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Test report

FCC-15.247 and RSS-247 2016#308682

Date of issue: August 16, 2016

Applicant: Indyme Solutions, Inc.

Product: WIRELESS Monitoring Sensor

Model: DM9025 Model variant: DM9021/22/23

FCC ID: J69DM IC Registration number: 1809A-DM90

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.247

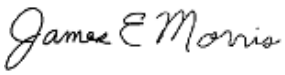
  Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz

- RSS-247, Issue 1, May 2015

  Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

Test location

Company name	Nemko USA, Inc.
Address	2210 Faraday Ave, Suite 150
City	Carlsbad
Province	California
Postal code	92008
Country	USA
Telephone	+1 760 444 3500
Website	www.nemko.com
Site number	FCC: US5058; IC: 2040B

Tested by	Feng You, Sr. Wireless Engineer
Reviewed by	James Morris
Review date	August 16, 2016
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 USA's ISO/IEC 17025 accreditation.

Copyright notification

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	INDYME SOLUTIONS, INC.
Address	8295 Aero Place
City	San Diego
Province/State	CA
Postal/Zip code	92123
Country	U.S.A.

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.247	Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz
RSS-247, Issue 1	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

1.3 Test methods

ANSI C64.3-2014	American National Standard for Methods of Measurement of Radio- Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2013	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
1	Original report issued
2	Updated according to review comment.

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]
§15.205	Restricted bands of operation	Pass

Notes: [1] Test also performed with new batteries.

[2] The Antennas are located within the protective cover of EUT and embedded on PCB.

2.2 FCC Part 15 Subpart C, intentional radiators test results

Part	Test description	Verdict
§15.247(a)(1)	20 dB bandwidth of the hopping channel	Pass
§15.247(a)(1)(i)	Frequency hopping systems operating in the 902–928 MHz band	Pass
§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	Not applicable
§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	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	Not applicable
§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	Not applicable
§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	Not applicable
8.10	Restricted Frequency Bands	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 IC RSS-247, Issue 1, test results

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

Notes: EUT is FHSS in the 902-928 MHz band

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	May 16, 2016
Nemko sample ID number	308682 #1, #2, #3, #4, #5

3.2 EUT information

Product name	WIRELESS Monitoring Sensor
Model	DM9025
Model variant	DM9021/22/23
Serial number	Refer to table 3.7-1

3.3 Technical information

Applicant IC company number	1809A
IC UPN number	DM90
All used IC test site(s) Reg. number	2040B
RSS number and Issue number	RSS-247, Issue 1, May 2015
Frequency band	902-928 MHz
Frequency Min (MHz)	918.1
Frequency Max (MHz)	923
RF power Min (W), Conducted/ERP/EIRP	N/A
RF power Max (W), Conducted/ERP/EIRP	0.001618 (Conducted)
Field strength, Units @ distance	N/A
Measured BW (kHz) (20 dB)	80.4
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	FHSS/FSK
Emission classification (F1D, G1D, D1D)	F1D
Transmitter spurious, Units @ distance	59.63 / 46.66 dBµV/m @ 3m (peak/AVG)
Power requirements	3V Lithium Battery (DM9023: 2 X CR123, DM9025: CR2477)
Antenna information	0dBi gain PCB antenna. The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

EUTs are Wireless Monitoring Sensors. The alert signal is transmitted using FHSS in 902-928MHz band.
The EUT was exercised by continuously transmitting or receiving in a test mode.

The DM9025 SSD Assembly is a device that monitors suspicious movement on a fixture by detection vibrations. Too much movement based on the vibration profile setting will trigger a message over the store PA/Radios to alert personnel of suspicious activity.

The DM90XX (DM9021/22/23) devices have an infrared motion sensor to monitor and notify store personnel if a person is loitering in an aisle, walkway, or other particular areas where presence detection is desired. The device is mounted pointed down from in the ceiling tile.

The DM9025 and DM90XX have different housings but use the same PCB with minimal BOM component changes.
BOM Differences by Device Model:

Device Model	Component	Description
DM9021/22	1. R14: RES SM, 10K, 5% 1/10W, 0404 2. PIR, Sensor 6u, Black	1. Hardware configuration resistors 2. Infrared sensor
DM9023	1. R15: RES SM, 10K, 5% 1/10W, 0404 2. PIR, Sensor 6u, Black	1. Hardware configuration resistors 2. Infrared sensor
DM9025	1. R12/R13: RES SM, 10K, 5% 1/10W, 0404 2. Piezo, Speaker/Buzzer	1. Hardware configuration resistors 2. Chime alert speaker

3.5 EUT exercise details

Depends on test cases, the EUT is set either to fixed channel (L/M/H) or frequency hopping mode, using test FW.

Both DM9025 and DM9021 were tested for Radiated Spurious Emissions. RF Conducted test was performed with RF board modified with RF connector.

Worst cases of the 3 orthogonal positions were reported.

3.6 EUT setup diagram

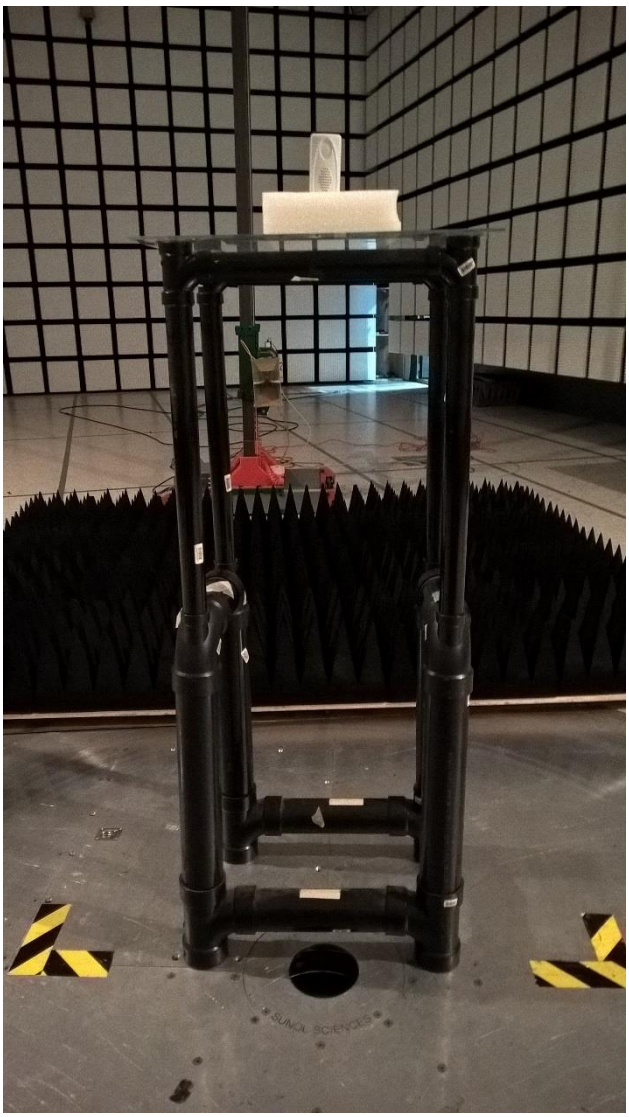


Figure 3.6-1: *Setup Photo – Radiated Emissions > 1GHz*

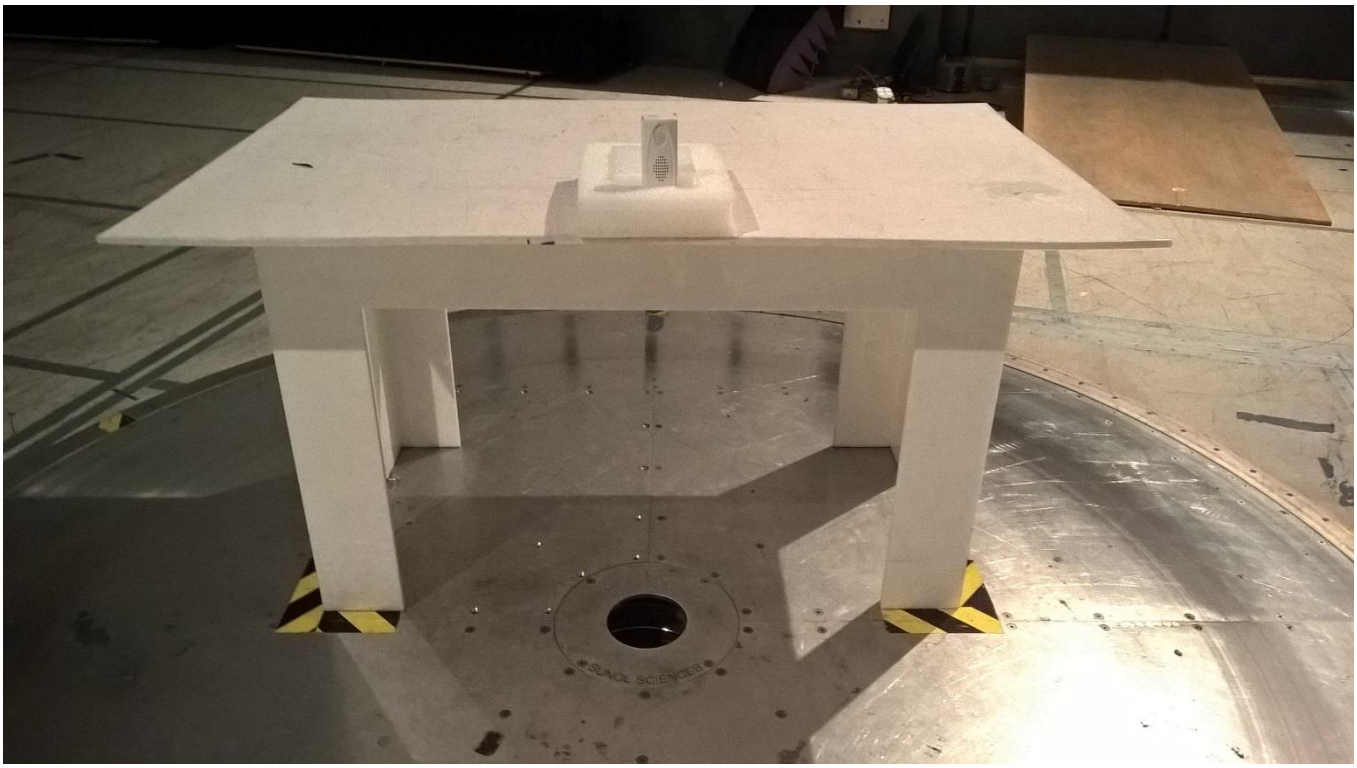


Figure 3.6-2: *Setup Photo – Radiated Emissions < 1GHz*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
Infrared Alarm	Indyme	DM9023	00B01496
Vibration Alarm	Indyme	DM9025	00B0137D
RF Test Board	Indyme	N/A	2646-002

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

The following modifications were performed by client:
DM9025 was tested with external battery modification (internal battery will not be able to last long enough to complete normal test case). Not affecting RF/Radio performance.

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.

3V Lithium Battery.

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*

Asset Tag	Description	Manufacturer	Model	Serial #	Last Cal	Next Cal
529	Antenna, DRWG	EMCO	3115	2505	01-Feb-2016	01-Feb-2017
30	True RMS Multimeter	FLUKE	76	63860880	21-Aug-2015	21-Aug-2016
E1026	EMI Test Receiver 9kHz to 7GHz	Rohde & Schwarz	ESCI 7	100800	17-Mar-2016	17-Mar-2017
1763	Antenna, Bilog	Schaffner	CBL 6111D	22926	02-Jul-2015	02-Jul-2016
1767	Receiver, EMI Test 20Hz - 26.5 GHz - 150 - +30 dBm LCD	Rohde & Schwartz	ESIB26	837491/0002	03-Feb-2016	03-Feb-2017
1936	Triple output DC power supply 0-6v, 5A	Agilent	E3631A	KR94623593	Verify	Verify

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(1) 20 dB bandwidth of the hopping channel

8.1.1 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:

(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.

(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

8.1.2 Test summary

Test date	May 19, 2016	Temperature	21 °C
Test engineer	Feng You	Air pressure	1002 mbar
Verdict	Pass	Relative humidity	62 %

8.1.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	1–5 % of Channel BW (no wider than 100 kHz)
Video bandwidth	≥3 × RBW
Frequency span	2 – 5 times OBW
Detector mode	Peak
Trace mode	Max Hold

Tested with RF Test Board.

8.1.4 Test data

Table 8.1-1: *20 dB bandwidth results*

Modulation	Frequency, MHz	20 dB bandwidth, kHz	Channel Bandwidth, kHz	Margin, kHz
FSK	918.1	80.4	500	419.6
	920.6	80	500	420
	923.0	80.4	500	419.6

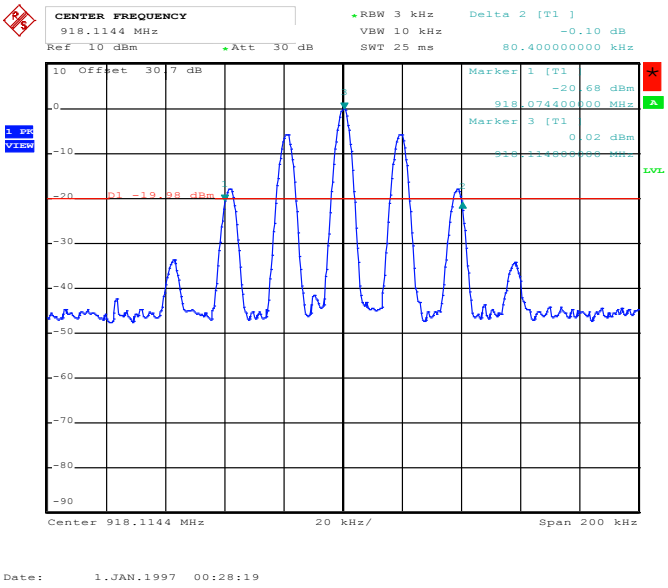


Figure 8.1-1: *20 dB bandwidth, 918.1MHz*

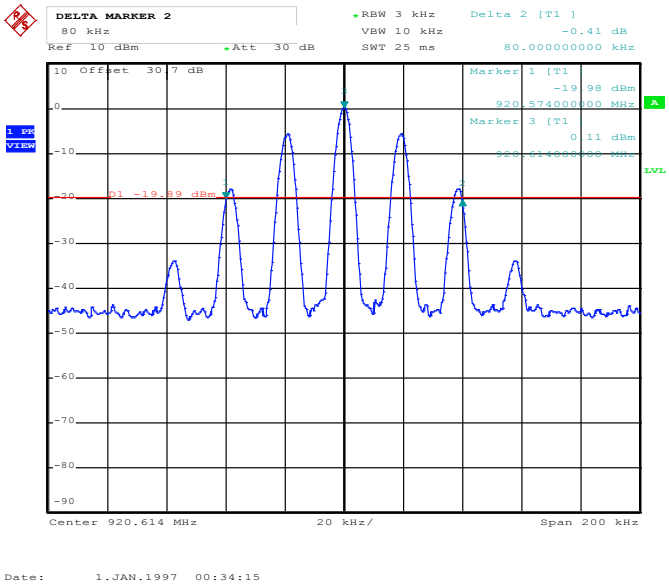


Figure 8.1-2: *20 dB bandwidth, 920.6MHz*

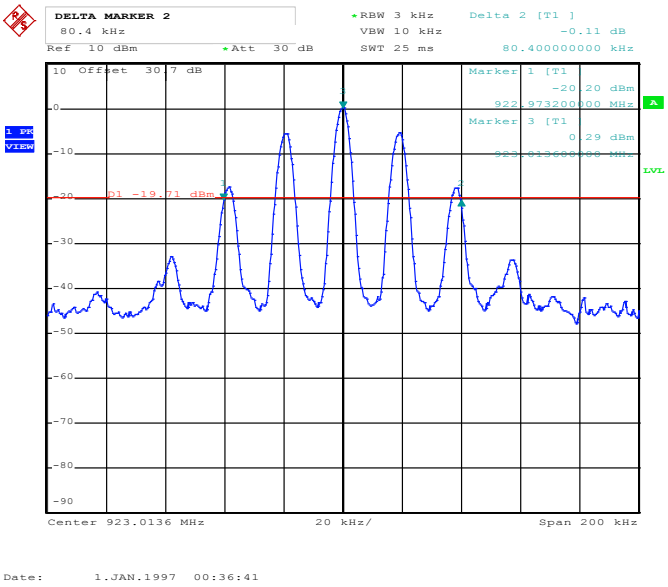


Figure 8.1-3: *20 dB bandwidth, 923MHz*

8.2 FCC 15.247(b) and RSS-247 5.4 (4) 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. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

(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.

IC:

5.4 Transmitter Output Power and Equivalent Isotropically Radiated Power (E.I.R.P.) Requirements

(2) For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W and the e.i.r.p. shall not exceed 4 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W and the e.i.r.p. shall not exceed 0.5 W if the hopset uses less than 75 hopping channels (see Section 5.4(5) for exceptions).

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling 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 transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

8.2.2 Test summary

Test date	May 19, 2016	Temperature	21 °C
Test engineer	Feng You	Air pressure	1002 mbar
Verdict	Pass	Relative humidity	62 %

8.2.3 Observations, settings and special notes

Tested with RF Test Board.

8.2.4 Test data

Table 8.2-1: *Output power measurements results*

Power Source	Frequency, MHz	Conducted output power, dBm		Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
		Measured	Limit					
Battery	918.1	1.59	30	28.41	0	1.59	36	34.41
	920.6	1.96	30	28.04	0	1.96	36	34.04
	923	2.09	30	27.91	0	2.09	36	33.91

8.3 FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) emissions

8.3.1 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)).

IC:
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.

(a) Fundamental components of modulation of licence-exempt radio apparatus shall not fall within the restricted bands of Table 8.4-1 except for apparatus complying under RSS-287;
(b) Unwanted emissions that fall into restricted bands of Table 6 shall comply with the limits specified in RSS-Gen; and
(c) Unwanted emissions that do not fall within the restricted frequency bands of Table 8.4-1 shall comply either with the limits specified in the applicable RSS or with those specified in this RSS-Gen.

Table 8.3-1: *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 8.3-2: *IC 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 8.3-2 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 8.3-3: *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			

8.3.2 Test summary

Test date	May 16, 2016	Temperature	20 °C
Test engineer	Feng You	Air pressure	1002 mbar
Verdict	Pass	Relative humidity	61 %

8.3.3 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 on both MIMO chains simultaneously.
Since fundamental power was tested using average method, the spurious emissions limit is −30 dBc/100 kHz

RF Conducted Test with RF Test Board if no model specified. Both DM9025 and DM9023 were tested radiated.

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:	10 Hz
Detector mode:	Peak
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

8.3.4 Test data

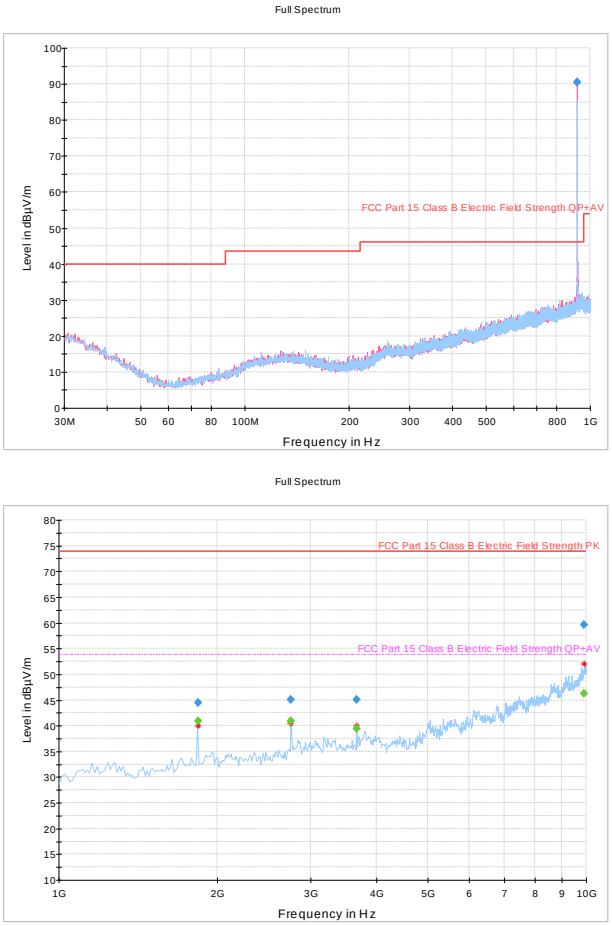


Figure 8.3-1: *Radiated spurious emissions, low channel, DM9023*

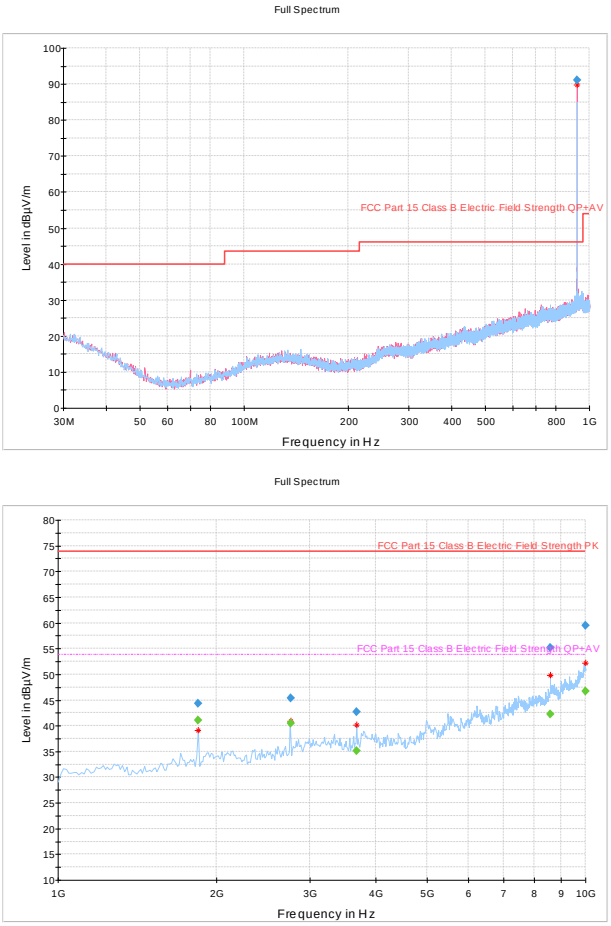
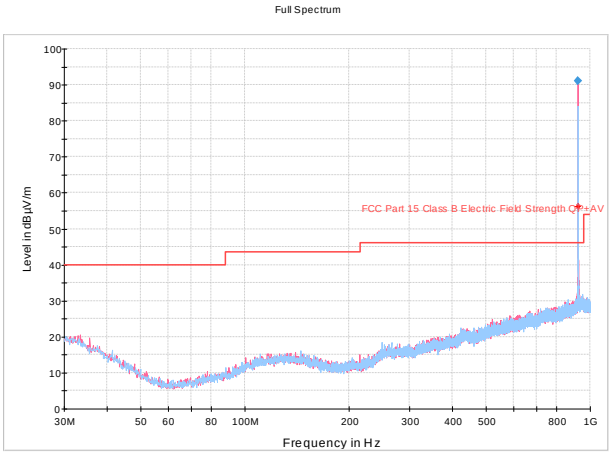
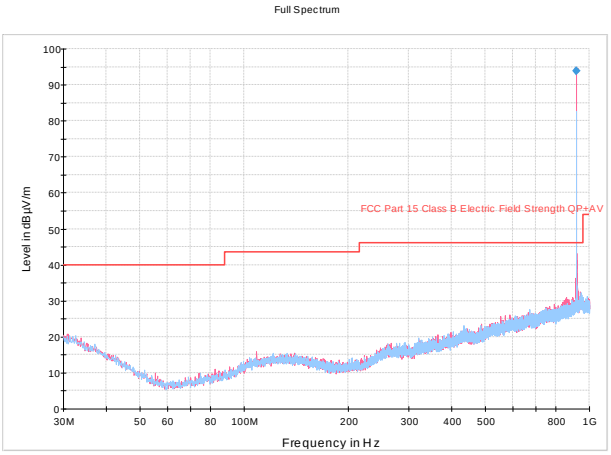
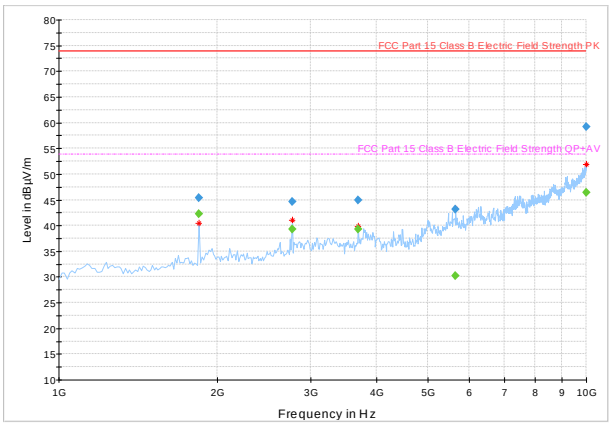


Figure 8.3-2: *Radiated spurious emissions, mid channel, DM9023*







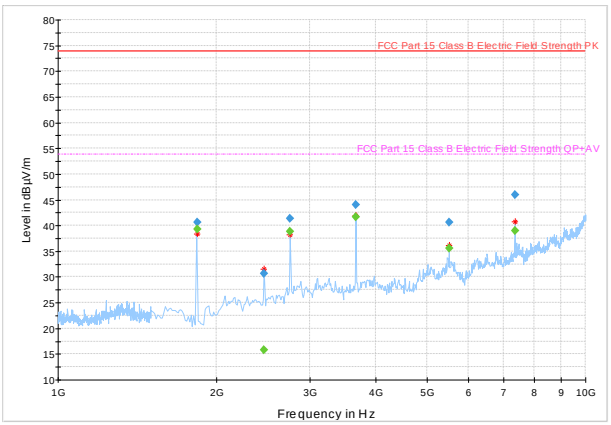
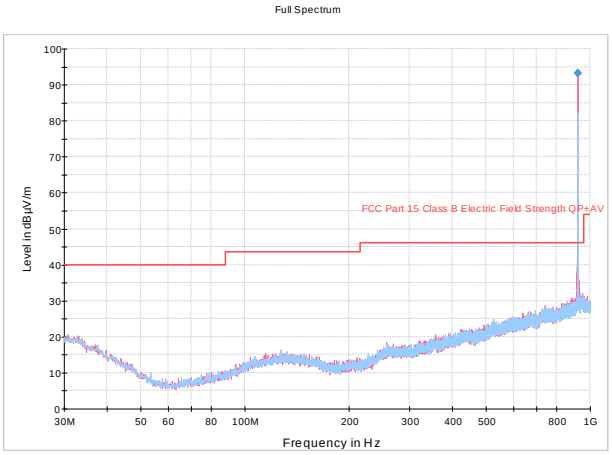
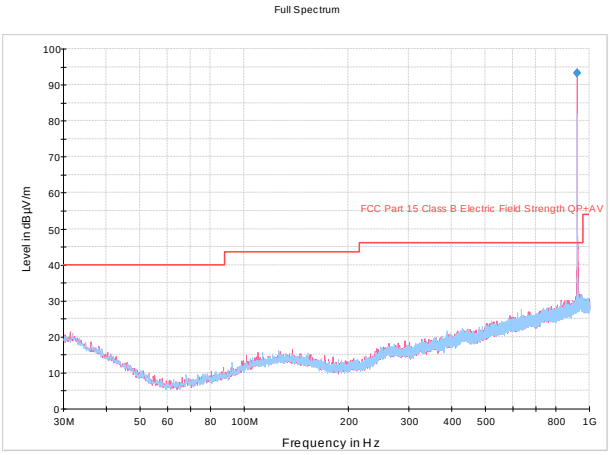
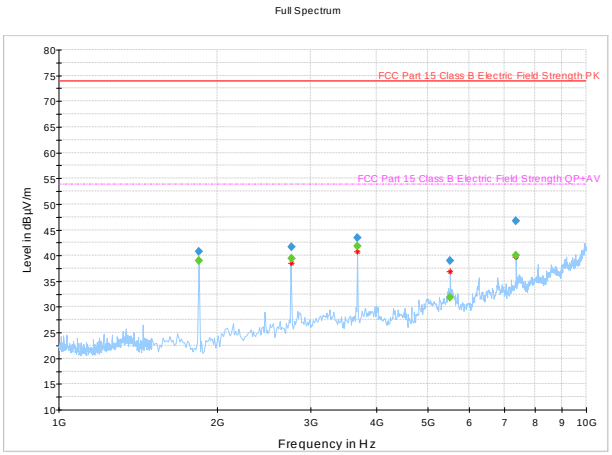


Figure 8.3-3: *Radiated spurious emissions, high channel, DM9023*

Figure 8.3-4: *Radiated spurious emissions, low channel, DM9025*







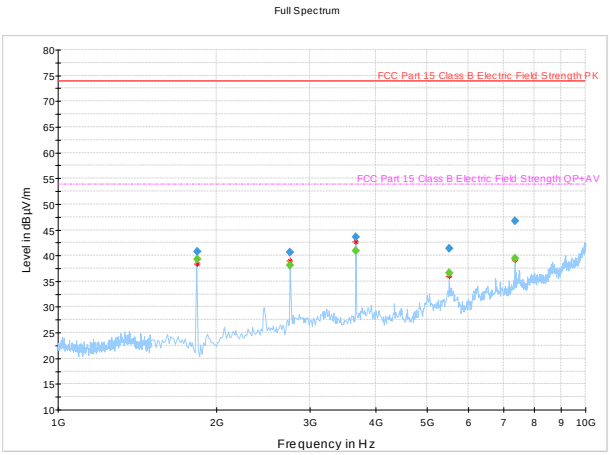


Figure 8.3-5: *Radiated spurious emissions, mid channel, DM9025*

Figure 8.3-6: *Radiated spurious emissions, high channel, DM9025*

Peaks within 902-928MHz are transmitter fundamentals.

Table 8.3-4: *Radiated field strength measurement results for low channel, DM9023*

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1836.059319	---	40.91	53.90	12.99	1000.0	1000.000	265.9	H
1836.059319	44.52	---	73.90	29.38	1000.0	1000.000	265.9	H
2754.311022	---	40.90	53.90	13.00	1000.0	1000.000	120.0	V
2754.311022	45.07	---	73.90	28.83	1000.0	1000.000	120.0	V
3672.538677	45.01	---	73.90	28.89	1000.0	1000.000	181.0	V
3672.538677	---	39.39	53.90	14.51	1000.0	1000.000	181.0	V
9914.243687	59.63	---	73.90	14.27	1000.0	1000.000	178.8	V
9914.243687	---	46.27	53.90	7.63	1000.0	1000.000	178.8	V

Table 8.3-5: *Radiated field strength measurement results for mid channel, DM9023*

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1841.283367	---	41.00	53.90	12.90	1000.0	1000.000	267.9	H
1841.283367	44.37	---	73.90	29.53	1000.0	1000.000	267.9	H
2761.911022	45.30	---	73.90	28.60	1000.0	1000.000	174.1	V
2761.911022	---	40.53	53.90	13.37	1000.0	1000.000	174.1	V
3682.562725	42.65	---	73.90	31.25	1000.0	1000.000	105.9	V
3682.562725	---	35.09	53.90	18.81	1000.0	1000.000	105.9	V
8582.750301	55.23	---	73.90	18.67	1000.0	1000.000	132.3	V
8582.750301	---	42.23	53.90	11.67	1000.0	1000.000	132.3	V
9983.563928	59.47	---	73.90	14.43	1000.0	1000.000	193.7	V
9983.563928	---	46.66	53.90	7.24	1000.0	1000.000	193.7	V

Table 8.3-6: *Radiated field strength measurement results for high channel, DM9023*

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1846.083367	---	42.24	53.90	11.66	1000.0	1000.000	262.4	H
1846.083367	45.32	---	73.90	28.58	1000.0	1000.000	262.4	H
2769.135070	44.66	---	73.90	29.24	1000.0	1000.000	121.0	V
2769.135070	---	39.21	53.90	14.69	1000.0	1000.000	121.0	V
3691.786774	---	39.28	53.90	14.62	1000.0	1000.000	191.9	V
3691.786774	44.88	---	73.90	29.02	1000.0	1000.000	191.9	V
5650.506613	---	30.27	53.90	23.63	1000.0	1000.000	95.0	H
5650.506613	43.10	---	73.90	30.80	1000.0	1000.000	95.0	H
9997.600000	59.22	---	73.90	14.68	1000.0	1000.000	342.1	V
9997.600000	---	46.45	53.90	7.45	1000.0	1000.000	342.1	V

Table 8.3-7: *Radiated field strength measurement results for low channel, DM9025*

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1836.261323	40.61	---	73.90	33.29	100.0	1000.000	105.1	V
1836.261323	---	39.24	53.90	14.66	100.0	1000.000	105.1	V
2458.517836	30.67	---	73.90	43.23	100.0	1000.000	143.8	H
2458.517836	---	15.75	53.90	38.15	100.0	1000.000	143.8	H
2754.113026	41.36	---	73.90	32.54	100.0	1000.000	129.3	H
2754.113026	---	38.88	53.90	15.02	100.0	1000.000	129.3	H
3672.542685	---	41.67	53.90	12.23	100.0	1000.000	100.0	H
3672.542685	43.98	---	73.90	29.92	100.0	1000.000	100.0	H
5508.424048	---	35.50	53.90	18.41	100.0	1000.000	110.0	V
5508.424048	40.65	---	73.90	33.25	100.0	1000.000	110.0	V
7344.685371	46.03	---	73.90	27.87	100.0	1000.000	111.3	V
7344.685371	---	38.95	53.90	14.95	100.0	1000.000	111.3	V

Table 8.3-8: *Radiated field strength measurement results for mid channel, DM9025*

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1841.283367	40.72	---	73.90	33.18	100.0	1000.000	141.2	V
1841.283367	---	39.05	53.90	14.85	100.0	1000.000	141.2	V
2761.713026	41.60	---	73.90	32.30	100.0	1000.000	126.3	H
2761.713026	---	39.44	53.90	14.46	100.0	1000.000	126.3	H
3682.364730	43.49	---	73.90	30.41	100.0	1000.000	120.7	H
3682.364730	---	41.80	53.90	12.10	100.0	1000.000	120.7	H
5523.846092	---	31.79	53.90	22.11	100.0	1000.000	107.4	H
5523.846092	38.99	---	73.90	34.91	100.0	1000.000	107.4	H
7364.721443	46.77	---	73.90	27.13	100.0	1000.000	200.0	V
7364.721443	---	40.07	53.90	13.83	100.0	1000.000	200.0	V

Table 8.3-9: *Radiated field strength measurement results for mid channel, DM9025*

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol
1836.261323	---	39.27	53.90	14.63	100.0	1000.000	110.3	V
1836.261323	40.73	---	73.90	33.17	100.0	1000.000	110.3	V
2754.113026	---	38.08	53.90	15.82	100.0	1000.000	135.4	H
2754.113026	40.65	---	73.90	33.25	100.0	1000.000	135.4	H
3672.542685	43.55	---	73.90	30.35	100.0	1000.000	120.7	H
3672.542685	---	40.92	53.90	12.98	100.0	1000.000	120.7	H
5508.424048	41.33	---	73.90	32.57	100.0	1000.000	114.2	V
5508.424048	---	36.54	53.90	17.36	100.0	1000.000	114.2	V
7344.685371	---	39.45	53.90	14.45	100.0	1000.000	219.0	V
7344.685371	46.67	---	73.90	27.23	100.0	1000.000	219.0	V

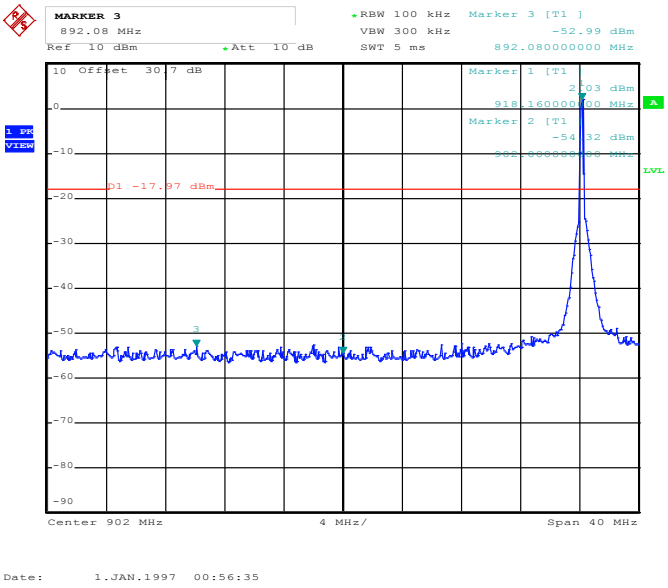


Figure 8.3-7: *Low Bandedge Measurement*

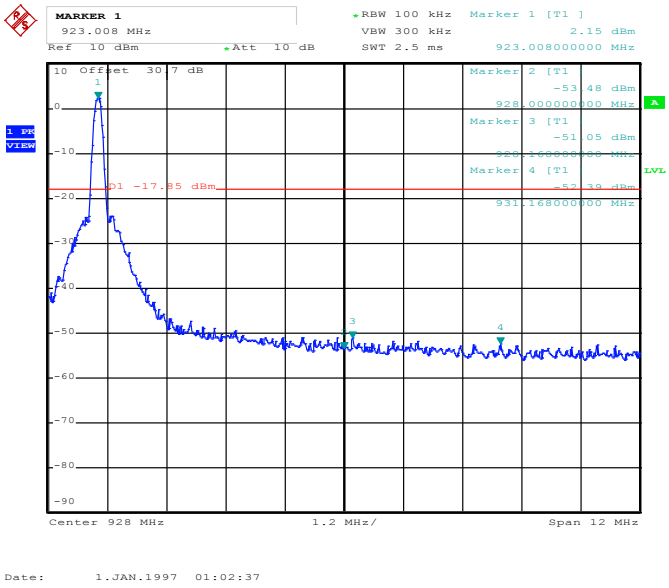


Figure 8.3: *High Bandedge Measurement*

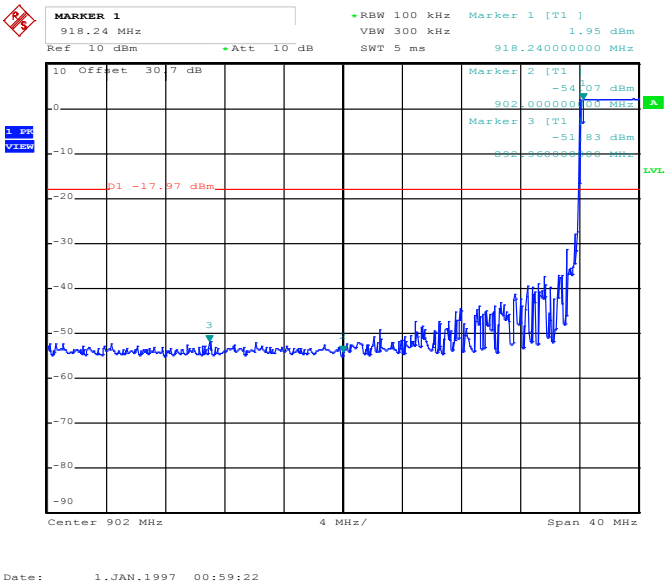


Figure 8.3-9: *Low Bandedge Measurement, hopping*

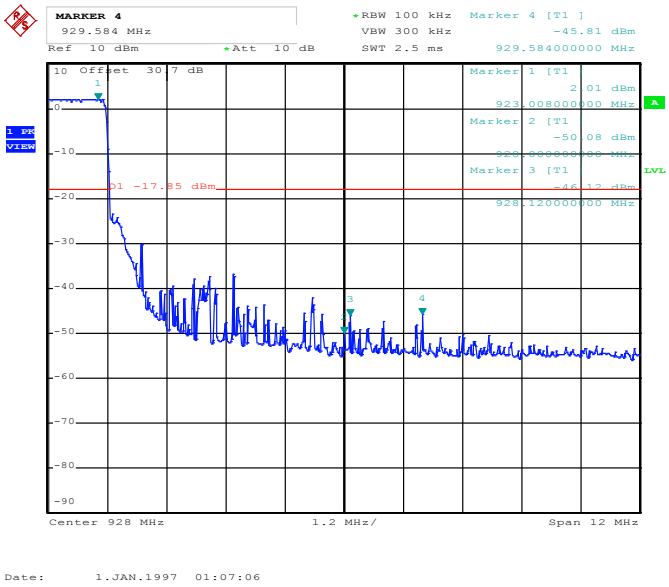


Figure 8.3-10: *High Bandedge Measurement, hopping*

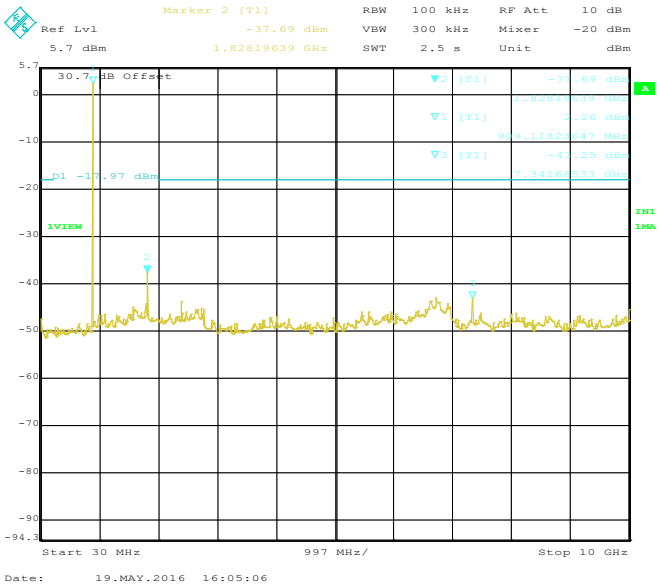


Figure 8.3-11: *Conducted spurious emissions, low channel*

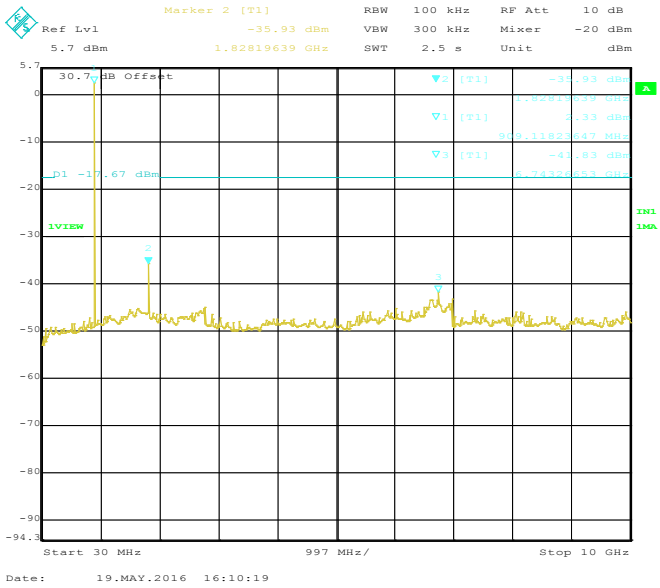


Figure 8.3-12: *Conducted spurious emissions, mid channel*

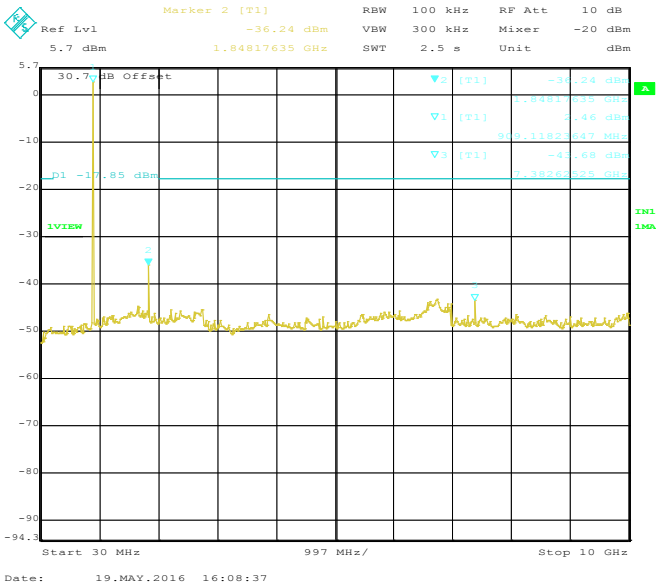


Figure 8.3-13: *Conducted spurious emissions, high channel*

Peaks within 902-928MHz are transmitter fundamentals.

8.4 FCC 15.247(a)(1)(i) and RSS-247 5.1(3) Frequency hopping systems in the 902-928MHz

8.4.1 Definitions and limits

FCC:
(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz..
IC:
For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

8.4.2 Test summary

Test date	May 19, 2016	Temperature	21 °C
Test engineer	Feng You	Air pressure	1002 mbar
Verdict	Pass	Relative humidity	62 %

8.4.3 Observations, settings and special notes

The test was performed using EUT set to normal hopping operation.

RF Conducted Test with RF Test Board.

8.4.4 Test data

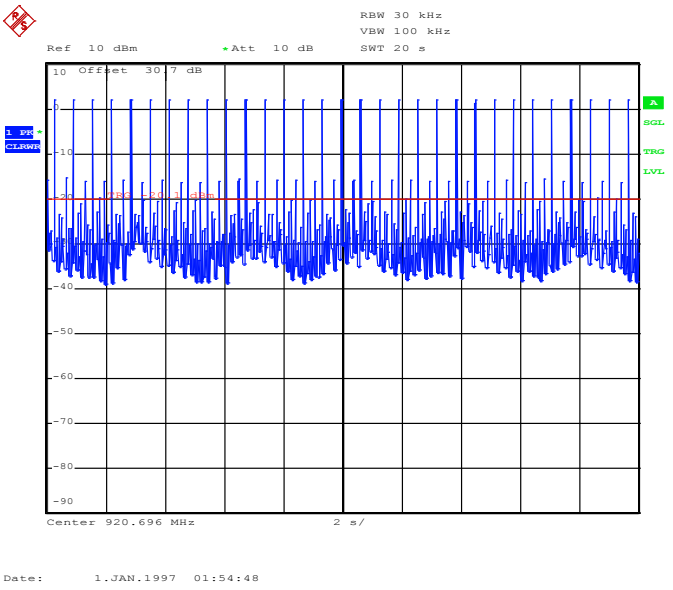


Diagram 8.4-1: *Pulse count in 20s, 920.6MHz*

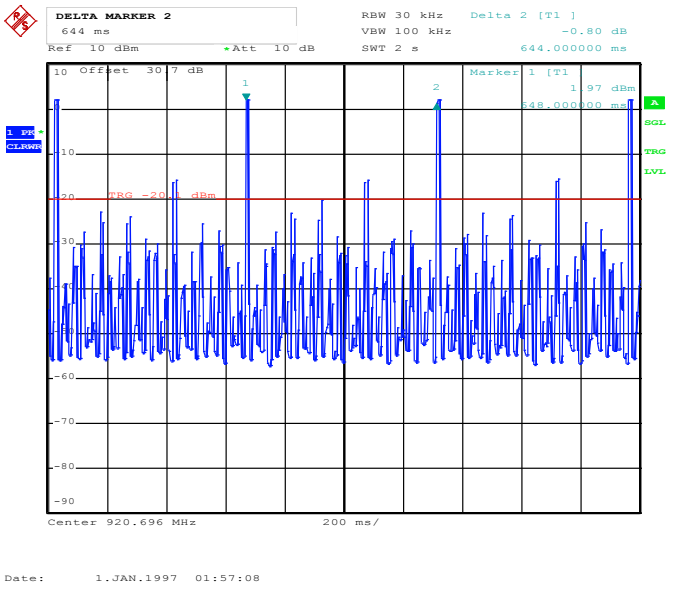


Diagram 8.4-2: *TX-Gap, 920.6MHz*

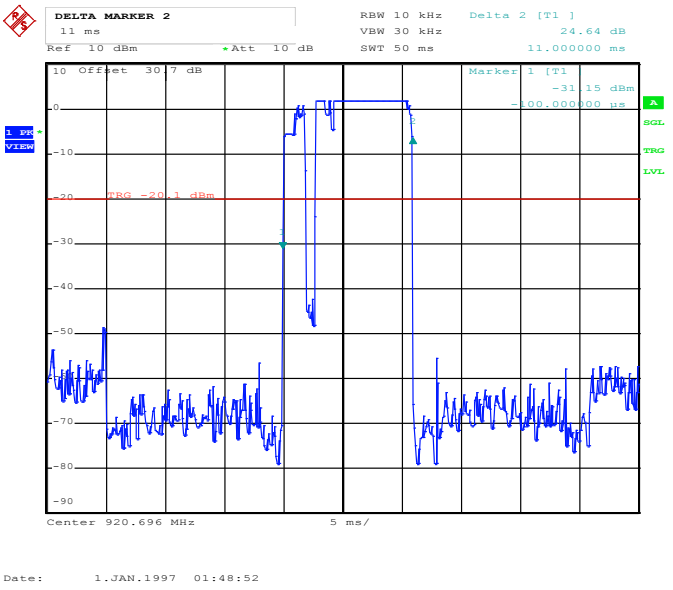


Diagram 8.4-3: *Pulse width, 920.6MHz*

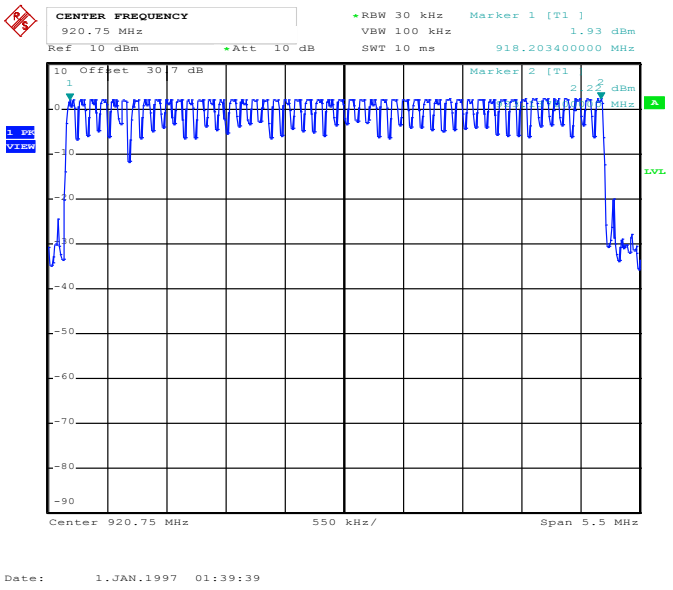


Diagram 8.4-4: *Hopping channels 50*

Table 8.4-1: *Time of occupancy*

Frequency MHz	Pulse count in 20s	TX-Gap (ms)	Pulse width (ms)	Time of occupancy Time (ms)	Limit (ms)
902.6	31	644	11	341	400

Table 8.4: *Hopping Frequencies*

Minimum Hopping Frequencies	Measured Hopping Frequencies	Result
50	50	Pass

8.5 FCC 15.247(a) (1) and RSS-247 5.1(2) Carrier frequency separation

8.5.1 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:

(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.

8.5.2 Test summary

Test date	May 19, 2016	Temperature	21 °C
Test engineer	Feng You	Air pressure	1002 mbar
Verdict	Pass	Relative humidity	62 %

8.5.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	100 kHz
Video bandwidth	≥ RBW
Frequency span	4 MHz
Detector mode	Peak
Trace mode	Max Hold

RF Conducted Test with RF Test Board.

8.5.4 Test data

Table 8.5-1: *Hopping Frequency Separation*

Modulation	Frequency, kHz	Minimum, kHz (20dB OBW)	Margin, kHz
FSK	100	80.4	19.6

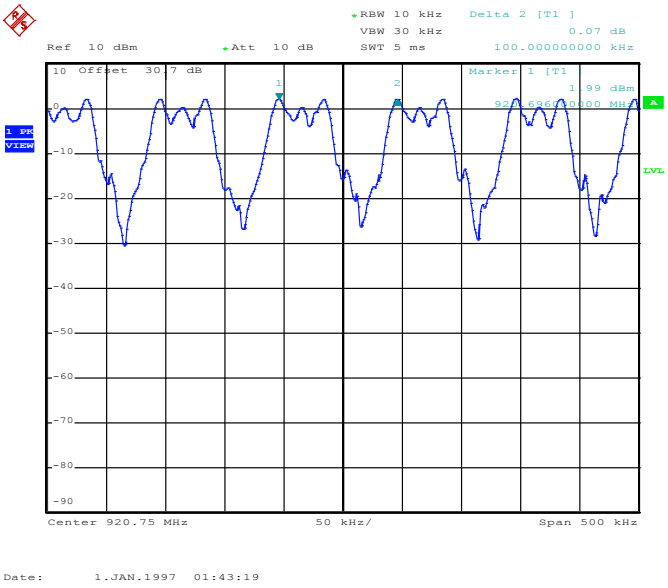
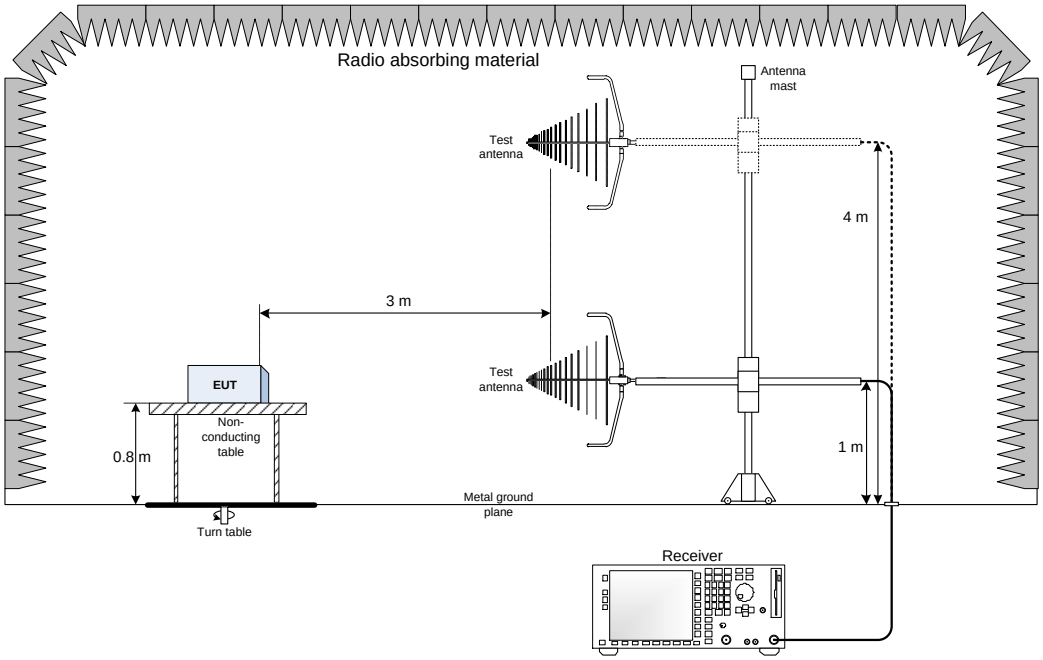


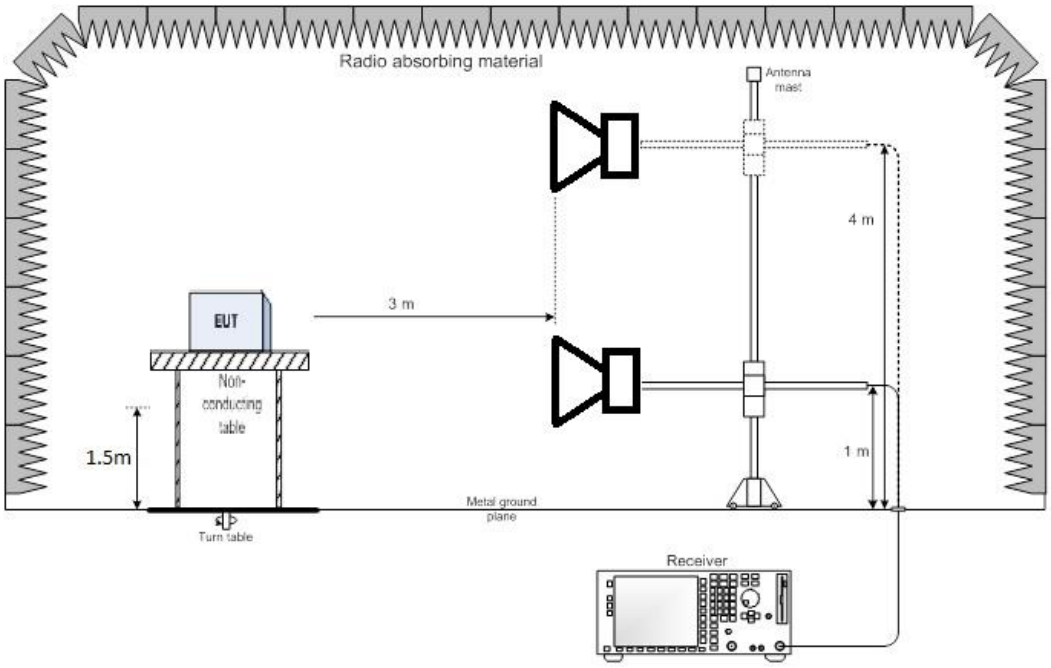
Figure 8.5-1: *Hopping Frequency Separation*

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up



30-1000MHz Setup



Above 1GHz Setup