ONE WORLD ○ OUR APPROVAL

Test report

336776-1TRFWL

Date of issue: October 31, 2017

Applicant:

SMART Technologies ULC

Product:

SMART Board 7000 series interactive display

Model:

ID7086-1

FCC ID: QCI7086

IC Registration number: 4302A-7086

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.247
  Operation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz
- RSS-247, Issue 2, Feb 2017, Section 5
  Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

Test location

Company name	Montreal
Address	292 Labrosse Avenue
City	Pointe-Claire
Province	QC
Postal code	H9R 5L8
Country	Canada
Telephone	+1 514 694 2684
Facsimile	+1 514 694 3528
Toll free	+1 800 563 6336
Website	www.nemko.com
Site number	FCC: CA2041; IC: 2040G-5 (3 m semi anechoic chamber)

Tested by	Avul Nzenza, Wireless/EMC Specialist and Yong Huang, Wireless/EMC Specialist
Reviewed by	Andrey Adelberg, Senior Wireless/EMC Specialist
Review date	October 31, 2017
Reviewer 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	SMART Technologies ULC
Address	3636 Research Road N.W.
City	Calgary
Province/State	Alberta
Postal/Zip code	T2L 1Y1
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.247	Operation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–585 MHz
RSS-247, Issue 2, Feb 2017, Section 5	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

1.3 Test methods

558074 D01 DTS Meas Guidance v04 (April 5, 2017)	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
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 Subpart C, 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 located within the enclosure of EUT and not user accessible.

2.2 FCC Part 15 Subpart C, intentional radiators test results

Part	Test description	Verdict
§15.247(a)(1)(i)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(a)(1)(ii)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
§15.247(a)(1)(iii)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
§15.247(a)(2)	Minimum 6 dB bandwidth for systems using digital modulation techniques	Pass
§15.247(b)(1)	Maximum peak output power of frequency hopping systems operating in the 2400–2483.5 MHz band and 5725–5850 MHz band	Not applicable
§15.247(b)(2)	Maximum peak output power of Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(b)(3)	Maximum peak output power of systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands	Pass
§15.247(c)(1)	Fixed point-to-point operation with directional antenna gains greater than 6 dBi	Not applicable
§15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	Not applicable
§15.247(d)	Spurious emissions	Pass
§15.247(e)	Power spectral density for digitally modulated devices	Pass
§15.247(f)	Time of occupancy for hybrid systems	Not applicable

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 ISED RSS-247, Issue 2, test results

Part	Test description	Verdict
5.1	Frequency Hopping Systems (FHSs)	
5.1 (a)	Bandwidth of a frequency hopping channel	Not applicable
5.1 (b)	Minimum channel spacing for frequency hopping systems	Not applicable
5.1 (c)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
5.1 (d)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
5.1 (e)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
5.2	Digital Transmission Systems (DTSs)	
5.2 (a)	Minimum 6 dB bandwidth	Pass
5.2 (b)	Maximum power spectral density	Pass
5.3	Hybrid Systems	
5.3 (a)	Digital modulation turned off	Not applicable
5.3 (b)	Frequency hopping turned off	Not applicable
5.4	Transmitter output power and e.i.r.p. requirements	
5.4 (a)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
5.4 (b)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
5.4 (c)	Frequency hopping systems operating in the 5725–5850 MHz	Not applicable
5.4 (d)	Systems employing digital modulation techniques	Pass
5.4 (e)	Point-to-point systems in 2400–2483.5 MHz and 5725–5850 MHz band	Not applicable
5.4 (f)	Transmitters which operate in the 2400–2483.5 MHz band with multiple directional beams	Not applicable
5.5	Unwanted emissions	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	September 8, 2017
Nemko sample ID number	Item # 1

3.2 EUT information

Product name	SMART Board 7000 series interactive display
Model	ID7086-1
Model variant	N/A
Serial number	K0101JW32Z009

3.3 Technical information

Applicant IC company number	4302A
IC UPN number	7086
All used IC test site(s) Reg. number	2040G-5
RSS number and Issue number	RSS-247 Issue 2, Feb 2017
Frequency band	2400–2483.5 MHz
Frequency Min (MHz)	2402
Frequency Max (MHz)	2480
RF power Min (W), Conducted/ERP/EIRP	N/A
RF power Max (W), Conducted	0.0023 (3.62 dBm)
Field strength, Units @ distance	N/A
Measured BW (kHz) (6 dB)	842
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	GFSK
Emission classification (F1D, G1D, D1D)	840KF1D
Transmitter spurious, Units @ distance	53.5 dBµV @ 3 m
Power requirements	100–240 $V_{AC,}$ 50–60 Hz
Antenna information	The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator. Max antenna gain is 5 dBi.

3.4 Product description and theory of operation

The SMART Board ID7086-1 interactive display connects devices, lesson content and pedagogically relevant software to create a cohesive educational experience. PC-free embedded computing provides one-touch access to a diverse suite of SMART applications.
You can write over any application in digital ink using one of the supplied pens, and then erase the digital ink using your palm, the eraser or the erasers on the pens. Up to four users can write or draw digital ink on the screen at the same time. Each pen writes and draws in its own color. The Pen ID™ feature enables you to assign different ink appearances to each pen.

3.5 EUT exercise details

EUT was configured by client on site, RF module was set to continuous transmit mode during the test.

3.6 EUT setup diagram

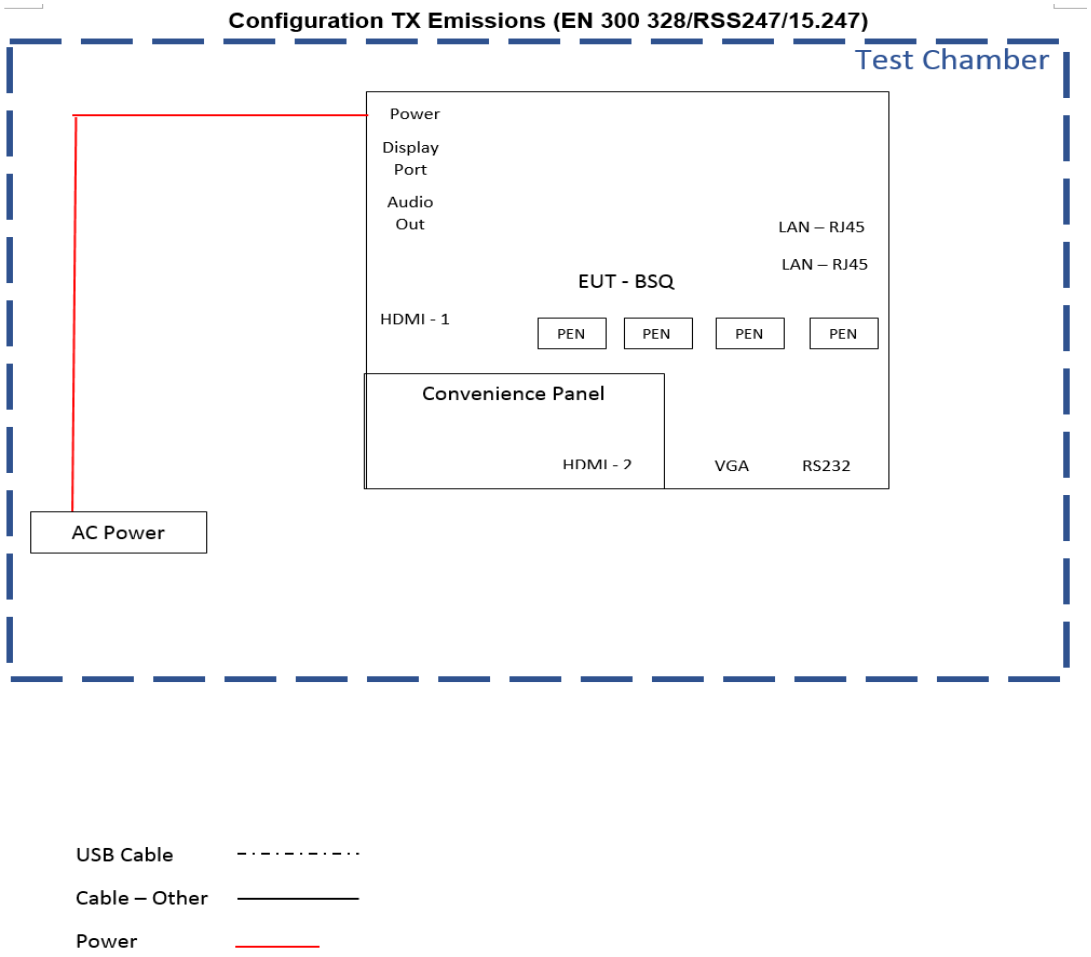


Figure 3.6-1: *Setup diagram*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
Open Pluggable Specification (OPS)	AM30	SMART Technologies AM30	Q021IW42B0545

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

As per quotation Q102124730R1, radiated spurious emissions were performed on EUT. All antenna port conducted measurements and power line conducted emissions were transferred from Nemko project number NEX-325297. As per customer, EUT's RF portion and power supply are identical to the model SBID-7075.

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

UKAS Lab 34 and TIA-603-B have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada, Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products.

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-original assessment*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002532	2 year	May 25/17
Flush mount turntable	Sunol	FM2022	FA002550	—	NCR
Controller	Sunol	SC104V	FA002551	—	NCR
Antenna mast	Sunol	TLT2	FA002552	—	NCR
Three phase power system	TESEQ	ProfLine 2115-400	FA002516	1 year	Aug. 4/17
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	Apr. 23/17
Bilog antenna (20–2000 MHz)	Sunol	JB1	FA002517	1 year	Oct. 5/17
Horn antenna (1–18 GHz)	EMCO	3115	FA001452	1 year	Oct. 26/17
Pre-amplifier (0.5–18 GHz)	COM-POWER	PAM-118A	FA002561	1 year	May 6/17
Pre-amplifier (18–40 GHz)	COM-POWER	PAM-840	FA002508	1 year	May 6/17
Horn antenna (18–40 GHz)	EMCO	3116	FA002487	2 year	Aug. 16/17
LISN	Rohde & Schwarz	ENV216	FA002514	1 year	Nov. 25/17

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

Table 7.1-2: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002532	2 year	June 5/19
Flush mount turntable	Sunol	FM2022	FA002550	—	NCR
Controller	Sunol	SC104V	FA002551	—	NCR
Antenna mast	Sunol	TLT2	FA002552	—	NCR
Three phase power system	TESEQ	ProfLine 2115-400	FA002516	1 year	Aug. 21/18
Spectrum analyzer	Rohde & Schwarz	FSV 40	FA002731	1 year	July 10/18
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	May 3/18
Bilog antenna (20–2000 MHz)	Sunol	JB1	FA002517	1 year	Oct. 5/17
Horn antenna (1–18 GHz)	EMCO	3115	FA001452	1 year	Oct. 26/17
Pre-amplifier (0.5–18 GHz)	COM-POWER	PAM-118A	FA002561	1 year	May 8/18
Pre-amplifier (18–40 GHz)	COM-POWER	PAM-840	FA002508	1 year	May 8/18
Horn antenna (18–40 GHz)	EMCO	3116	FA002487	2 year	Aug. 16/18

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

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	March 7, 2017	Temperature	24.2 °C
Test engineer	Avul Nzenza	Air pressure	1011.3 mbar
Verdict	Pass	Relative humidity	38 %

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.

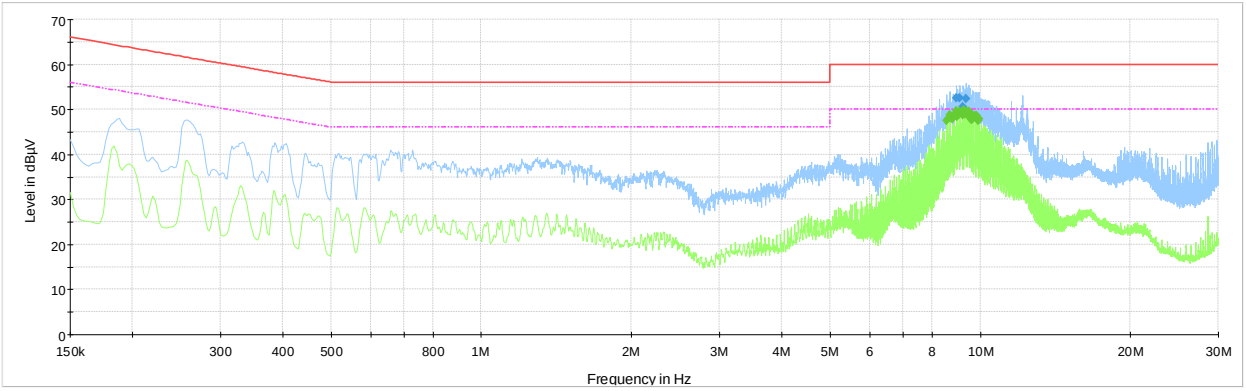
Receiver settings for preview measurements:

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: *Quasi-Peak conducted emissions results on phase line*

Frequency, MHz	Q-Peak result, dBµV	Meas. Time, ms	Bandwidth, kHz	Filter	Correction, dB	Margin, dB	Limit, dBµV
8.968	52.55	100	9	ON	10.28	7.45	60
9.107	52.63	100	9	ON	10.28	7.37	60
9.240	50.61	100	9	ON	10.28	9.39	60
9.377	52.37	100	9	ON	10.29	7.63	60

Note: 43.5 dBµV = 23.2 dBµV (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss) + 10 dB (attenuator)

8.1.1 Test data, continued

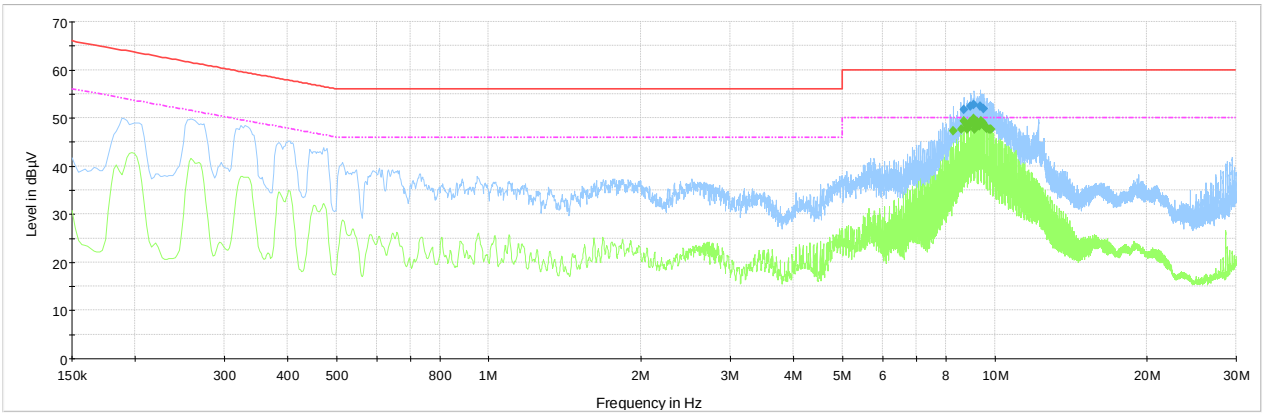
Table 8.1-3: *Average conducted emissions results on phase line*

Frequency, MHz	Average result, dBµV	Meas. Time, ms	Bandwidth, kHz	Filter	Correction, dB	Margin, dB	Limit, dBµV
8.561	47.57	100	9	ON	10.27	2.43	50
8.698	48.70	100	9	ON	10.27	1.3	50
8.801	47.80	100	9	ON	10.27	2.2	50
8.864	48.55	100	9	ON	10.27	1.45	50
8.968	49.60	100	9	ON	10.28	0.4	50
8.999	48.48	100	9	ON	10.28	1.52	50
9.074	49.36	100	9	ON	10.28	0.64	50
9.105	49.46	100	9	ON	10.28	0.54	50
9.211	48.73	100	9	ON	10.28	1.27	50
9.238	49.12	100	9	ON	10.28	0.88	50
9.272	49.83	100	9	ON	10.29	0.17	50
9.341	48.98	100	9	ON	10.29	1.02	50
9.375	49.45	100	9	ON	10.29	0.55	50
9.411	49.47	100	9	ON	10.29	0.53	50
9.481	49.56	100	9	ON	10.29	0.44	50
9.517	49.49	100	9	ON	10.29	0.51	50
9.548	48.12	100	9	ON	10.29	1.88	50
9.618	47.77	100	9	ON	10.29	2.23	50
9.645	48.45	100	9	ON	10.30	1.55	50
9.679	48.03	100	9	ON	10.30	1.97	50
9.749	48.54	100	9	ON	10.30	1.46	50
9.818	48.59	100	9	ON	10.30	1.41	50
9.888	47.49	100	9	ON	10.30	2.51	50
9.924	47.85	100	9	ON	10.30	2.15	50

Sample calculation:
Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)
Result (dBµV) = XX dBµV (reading from receiver) + XX dB (Correction factor)

Example:
43.5 dBµV = 23.2 dBµV (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss) + 10 dB (attenuator)

8.1.2 Test data, continued



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

Table 8.1-4: *Quasi-Peak conducted emissions results on neutral line*

Frequency, MHz	Q-Peak result, dBµV	Meas. Time, ms	Bandwidth, kHz	Filter	Correction, dB	Margin, dB	Limit, dBµV
8.698	51.66	8.34	100	ON	10.28	8.34	60
8.968	52.41	7.59	100	ON	10.29	7.59	60
9.107	52.70	7.30	100	ON	10.29	7.30	60
9.375	52.43	7.57	100	ON	10.30	7.57	60
9.515	51.89	8.11	100	ON	10.30	8.11	60

Note: 43.5 dBµV = 23.2 dBµV (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss) + 10 dB (attenuator)

8.1.1 Test data, continued

Table 8.1-5: *Average conducted emissions results on neutral line*

Frequency, MHz	Average result, dBµV	Meas. Time, ms	Bandwidth, kHz	Filter	Correction, dB	Margin, dB	Limit, dBµV
8.291	47.26	100	9	ON	10.27	2.74	50
8.592	47.57	100	9	ON	10.28	2.43	50
8.698	49.34	100	9	ON	10.28	0.66	50
8.804	48.47	100	9	ON	10.28	1.53	50
8.837	47.65	100	9	ON	10.28	2.35	50
8.864	48.19	100	9	ON	10.28	1.81	50
8.968	49.19	100	9	ON	10.29	0.81	50
9.002	49.07	100	9	ON	10.29	0.93	50
9.074	48.77	100	9	ON	10.29	1.23	50
9.105	49.82	100	9	ON	10.29	0.18	50
9.141	47.66	100	9	ON	10.29	2.34	50
9.211	49.20	100	9	ON	10.29	0.80	50
9.245	48.54	100	9	ON	10.29	1.46	50
9.272	49.04	100	9	ON	10.30	0.96	50
9.341	48.35	100	9	ON	10.30	1.65	50
9.375	49.08	100	9	ON	10.30	0.92	50
9.409	49.30	100	9	ON	10.30	0.70	50
9.479	48.92	100	9	ON	10.30	1.08	50
9.517	48.65	100	9	ON	10.30	1.35	50
9.548	48.37	100	9	ON	10.30	1.63	50
9.618	47.95	100	9	ON	10.30	2.05	50
9.654	47.87	100	9	ON	10.31	2.13	50
9.749	47.56	100	9	ON	10.31	2.44	50
9.821	47.62	100	9	ON	10.31	2.38	50

Sample calculation:
Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)
Result (dBµV) = XX dBµV (reading from receiver) + XX dB (Correction factor)

Example:
43.5 dBµV = 23.2 dBµV (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss) + 10 dB (attenuator)

8.2 FCC 15.247(a)(2) and RSS-247 5.2(a) Minimum 6 dB bandwidth for systems using digital modulation techniques

8.2.1 Definitions and limits

FCC and ISED:

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(2) Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

8.2.2 Test summary

Test date	March 8, 2017	Temperature	24 °C
Test engineer	Avul Nzenza	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	39 %

8.2.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	100 kHz
Video bandwidth	≥3 × RBW
Frequency span	2 MHz
Detector mode	Peak
Trace mode	Max Hold

8.2.4 Test data

Table 8.2-1: *6 dB bandwidth*

Frequency, MHz	6 dB bandwidth, MHz	Limit, MHz	Margin, MHz
2402	0.836	0.50	0.336
2440	0.842	0.50	0.342
2480	0.792	0.50	0.292

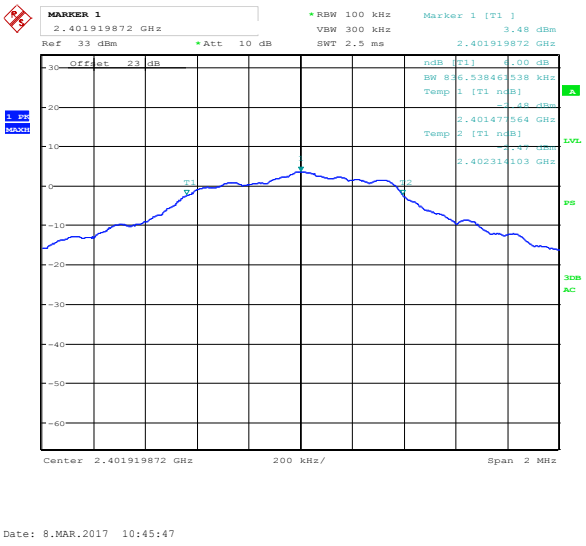


Figure 8.2-1: *6 dB bandwidth on low channel*

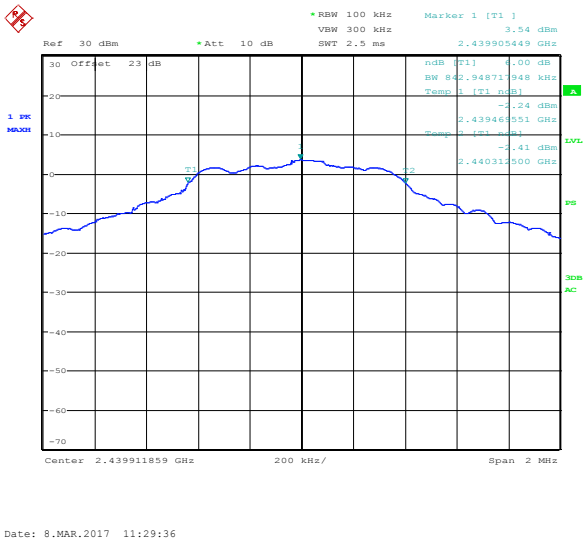


Figure 8.2-2: *6 dB bandwidth on mid channel*

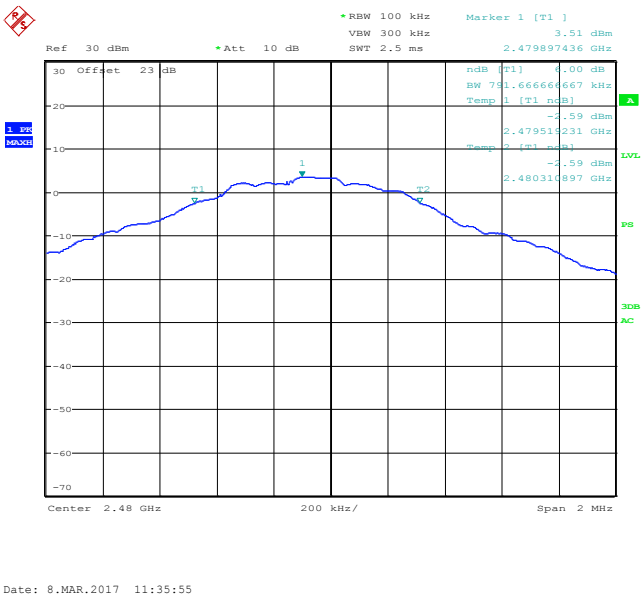


Figure 8.2-3: *6 dB bandwidth on high channel*

8.3 FCC 15.247(b) and RSS-247 5.4 (d) Transmitter output power and e.i.r.p. requirements

8.3.1 Definitions and limits

FCC:

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(3) For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 W (30 dBm). As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(i) Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Fixed, point-to-point operation, as used in paragraphs (b)(3)(i) and (b)(3)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

(c) Operation with directional antenna gains greater than 6 dBi.

(2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

(i) Different information must be transmitted to each receiver.

(ii) If the transmitter employs an antenna system that emits multiple directional beams but does not do emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:

(A) The directional gain shall be calculated as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

ISED:

For DTSs employing digital modulation techniques operating in the bands 902–928 MHz and 2400–2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. Except as provided in Section 5.4(5), the e.i.r.p. shall not exceed 4 W.

Fixed point-to-point systems in the bands 2400-2483.5 MHz and 5725-5850 MHz are permitted to have an e.i.r.p. higher than 4 W provided that the higher e.i.r.p. is achieved by employing higher gain directional antennas and not higher transmitter output powers. Point-to-multipoint systems, omnidirectional applications and multiple co-located transmitters transmitting the same information are prohibited from exceeding an e.i.r.p. of 4 W.

8.3.2 Test summary

Test date	March 8, 2017	Temperature	24 °C
Test engineer	Avul Nzenza	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	39 %

8.3.3 Observations, settings and special notes

The test was performed according to DTS guidelines section 9.2.2.1: Measurement using a spectrum analyzer (SA) Method AVGSA-1 averaging with the EUT transmitting at full power throughout each sweep.

8.3.4 Test data

Table 8.3-1: *Output power measurements results*

Frequency, MHz	Conducted output power, dBm		Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
	Measured	Limit					
2402	3.62	30	26.38	5	8.62	36	27.38
2440	3.57	30	26.43	5	8.57	36	27.43
2480	3.61	30	26.39	5	8.61	36	27.39

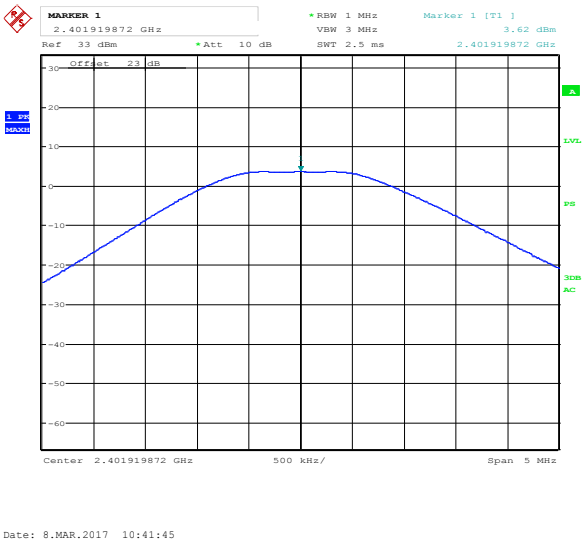


Figure 8.3-1: *Output power on low channel*

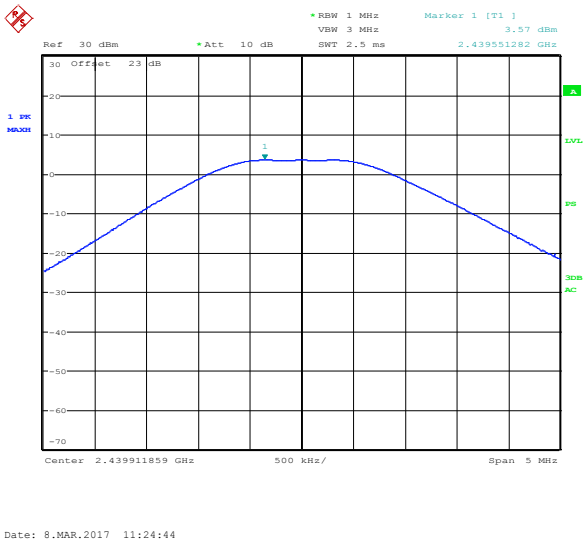


Figure 8.3-2: *Output power on mid channel*

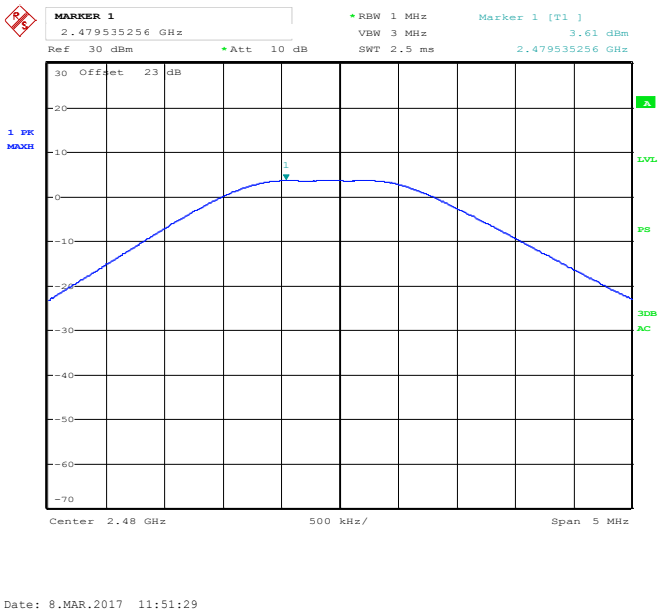


Figure 8.3-3: *Output power on high channel*

8.4 FCC 15.247(d) and RSS-247 5.5 Unwanted emissions

8.4.1 Definitions and limits

FCC:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

ISED:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Table 8.4-1: *FCC §15.209 and RSS-Gen – Radiated emission limits*

Frequency, MHz	Field strength of emissions		Measurement distance, m
	µV/m	dBµV/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

Table 8.4-2: *ISED restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	12.51975–12.52025	399.9–410	5.35–5.46
2.1735–2.1905	12.57675–12.57725	608–614	7.25–7.75
3.020–3.026	13.36–13.41	960–1427	8.025–8.5
4.125–4.128	16.42–16.423	1435–1626.5	9.0–9.2
4.17725–4.17775	16.69475–16.69525	1645.5–1646.5	9.3–9.5
4.20725–4.20775	16.80425–16.80475	1660–1710	10.6–12.7
5.677-5.683	25.5–25.67	1718.8–1722.2	13.25–13.4
6.215–6.218	37.5–38.25	2200–2300	14.47–14.5
6.26775–6.26825	73–74.6	2310–2390	15.35–16.2
6.31175–6.31225	74.8–75.2	2655–2900	17.7–21.4
8.291–8.294	108–138	3260–3267	22.01–23.12
8.362–8.366	156.52475–156.52525	3332–3339	23.6–24.0
8.37625–8.38675	156.7–156.9	3345.8–3358	31.2–31.8
8.41425–8.41475	240–285	3500–4400	36.43–36.5
12.29–12.293	322–335.4	4500–5150	Above 38.6

Note: Certain frequency bands listed in Table 8.4-2 and above 38.6 GHz are designated for low-power licence-exempt applications. These frequency bands and the requirements that apply to the devices are set out in this Standard

Table 8.4-3: *FCC restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Above 38.6
13.36–13.41			

8.4.2 Test summary

Original assessment:

Test date	March 8, 2017 and April 5, 2017	Temperature	24 °C
Test engineer	Avul Nzenza and Yong Huang	Air pressure	1010 mbar
Verdict	Pass	Relative humidity	34 %

Current assessment:

Test date	September 14, 2017	Temperature	25 °C
Test engineer	Yong Huang	Air pressure	1006 mbar
Verdict	Pass	Relative humidity	45 %

8.4.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
EUT was set to transmit with 100 % duty cycle.
Radiated measurements were performed at a distance of 3 m, the EUT was transmitting continuously.

Spectrum analyser settings for radiated measurements within restricted bands below 1 GHz:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for peak radiated measurements within restricted bands 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 within restricted bands above 1 GHz:

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

Spectrum analyser settings for conducted spurious emissions measurements:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

8.4.4 Test data(original assessment)

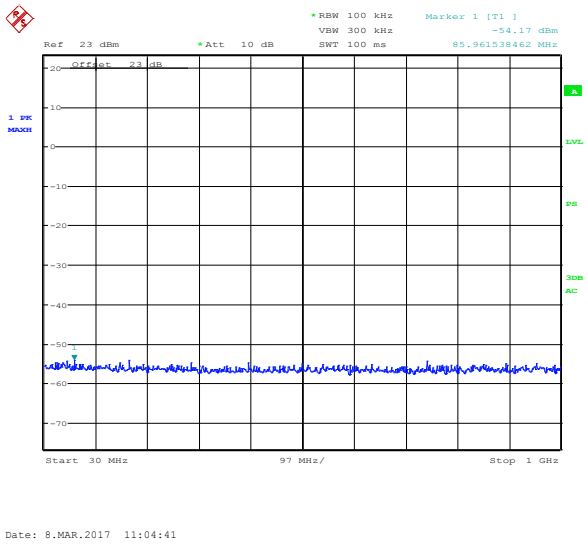


Figure 8.4-1: *Conducted spurious (out-of-band) emissions, low channel, 30 to 1000 MHz*

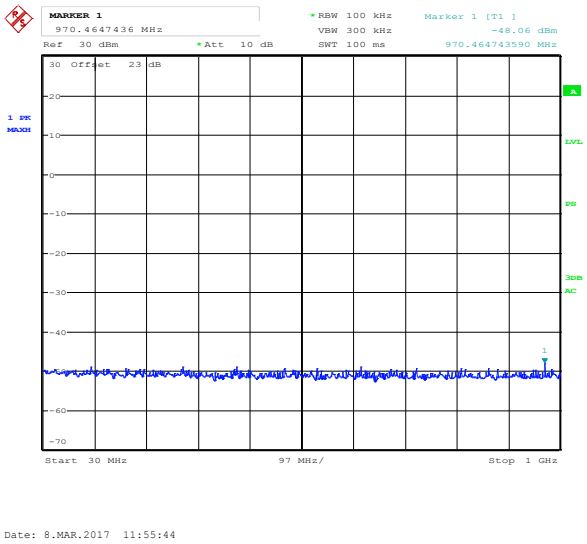


Figure 8.4-2: *Conducted spurious (out-of-band) emissions, mid channel, 30 to 1000 MHz*

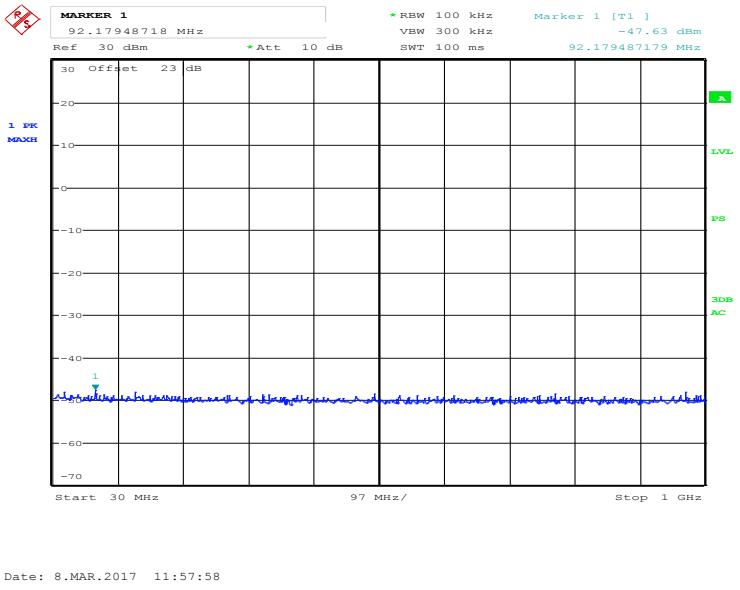


Figure 8.4-3: *Conducted spurious (out-of-band) emissions, high channel, 30 to 1000 MHz*

8.4.5 Test data, continued (original assessment)

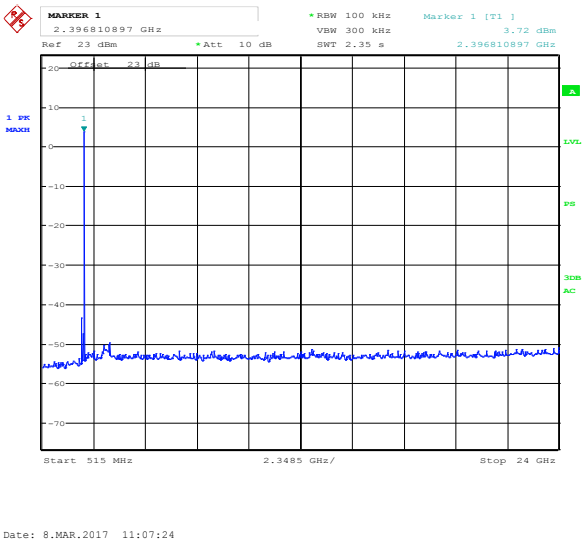


Figure 8.4-4: *Conducted spurious (out-of-band) emissions, low channel*

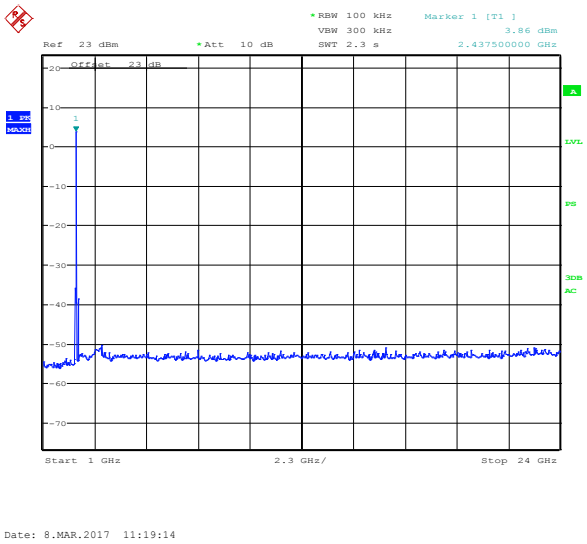


Figure 8.4-5: *Conducted spurious (out-of-band) emissions, mid channel*

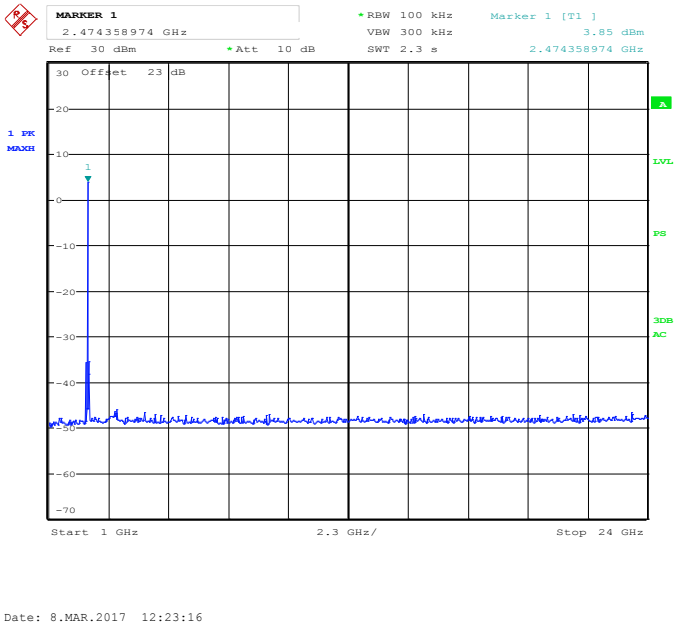


Figure 8.4-6: *Conducted spurious (out-of-band) emissions, high channel*

8.4.6 Test data, continued(original assessment)

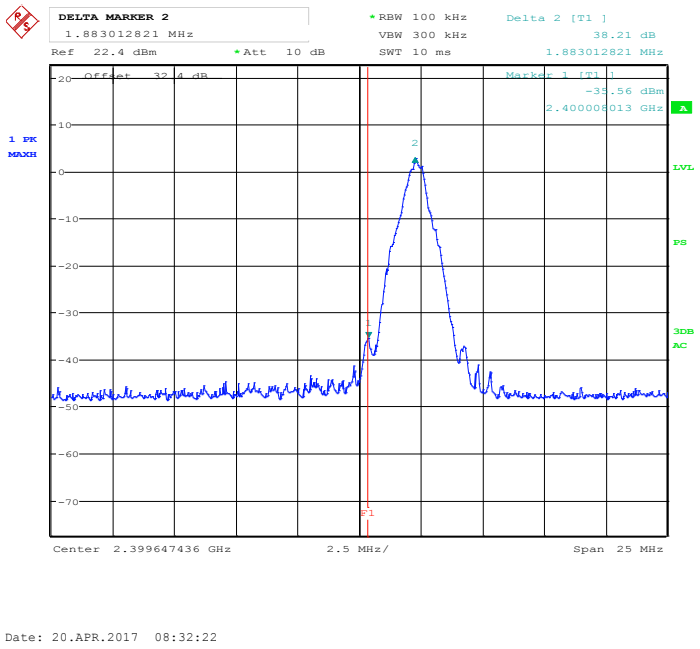


Figure 8.4-7: *Conducted spurious (out-of-band) emissions Lower band, low channel)*

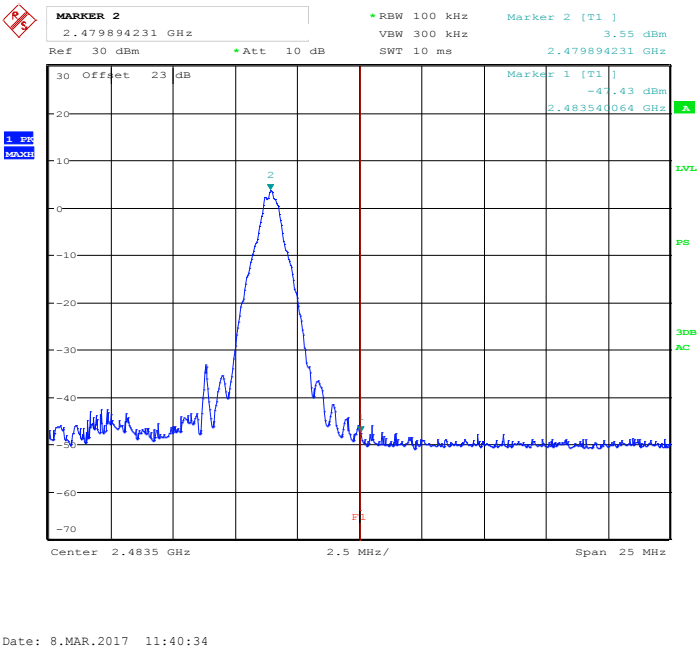


Figure 8.4-8: *Conducted spurious (out-of-band) emissions upper band, high channel*

8.4.4 Test data, continued(current assessment)

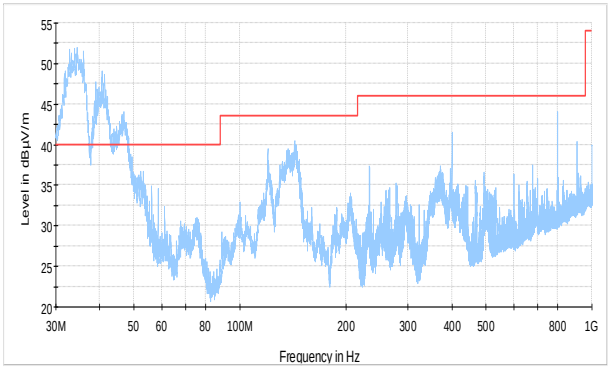


Figure 8.4-9: *Radiated spurious emissions for low channel below 1 GHz for restricted band emissions*

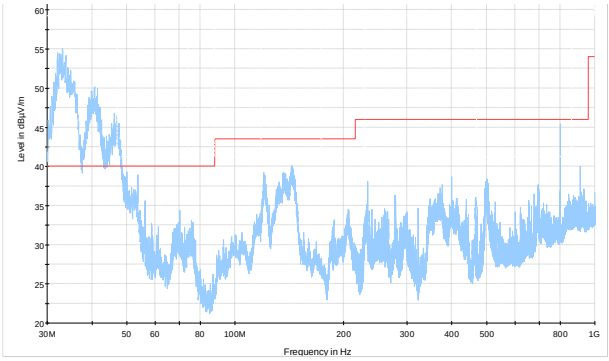


Figure 8.4-10: *Radiated spurious emissions for mid channel below 1 GHz for restricted band emissions*

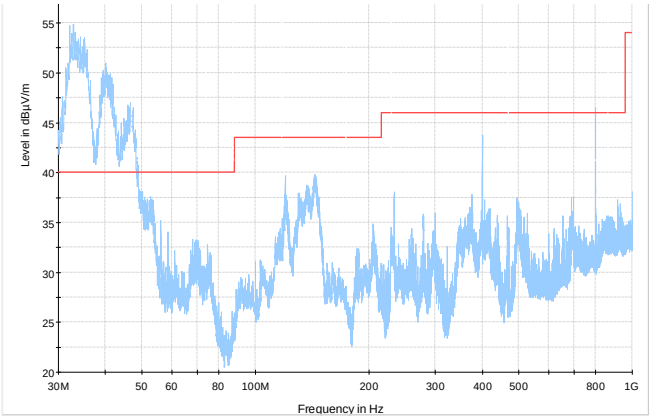


Figure 8.4-11: *Radiated spurious emissions for high channel below 1 GHz for restricted band emissions*

Note: Emissions form 30 MHz to 50 MHz were not related to the RF portion of EUT.

8.4.4 Test data, continued(current assessment)

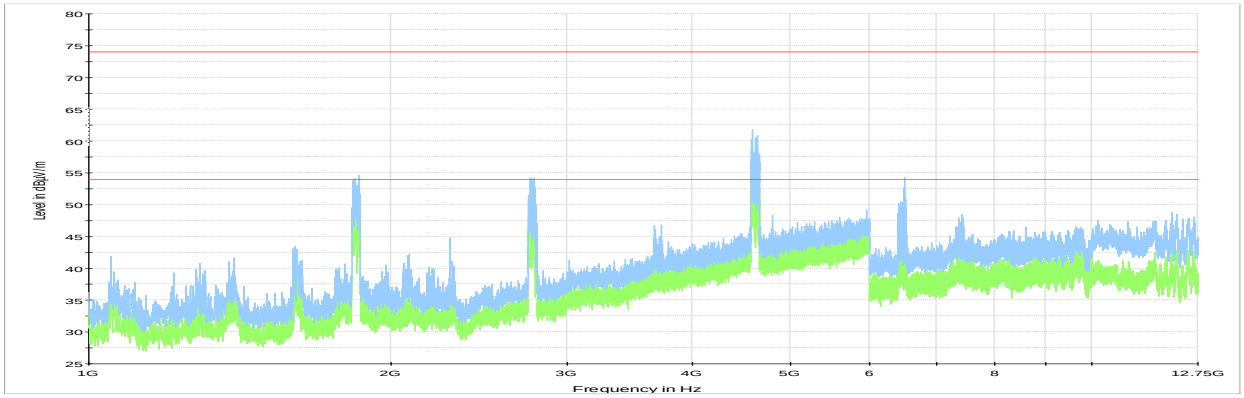


Figure 8.4-12: *Radiated spurious emissions for low channel above 1 GHz for restricted band emissions*

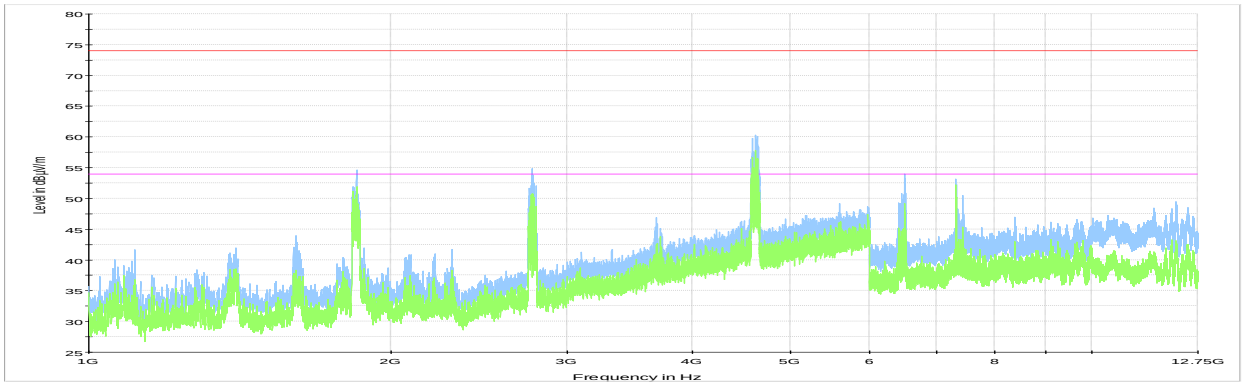


Figure 8.4-13: *Radiated spurious emissions for mid channel above 1 GHz for restricted band emissions*

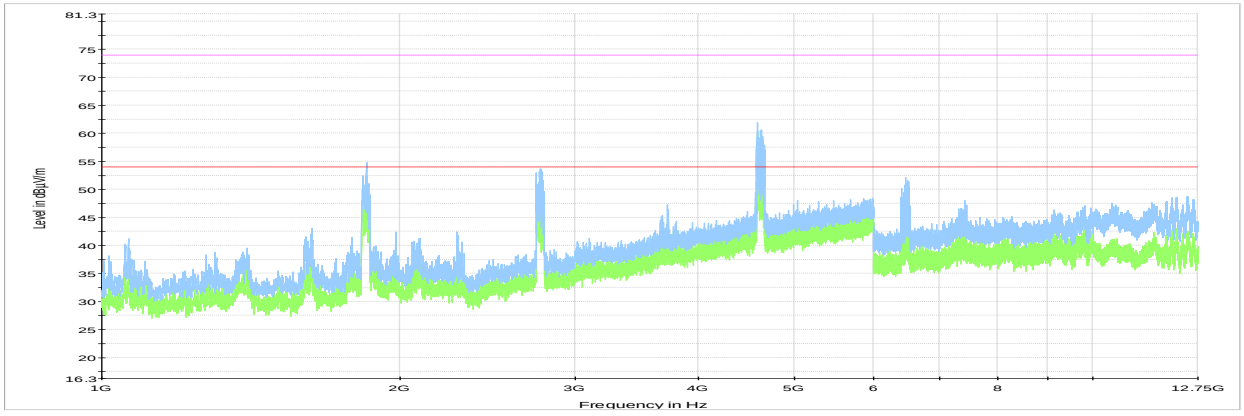


Figure 8.4-14: *Radiated spurious emissions for high channel above 1 GHz for restricted band emissions*

Note: Spectrum up to 25 GHz was investigated, no RF related emissions were detected within 6 dB below the limit above 12.75 GHz

8.4.5 Test data, continued(current assessment)

Table 8.4-4: *Radiated emissions (Quasi-Peak) results below 1 GHz*

Channel	Frequency (MHz)	Quasi-Peak field strength[1 and 4] (dBµV/m)	3 m Quasi-Peak limit [3] (dBµV/m)	Margin (dB)
Low	800.01	41.1	46.0	4.9
Mid	800.01	41.5	46.0	4.5
High	399.99	40.5	46.0	5.5
High	800.01	42.3	46.0	3.7

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

Table 8.4-5: *Radiated field strength measurement results above 1 GHz*

Channel	Frequency, MHz	Peak Field strength, dBµV/m		Margin, dB	Average Field strength, dBµV/m		Margin, dB
		Measured	Limit		Measured	Limit	
Low	2390.0	50.1	74	23.9	47.6	54	6.4
Low	2358.0	54.9	74	19.1	52.7	54	1.3
Low	4610.0	62.5	74	11.5	46.9	54	7.1
mid	2821.0	56.4	74	17.6	49.4	54	4.6
mid	4610.0	62.5	74	11.5	47.6	54	6.4
High	2483.5	52.5	74	21.5	49.4	54	4.6
High	2511.0	58.3	74	15.7	53.5	54	0.5
High	4629.7	62.3	74	11.7	46.2	54	7.8

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

8.5 FCC 15.247(e) and RSS-247 5.2(b) Maximum power spectral density

8.5.1 Definitions and limits

FCC:
For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

ISED:
The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of Section 5.4(4), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

8.5.2 Test summary

Test date	March 8, 2017	Temperature	24 °C
Test engineer	Avul Nzenza	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	39 %

8.5.3 Observations, settings and special notes

The test was performed using method described in section 10.2 Method PKPSD (peak PSK). Spectrum analyser settings:

Resolution bandwidth:	3 kHz
Video bandwidth:	10 kHz
Frequency span:	5 MHz
Detector mode:	Peak
Trace mode:	Max hold

8.5.4 Test data

Table 8.5-1: *PSD measurements results*

Frequency, MHz	PSD, dBm/3 kHz	PSD limit, dBm/3 kHz	Margin, dB
2402	-8.32	8.00	16.32
2440	-9.07	8.00	17.07
2480	-8.53	8.00	16.53

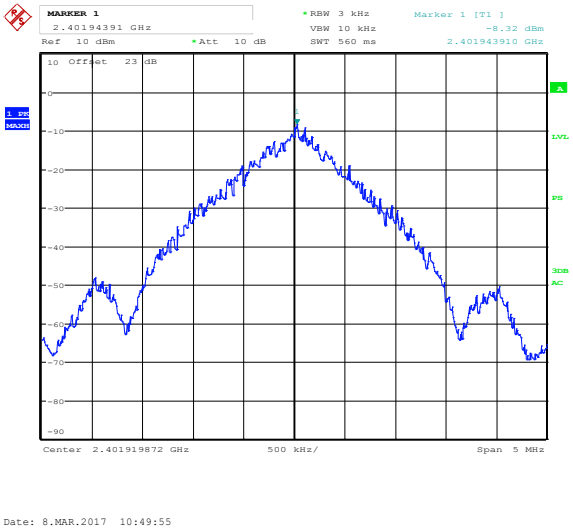


Figure 8.5-1: *PSD sample plot on low channel*

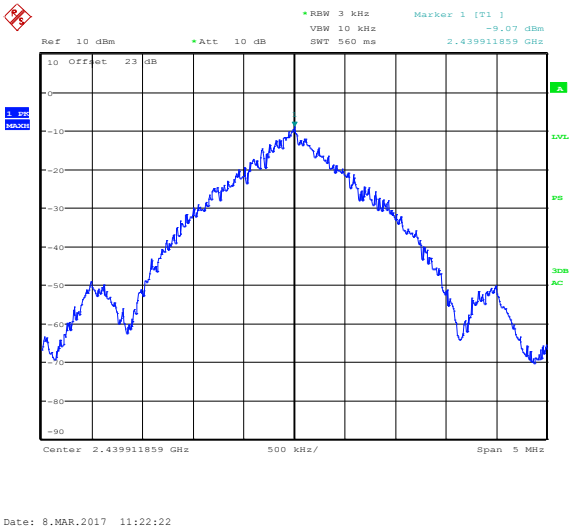


Figure 8.5-2: *PSD sample plot on mid channel*

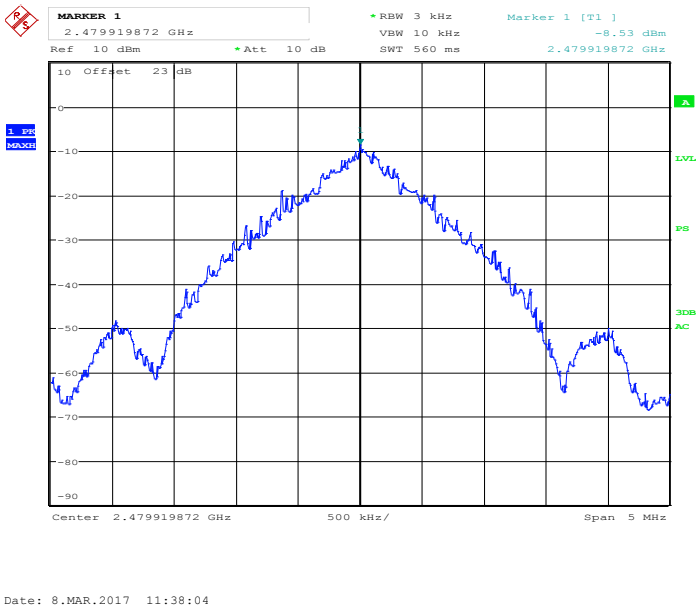
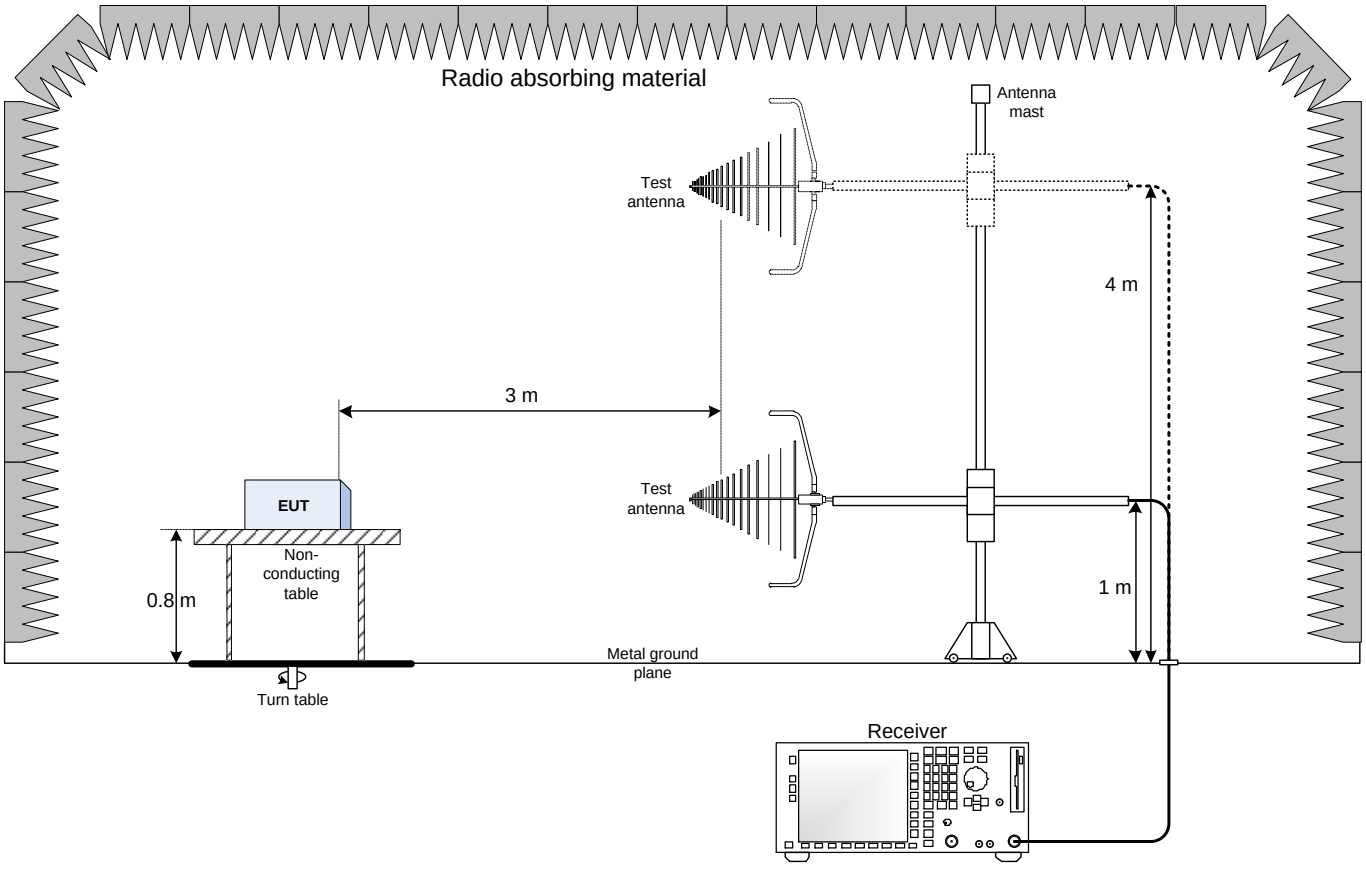


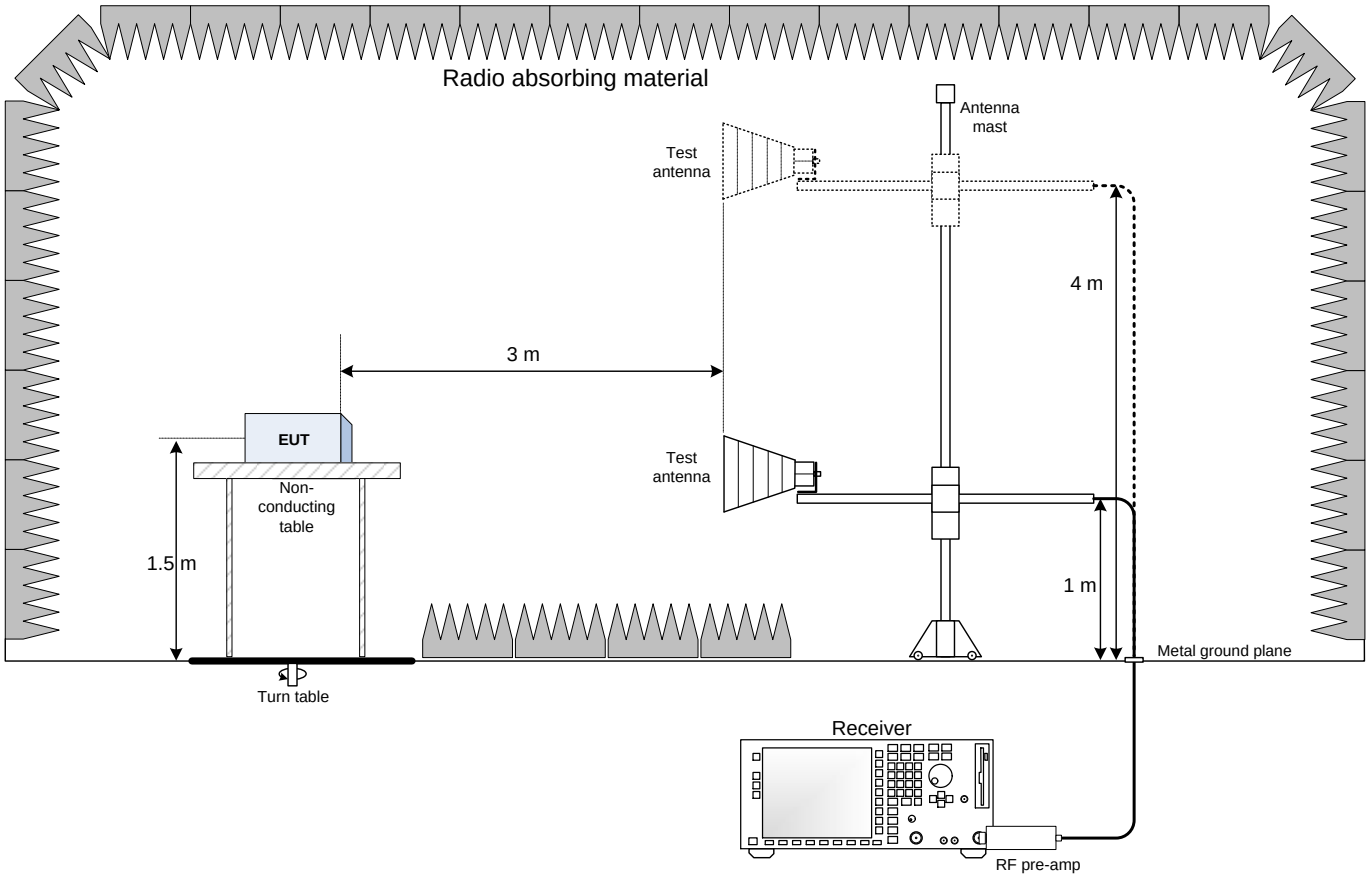
Figure 8.5-3: *PSD sample plot on high channel*

Section 9. Block diagrams 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



Note: Due to the size of EUT, this test set-up is with a table of 0.8 m height while the center of the EUT is at 1.5 m height.

9.3 Conducted emissions set-up