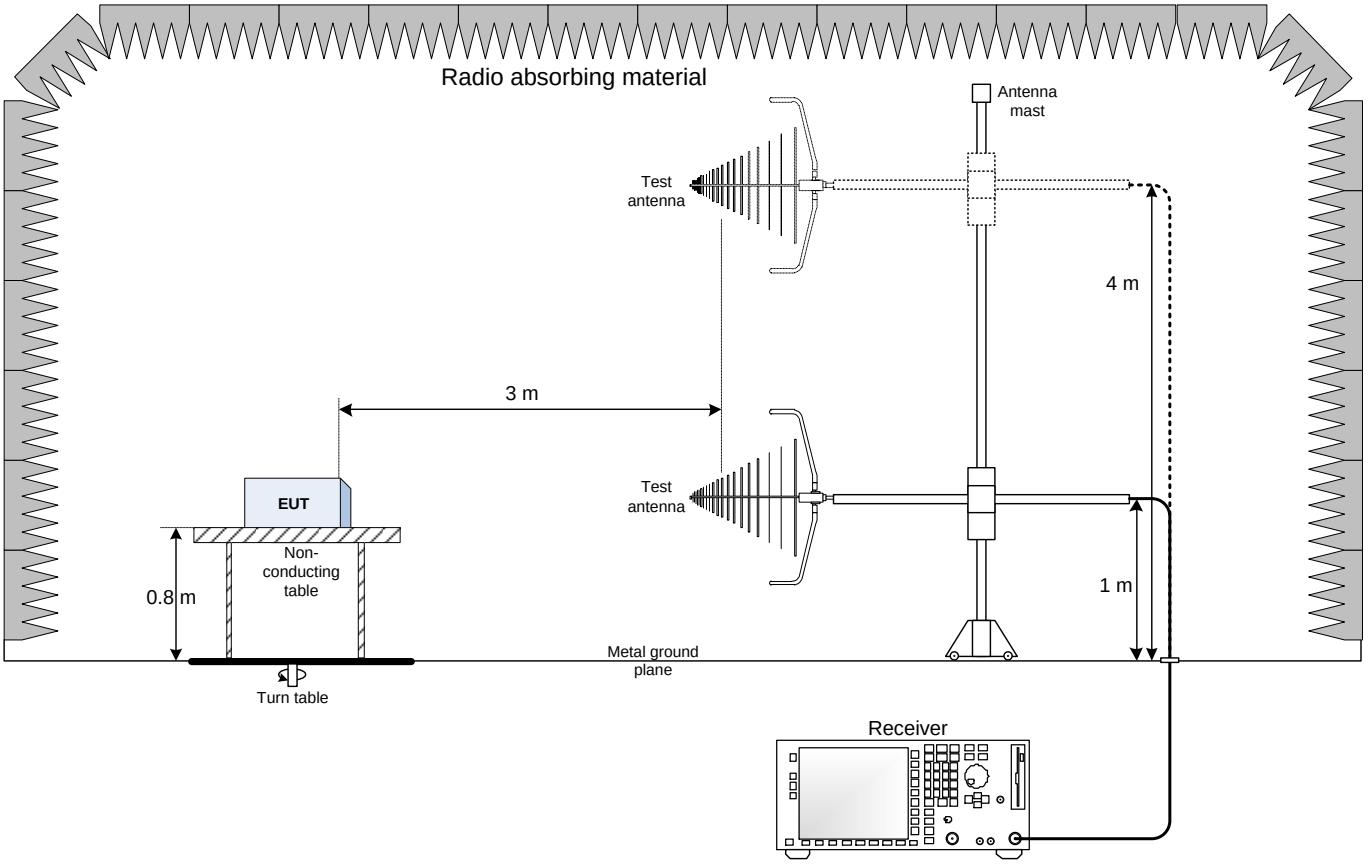


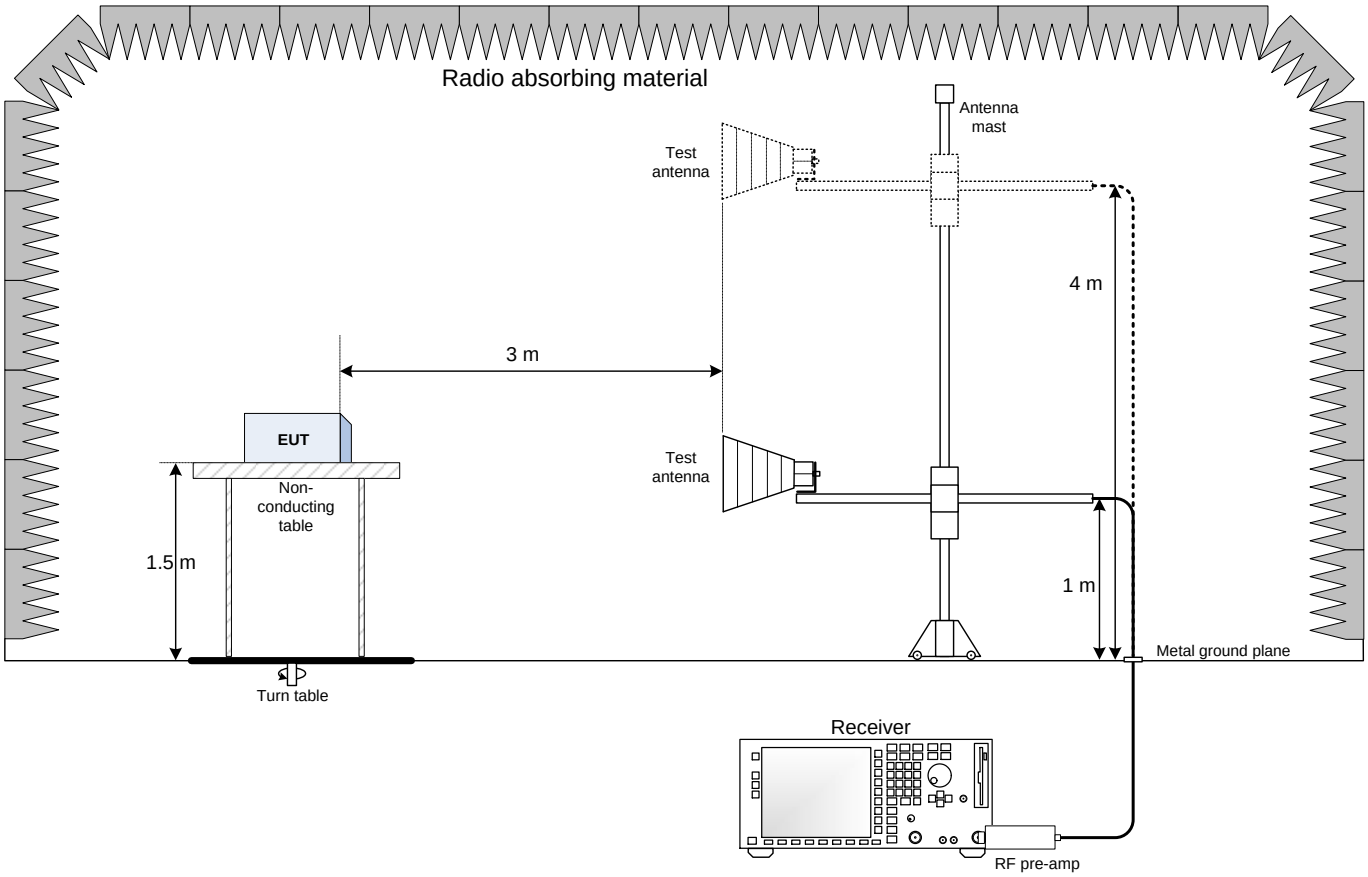
Figure 8.6-5: *Radiated spurious emissions within 602–620 MHz for upper adjacent channel to the restricted band (626 MHz), Directional antenna*

Section 9. Block diagrams and photos of test set-ups

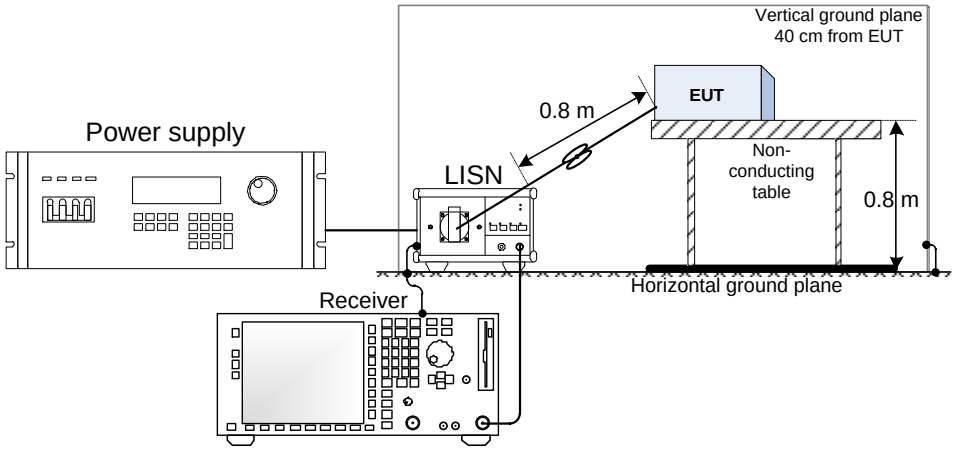
9.1 Radiated emissions set-up for frequencies below 1 GHz



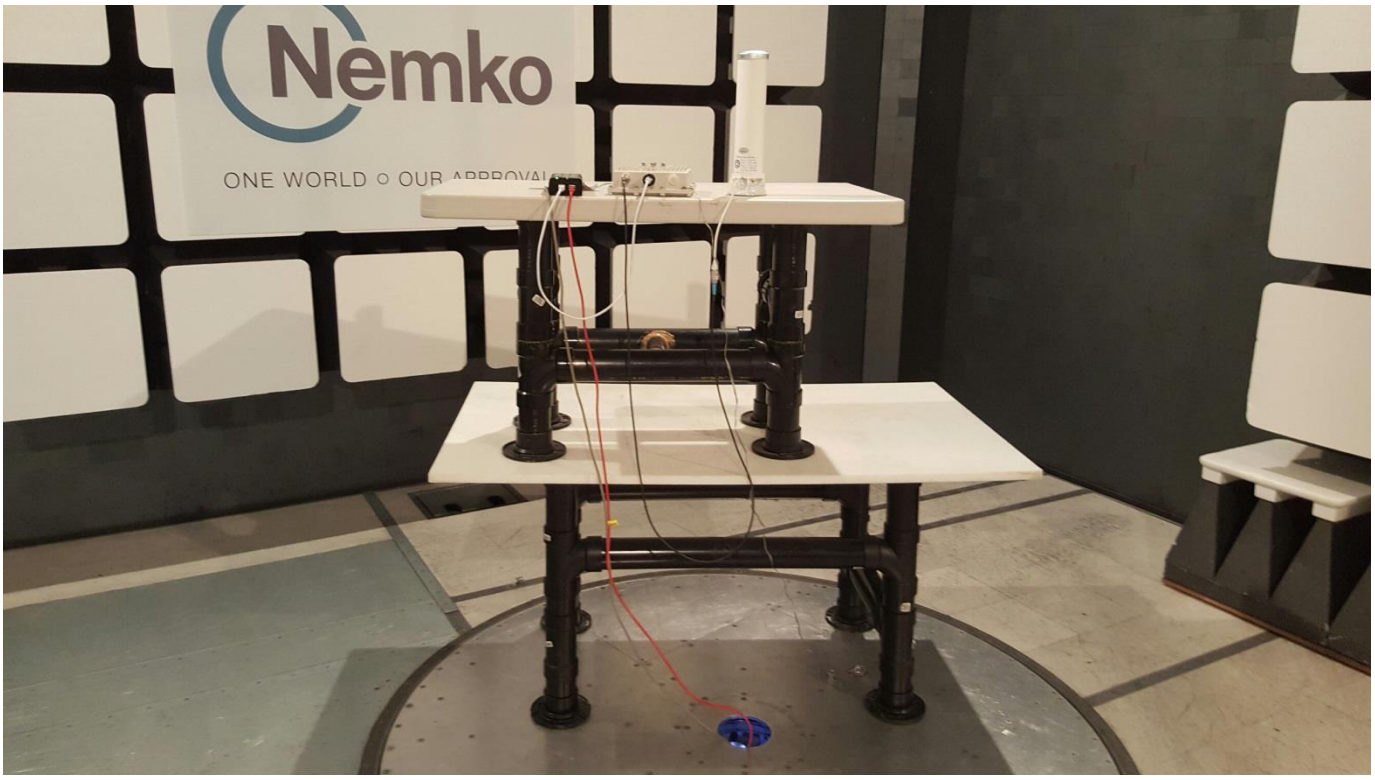
9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Conducted emissions set-up



9.4 Photo of set-up with Omnidirectional antenna



9.5 Photo of set-up with Directional antenna