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Test report

333777-1TRFWL

Date of issue: July 27, 2017

Applicant:

ÉLECTRONIQUE BLUEWAVE INC.

Product:

GET

Model:

BWG01

FCC ID: 2AL8WBWG01

IC Registration number: 22763-BWG01

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

  5) Standard specifications for frequency hopping systems and digital transmission systems operating in the bands 902–928 MHz, 2400–2483.5 MHz and 5725–5850 MHz

Test location

Company name	Nemko Canada Inc.
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	Yong Huang, Wireless/EMC Specialist
Reviewed by	Kevin Rose, Wireless/EMC Specialist
Review date	July 27, 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

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	ÉLECTRONIQUE BLUEWAVE INC.
Address	5292 rue Marquette
City	Montréal
Province/State	Quebec
Postal/Zip code	H2J 3Z3
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

DA 00-705, Released March 30, 2000	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems
KDB 558074 D01 DTS Meas Guidance v04	GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER SECTION 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 or as per detailed in the section 1.5 Exclusions below. 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	Not applicable
§15.31(e)	Variation of power source	Pass[1]
§15.203	Antenna requirement	Pass[2]

Notes: [1] As per customer, EUT was battery powered, tests were perform when battery fully charged.

[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	Pass
§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	Pass
§15.247(b)(2)	Maximum peak output power of Frequency hopping systems operating in the 902–928 MHz band	Pass
§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	Pass

2.3 ISED RSS-GEN, Issue 4, test results

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

Notes: None

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	Pass
5.1 (b)	Minimum channel spacing for frequency hopping systems	Pass
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	Pass
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	Pass
5.3 (b)	Frequency hopping turned off	Pass
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	Pass
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	July 4, 2017
Nemko sample ID number	Item 1

3.2 EUT information

Product name	GET
Model	BWG01
Model variant	None
Serial number	None

3.3 Technical information

Applicant IC company number	22763
IC UPN number	BWG01
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), EIRP	0.0022 (3.4 dBm), FHSS mode 0.0020 (3.0 dBm), DTS mode
Field strength, Units @ distance	98.6 dBµV/m, @ 3 m, FHSS mode 98.2 dBµV/m, @ 3 m, DTS mode
Measured BW (kHz)	1058 (20 dB, FHSS mode) 718 (6 dB, DTS mode)
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	FM π/4-DQPSK and 8DPSK
Emission classification (F1D, G1D, D1D)	G1D
Transmitter spurious, Units @ distance	53.4 dBµV/m, @ 3 m
Power requirements	3.7 V_{DC} battery
Antenna information	The EUT uses a non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

Get is a Bluetooth receiver which main usage is to be a audio Sink. You can pair it with any bluetooth source and is used to receive audio wirelessly trough the A2DP Bluetooth profile. It then converts the bluetooth signal to analog amplify it and feed a 3.5 mm stereo audio output. It also has remote control features for music, a volume control an indicator LED and a microphone to receive phone calls.

3.5 EUT exercise details

EUT was configured and operated by customer on site. During transmitter testing, EUT was set to transmit continuously.

3.6 EUT setup diagram

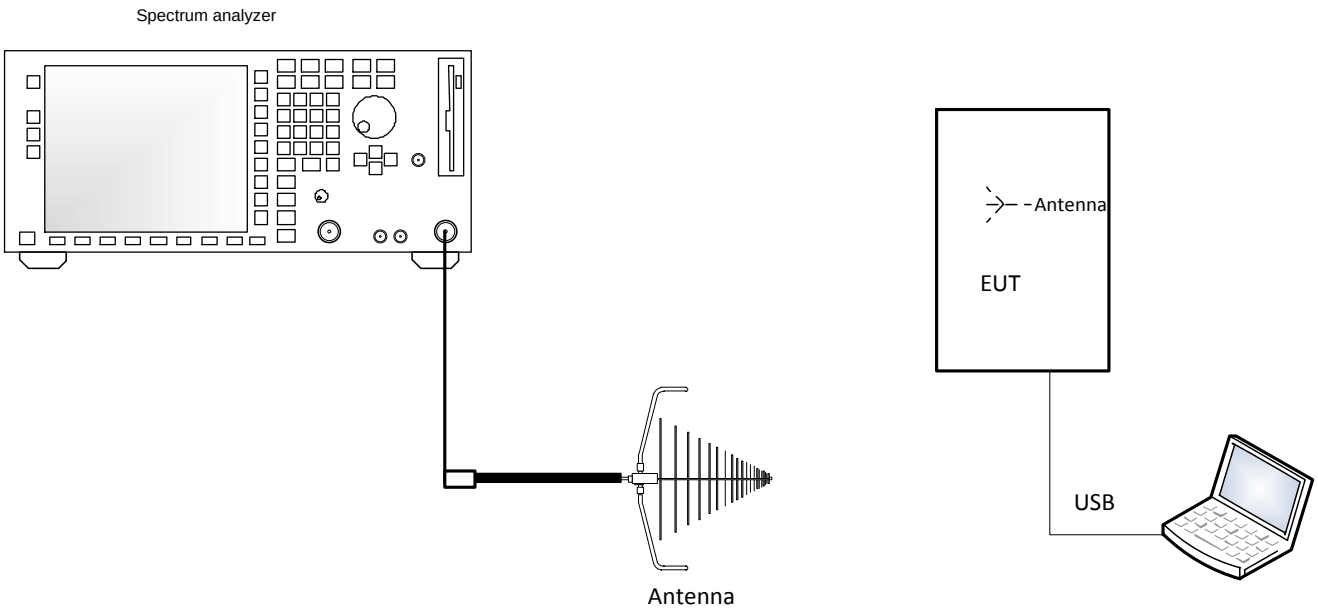


Figure 3.6-1: *Setup diagram*

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 customer, EUT is able to employ two mutually exclusive operational modes. One mode is as a FHSS system and the other is as a DTS. Both FHSS and DTS modes were tested to show compliance.

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*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Flush mount turntable	Sunol	FM2022	FA002550	—	NCR
Controller	Sunol	SC104V	FA002551	—	NCR
Antenna mast	Sunol	TLT2	FA002552	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	May 3/18
50 Ω coax cable	C.C.A.	None	FA002603	—	VOU
50 Ω coax cable	C.C.A.	None	FA002605	—	VOU
50 Ω coax cable	C.C.A.	None	FA002607	—	VOU
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
Horn antenna (18–40 GHz)	EMCO	3116	FA002487	2 year	Aug. 16/17
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
2.4 GHz band Notch Filter	Microwave Circuits	N0324413	FA002693	—	VOU
50 Ω coax cable	HUBER+SUHNER	SUCOFLEX 100	FA002564	—	VOU
Power source	California Instruments	5001ix	FA001770	1 year	Feb 1/18

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

Section 8. Testing data

8.1 FCC 15.247(a)(1) and RSS-247 5.1 Frequency Hopping Systems requirements

8.1.1 Definitions and limits

FCC:

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

(iii) Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

ISED:

a) The bandwidth of a frequency hopping channel is the 20 dB emission bandwidth, measured with the hopping stopped. The system's radio frequency (RF) bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

b) FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSs operating in the band 2400–2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

d) FHSs operating in the band 2400–2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used.

8.1.2 Test summary

Test date	July 4, 2017 to July 6, 2017	Temperature	25 °C
Test engineer	Yong Huang	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	40 %

8.1.3 Observations, settings and special notes

Spectrum analyser settings for carrier frequency separation:

Resolution bandwidth	≥ 1 % of the span
Video bandwidth	≥ RBW
Frequency span	wide enough to capture the peaks of two adjacent channels
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyser settings for number of hopping frequencies:

Resolution bandwidth	≥ 1 % of the span
Video bandwidth	≥ RBW
Frequency span	the frequency band of operation
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyser settings for time of occupancy (dwell time):

Resolution bandwidth	1 MHz
Video bandwidth	≥ RBW
Frequency span	Zero span
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyser settings for 20 dB bandwidth:

Resolution bandwidth	≥ 1% of the 20 dB bandwidth
Video bandwidth	≥ RBW
Frequency span	approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
Detector mode	Peak
Trace mode	Max Hold

8.1.4 Test data

Table 8.1-1: *20 dB bandwidth results*

Frequency, MHz	20 dB bandwidth, kHz
2402	1048
2441	1058
2480	1048

Table 8.1-2: *Carrier frequency separation results*

Carrier frequency separation, kHz	Minimum limit, kHz	Margin, kHz
996.8	705.3	291.5

Note: Limit is two-thirds of the 20 dB bandwidth

Table 8.1-3: *Number of hopping frequencies results*

Number of hopping frequencies	Minimum limit	Margin
79	15	64

Table 8.1-4: *Average time of occupancy results*

Dwell time of each pulse, ms	Number of pulses within period	Total dwell time within period, ms	Limit, ms	Margin, ms
2.9	107	310.3	400	89.7

Measurement Period is 31.6 s, which equal to 0.4 s multiplied by the number of hopping channels 79

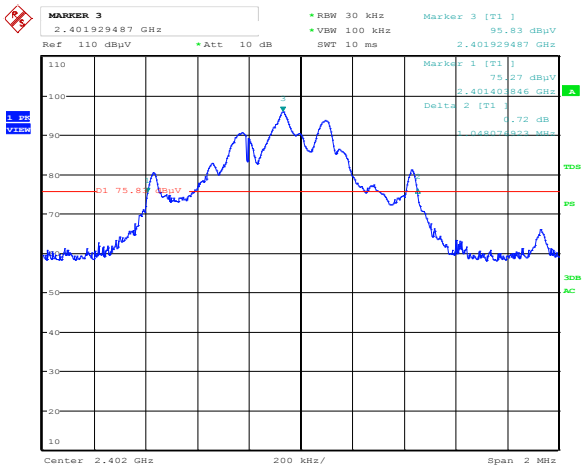


Figure 8.1-1: *20 dB bandwidth on low channel*

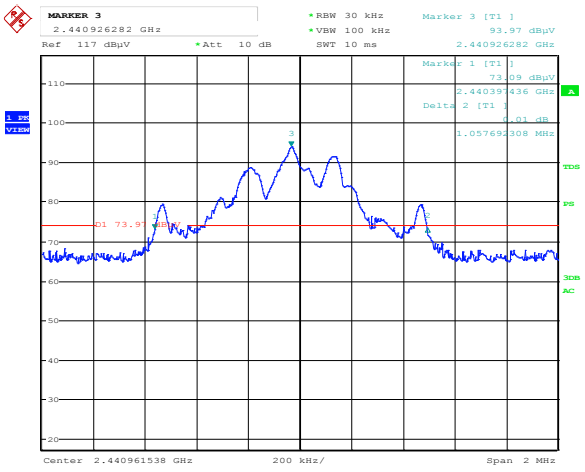


Figure 8.1-2: *20 dB bandwidth on mid channel*

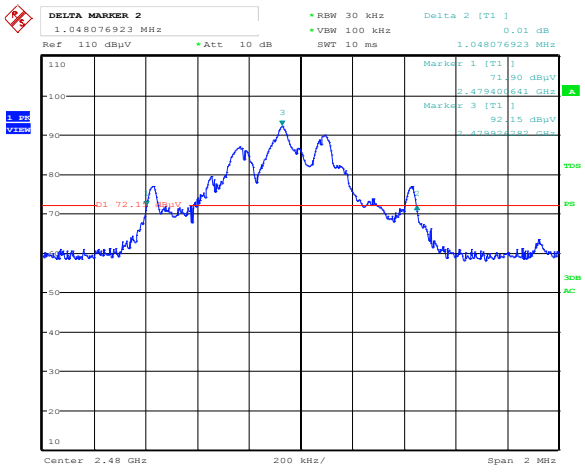


Figure 8.1-3: *20 dB bandwidth on high channel*

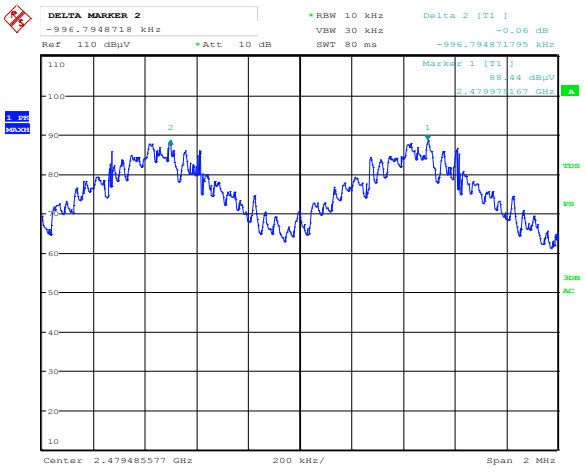


Figure 8.1-4: *Carrier frequency separation*

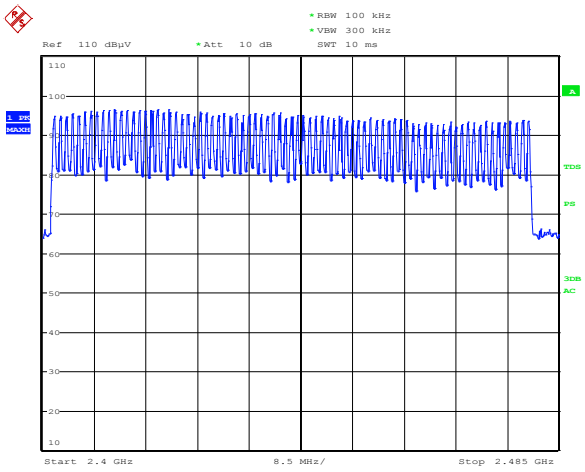


Figure 8.1-5: *Number of hopping channels*

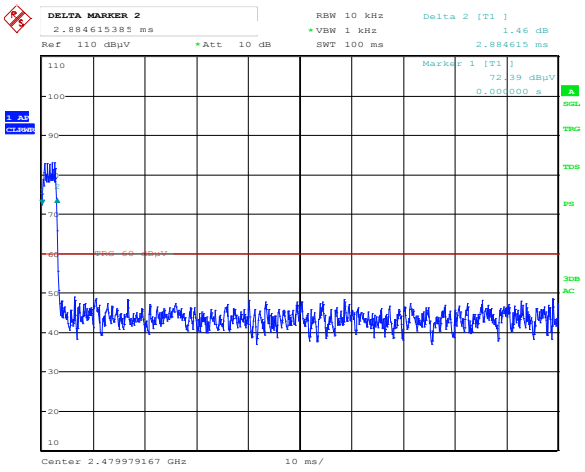


Figure 8.1-6: *Dwell time- sweep time 100ms*

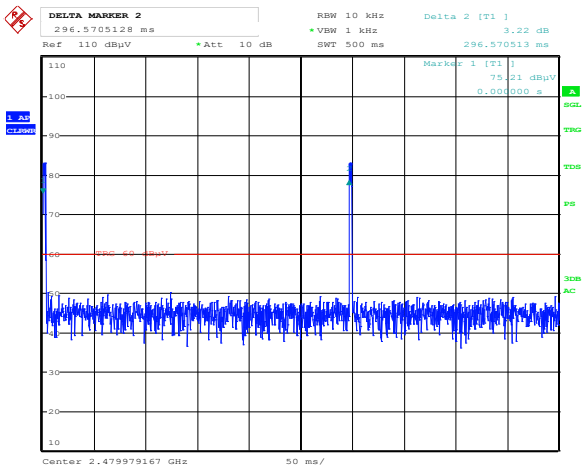


Figure 8.1-7: *Dwell time, sweep time 500 ms*

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

8.2.1 Definitions and limits

FCC:

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

(1) For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt (30 dBm). For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts (21 dBm).

(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.

ISED:

b. For FHSs operating in the band 2400–2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W (30 dBm) if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W (21 dBm) if the hopset uses less than 75 hopping channels. The e.i.r.p. shall not exceed 4 W (36 dBm), except as provided in section 5.4(e).

d. 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 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

8.2.2 Test summary

Test date	July 4, 2017 to July 6, 2017	Temperature	25 °C
Test engineer	Yong Huang	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	40 %

8.2.3 Observations, settings and special notes

As per customer, EUT uses integral antenna, conducted antenna port is not available. Radiated measurements were performed to show compliance.

Spectrum analyser settings for output power:

Resolution bandwidth	> the 20 dB bandwidth of the emission being measured
Video bandwidth	≥ RBW
Frequency span	approximately 5 times the 20 dB bandwidth, centered on a hopping channel
Detector mode	Peak
Trace mode	Max Hold

8.2.4 Test data

Table 8.2-1: *Output power and EIRP results for FHSS mode*

Frequency, MHz	Field Strength @ 3 m, dBµV/m	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
2402	98.6	3.4	27	23.6
2441	98.1	2.9	27	24.1
2480	98.4	3.2	27	23.8

EIRP(dBm) = Field Strengthe(dBµV/m, @ 3 m) -95.2

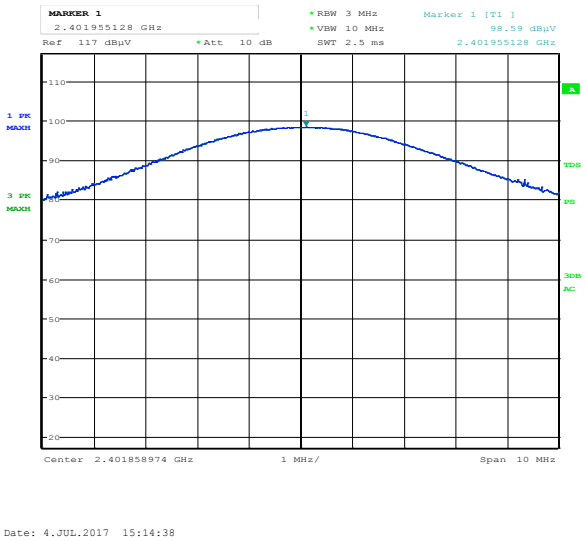


Figure 8.2-1: *Output power on low channel, FHSS mode*

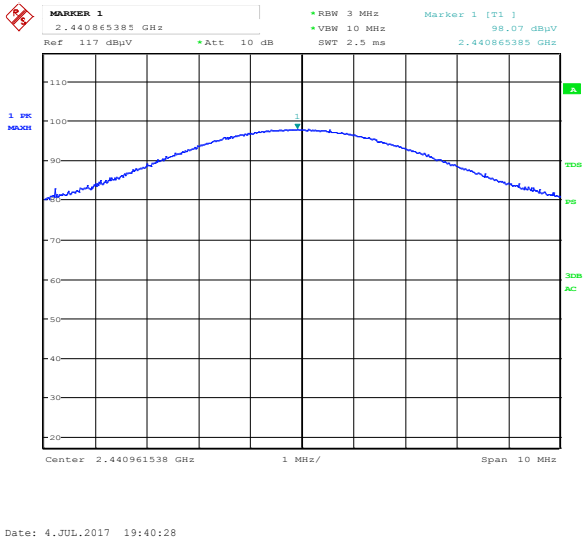


Figure 8.2-2: *Output power on mid channel, FHSS mode*

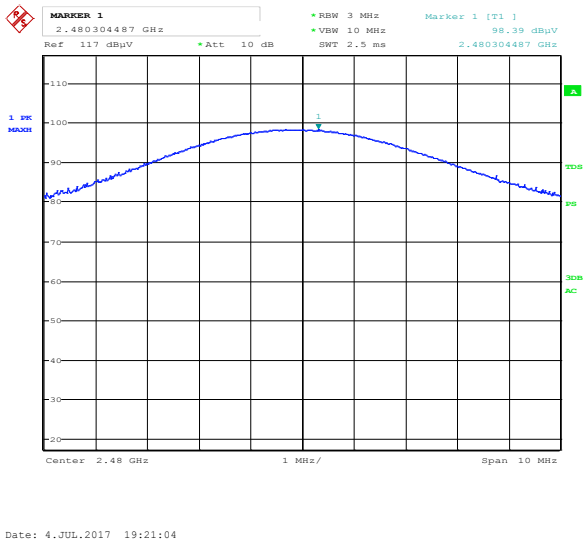


Figure 8.2-3: *Output power on high channel, FHSS mode*

Table 8.2-2: *Output power and EIRP results for DTS mode*

Frequency, MHz	Field Strength @ 3 m, dBµV/m	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
2402	97.8	2.6	36	33.4
2440	98.2	3.0	36	33.0
2480	97.9	2.7	36	33.3

EIRP(dBm) = Field Strengthe(dBµV/m, @ 3 m) -95.2

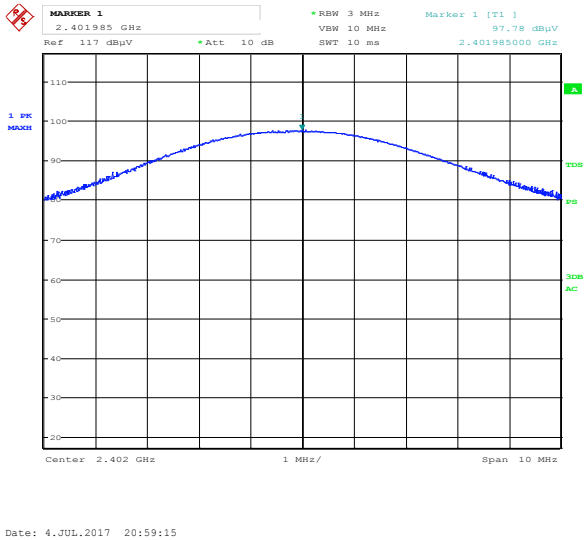


Figure 8.2-4: *Output power on low channel, DTS mode*

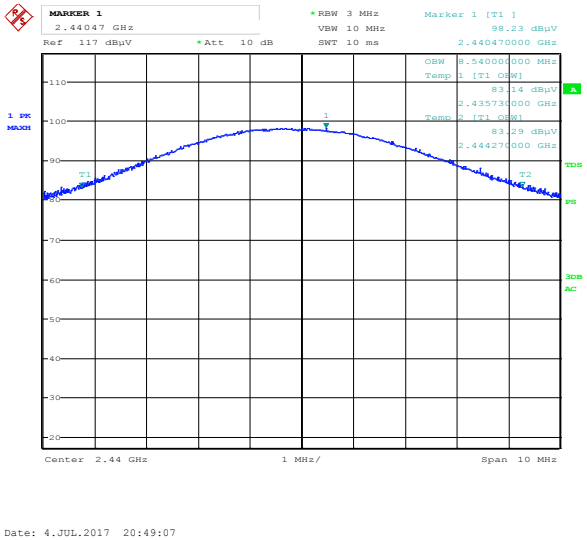


Figure 8.2-5: *Output power on mid channel, DTS mode*

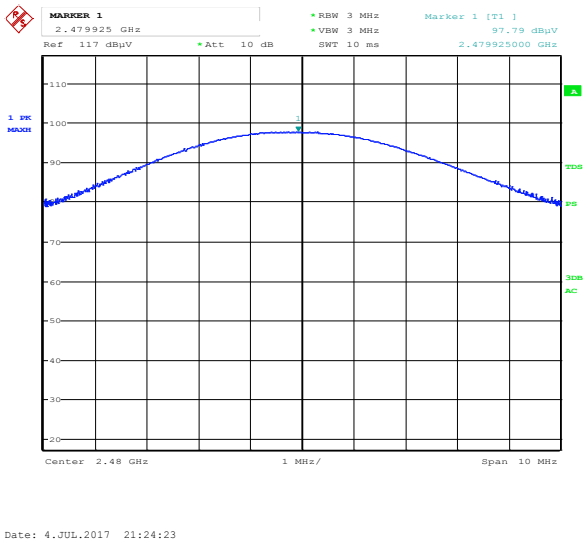


Figure 8.2-6: *Output power on high channel, DTS mode*

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

8.3.1 Definitions and limits

FCC and IC:

(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.

8.3.2 Test summary

Test date	July 4, 2017 to July 6, 2017	Temperature	25 °C
Test engineer	Yong Huang	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	40 %

8.3.3 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

8.3.4 Test data

Table 8.3-1: 6 dB bandwidth results

Frequency, MHz	6 dB bandwidth, kHz	Minimum Limit, kHz	Margin, kHz
2402	697	500	197
2440	718	500	218
2480	696	500	196

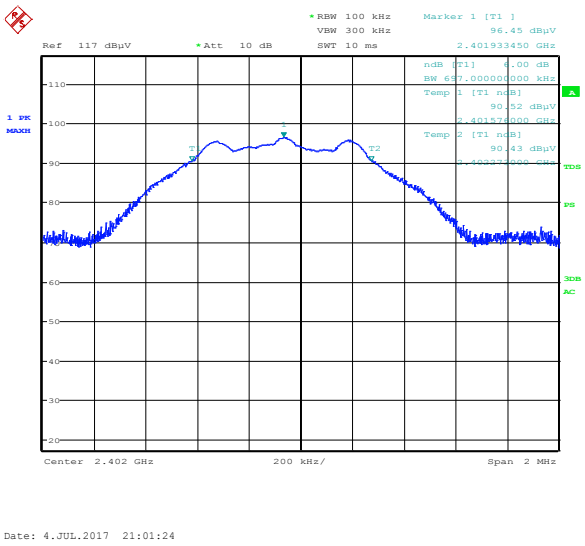


Figure 8.3-1: *6 dB bandwidth on low channel*

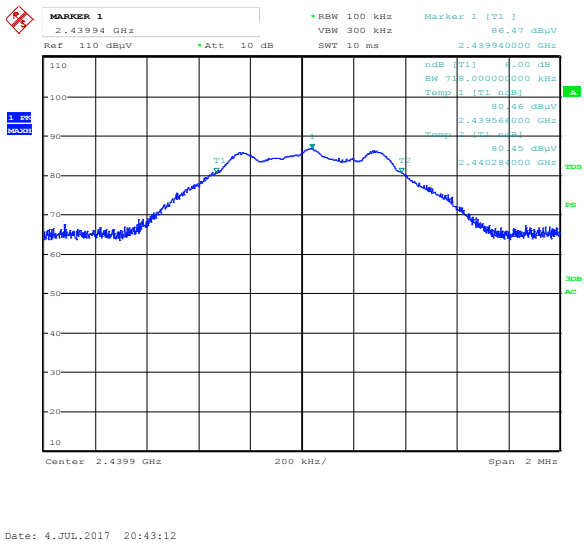


Figure 8.3-2: *6 dB bandwidth on mid channel*

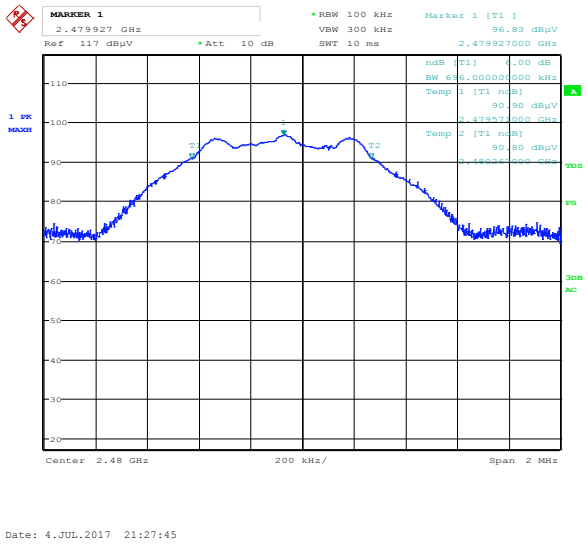


Figure 8.3-3: *6 dB bandwidth on high channel*

8.4 FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) 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(d), 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

Test date	July 4, 2017 to July 6, 2017	Temperature	25 °C
Test engineer	Yong Huang	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	40 %

8.4.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
EUT was set to transmit continuously.
As per customer, EUT uses integral antenna, conducted antenna port is not available. Radiated measurements at 3 m were performed to show compliance.

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:	RMS
Trace mode:	Average

For FHSS mode, average radiated measurements within restricted bands above 1 GHz were calculated with duty cycle correction factors.

8.4.4 Test data

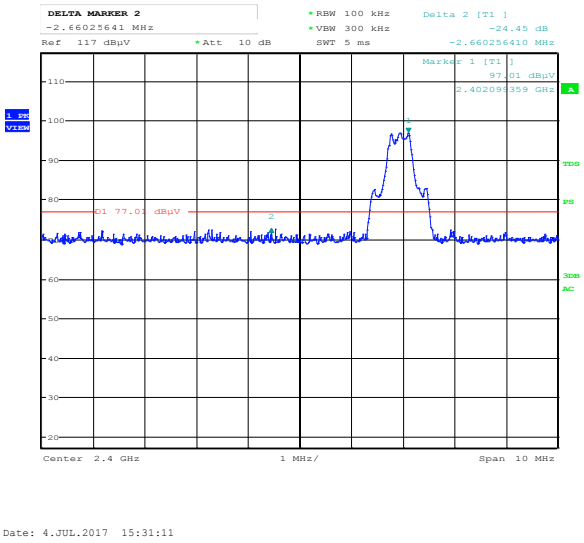


Figure 8.4-1: *Lower band edge emission, tx on low ch, FHSS mode*

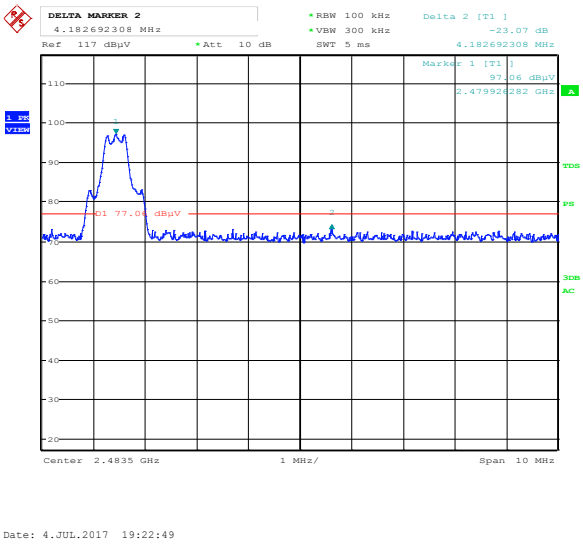


Figure 8.4-2: *Upper band edge emission, tx on high channel, FHSS mode*

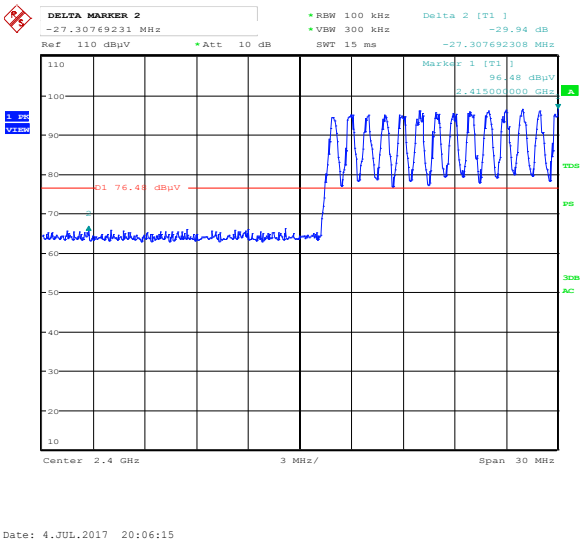


Figure 8.4-3: *Lower band edge emission, tx hopping on, FHSS mode*

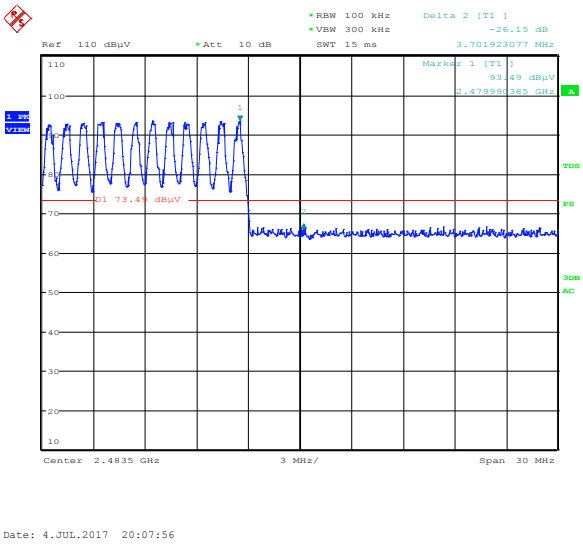


Figure 8.4-4: *Upper band edge emission, tx hopping on, FHSS mode*

8.4.5 Test data, continued

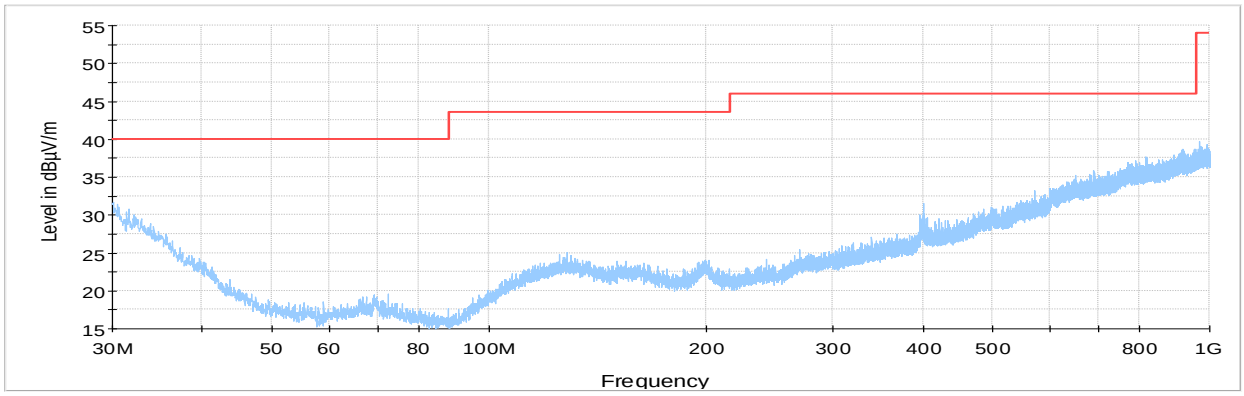


Figure 8.4-5: *Radiated spurious emissions for low channel below 1 GHz for restricted band emissions, FHSS mode*

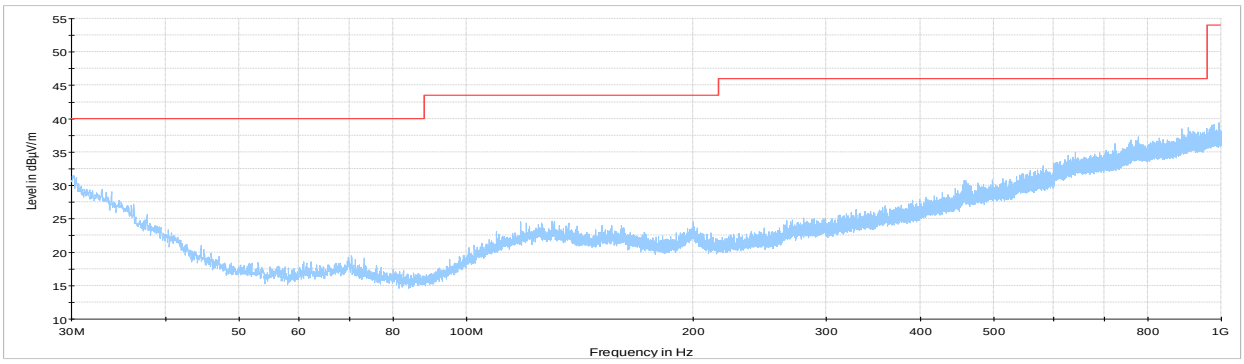


Figure 8.4-6: *Radiated spurious emissions for mid channel below 1 GHz for restricted band emissions, FHSS mode*

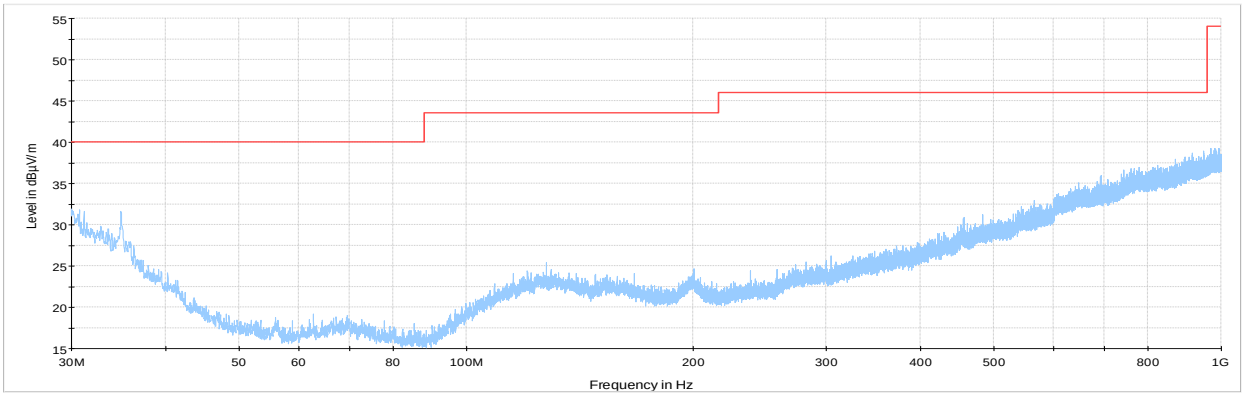


Figure 8.4-7: *Radiated spurious emissions for high channel below 1 GHz for restricted band emissions, FHSS mode*

8.4.6 Test data, continued

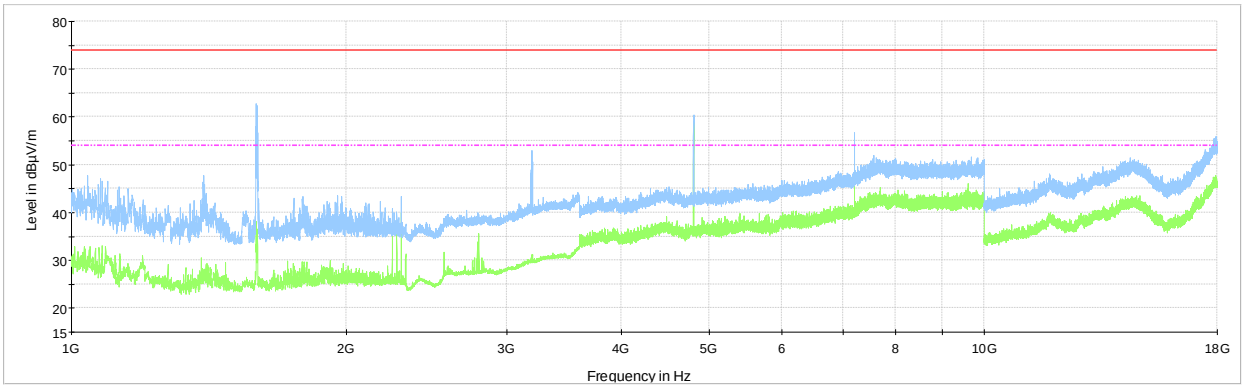


Figure 8.4-8: *Radiated spurious emissions for low channel above 1 GHz for restricted band emissions, FHSS mode*

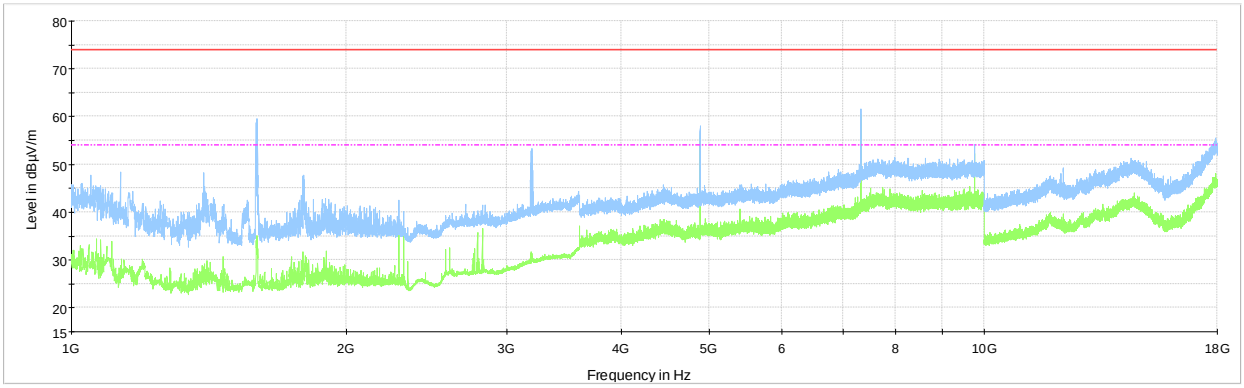


Figure 8.4-9: *Radiated spurious emissions for mid channel above 1 GHz for restricted band emissions, FHSS mode*

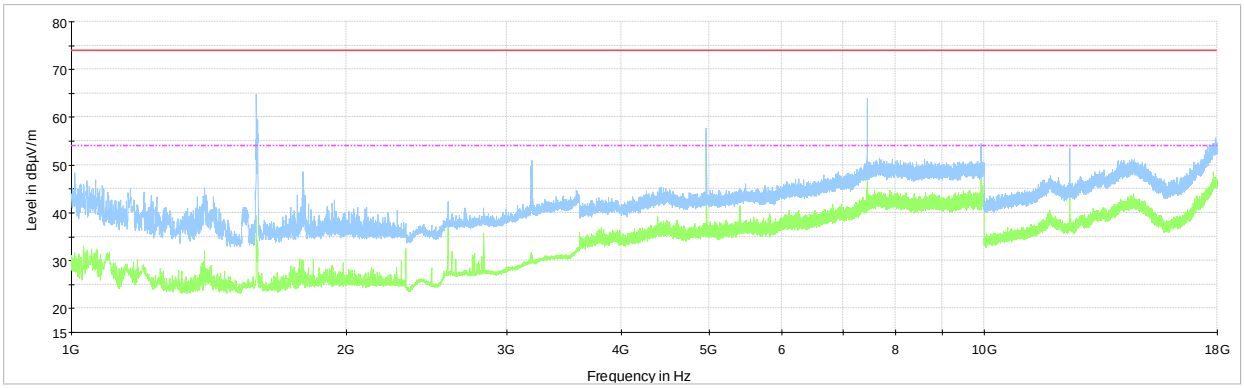


Figure 8.4-10: *Radiated spurious emissions for high channel above 1 GHz for restricted band emissions, FHSS mode*

Note:. Spectrum was investigated up to 25 GHz, no emission related to RF transmission was detected within 6 dB below the limit above 18 GHz

8.4.4 Test data, continued

Table 8.4-4: *Radiated field strength measurement results, FHSS mode*

Channel	Frequency, MHz	Peak Field strength, dBµV/m		Margin, dB	Average Field strength, dBµV/m		Margin, dB
		Measured	Limit		Calculated	Limit	
Low	2390.0	51.0	74	23.0	20.3	54	33.7
Low	4804.0	59.8	74	14.2	29.1	54	24.9
Low	7206.0	56.7	74	17.3	26.0	54	28.0
Mid	4882.5	58.0	74	16.0	27.3	54	26.7
Mid	7322.8	61.6	74	12.4	30.9	54	23.1
Mid	9763.6	54.0	74	20.0	23.3	54	30.7
High	2483.5	53.0	74	21.0	22.3	54	31.7
High	4960.5	57.7	74	16.3	27.0	54	27.0
High	7439.2	64.0	74	10.0	33.3	54	20.7
High	9920.8	54.5	74	19.5	23.8	54	30.2
High	12399.2	53.5	74	20.5	22.8	54	31.2

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.
Average radiated measurements within restricted bands above 1 GHz were calculated with duty cycle correction factors (DCCF) as below:.
Average Field strength = Peak Field strength + DCCF
DCCF = 20*log(2.9 ms / 100 ms)=-30.7 dB

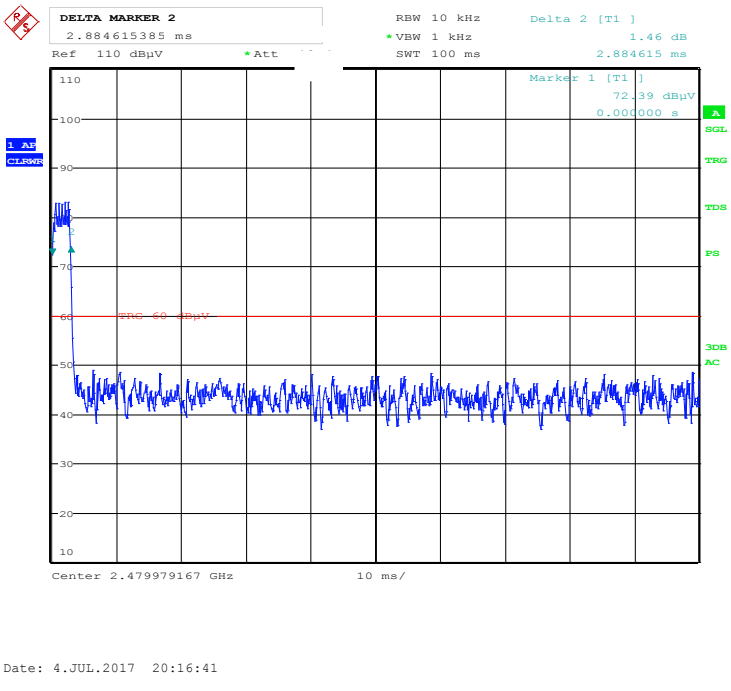


Figure 8.4-11: *Duty cycle in 100ms*

8.4.4 Test data, continued

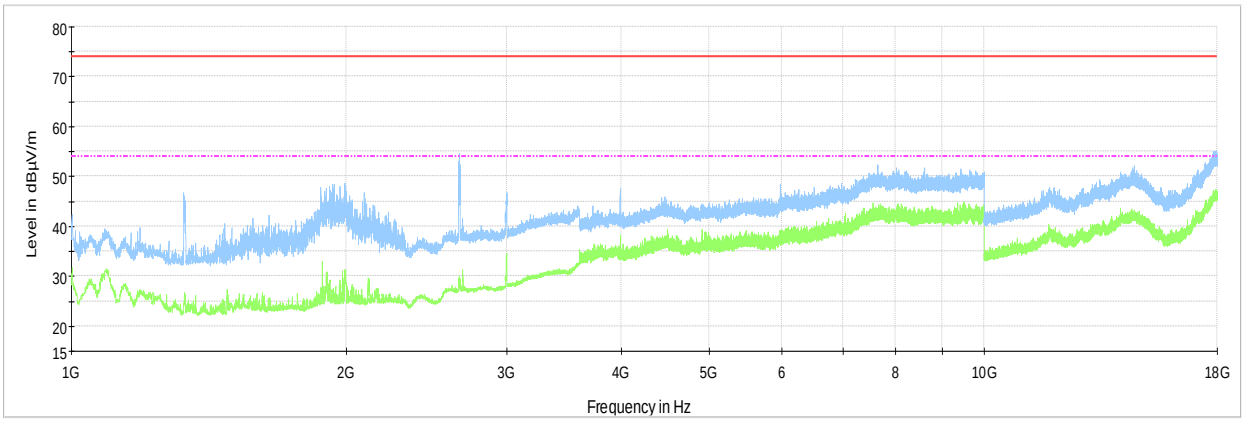


Figure 8.4-12: *Radiated spurious emissions 1 GHz to 18 GHz, FHSS Receiver mode*

Note:. Spectrum was investigated from 30 MHz to 25 GHz, no emission related to RF transmission was detected within 6 dB below the limit above 18 GHz and below 1 GHz.

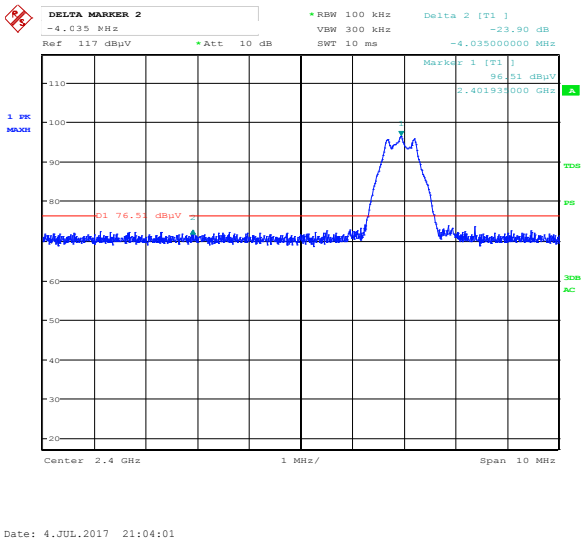


Figure 8.4-13: *Lower band edge emission, tx on low ch, DTS mode*

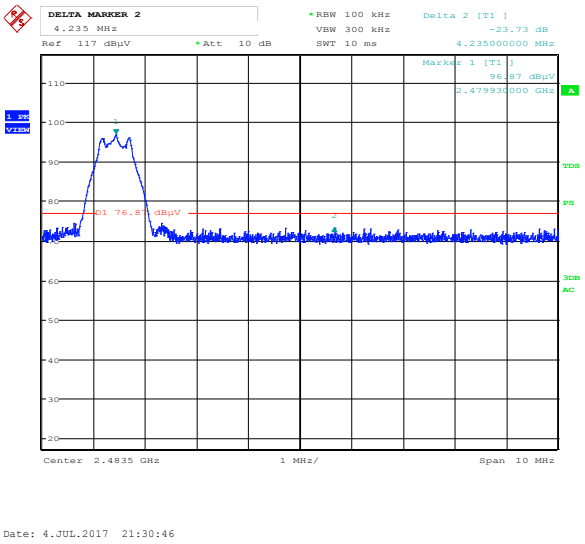


Figure 8.4-14: *Upper band edge emission, tx on high channel, DTS mode*

8.4.4 Test data, continued

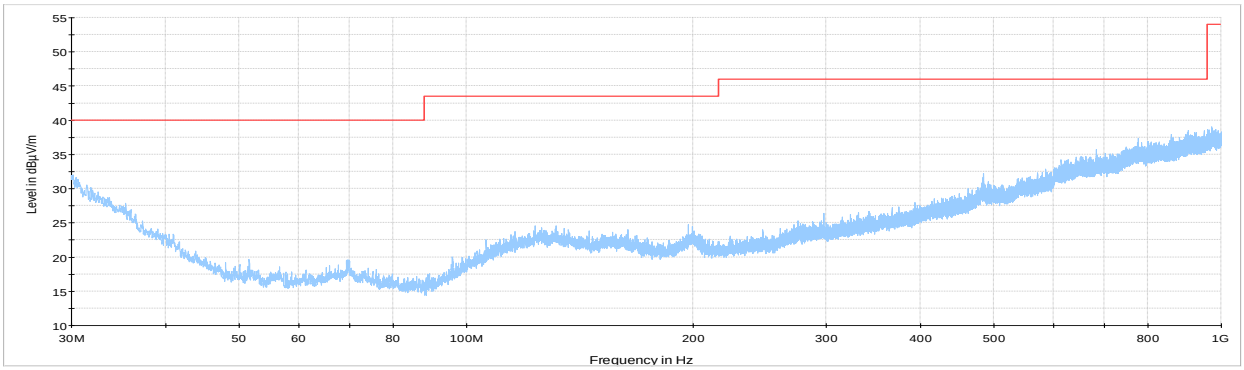


Figure 8.4-15: *Radiated spurious emissions for low channel below 1 GHz for restricted band emissions, DTS mode*

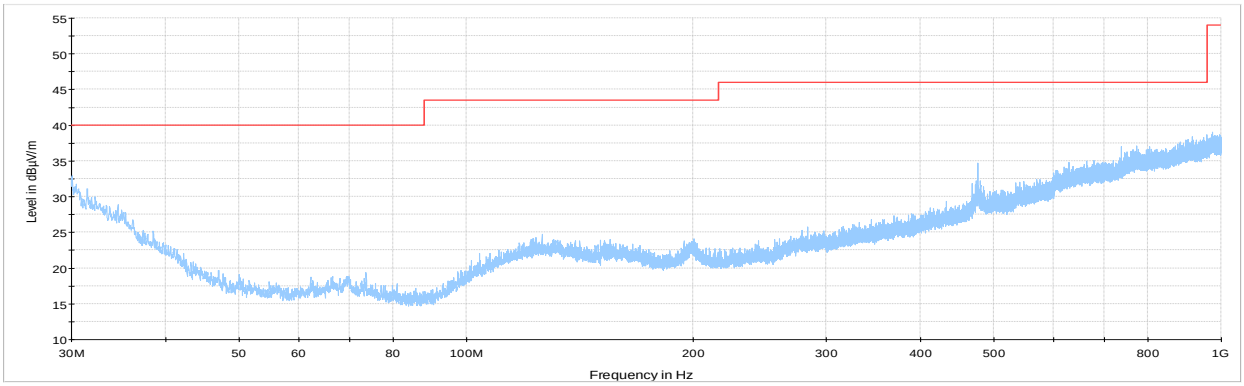


Figure 8.4-16: *Radiated spurious emissions for mid channel below 1 GHz for restricted band emissions, DTS mode*

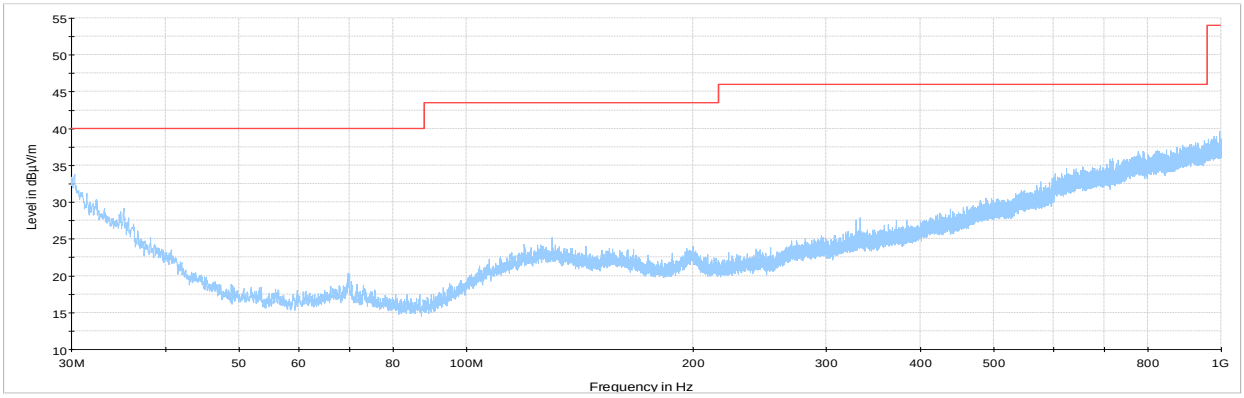


Figure 8.4-17: *Radiated spurious emissions for high channel below 1 GHz for restricted band emissions, DTS mode*

8.4.5 Test data, continued

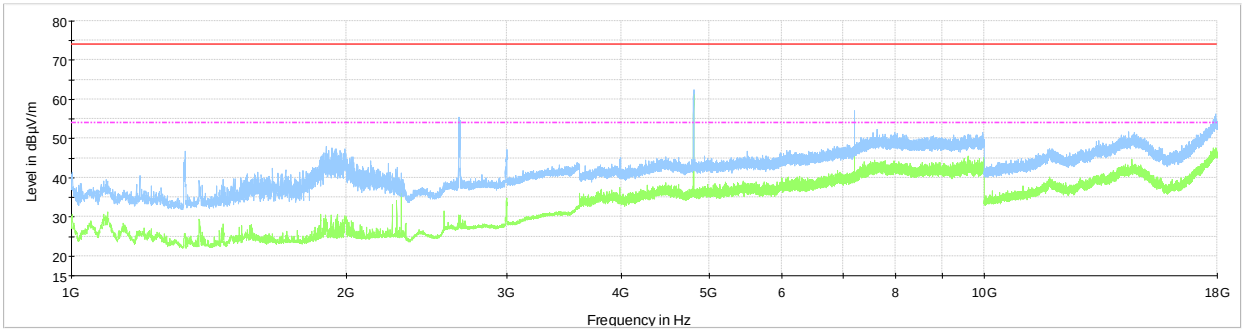


Figure 8.4-18: *Radiated spurious emissions for low channel above 1 GHz for restricted band emissions, DTS mode*

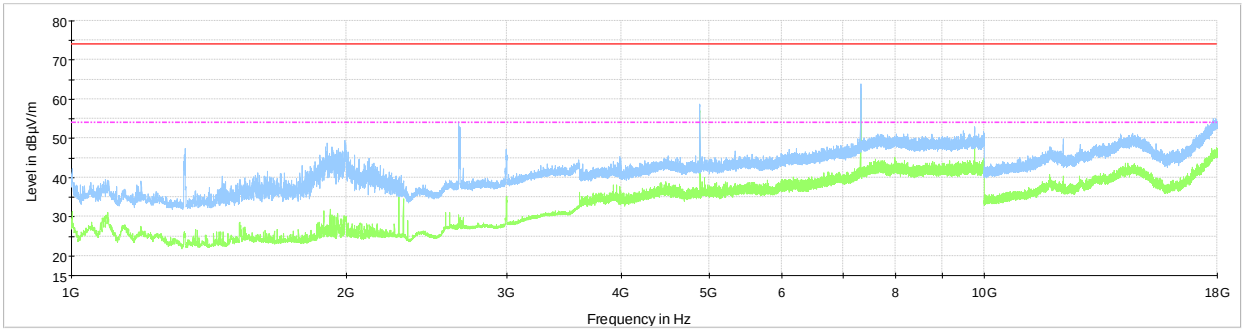


Figure 8.4-19: *Radiated spurious emissions for mid channel above 1 GHz for restricted band emissions, DTS mode*

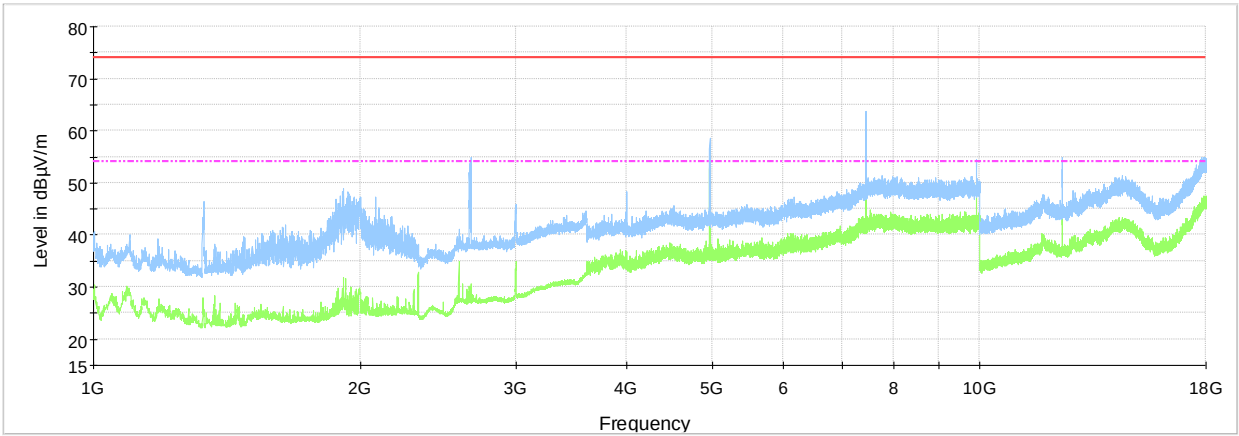


Figure 8.4-20: *Radiated spurious emissions for high channel above 1 GHz for restricted band emissions, DTS mode*

Note:. Spectrum was investigated up to 25 GHz, no emission related to RF transmission was detected within 6 dB below the limit above 18 GHz

8.4.4 Test data, continued

Table 8.4-5: *Radiated field strength measurement results for DTS mode*

Channel	Frequency, MHz	Peak Field strength, dBµV/m		Margin, dB	Average Field strength, dBµV/m		Margin, dB
		Measured	Limit		Measured	Limit	
Low	2390	52.6	74	21.4	40.7	54	13.3
Low	4803.9	62.6	74	11.4	52.9	54	1.1
Low	7206.5	57.1	74	16.9	46.2	54	7.8
Mid	4879.5	58.8	74	15.2	49.8	54	4.2
Mid	7319.2	63.9	74	10.1	53.4	54	0.6
High	2483.5	56.0	74	18.0	46.1	54	7.9
High	4960.4	58.6	74	15.4	49.3	54	4.7
High	7439.8	63.7	74	10.3	53.5	54	0.5

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

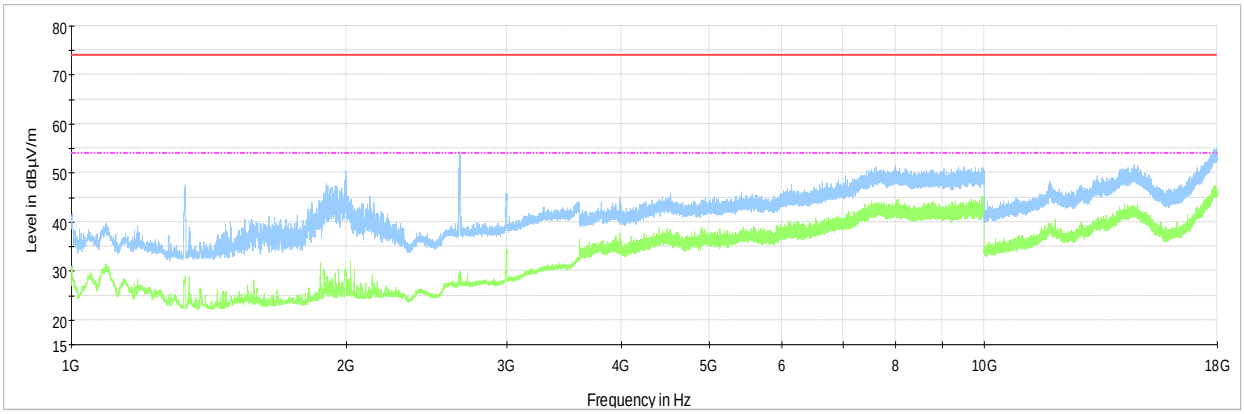


Figure 8.4-21: *Radiated spurious emissions 1 GHz to 18 GHz, DTS Receiver mode*

Note:. Spectrum was investigated from 30 MHz to 25 GHz, no emission related to RF transmission was detected within 6 dB below the limit above 18 GHz and below 1 GHz.

8.5 FCC 15.247(e) and RSS-247 5.2(b) Power spectral density for digitally modulated devices

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(d), (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	July 4, 2017 to July 6, 2017	Temperature	25 °C
Test engineer	Yong Huang	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	40 %

8.5.3 Observations, settings and special notes

As per customer, EUT uses integral antenna, conducted antenna port is not available. Radiated measurements at 3 m were performed to show compliance.

Resolution bandwidth:	3 kHz ≤ RBW ≤ 100 kHz
Video bandwidth:	≥3 × RBW
Frequency span:	1.5 times the OBW
Detector mode:	Peak
Trace mode:	Max hold

8.5.4 Test data

Table 8.5-1: PSD measurements results, DTS mode

Frequency, MHz	Field Strength@ 3m, dBµV/m/100 kHz	PSD, dBm/100 kHz	PSD limit, dBm/3 kHz	Margin, dB
2402	96.3	1.1	8	6.9
2440	95.3	0.1	8	7.9
2480	96.8	1.6	8	6.4

EIRP(dBm) = Field Strengthe(dBµV/m, @ 3 m) -95.2

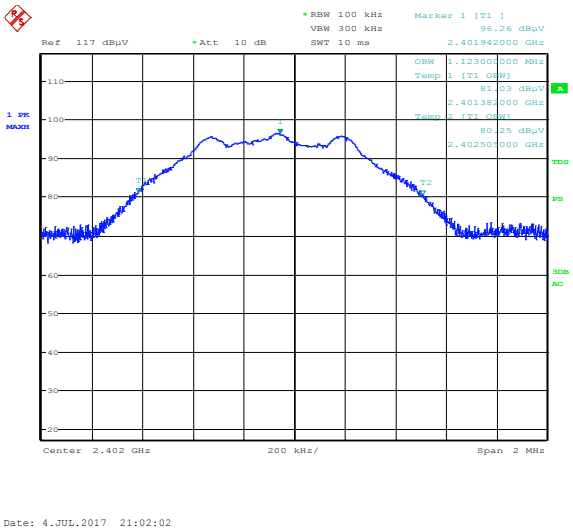


Figure 8.5-1: PSD plot on Low channel

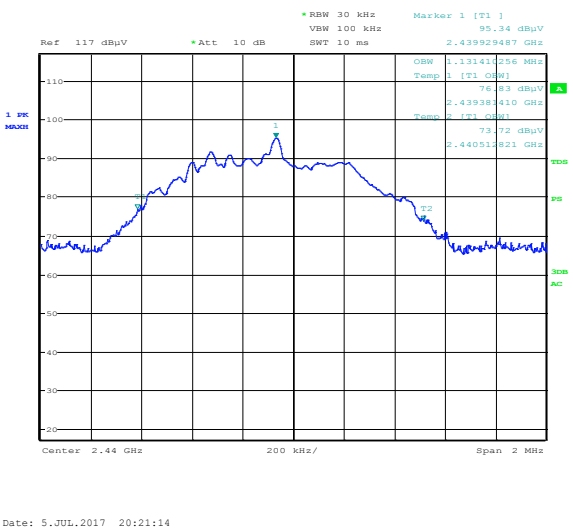


Figure 8.5-2: PSD plot on mid channel

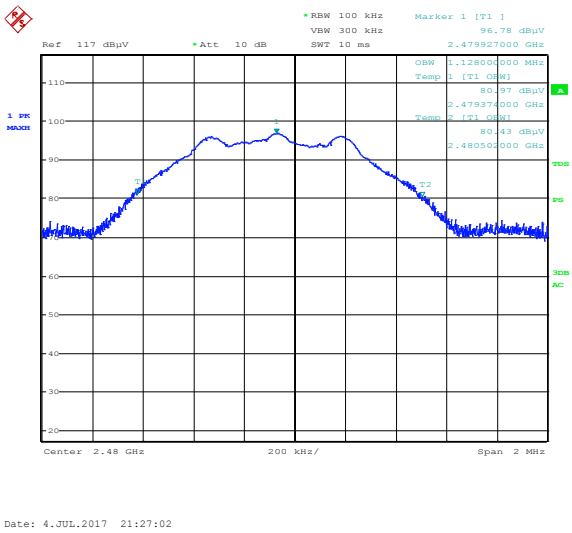
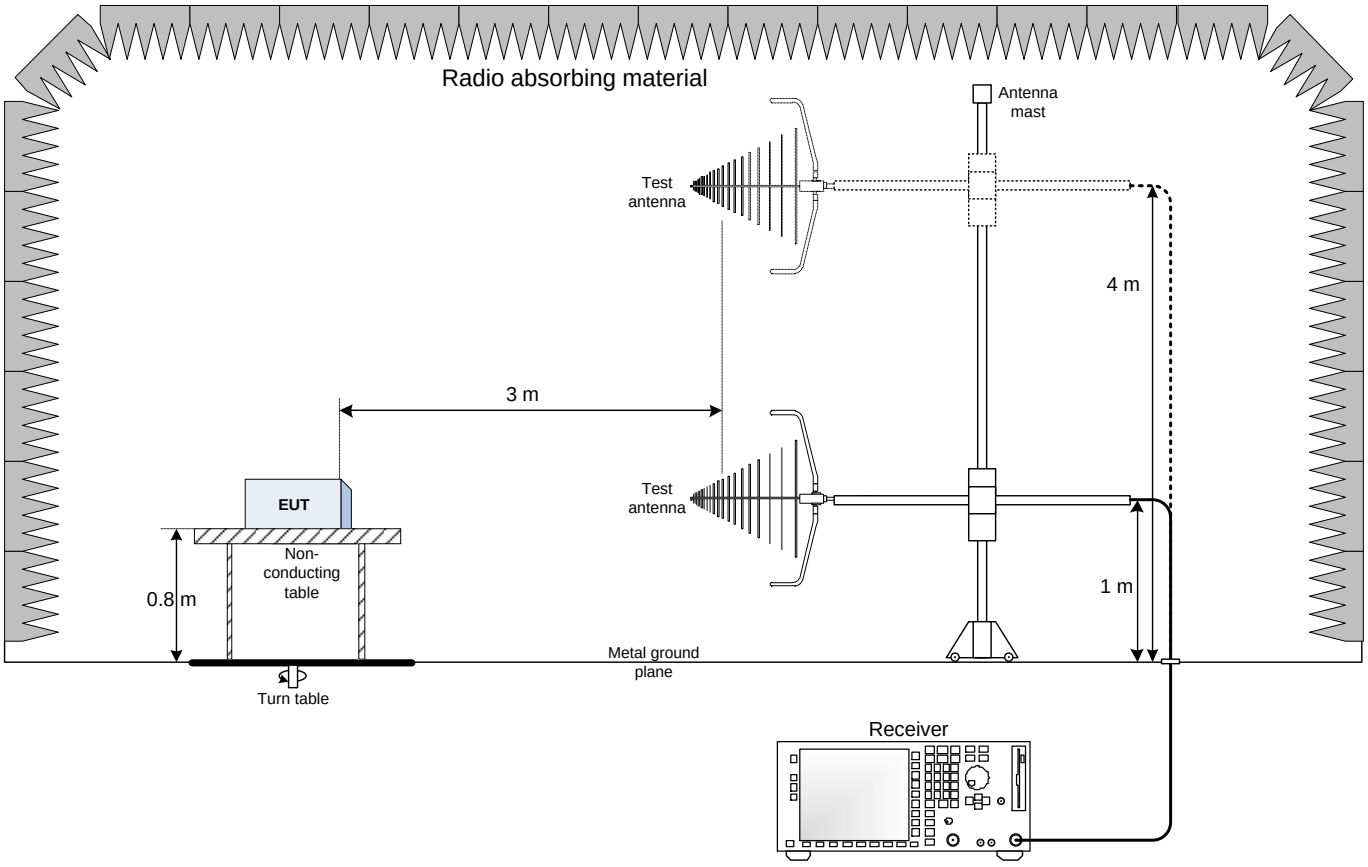


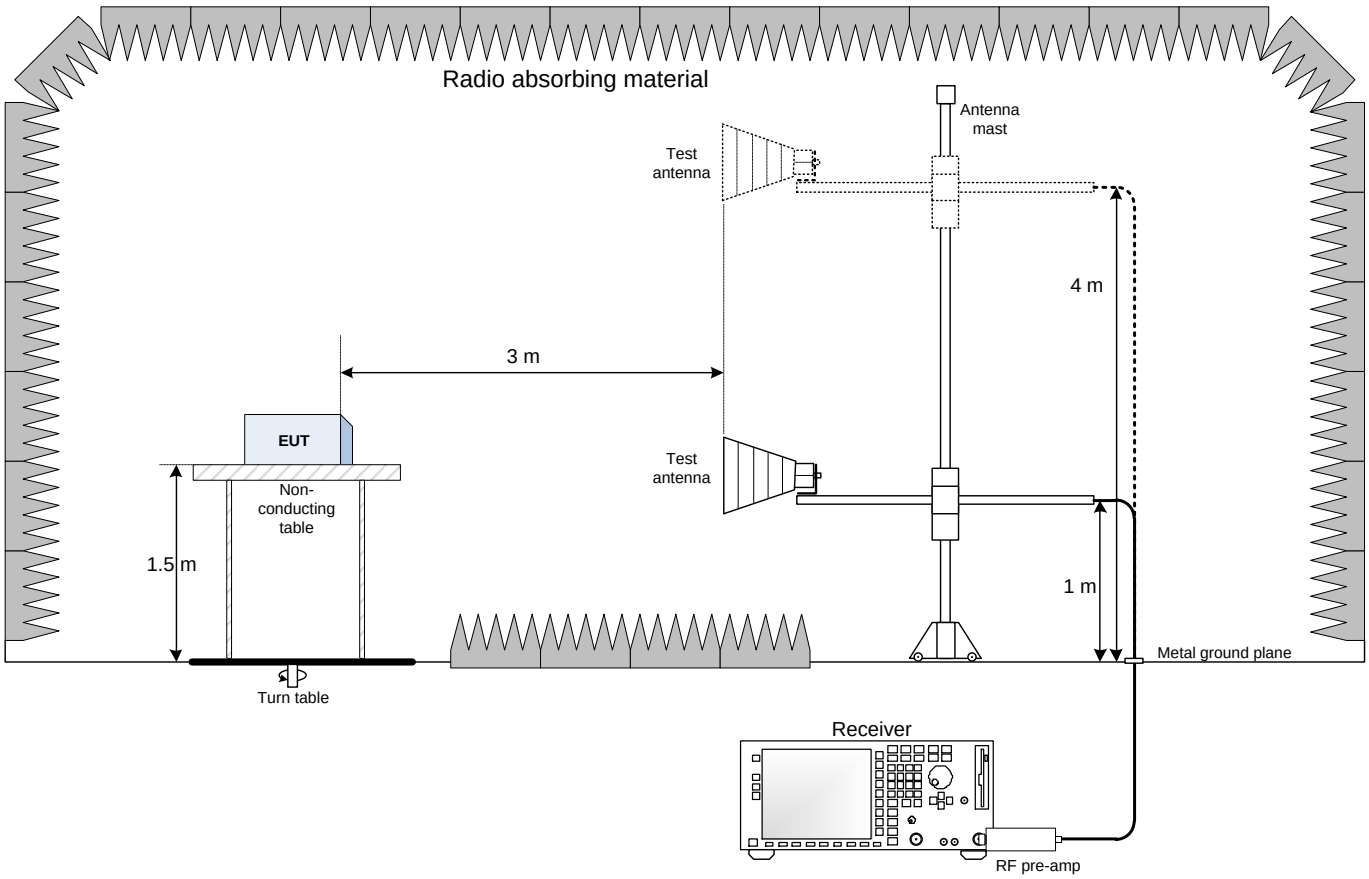
Figure 8.5-3: PSD plot on high channel

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



9.3 Conducted antenna port set-up