

Wireless test report – TRFWL

Applicant:

eleven-x Incorporated

Product name:

eleven-x Interface Unit

Model:

XIU001000

FCC ID:

2AOX5XIU001000

ISED Registration number:

22369-XIU001000

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

Date of issue: **May 11, 2018**

Test engineer(s): **Andrey Adelberg, Senior Wireless/EMC Specialist**

Signature:



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Test location(s)

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Site number	FCC: CA2040; IC: 2040A-4 (3 m SAC)	FCC: CA2041; IC: 2040G-5 (3 m SAC)

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.

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Eleven-X Inc.
Address	300-460 Phillip Street
City	Waterloo
Province/State	ON
Postal/Zip code	N2L 5J2
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
DA 00-705, Released March 30, 2000	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems
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 performed against all relevant requirements of the test standard except as noted in section 1.5 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 #	Date of issue	Details of changes made to test report
TRF	May 11, 2018	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Table 2.1-1: FCC general requirements results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Not applicable
§15.31(e)	Variation of power source	Pass
§15.31(m)	Number of tested frequencies	Pass
§15.203	Antenna requirement	Pass

Notes: EUT is a battery operated device

2.2 FCC Part 15 Subpart C, intentional radiators test results for frequency hopping spread spectrum systems

Table 2.2-1: FCC 15.247 results for FHSS

Part	Test description	Verdict
§15.247(a)(1)(i)	Requirements for operation in the 902–928 MHz band	Pass
§15.247(a)(1)(ii)	Requirements for operation in the 5725–5850 MHz band	Not applicable
§15.247(a)(1)(iii)	Requirements for operation in the 2400–2483.5 MHz band	Not applicable
§15.247(b)(1)	Maximum peak output power in the 2400–2483.5 MHz band and 5725–5850 MHz band	Not applicable
§15.247(b)(2)	Maximum peak output power in the 902–928 MHz band	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
	Pass	Pass
§15.247(f)	Time of occupancy for hybrid systems	Pass

2.3 FCC Part 15 Subpart C, intentional radiators test results for digital transmission systems (DTS)

Table 2.3-1: FCC 15.247 results for DTS

Part	Test description	Verdict
§15.247(a)(2)	Minimum 6 dB bandwidth	Pass
§15.247(b)(3)	Maximum peak output power 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	Pass
§15.247(f)	Time of occupancy for hybrid systems	Pass

2.4 ISED RSS-Gen, Issue 4, test results

Table 2.4-1: RSS-Gen results

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

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.

2.5 ISED RSS-247, Issue 2, test results for frequency hopping spread spectrum systems (FHSS)

Table 2.5-1: RSS-247 results for FHSS

Part	Test description	Verdict
5.1 (a)	Bandwidth of a frequency hopping channel	Pass
5.1 (b)	Minimum channel spacing	Pass
5.1 (c)	Systems operating in the 902–928 MHz band	Pass
5.1 (d)	Systems operating in the 2400–2483.5 MHz band	Not applicable
5.1 (e)	Systems operating in the 5725–5850 MHz band	Not applicable
5.4	Transmitter output power and e.i.r.p. requirements	
5.4 (a)	Systems operating in the 902–928 MHz band	Pass
5.4 (b)	Systems operating in the 2400–2483.5 MHz band	Not applicable
5.4 (c)	Systems operating in the 5725–5850 MHz	Not applicable
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

2.6 ISED RSS-247, Issue 2, test results for digital transmission systems (DTS)

Table 2.6-1: RSS-247 results for DTS

Part	Test description	Verdict
5.2 (a)	Minimum 6 dB bandwidth	Pass
5.2 (b)	Maximum power spectral density	Pass
5.4 (d)	Transmitter output power and e.i.r.p. requirements	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	March 27, 2018
Nemko sample ID number	1, 2, 3

3.2 EUT information

Product name	eleven-x Interface Unit
Model	XIU001000
Serial number	70B3B514900E0066 (internal antenna), 70B3B514900E0074 (conducted), 70B3B514900E0092 (external antenna)

3.3 Technical information

Applicant IC company number	22369
IC UPN number	XIU001000
All used IC test site(s) Reg. number	2040A-4
RSS number and Issue number	RSS-247 Issue 2, Feb 2017
Frequency band	902–928 MHz
Frequency Min (MHz)	902.3 (FHSS), 903.0 (DTS)
Frequency Max (MHz)	914.9 (FHSS), 914.2 (DTS)
RF power Min (W)	N/A
RF power Max (W), Conducted	0.0648 (18.12 dBm for FHSS DR0), 0.0652 (18.14 dBm for FHSS DR3), 0.0685 (18.36 dBm for DTS)
Field strength, Units @ distance	N/A
Measured BW (kHz) (6 dB) for DTS	849.36
Measured BW (kHz) (20 dB) for FHSS	138.46 (for DR0), 146.79 (for DR3)
Measured BW (kHz) (99 %) for DTS	743.59 (DTS), 126.28 (for FHSS DR0), 126.92 (for FHSS DR3)
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	LoRa™ (DTS and FHSS modes)
Emission classification (F1D, G1D, D1D)	F1D
Transmitter spurious (dBμV/m @ 3 m)	57.16 at 1.83 GHz
Power requirements	Battery powered 3.6 V _{DC}
Antenna information	Internal antenna 1 dBi, ANT-180321-001, eleven-x Inc, Monopole External antenna 3 dBi, W1063, PulseLarsen Antennas, Dipole

3.4 Product description and theory of operation

The eleven-x LoRa™ Interface Device module is based on the Semtech SX1272 Transceiver using LoRa™ modulation. It is designed to operate in the 915 MHz ISM band, and implements the LoRaWAN™ network protocol.

As per LoRaWAN™, the 902–928 MHz ISM band is divided into the following:

- 64 uplink (module Tx) channels using LoRa™ 125 kHz bandwidth, from 902.3 MHz to 914.9 MHz, incrementing linearly by 200 kHz.
- 8 uplink (module Tx) channels using LoRa™ 500 kHz bandwidth, from 903.0 MHz to 914.2 MHz, incrementing linearly by 1.6 MHz.
- 8 downlink (module Rx) channels using LoRa™ 500 kHz bandwidth, from 923.3 MHz to 927.5 MHz, incrementing linearly by 600 kHz.

3.5 EUT exercise details

EUT was connected with 4-wire cable allowing serial communication to the device, as well as providing a 3.6 V supply (which matches the battery voltage of the device) to custom control device which was connected to a laptop using micro-USB cable. Special commands were used to set device to continuously transmit, using LoRaTM modulation, at the specified bandwidth.

3.6 EUT setup diagrams

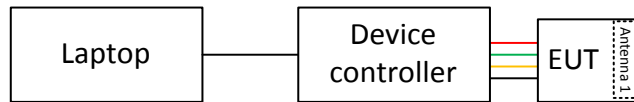


Figure 3.6-1: Setup diagram for internal antenna option

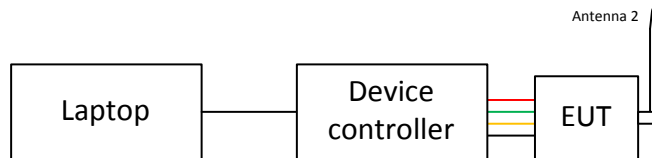


Figure 3.6-2: Setup diagram for external antenna option

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 mbar

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages $\pm 5\%$, 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.

Table 6.1-1: Measurement uncertainty

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: Equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Dec. 09/18
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	March 26/19
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	July 18/18
Preamplifier (1–18 GHz)	ETS-Lindgren	124334	FA002877	1 year	Nov. 14/18
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	June 27/18
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	June 21/18
Horn antenna (18–40 GHz)	EMCO	3116	FA001847	1 year	June 27/18
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU

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

Section 8. Testing data

8.1 FCC 15.31(e) Variation of power source

8.1.1 Definitions and limits

For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

8.1.2 Test date

Start date April 2, 2018

8.1.3 Observations, settings and special notes

Final installation will include a 3.6 V battery. EUT was powered from the device controller, which in return was powered from the laptop via USB connection.

8.1.4 Test data

EUT Power requirements: AC DC Battery
If EUT is an AC or a DC powered, was the noticeable output power variation observed? YES NO N/A
If EUT is battery operated, was the testing performed using fresh batteries? YES NO N/A
If EUT is rechargeable battery operated, was the testing performed using fully charged batteries? YES NO N/A

8.2 FCC 15.31(m) and RSS-Gen 6.8 Number of frequencies

8.2.1 Definitions and limits

FCC:

Measurements on intentional radiators or receivers shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table.

ISED:

Except where otherwise specified, measurements shall be performed for each frequency band of operation for which the radio apparatus is to be certified, with the device operating at the frequencies in each band of operation shown in table below. The frequencies selected for measurements shall be reported in the test report.

Table 8.2-1: Frequency Range of Operation

Frequency Range Over Which the Device Operates (in each Band)	Number of Measurement Frequencies Required	Location of Measurement Frequency in Band of Operation
1 MHz or less	1	Center (middle of the band)
1–10 MHz	2	1 near high end, 1 near low end
Greater than 10 MHz	3	1 near high end, 1 near center and 1 near low end

8.2.2 Test date

Start date April 2, 2018

8.2.3 Observations, settings and special notes

None

8.2.4 Test data

Table 8.2-2: Test channels selection for FHSS operation

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz
902	928	26	902.3	908.5	914.9

Table 8.2-3: Test channels selection for DTS operation

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz
902	928	26	903	907.8	914.2

8.3 FCC 15.203 Antenna requirement

8.3.1 Definitions and limits

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

8.3.2 Test date

Start date April 2, 2018

8.3.3 Observations, settings and special notes

EUT comes in two configurations one with internal and another with external antenna.

8.3.4 Test data

Must the EUT be professionally installed? YES NO
Does the EUT have detachable antenna(s)? YES NO
If detachable, is the antenna connector(s) non-standard? YES NO N/A

8.4 FCC 15.247(a)(1) and RSS-247 5.1 Frequency Hopping Systems requirements, 900 MHz operation

8.4.1 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.
- (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.
- (f) For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned-off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. The power spectral density conducted from the intentional radiator to the antenna due to the digital modulation operation of the hybrid system, with the frequency hopping operation turned off, shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

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.
- c) 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.

5.3 Hybrid systems

Hybrid systems employ a combination of both frequency hopping and digital transmission techniques and shall comply with the following:

- a) With the digital transmission operation of the hybrid system turned off, the frequency hopping operation shall have an average time of occupancy on any frequency not exceeding 0.4 seconds within a duration in seconds equal to the number of hopping frequencies multiplied by 0.4.

8.4.1 Test date

Start date	March 28, 2018
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8.4.2 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

8.4.3 Test data

Table 8.4-1: 20 dB bandwidth results for Data Rate 0

Frequency, MHz	20 dB bandwidth, kHz
902.3	137.18
908.5	137.82
914.9	138.46

Table 8.4-2: 20 dB bandwidth results for Data Rate 3

Frequency, MHz	20 dB bandwidth, kHz
902.3	146.15
908.5	146.79
914.9	144.23

Table 8.4-3: Carrier frequency separation results

Carrier frequency separation, kHz	Minimum limit, kHz	Margin, kHz
200.32	146.79	53.53

Table 8.4-4: Number of hopping frequencies results

Number of hopping frequencies	Minimum limit	Margin
64	15	49

Table 8.4-5: 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
371.667	1	371.667	400.000	28.333

Measurement Period is 20 s

Table 8.4-6: 99% bandwidth results for Data Rate 0

Frequency, MHz	99% occupied bandwidth, kHz
902.3	126.28
908.5	126.28
914.9	125.64

Note: there is no 99% OBW requirements in the standard. Measurement results for information purposes only.

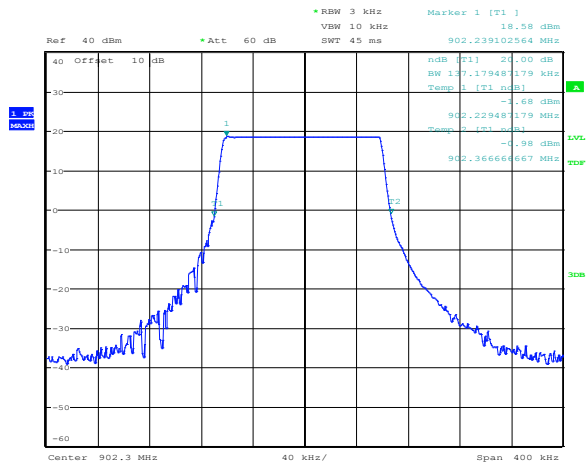
Table 8.4-7: 99% bandwidth results for Data Rate 3

Frequency, MHz	99% occupied bandwidth, kHz
902.3	126.92
908.5	126.92
914.9	126.92

Note: there is no 99% OBW requirements in the standard. Measurement results for information purposes only.

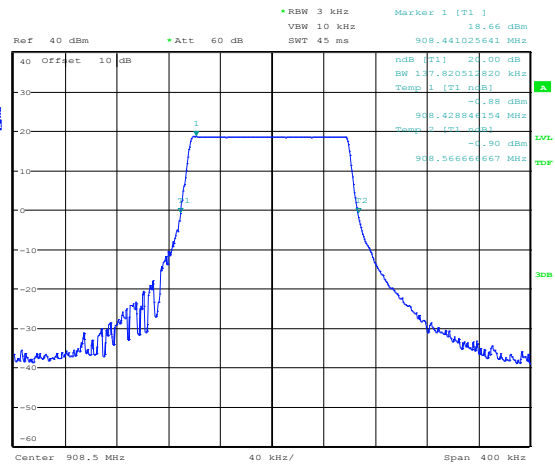
Section 8
Test name
Specification

Testing data
 FCC 15.247(a)(1) and RSS-247 5.1 Frequency Hopping Systems requirements
 FCC Part 15 Subpart C and RSS-247, Issue 2



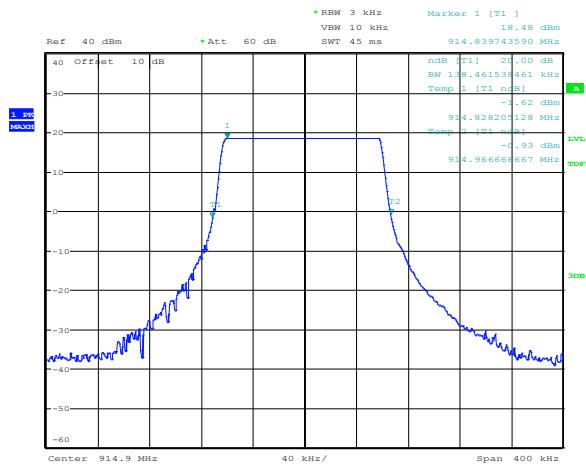
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Figure 8.4-1: 20 dB bandwidth on low channel, DRO



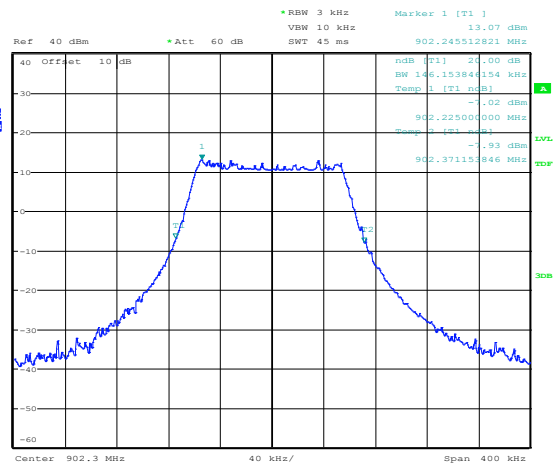
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Figure 8.4-2: 20 dB bandwidth on mid channel, DRO



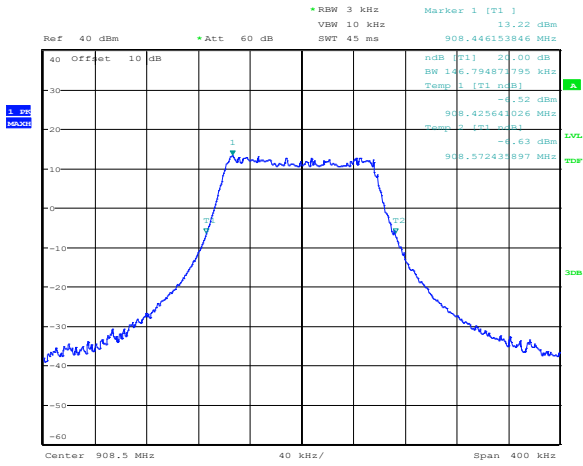
Date: 28.MAR.2018 12:18:03

Figure 8.4-3: 20 dB bandwidth on high channel, DRO



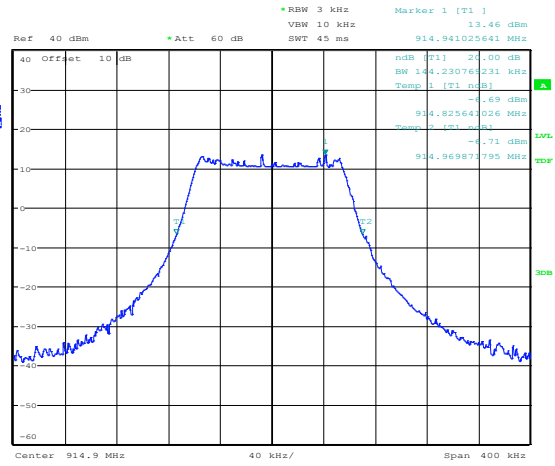
Date: 28.MAR.2018 12:12:05

Figure 8.4-4: 20 dB bandwidth on low channel, DR3



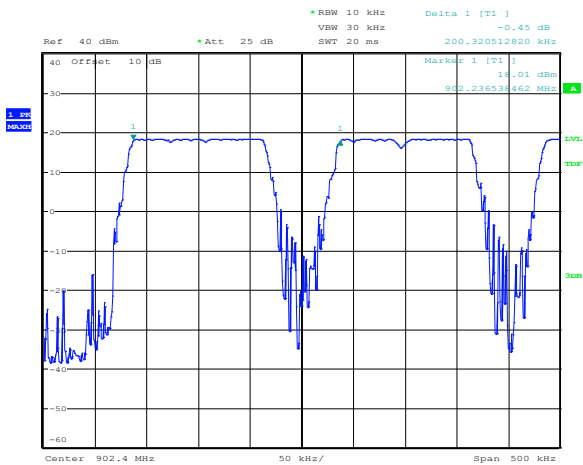
Date: 28.MAR.2018 12:16:09

Figure 8.4-5: 20 dB bandwidth on mid channel, DR3



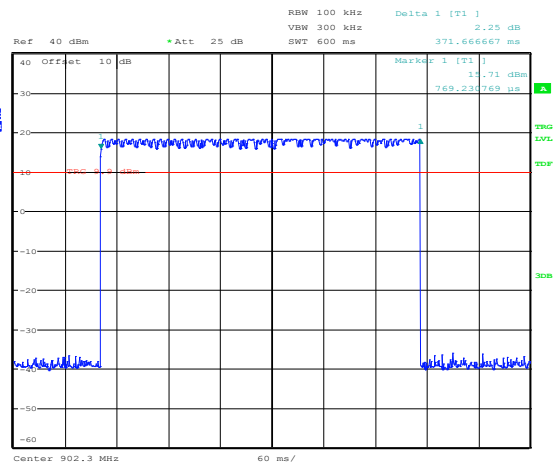
Date: 28.MAR.2018 12:18:57

Figure 8.4-6: 20 dB bandwidth on high channel, DR3



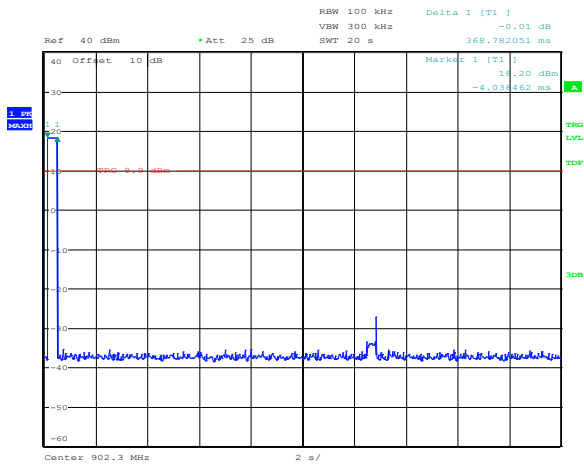
Date: 28.MAR.2018 14:53:31

Figure 8.4-7: Carrier frequency separation



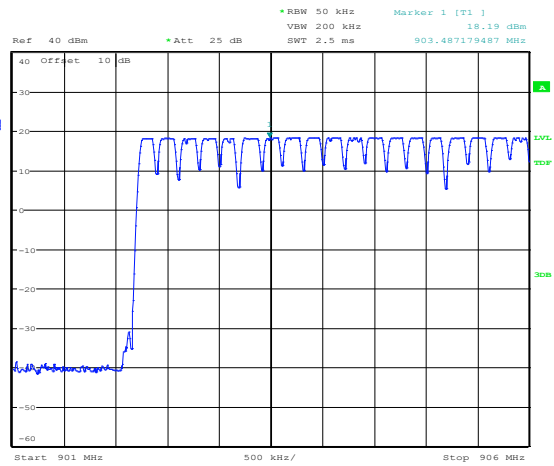
Date: 28.MAR.2018 15:11:06

Figure 8.4-8: Pulse width



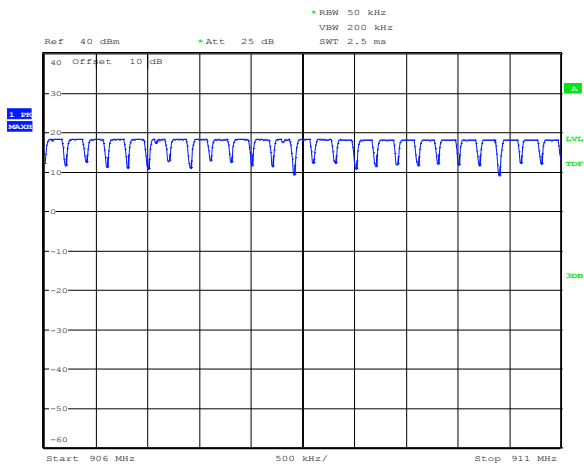
Date: 28.MAR.2018 15:06:00

Figure 8.4-9: Number of pulses within observation period



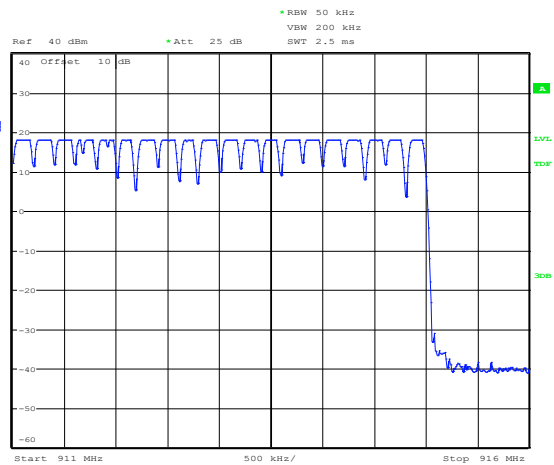
Date: 28.MAR.2018 13:58:21

Figure 8.4-10: Number of hopping channels, part 1



Date: 28.MAR.2018 14:06:47

Figure 8.4-11: Number of hopping channels, part 2

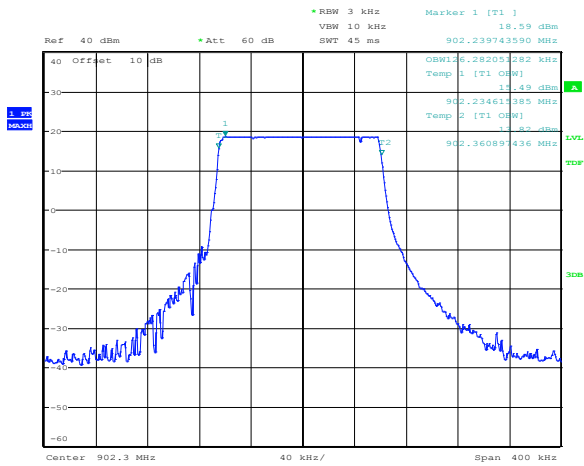


Date: 28.MAR.2018 14:14:43

Figure 8.4-12: Number of hopping channels, part 3

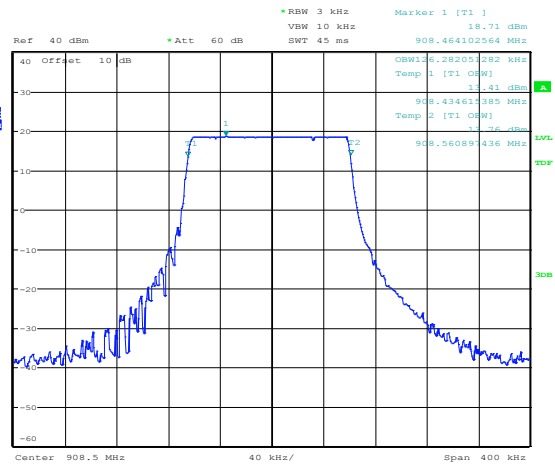
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 FCC 15.247(a)(1) and RSS-247 5.1 Frequency Hopping Systems requirements
 FCC Part 15 Subpart C and RSS-247, Issue 2



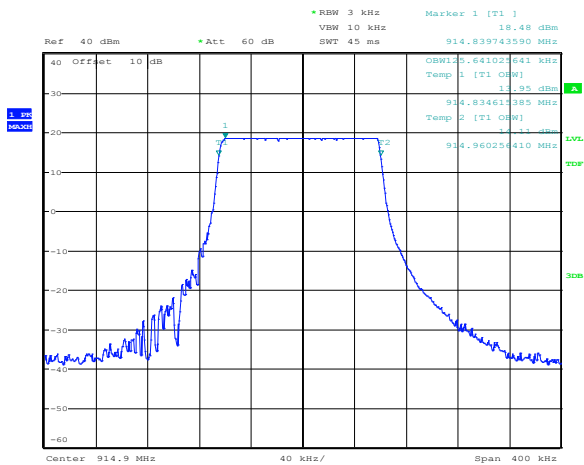
Date: 28.MAR.2018 12:25:40

Figure 8.4-13: 99% occupied bandwidth for Data Rate 0, low channel



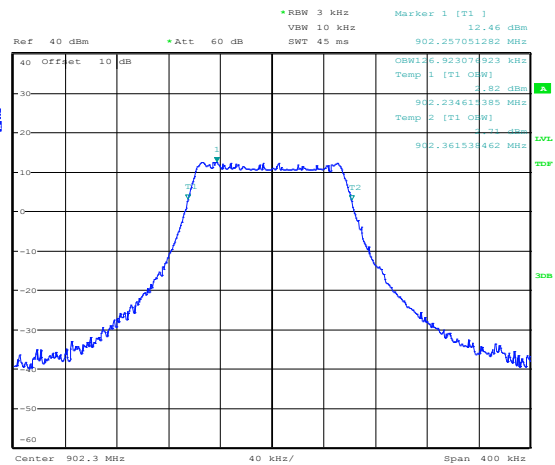
Date: 28.MAR.2018 12:22:53

Figure 8.4-14: 99% occupied bandwidth for Data Rate 0, mid channel



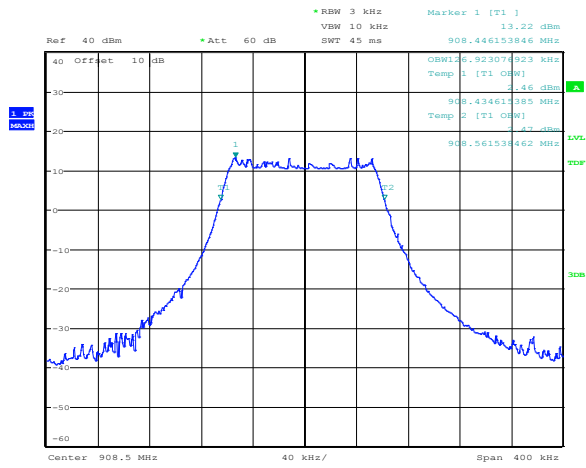
Date: 28.MAR.2018 12:21:40

Figure 8.4-15: 99% occupied bandwidth for Data Rate 0, high channel



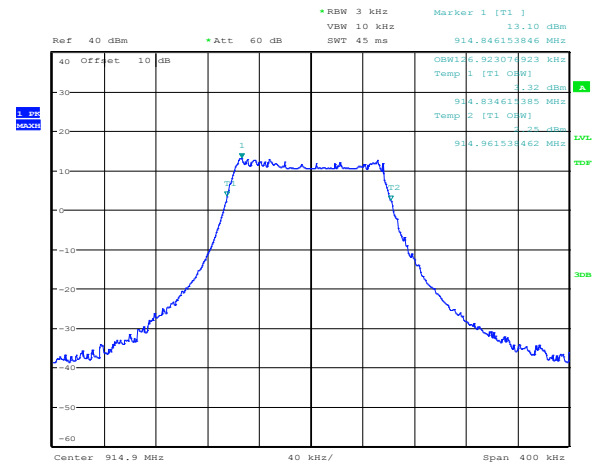
Date: 28.MAR.2018 12:24:43

Figure 8.4-16: 99% occupied bandwidth for Data Rate 3, low channel



Date: 28.MAR.2018 12:23:43

Figure 8.4-17: 99% occupied bandwidth for Data Rate 3, mid channel



Date: 28.MAR.2018 12:20:35

Figure 8.4-18: 99% occupied bandwidth for Data Rate 3, high channel



8.5 FCC 15.247(b) and RSS-247 5.4 (a) Transmitter output power and e.i.r.p. requirements for FHSS 900 MHz

8.5.1 Definitions and limits

FCC:

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

- (2) For frequency hopping systems operating in the 902–928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.
- (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:

For FHSs operating in the band 902–928 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 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W and the e.i.r.p. shall not exceed 1 W if the hopset uses less than 50 hopping channels.

8.5.1 Test date

Start date March 28, 2018

8.5.2 Observations, settings and special notes

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



8.5.3 Test data

Table 8.5-1: Output power and EIRP results for Data Rate 0, internal antenna

Frequency, MHz	Output power, dBm	Output power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
902.3	18.12	30.00	11.88	1.00	19.12	36.00	16.88
908.5	18.08	30.00	11.92	1.00	19.08	36.00	16.92
914.9	18.07	30.00	11.93	1.00	19.07	36.00	16.93

EIRP = Output power + Antenna gain

Table 8.5-2: Output power and EIRP results for Data Rate 0, external antenna

Frequency, MHz	Output power, dBm	Output power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
902.3	18.12	30.00	11.88	3.00	21.12	36.00	14.88
908.5	18.08	30.00	11.92	3.00	21.08	36.00	14.92
914.9	18.07	30.00	11.93	3.00	21.07	36.00	14.93

EIRP = Output power + Antenna gain

Table 8.5-3: Output power and EIRP results for Data Rate 3, internal antenna

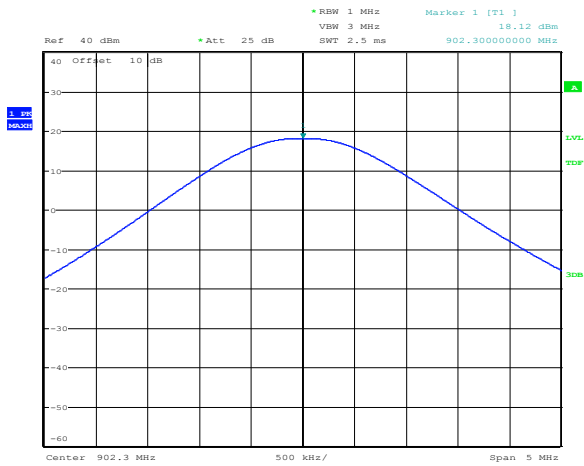
Frequency, MHz	Output power, dBm	Output power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
902.3	18.14	30.00	11.86	1.00	19.14	36.00	16.86
908.5	18.11	30.00	11.89	1.00	19.11	36.00	16.89
914.9	18.05	30.00	11.95	1.00	19.05	36.00	16.95

EIRP = Output power + Antenna gain

Table 8.5-4: Output power and EIRP results for Data Rate 3, external antenna

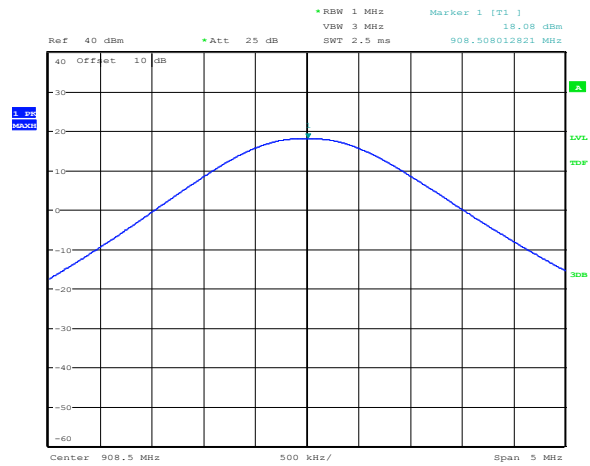
Frequency, MHz	Output power, dBm	Output power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
902.3	18.14	30.00	11.86	3.00	21.14	36.00	14.86
908.5	18.11	30.00	11.89	3.00	21.11	36.00	14.89
914.9	18.05	30.00	11.95	3.00	21.05	36.00	14.95

EIRP = Output power + Antenna gain



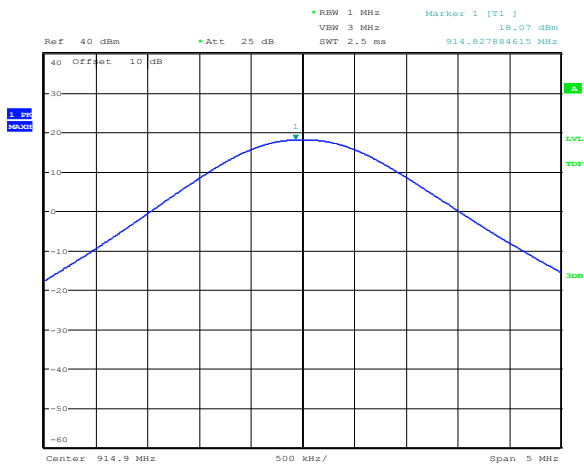
Date: 29.MAR.2018 10:40:47

Figure 8.5-1: Output power on low channel, DR0



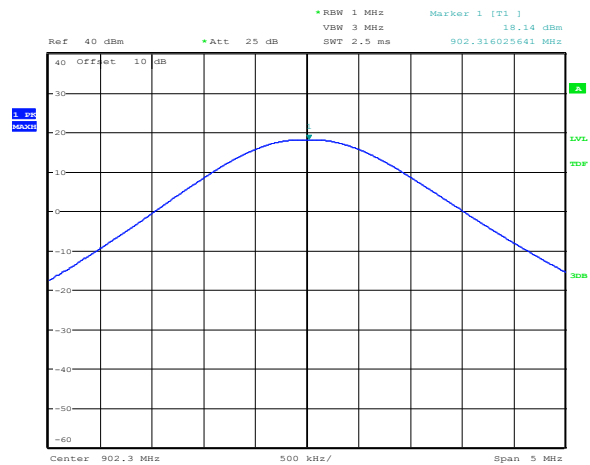
Date: 29.MAR.2018 10:41:44

Figure 8.5-2: Output power on mid channel, DR0



Date: 29.MAR.2018 10:44:24

Figure 8.5-3: Output power on high channel, DR0

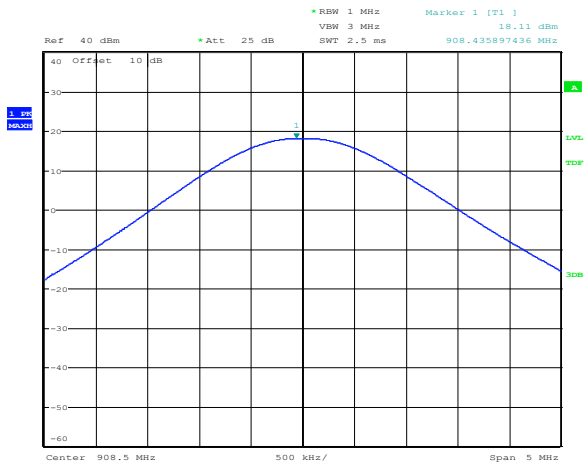


Date: 29.MAR.2018 10:46:20

Figure 8.5-4: Output power on low channel, DR3

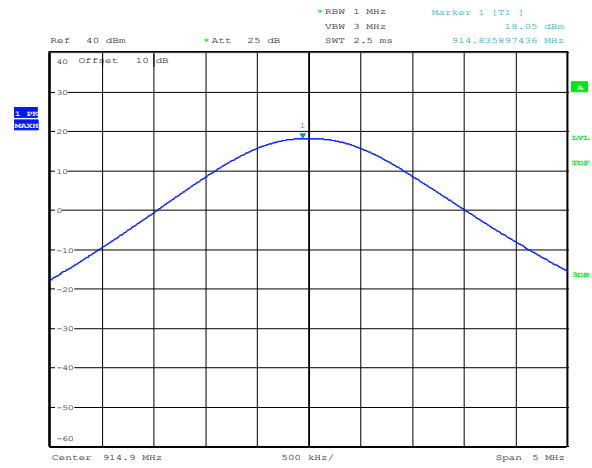
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FCC Part 15 Subpart C and RSS-247, Issue 2



Date: 29.MAR.2018 10:45:45

Figure 8.5-5: Output power on mid channel, DR3



Date: 29.MAR.2018 10:45:05

Figure 8.5-6: Output power on high channel, DR3

8.6 FCC 15.247(a)(2) and RSS-247 5.2(a) Minimum 6 dB bandwidth for DTS systems

8.6.1 Definitions and limits

FCC:
 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.

ISED:
 The minimum 6 dB bandwidth shall be 500 kHz.

8.6.1 Test date

Start date March 28, 2018

8.6.2 Observations, settings and special notes

Spectrum analyser settings for 6 dB BW:

Resolution bandwidth	100 kHz
Video bandwidth	$\geq 3 \times \text{RBW}$
Frequency span	2 MHz
Detector mode	Peak
Trace mode	Max Hold

8.6.3 Test data

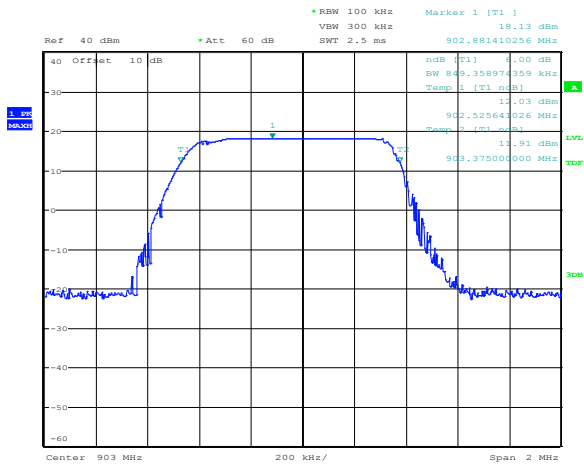
Table 8.6-1: 6 dB bandwidth results

Frequency, MHz	6 dB bandwidth, kHz	Minimum limit, kHz	Margin, kHz
903.0	849.36	500.00	349.36
907.8	846.15	500.00	346.15
914.2	846.15	500.00	346.15

Table 8.6-2: 99% occupied bandwidth results

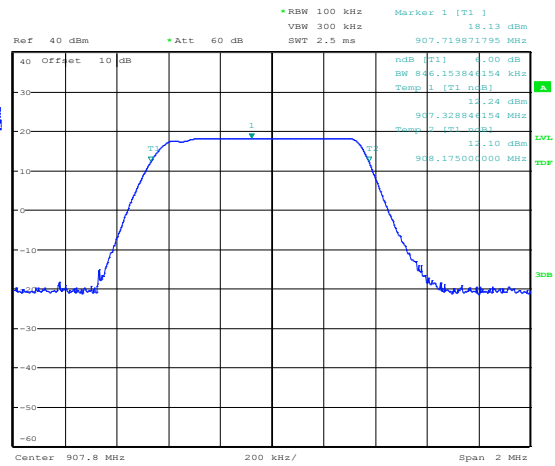
Frequency, MHz	99% occupied bandwidth, kHz
903.0	743.59
907.8	740.38
914.2	740.38

Note: there is no 99% OBW requirements in the standard. Measurement results for information purposes only.



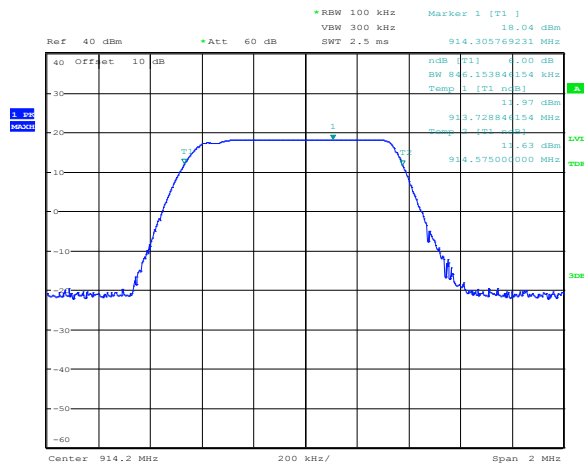
Date: 28.MAR.2018 12:01:20

Figure 8.6-1: 6 dB bandwidth on low channel



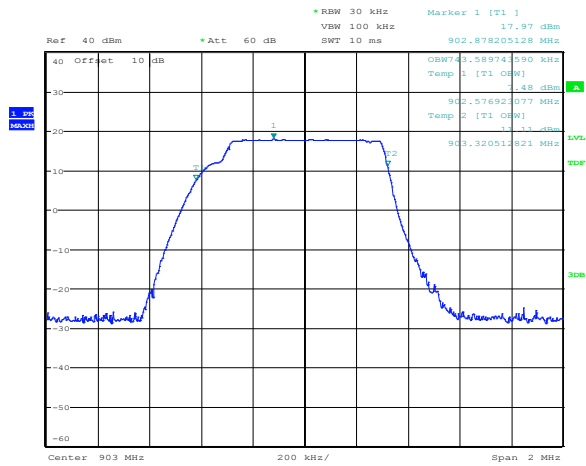
Date: 28.MAR.2018 12:58:03

Figure 8.6-2: 6 dB bandwidth on mid channel



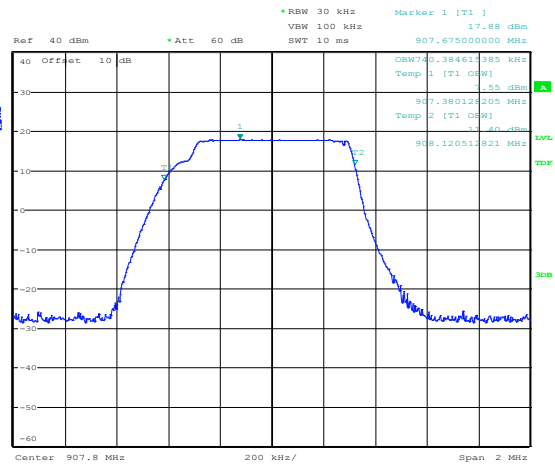
Date: 28.MAR.2018 12:05:55

Figure 8.6-3: 6 dB bandwidth on high channel



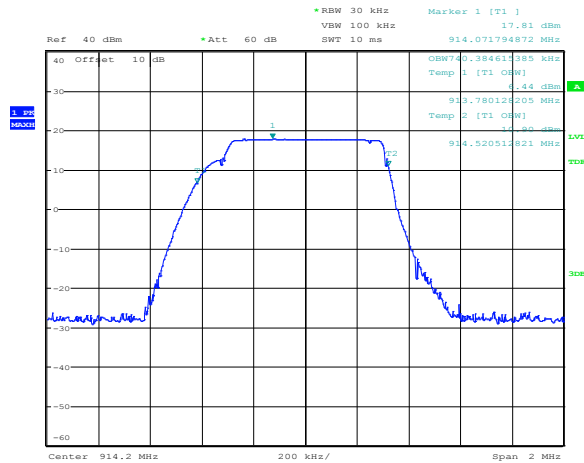
Date: 28.MAR.2018 12:28:47

Figure 8.6-4: 99% occupied bandwidth on low channel



Date: 28.MAR.2018 12:48:12

Figure 8.6-5: 99% occupied bandwidth on mid channel



Date: 28.MAR.2018 12:34:41

Figure 8.6-6: 99% occupied bandwidth on high channel

8.7 FCC 15.247(b) and RSS-247 5.4 (d) Transmitter output power and e.i.r.p. requirements for DTS in 900 MHz

8.7.1 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 band: 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.
- (c) Operation with directional antenna gains greater than 6 dBi.
- (1) Fixed point-to-point operation:
- (iii) Fixed, point-to-point operation, as used in paragraphs (c)(1)(i) and (c)(1)(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 or digitally modulated 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.

ISED:

- d. For DTSs employing digital modulation techniques operating in the 902–928 MHz band, 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).

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.

8.7.1 Test date

Start date March 28, 2018

8.7.2 Observations, settings and special notes

The test was performed using peak test method.
 Spectrum analyser settings:

Resolution bandwidth	3 MHz
Video bandwidth	≥3 × RBW
Frequency span	20 MHz
Detector mode	Peak
Trace mode	Max Hold

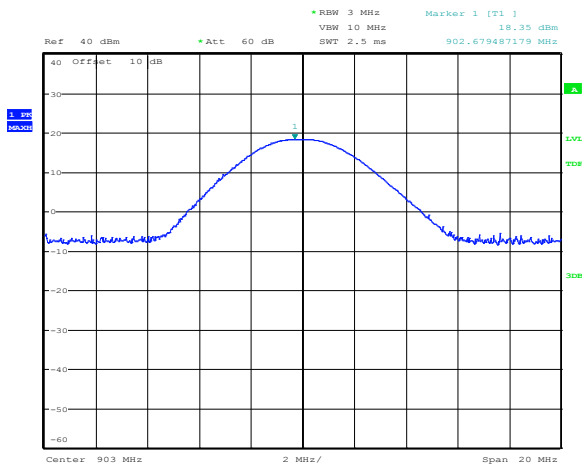
8.7.3 Test data

Table 8.7-1: Output power measurements results for internal antenna configuration

Frequency, MHz	Conducted output power, dBm		Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
	Measured	Limit					
903.0	18.35	30.00	11.65	1.00	19.35	36.00	16.65
907.8	18.36	30.00	11.64	1.00	19.36	36.00	16.64
914.2	18.26	30.00	11.74	1.00	19.26	36.00	16.74

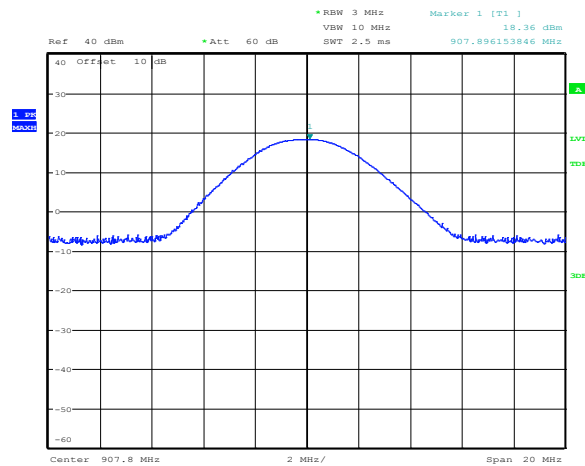
Table 8.7-2: Output power measurements results for external antenna configuration

Frequency, MHz	Conducted output power, dBm		Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
	Measured	Limit					
903.0	18.35	30.00	11.65	3.00	21.35	36.00	14.65
907.8	18.36	30.00	11.64	3.00	21.36	36.00	14.64
914.2	18.26	30.00	11.74	3.00	21.26	36.00	14.74



Date: 28.MAR.2018 12:40:28

Figure 8.7-1: Output power on low channel

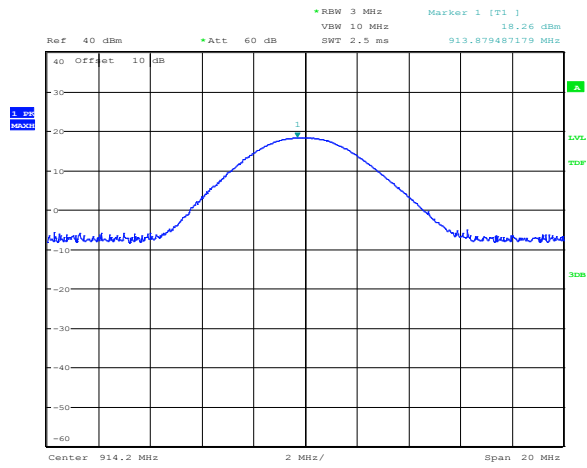


Date: 28.MAR.2018 12:46:31

Figure 8.7-2: Output power on mid channel

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FCC Part 15 Subpart C and RSS-247, Issue 2



Date: 28.MAR.2018 12:38:58

Figure 8.7-3: Output power on high channel

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

8.8.1 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 8.8-1: 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 × log ₁₀ (F)	300
0.490–1.705	24000/F	87.6 – 20 × 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 8.8-2: 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 8.8-2 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 8.8-3: 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			

8.8.1 Test date

Start date March 28, 2018

8.8.2 Observations, settings and special notes

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

Since fundamental power was tested using peak method, the spurious emissions limit is -20 dBc/100 kHz.

On the below plots showing 1–2 GHz frequency range, the 1.8 GHz emission (second harmonic of the fundamental) falls outside restricted bands, therefore it should be attenuated at least 20 dB below carrier measured with 100 kHz RBW. The carrier fundamental field strength is around 100 dBµV/m/100 kHz.

Everything below 80 dBµV/m/100 kHz is considered compliant with this requirement. All measurements were performed with higher RBW than needed for compliance, therefore were assessed and found compliant with much harder test instrument settings.

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:

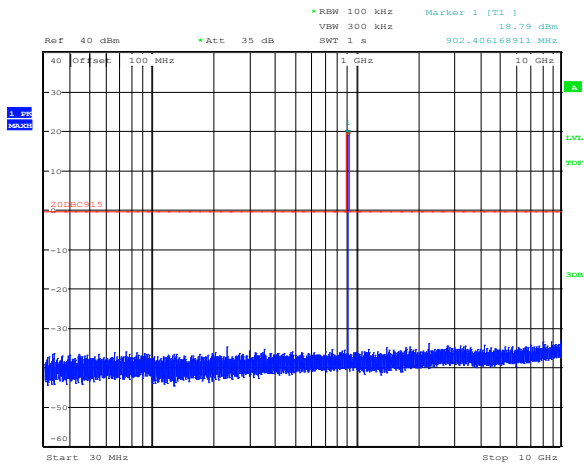
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for conducted spurious emissions measurements:

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

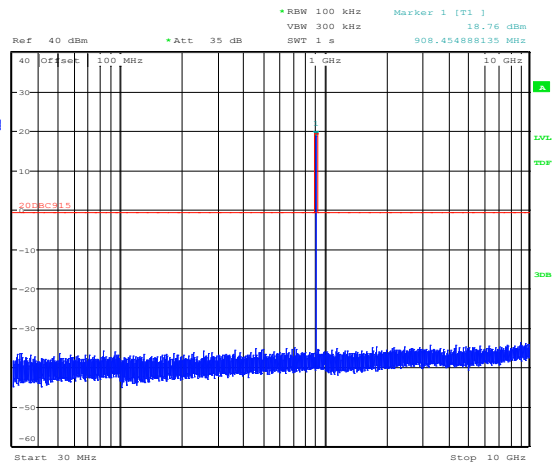
Note: all radiated spurious emissions were scanned using peak detector and they were found complying with quasi-peak and average limit lines (where applicable). No further testing was deemed necessary.

8.8.4 Test data



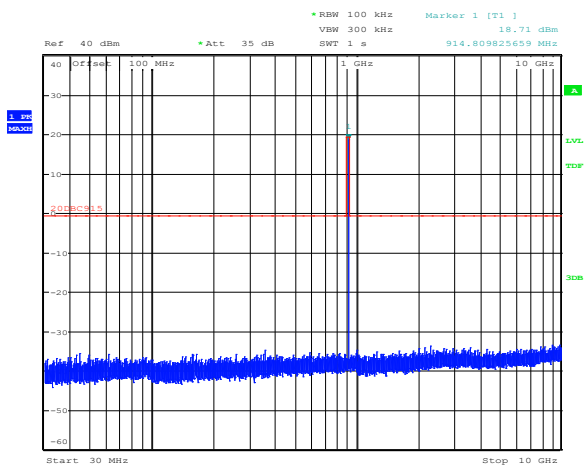
Date: 28.MAR.2018 13:16:35

Figure 8.8-1: Conducted spurious emissions for FHSS DR0, low channel



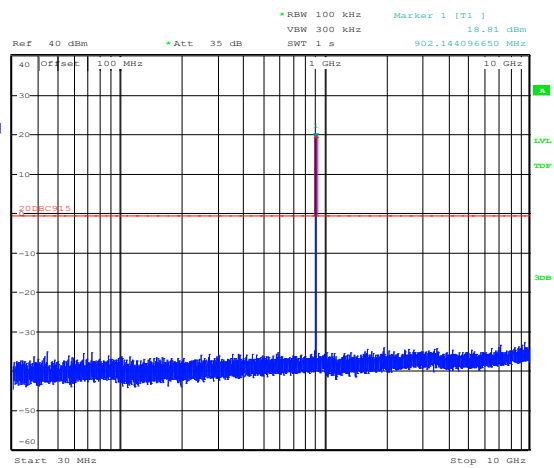
Date: 28.MAR.2018 13:17:48

Figure 8.8-2: Conducted spurious emissions for FHSS DR0, mid channel



Date: 28.MAR.2018 13:18:52

Figure 8.8-3: Conducted spurious emissions for FHSS DR0, high channel

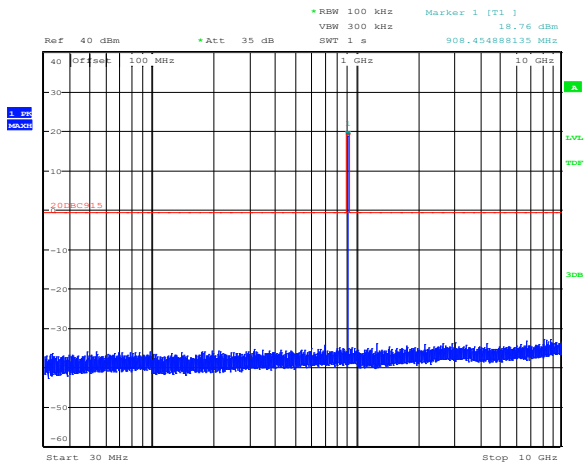


Date: 28.MAR.2018 13:19:55

Figure 8.8-4: Conducted spurious emissions for FHSS DR3, low channel

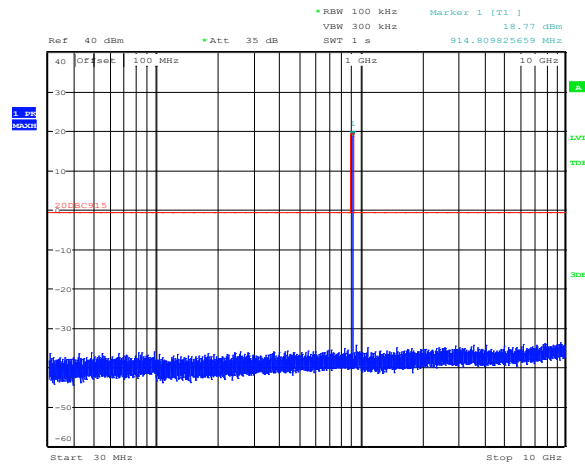
Section 8
Test name
Specification

Testing data
 FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) unwanted emissions
 FCC Part 15 Subpart C and RSS-247, Issue 2



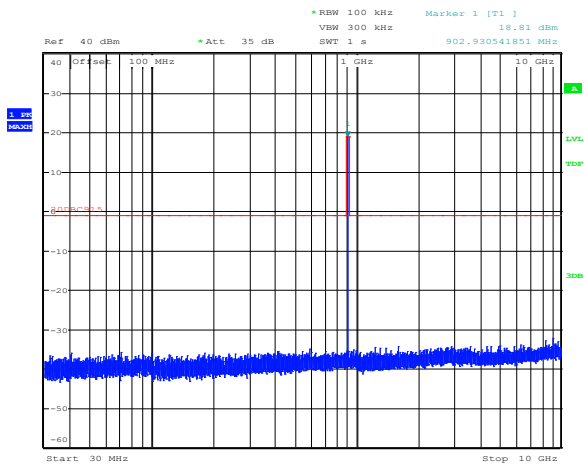
Date: 28.MAR.2018 13:22:23

Figure 8.8-5: Conducted spurious emissions for FHSS DR3, mid channel



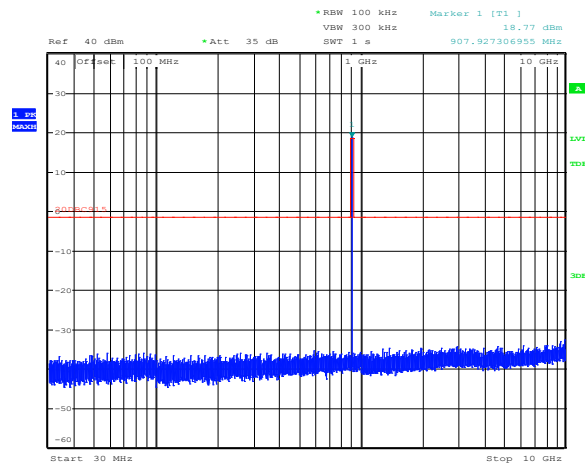
Date: 28.MAR.2018 13:23:56

Figure 8.8-6: Conducted spurious emissions for FHSS DR3, high channel



Date: 28.MAR.2018 13:05:30

Figure 8.8-7: Conducted spurious emissions for DTS, low channel



Date: 28.MAR.2018 13:03:50

Figure 8.8-8: Conducted spurious emissions for DTS, mid channel

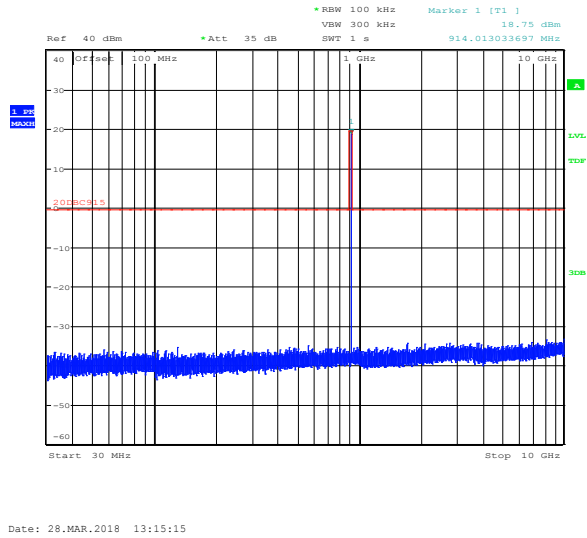


Figure 8.8-9: Conducted spurious emissions for DTS, high channel

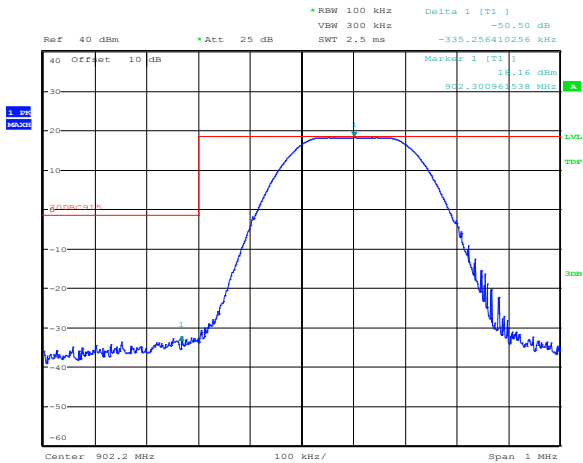


Figure 8.8-10: Conducted spurious emissions at the lower band edge for FHSS DRO, low channel

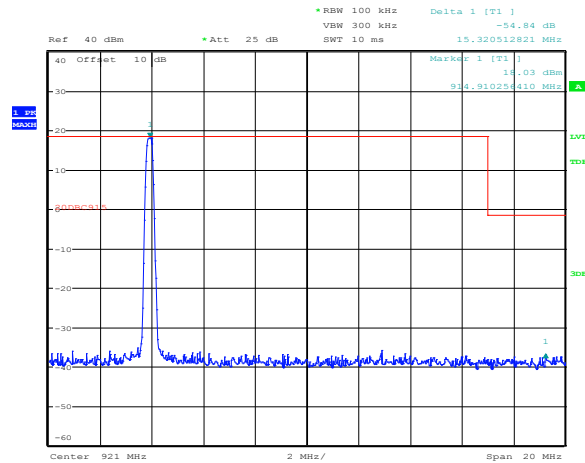


Figure 8.8-11: Conducted spurious emissions at the upper band edge for FHSS DRO, high channel

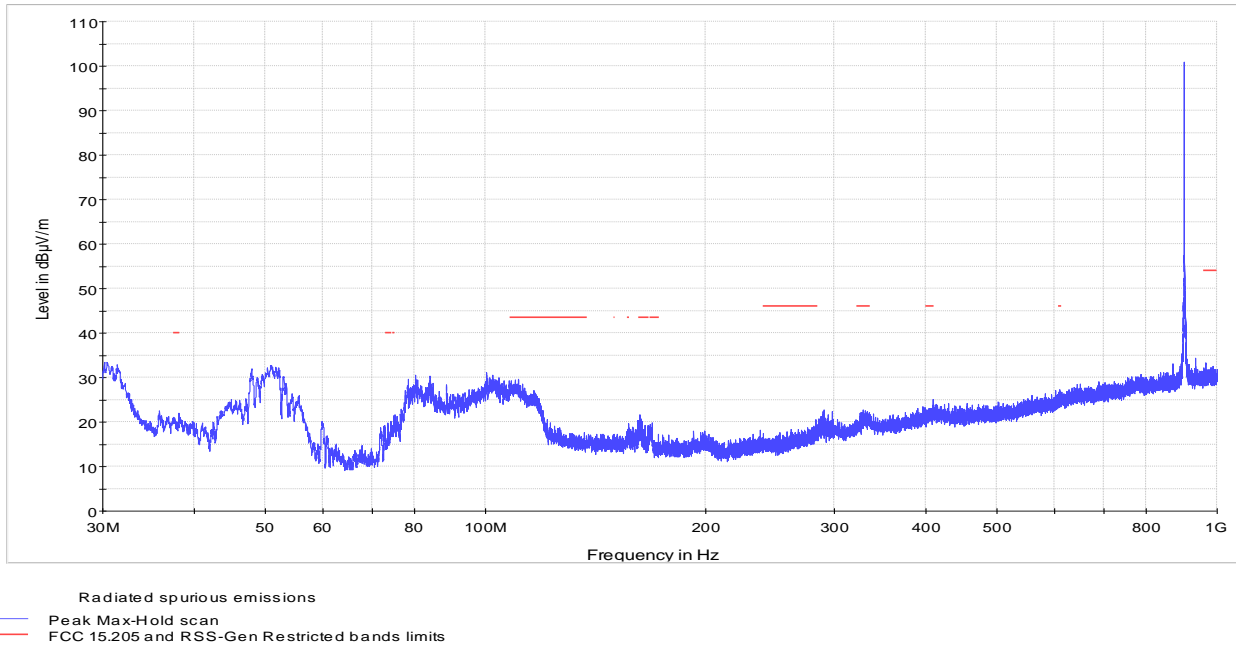


Figure 8.8-16: Radiated spurious emissions below 1 GHz for FHSS DRo, low channel, internal antenna

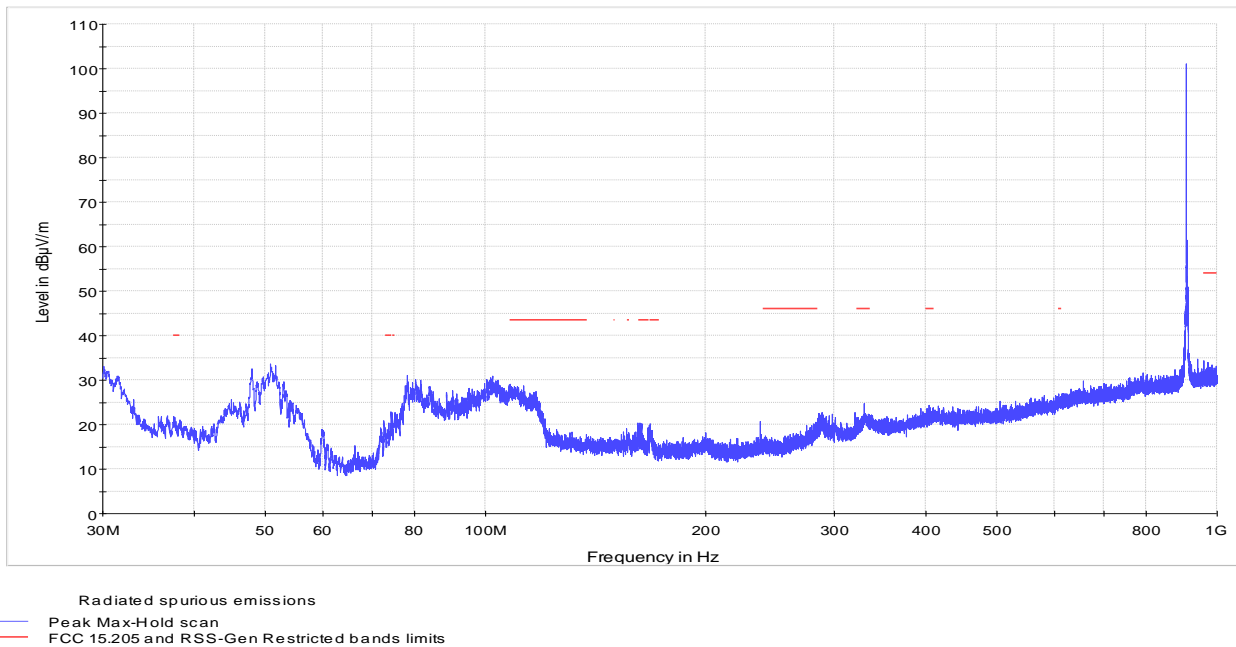


Figure 8.8-17: Radiated spurious emissions below 1 GHz for FHSS DRo, mid channel, internal antenna

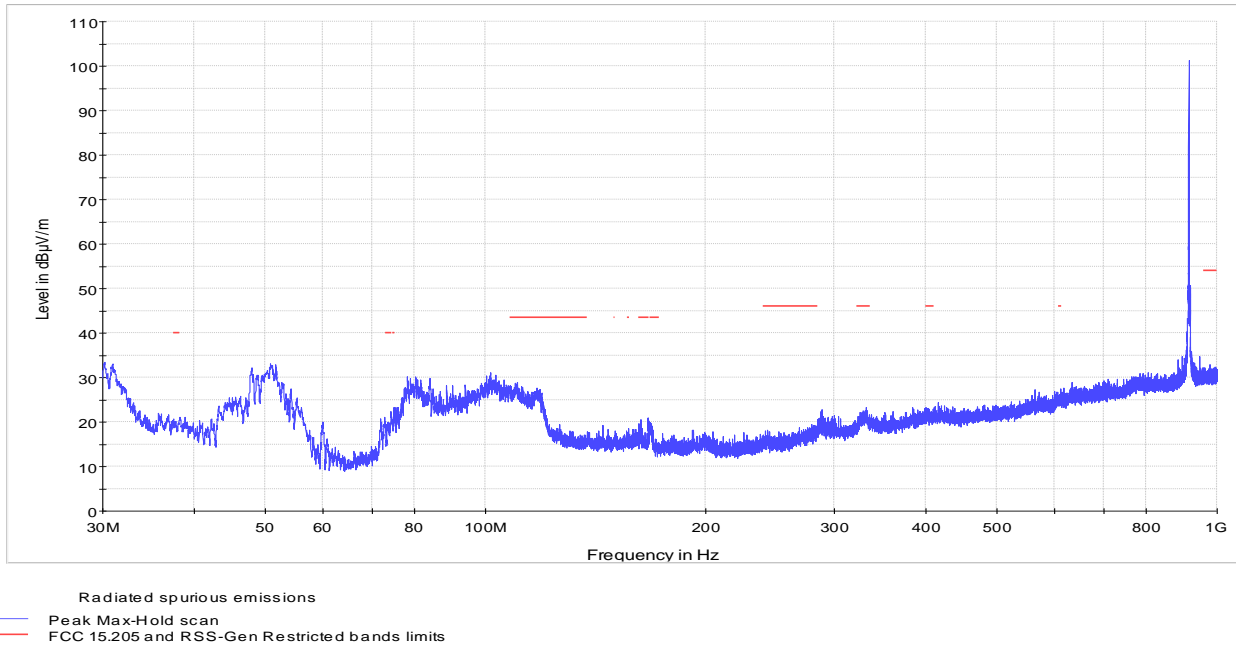


Figure 8.8-18: Radiated spurious emissions below 1 GHz for FHSS DR0, high channel, internal antenna

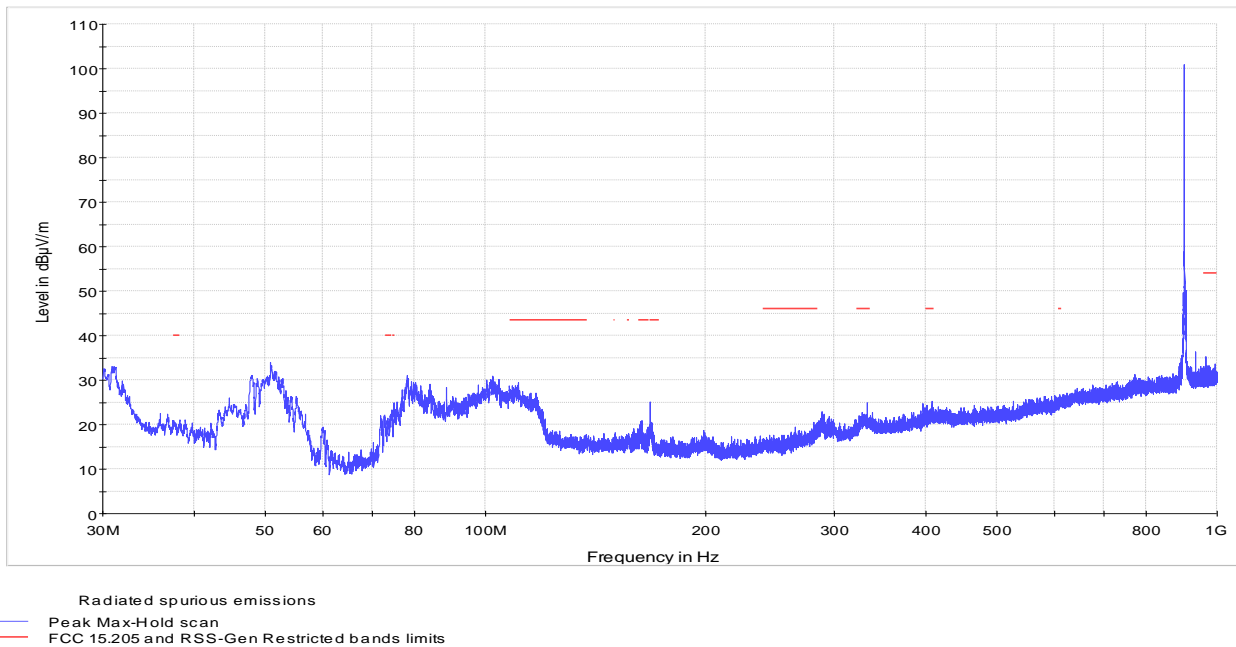
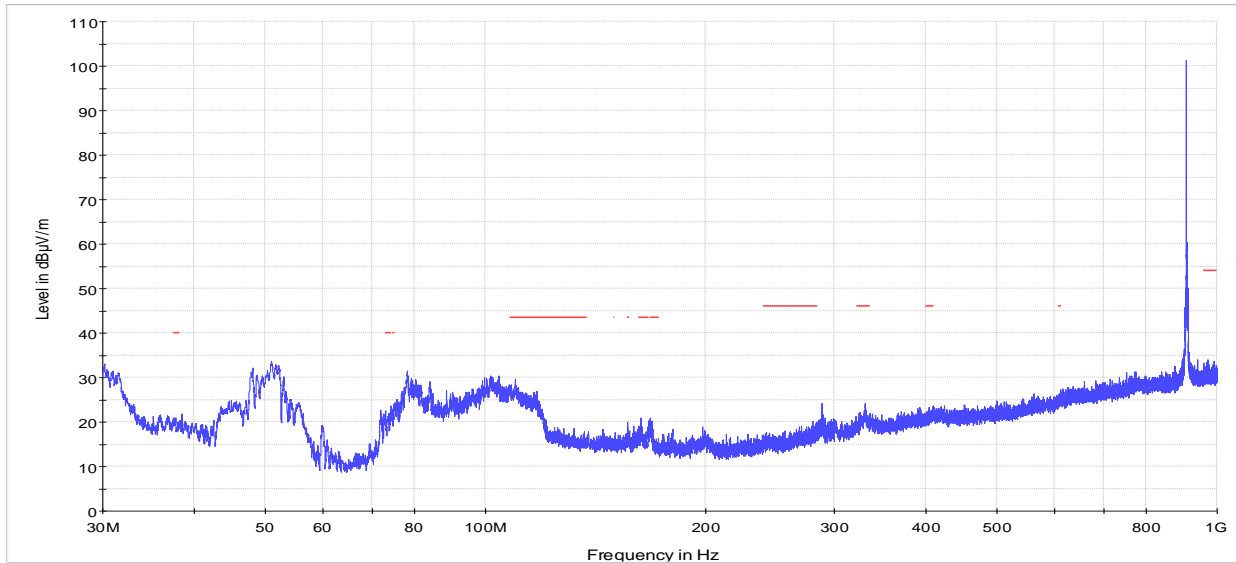
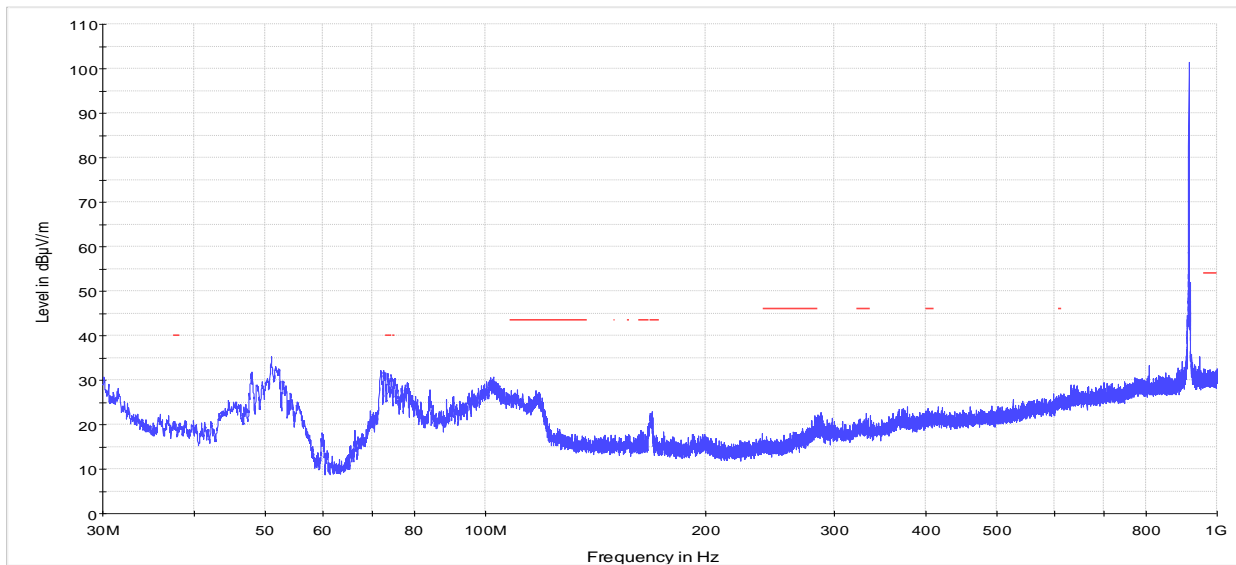


Figure 8.8-19: Radiated spurious emissions below 1 GHz for FHSS DR3, low channel, internal antenna



Radiated spurious emissions
— Peak Max-Hold scan
— FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-20: Radiated spurious emissions below 1 GHz for FHSS DR3, mid channel, internal antenna



Radiated spurious emissions
— Peak Max-Hold scan
— FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-21: Radiated spurious emissions below 1 GHz for FHSS DR3, high channel, internal antenna

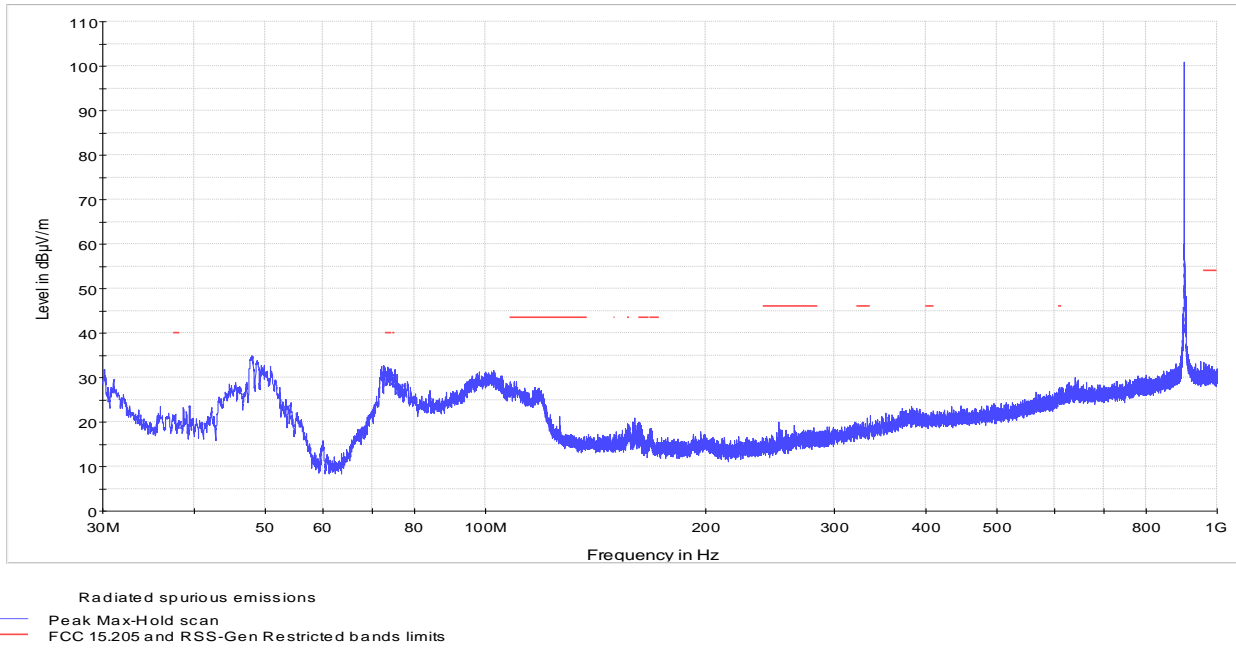


Figure 8.8-22: Radiated spurious emissions below 1 GHz for FHSS DR0, low channel, external antenna

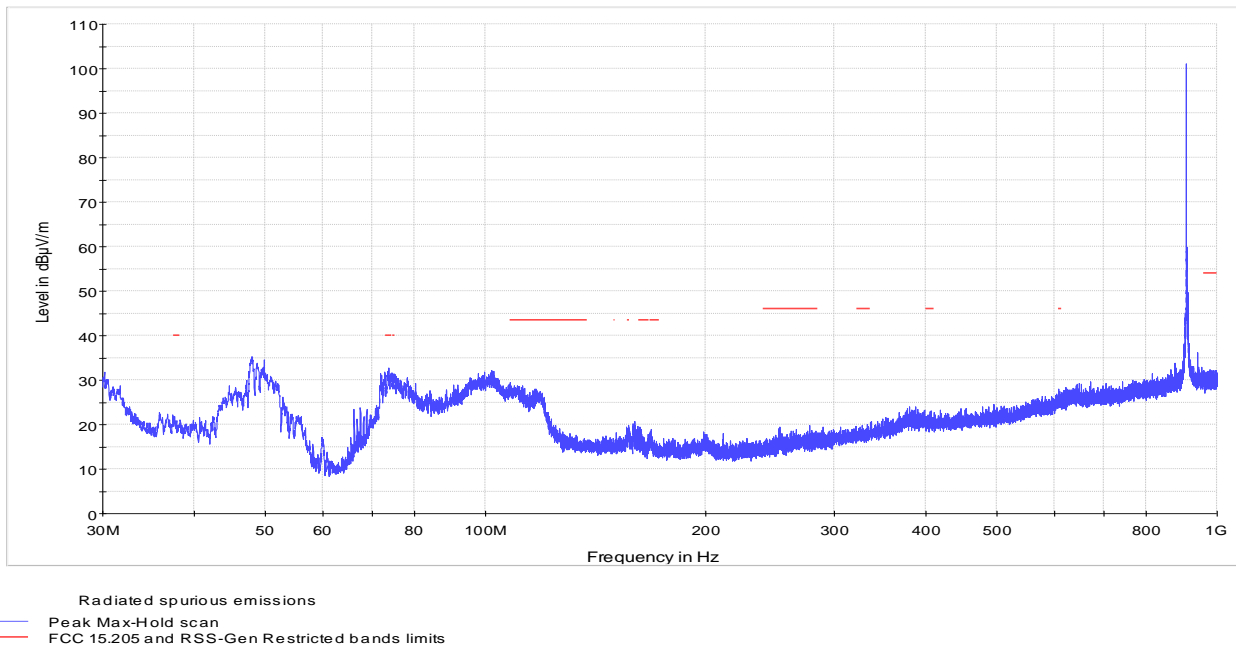


Figure 8.8-23: Radiated spurious emissions below 1 GHz for FHSS DR0, mid channel, external antenna

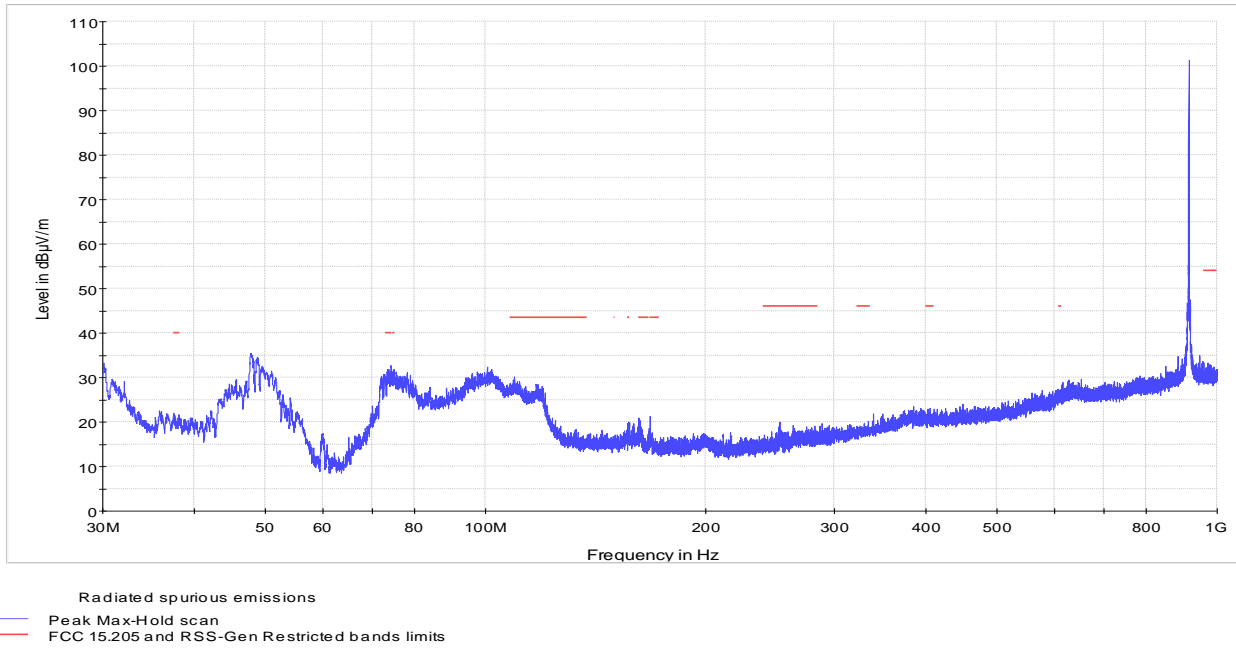


Figure 8.8-24: Radiated spurious emissions below 1 GHz for FHSS DR0, high channel, external antenna

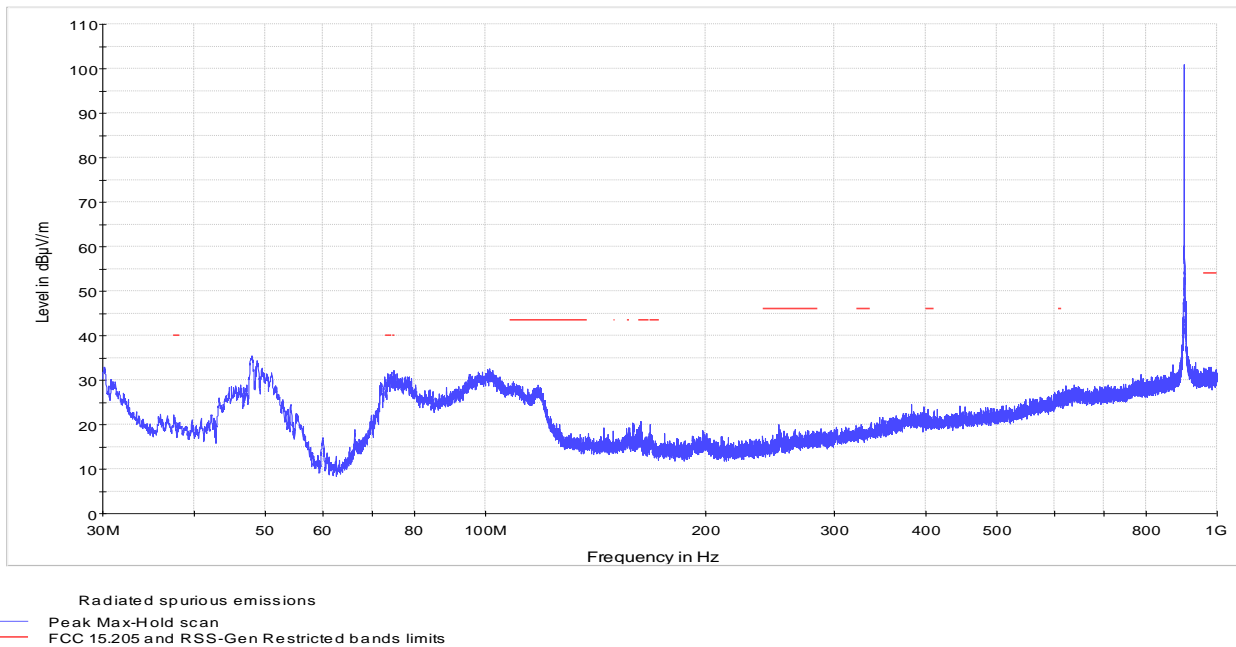


Figure 8.8-25: Radiated spurious emissions below 1 GHz for FHSS DR3, low channel, external antenna

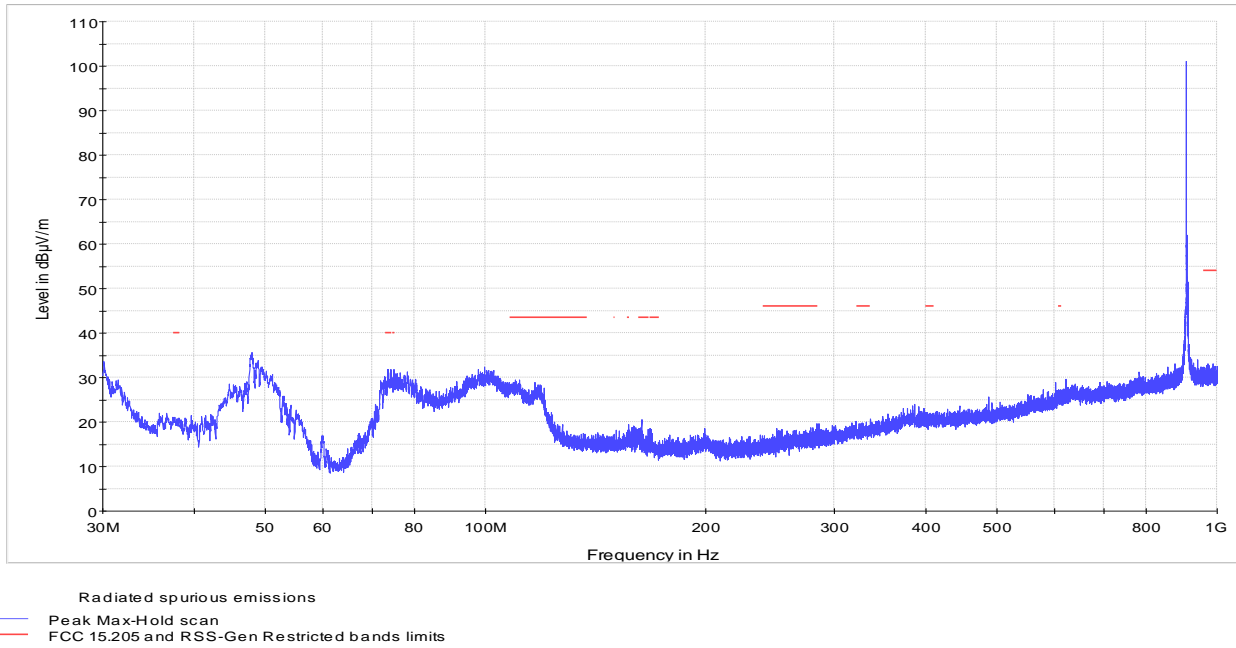


Figure 8.8-26: Radiated spurious emissions below 1 GHz for FHSS DR3, mid channel, external antenna

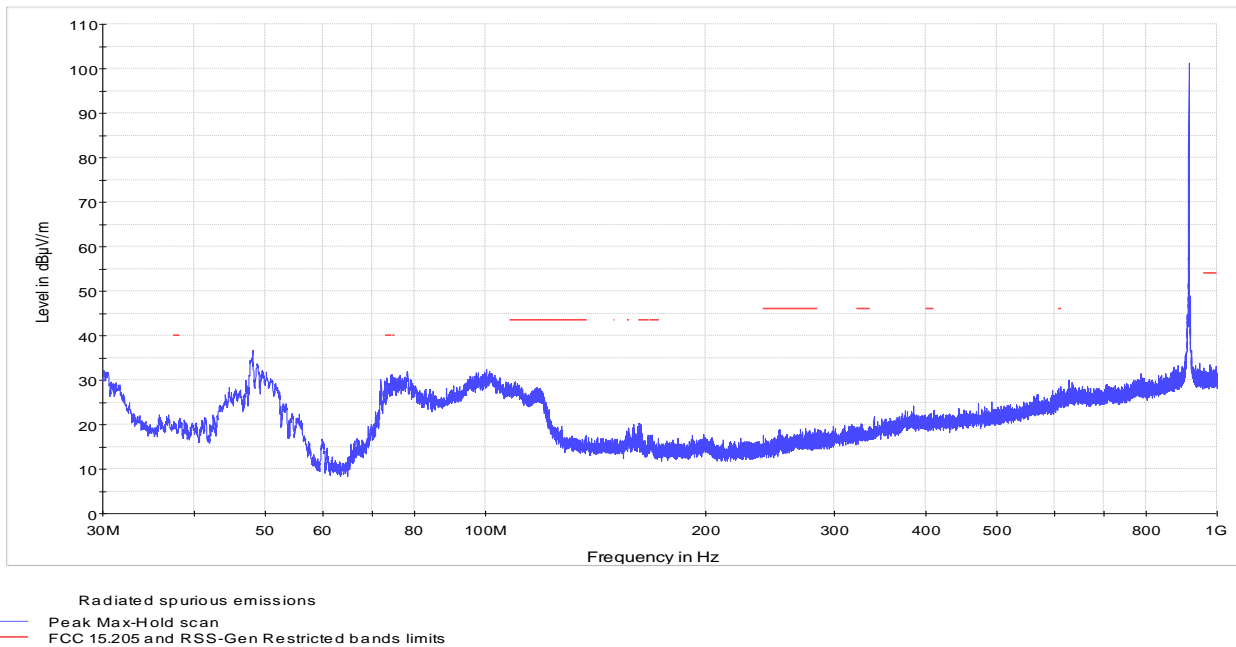


Figure 8.8-27: Radiated spurious emissions below 1 GHz for FHSS DR3, high channel, external antenna

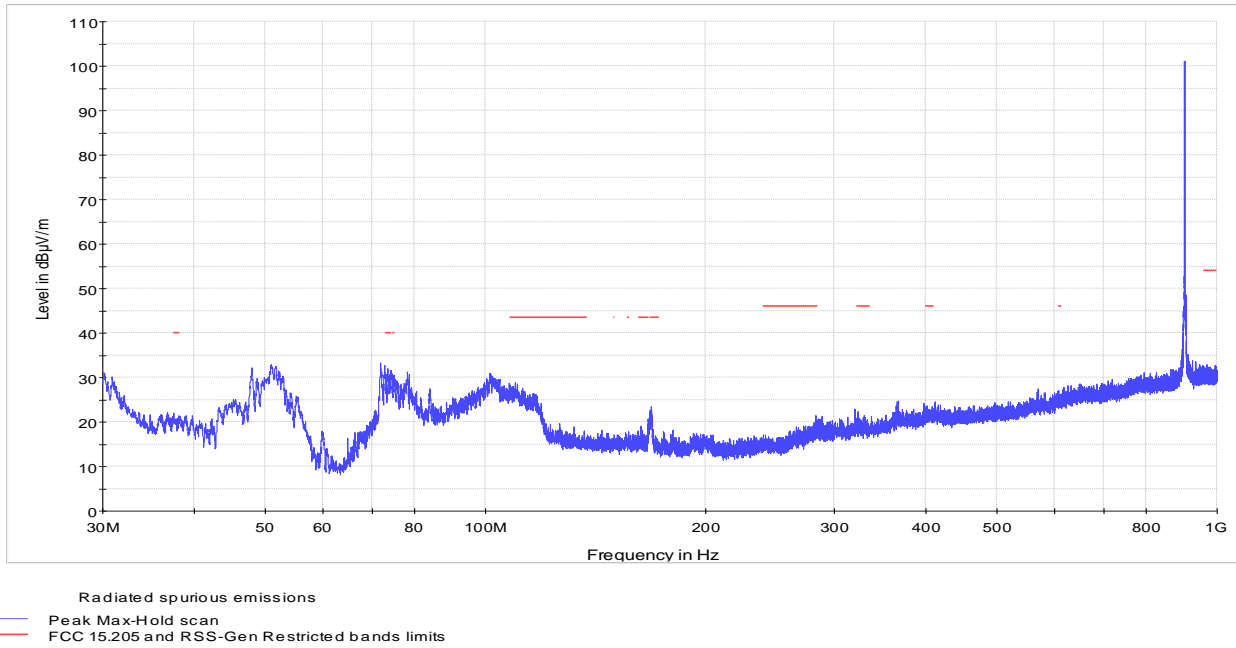


Figure 8.8-28: Radiated spurious emissions below 1 GHz for DTS, low channel, internal antenna

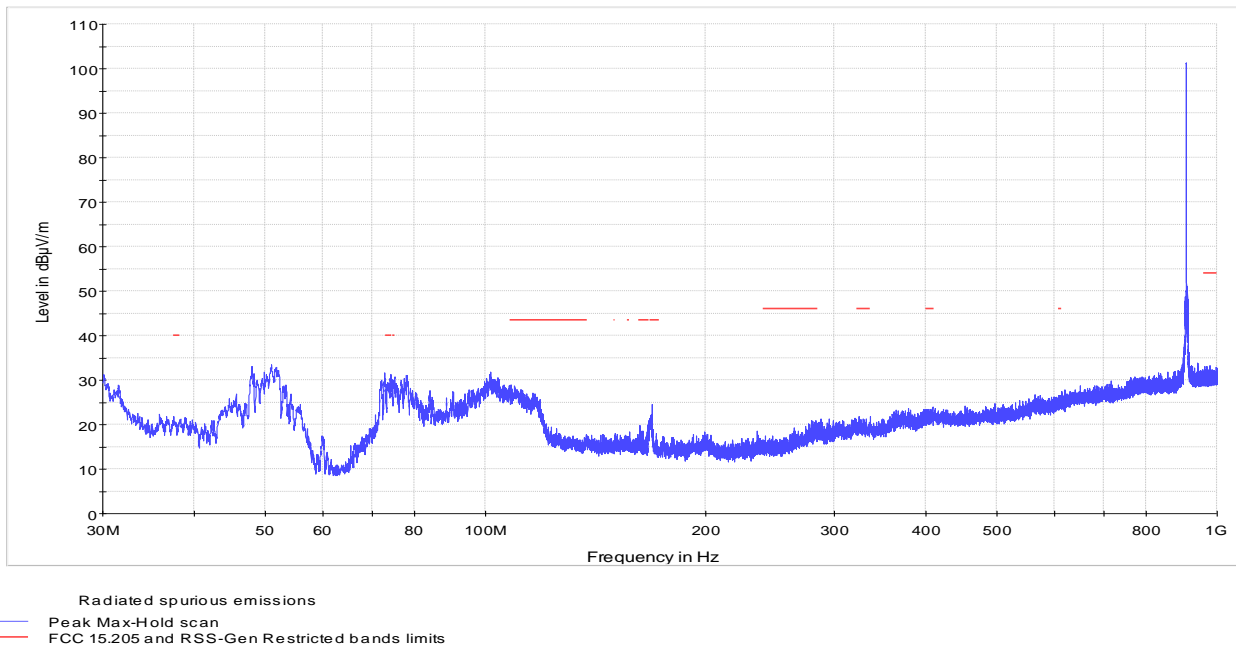
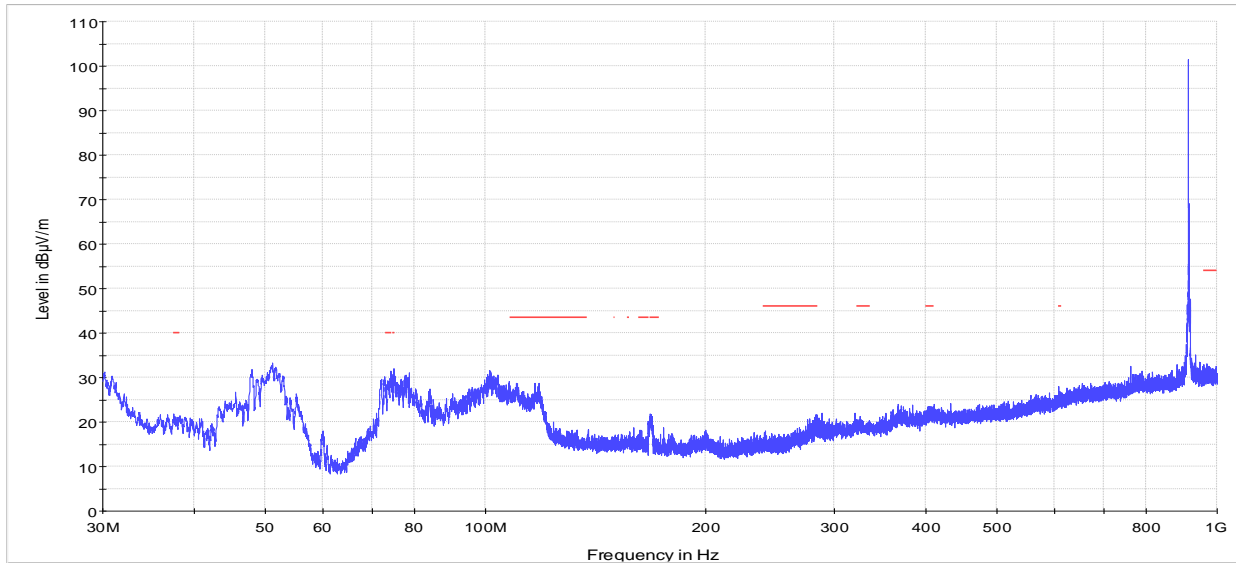
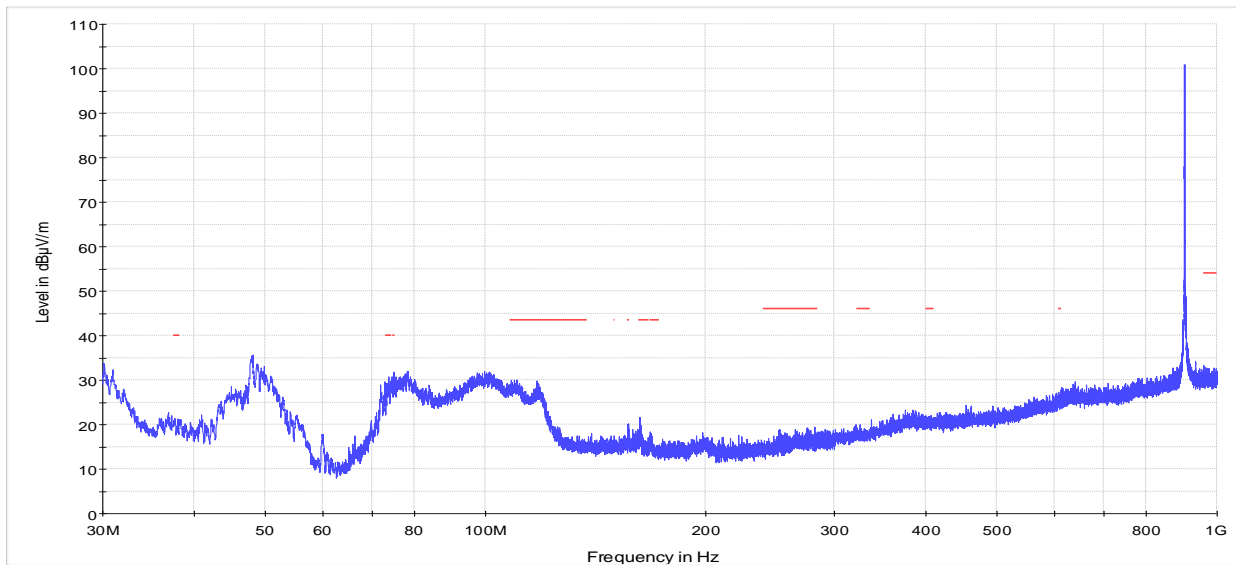


Figure 8.8-29: Radiated spurious emissions below 1 GHz for DTS, mid channel, internal antenna



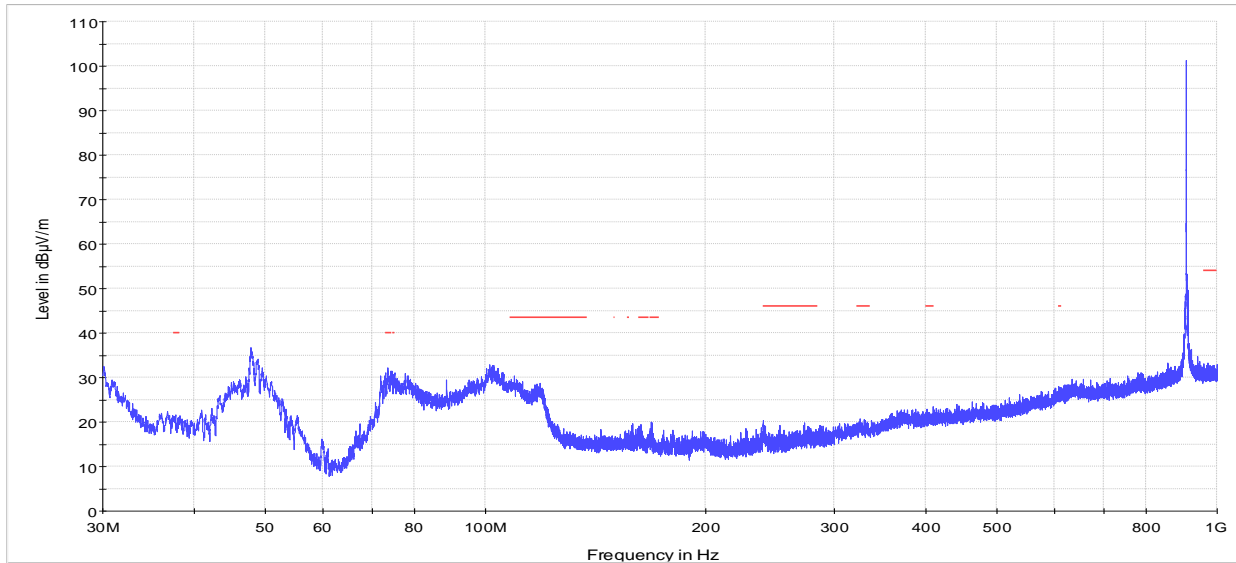
Radiated spurious emissions
— Peak Max-Hold scan
— FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-30: Radiated spurious emissions below 1 GHz for DTS, high channel, internal antenna



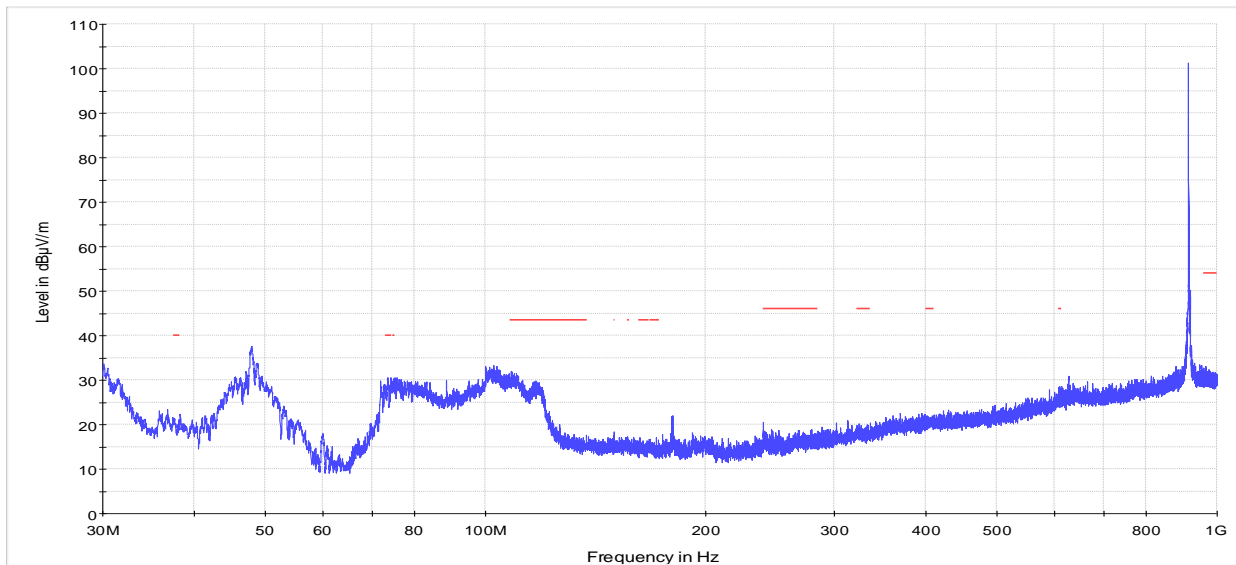
Radiated spurious emissions
— Peak Max-Hold scan
— FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-31: Radiated spurious emissions below 1 GHz for DTS, low channel, external antenna



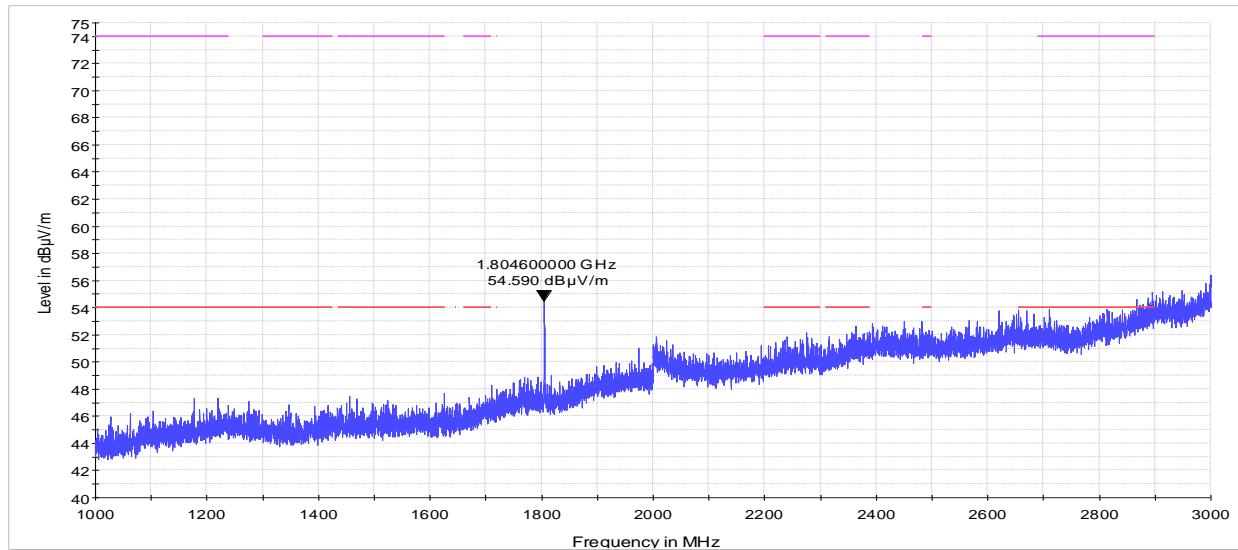
Radiated spurious emissions
— Peak Max-Hold scan
— FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-32: Radiated spurious emissions below 1 GHz for DTS, mid channel, external antenna



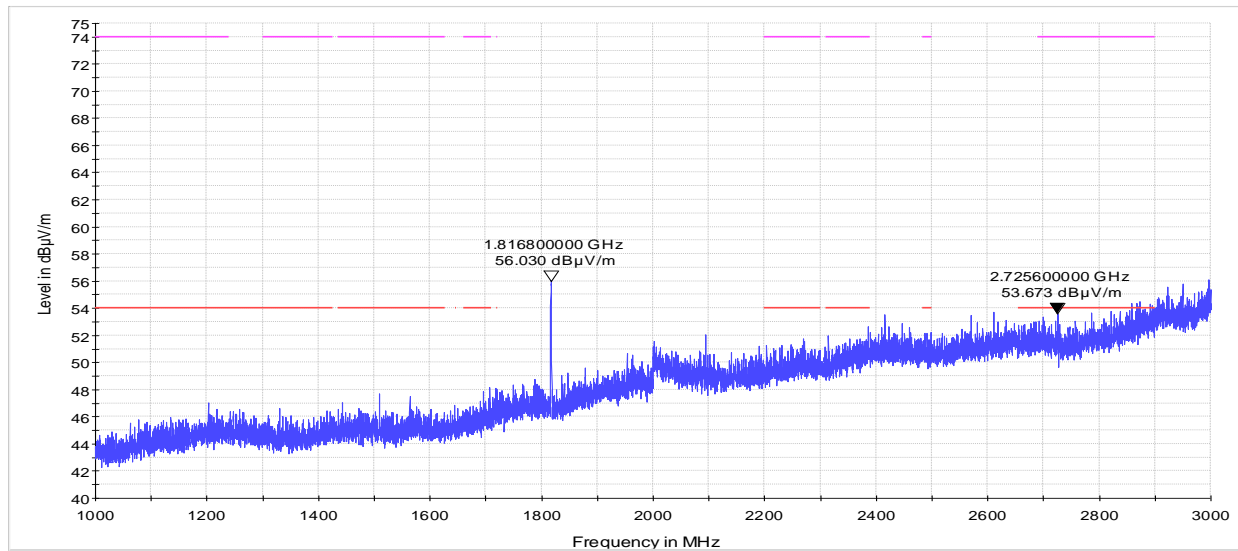
Radiated spurious emissions
— Peak Max-Hold scan
— FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-33: Radiated spurious emissions below 1 GHz for DTS, high channel, external antenna



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

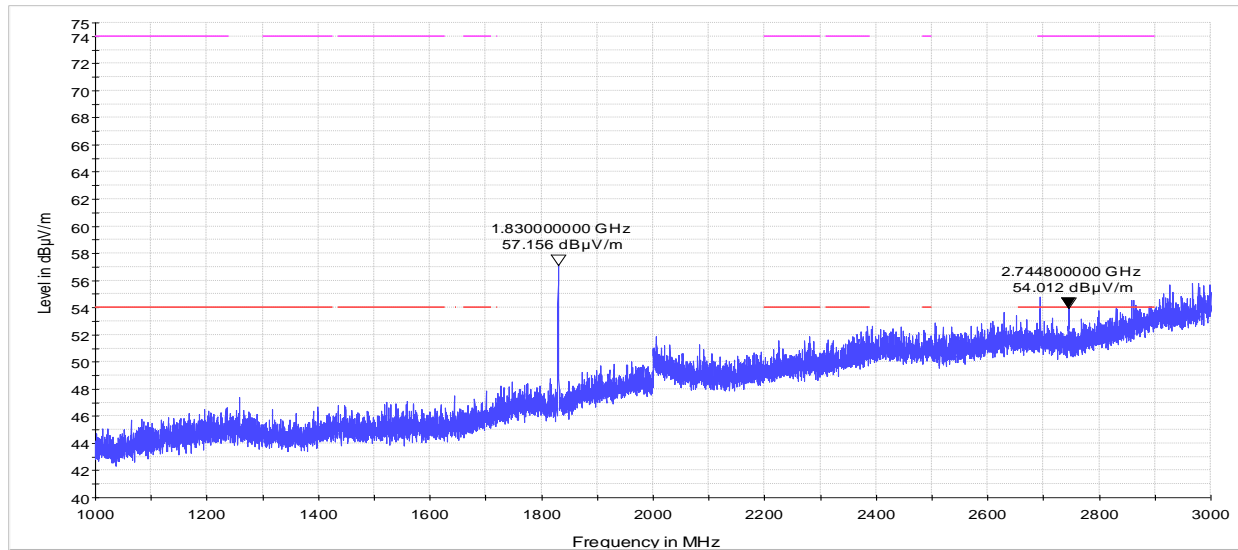
Figure 8.8-34: Radiated spurious emissions within 1–2 GHz for FHSS DR0, low channel, internal antenna



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

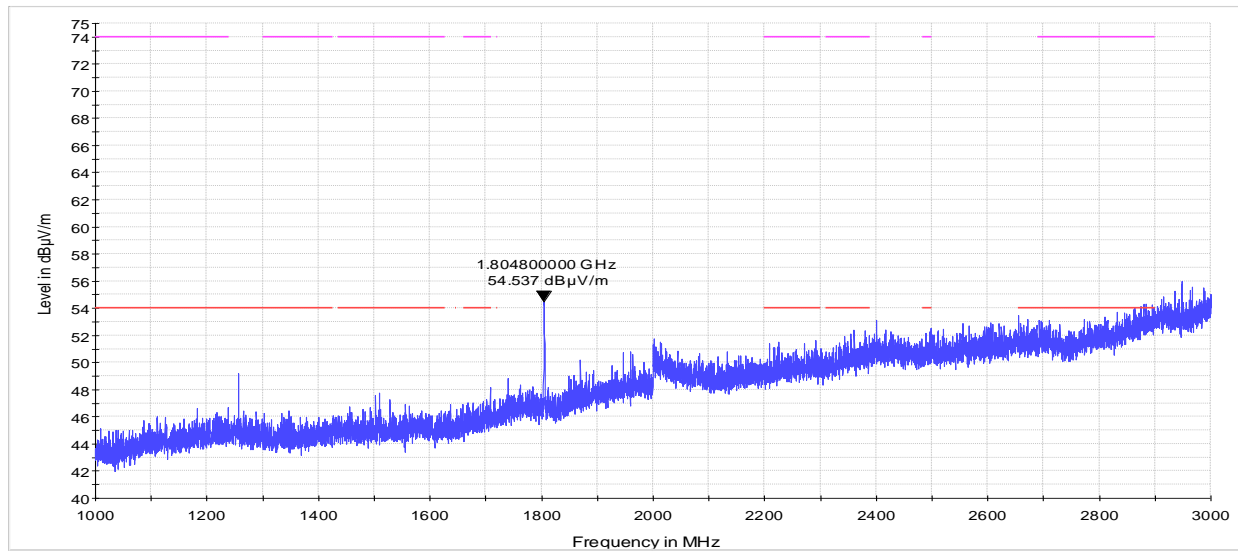
Figure 8.8-35: Radiated spurious emissions within 1–2 GHz for FHSS DR0, mid channel, internal antenna

Note: on this page only 1–2 GHz frequency range was investigated. Frequencies above 2 GHz were assessed separately with more appropriate setup. Test results are further below.



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

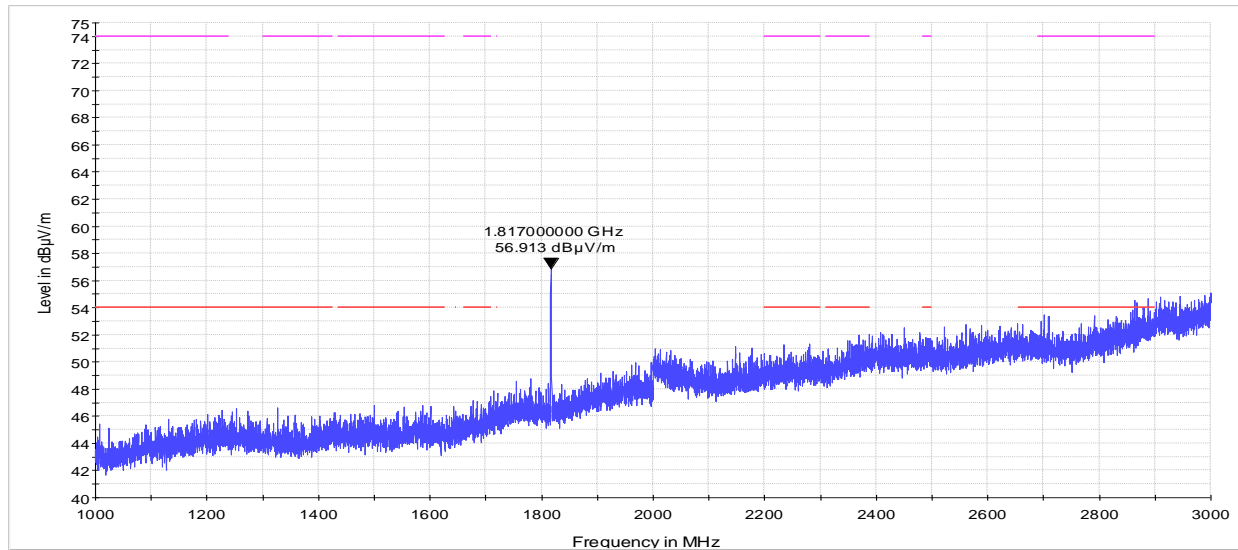
Figure 8.8-36: Radiated spurious emissions within 1–2 GHz for FHSS DR0, high channel, internal antenna



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

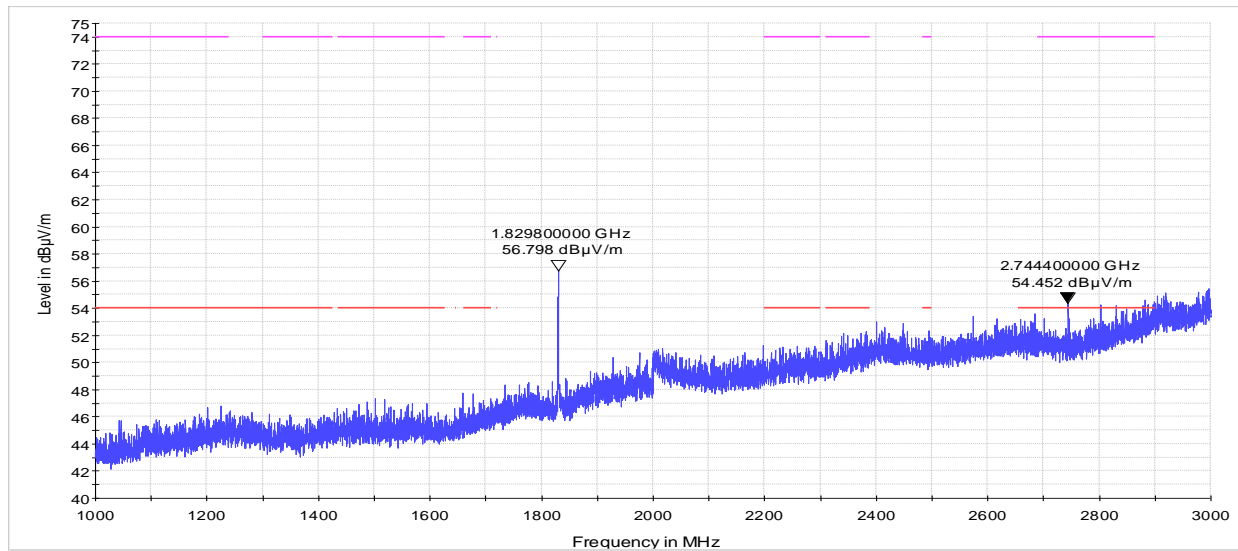
Figure 8.8-37: Radiated spurious emissions within 1–2 GHz for FHSS DR3, low channel, internal antenna

Note: on this page only 1–2 GHz frequency range was investigated. Frequencies above 2 GHz were assessed separately with more appropriate setup. Test results are further below.



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

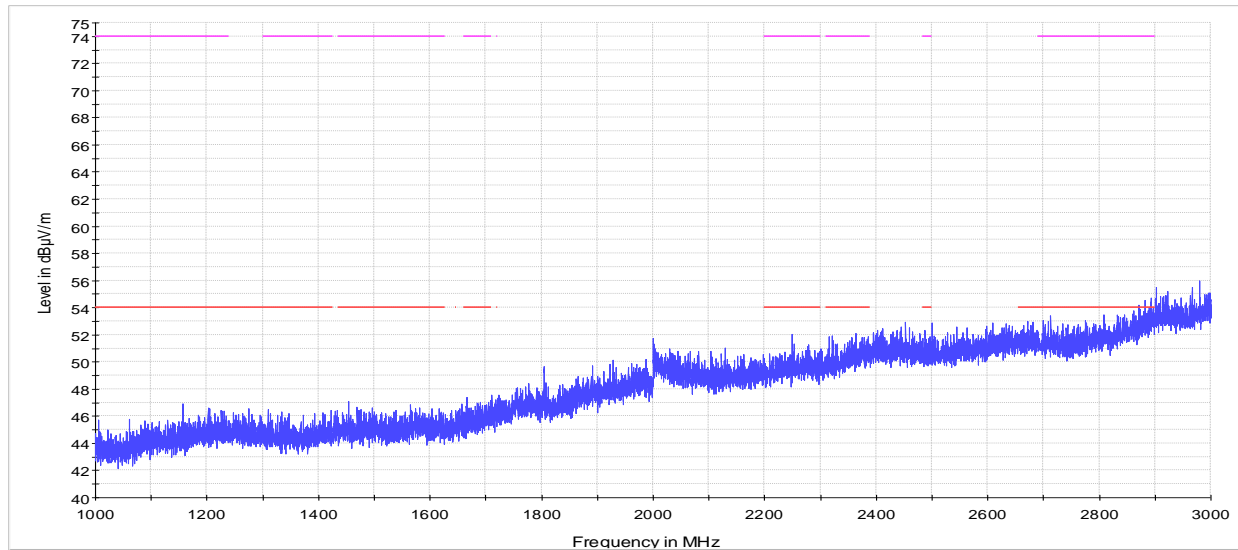
Figure 8.8-38: Radiated spurious emissions within 1–2 GHz for FHSS DR3, mid channel, internal antenna



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

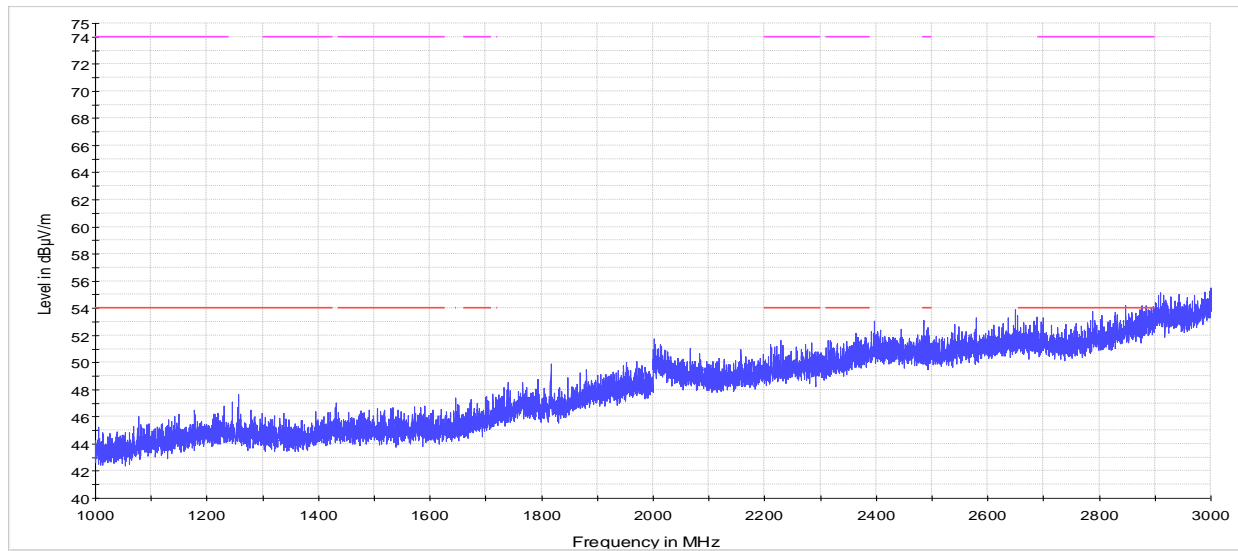
Figure 8.8-39: Radiated spurious emissions within 1–2 GHz for FHSS DR3, high channel, internal antenna

Note: on this page only 1–2 GHz frequency range was investigated. Frequencies above 2 GHz were assessed separately with more appropriate setup. Test results are further below.



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

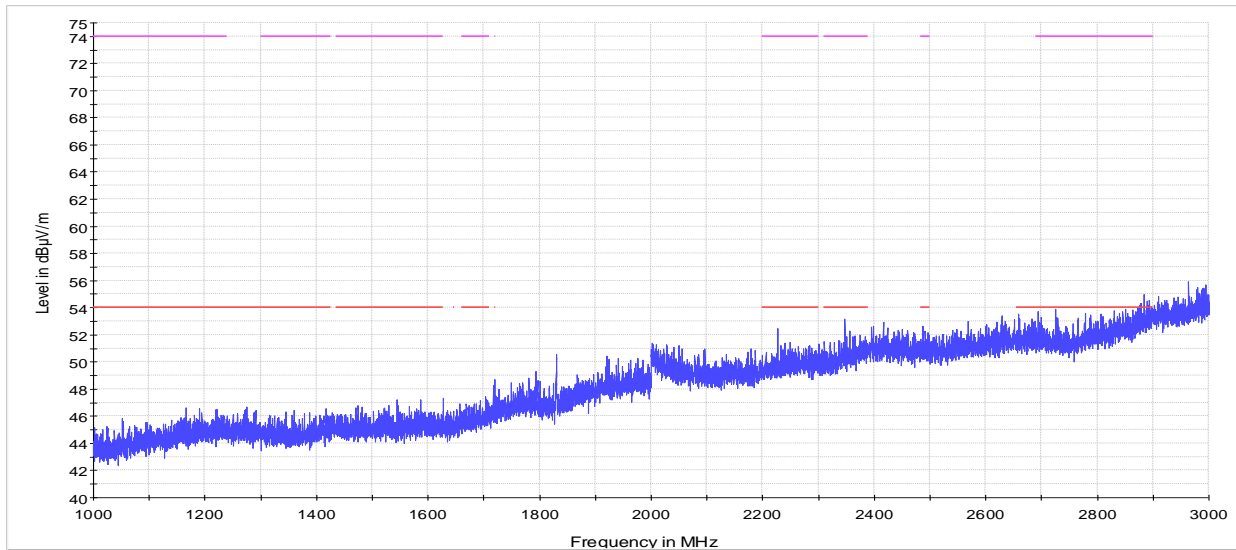
Figure 8.8-40: Radiated spurious emissions within 1–2 GHz for FHSS DR0, low channel, external antenna



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

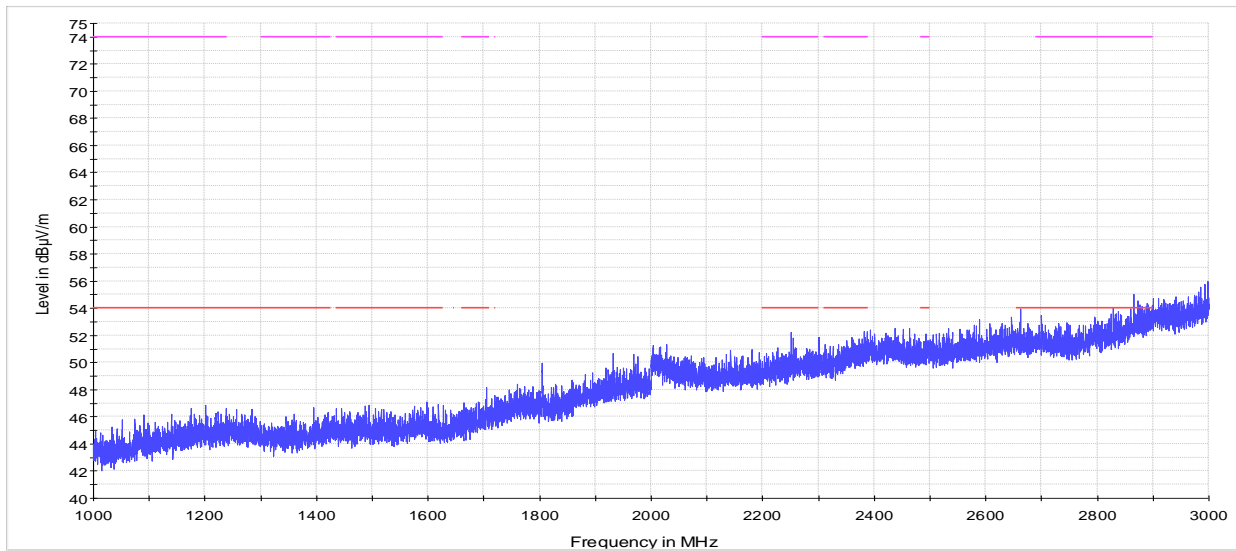
Figure 8.8-41: Radiated spurious emissions within 1–2 GHz for FHSS DR0, mid channel, external antenna

Note: on this page only 1–2 GHz frequency range was investigated. Frequencies above 2 GHz were assessed separately with more appropriate setup. Test results are further below.



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

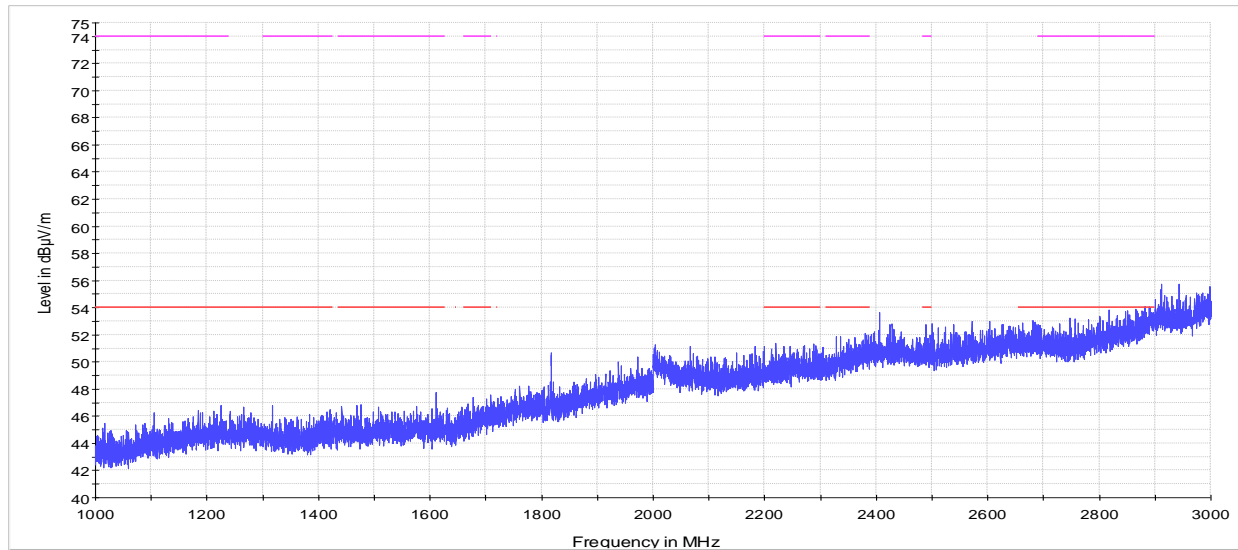
Figure 8.8-42: Radiated spurious emissions within 1–2 GHz for FHSS DR0, high channel, external antenna



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

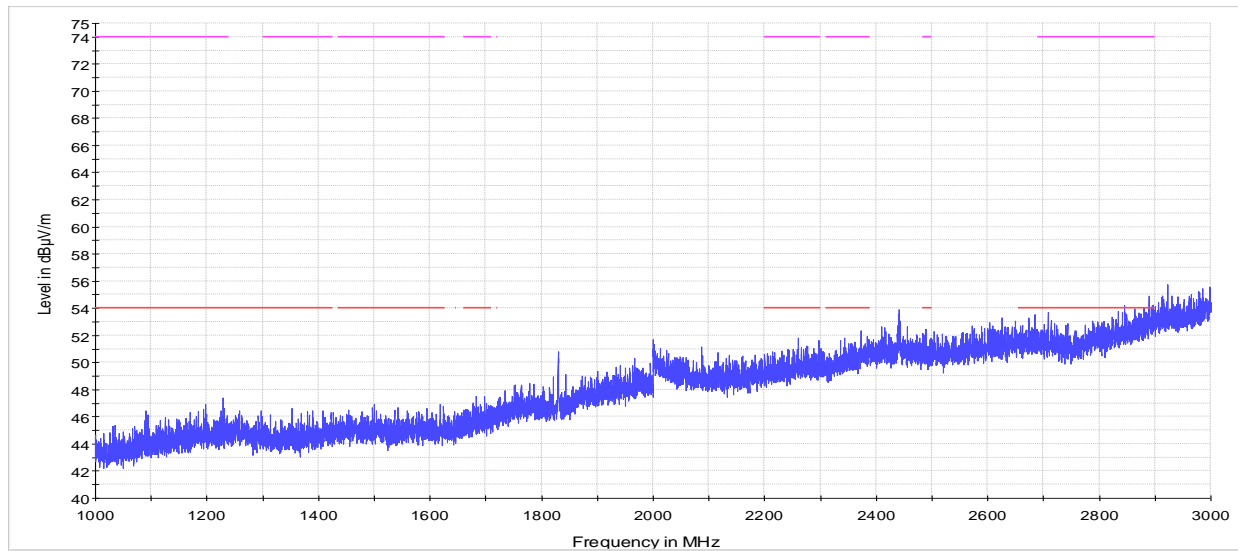
Figure 8.8-43: Radiated spurious emissions within 1–2 GHz for FHSS DR3, low channel, external antenna

Note: on this page only 1–2 GHz frequency range was investigated. Frequencies above 2 GHz were assessed separately with more appropriate setup. Test results are further below.



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

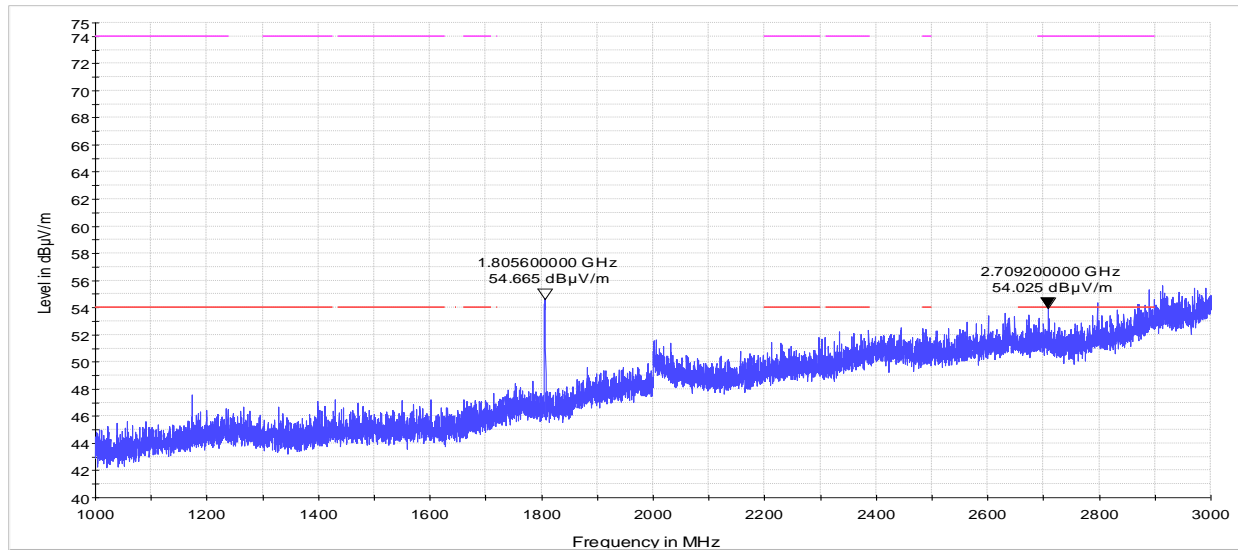
Figure 8.8-44: Radiated spurious emissions within 1–2 GHz for FHSS DR3, mid channel, external antenna



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

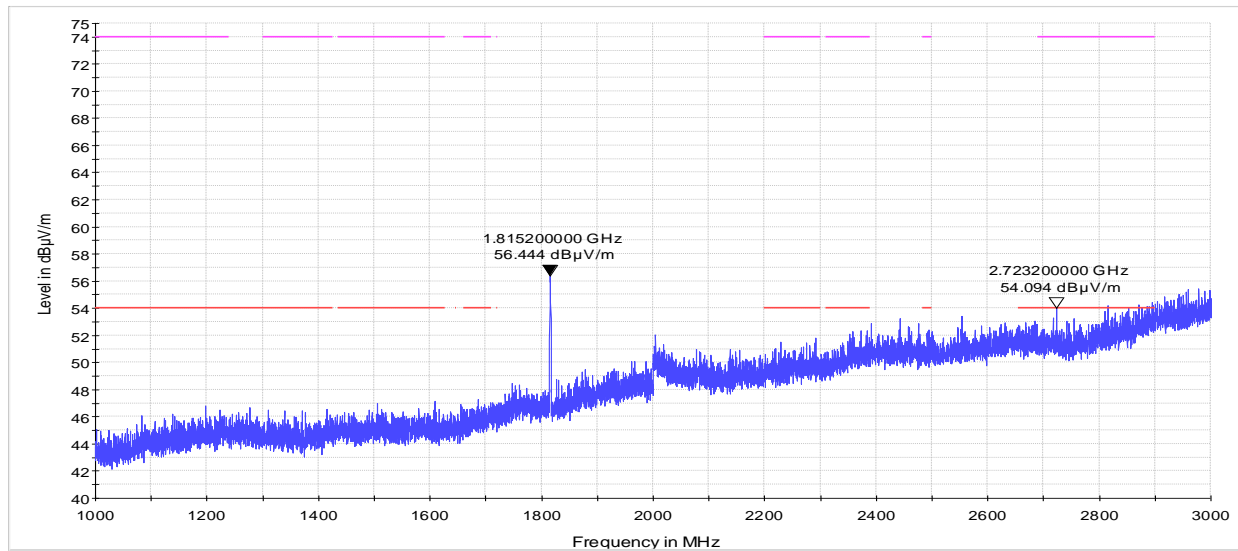
Figure 8.8-45: Radiated spurious emissions within 1–2 GHz for FHSS DR3, high channel, external antenna

Note: on this page only 1–2 GHz frequency range was investigated. Frequencies above 2 GHz were assessed separately with more appropriate setup. Test results are further below.



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

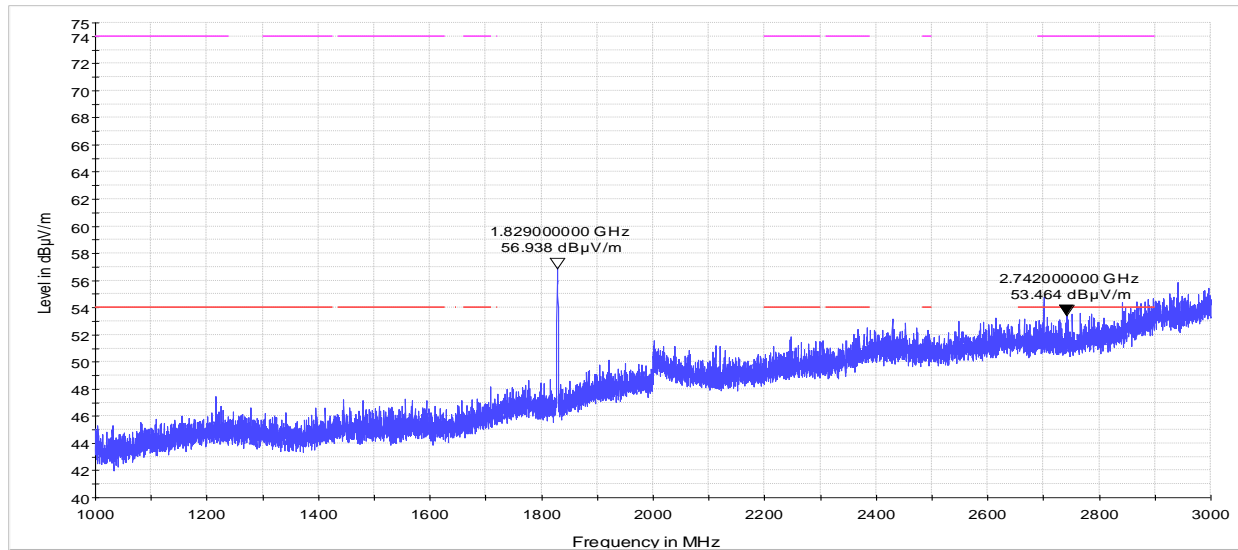
Figure 8.8-46: Radiated spurious emissions within 1–2 GHz for DTS, low channel, internal antenna



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

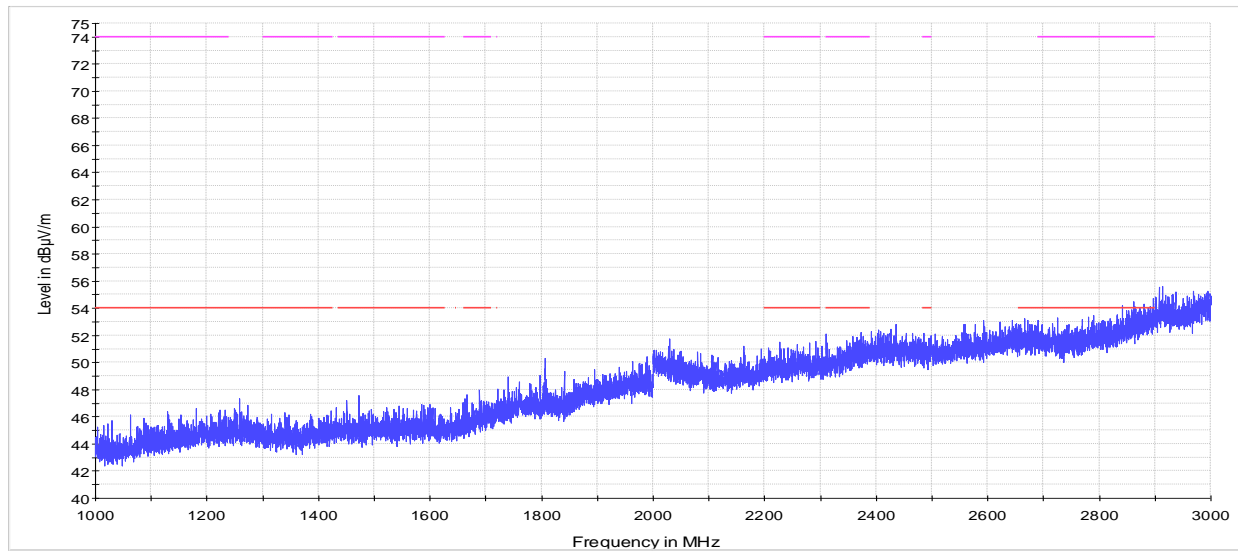
Figure 8.8-47: Radiated spurious emissions within 1–2 GHz for DTS, mid channel, internal antenna

Note: on this page only 1–2 GHz frequency range was investigated. Frequencies above 2 GHz were assessed separately with more appropriate setup. Test results are further below.



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

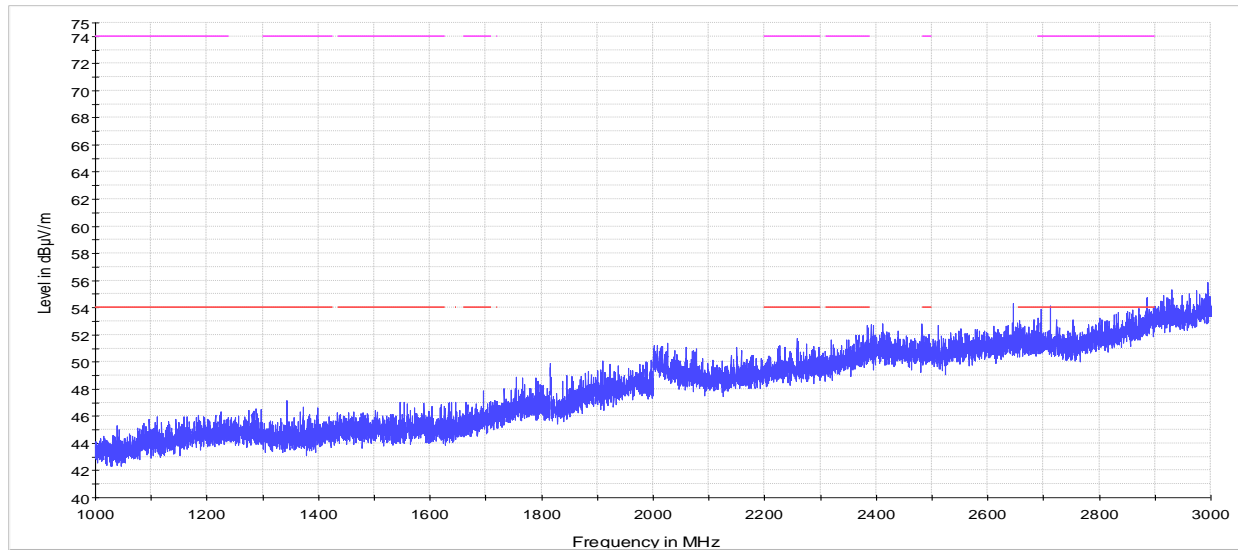
Figure 8.8-48: Radiated spurious emissions within 1–2 GHz for DTS, high channel, internal antenna



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

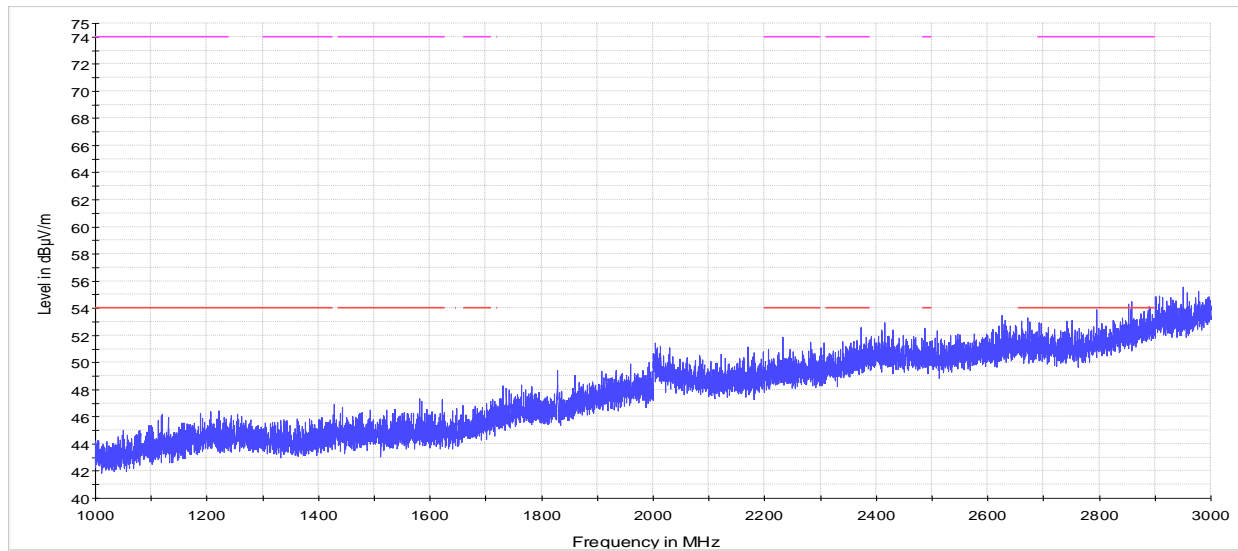
Figure 8.8-49: Radiated spurious emissions within 1–2 GHz for DTS, low channel, external antenna

Note: on this page only 1–2 GHz frequency range was investigated. Frequencies above 2 GHz were assessed separately with more appropriate setup. Test results are further below.



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

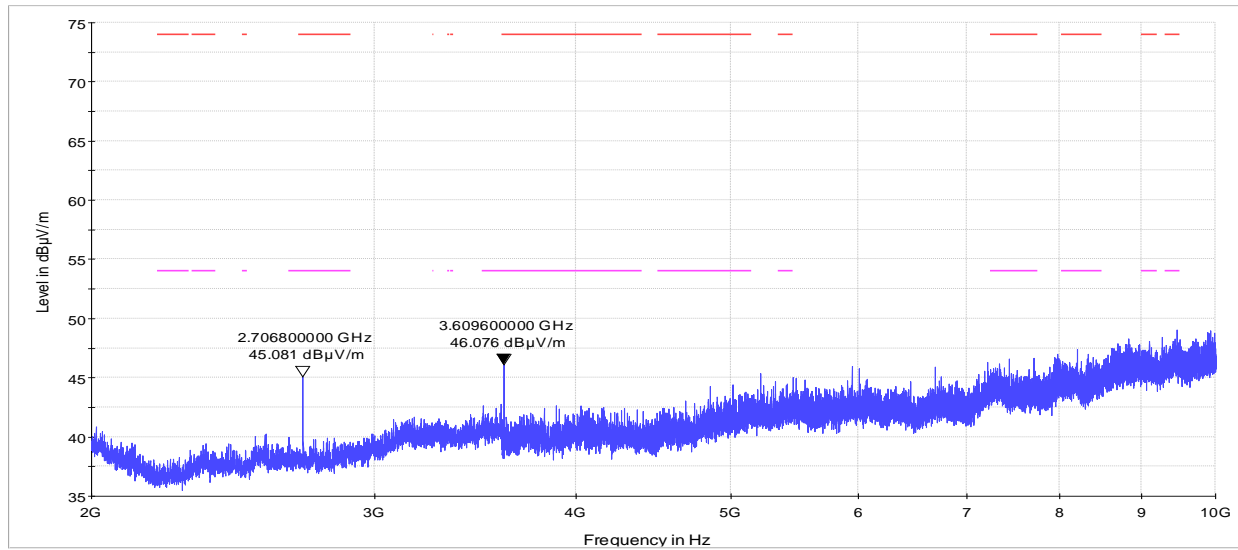
Figure 8.8-50: Radiated spurious emissions within 1–2 GHz for DTS, mid channel, external antenna



Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.205 and RSS-Gen Restricted bands average limits
 FCC 15.209 and RSS-Gen RB peak limit

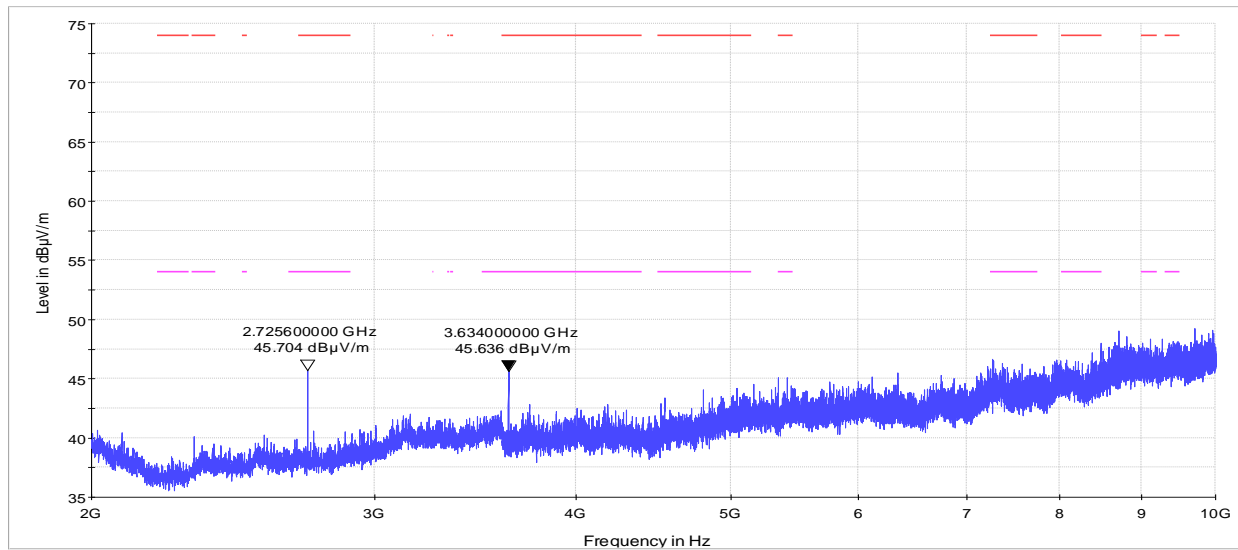
Figure 8.8-51: Radiated spurious emissions within 1–2 GHz for DTS, high channel, external antenna

Note: on this page only 1–2 GHz frequency range was investigated. Frequencies above 2 GHz were assessed separately with more appropriate setup. Test results are further below.



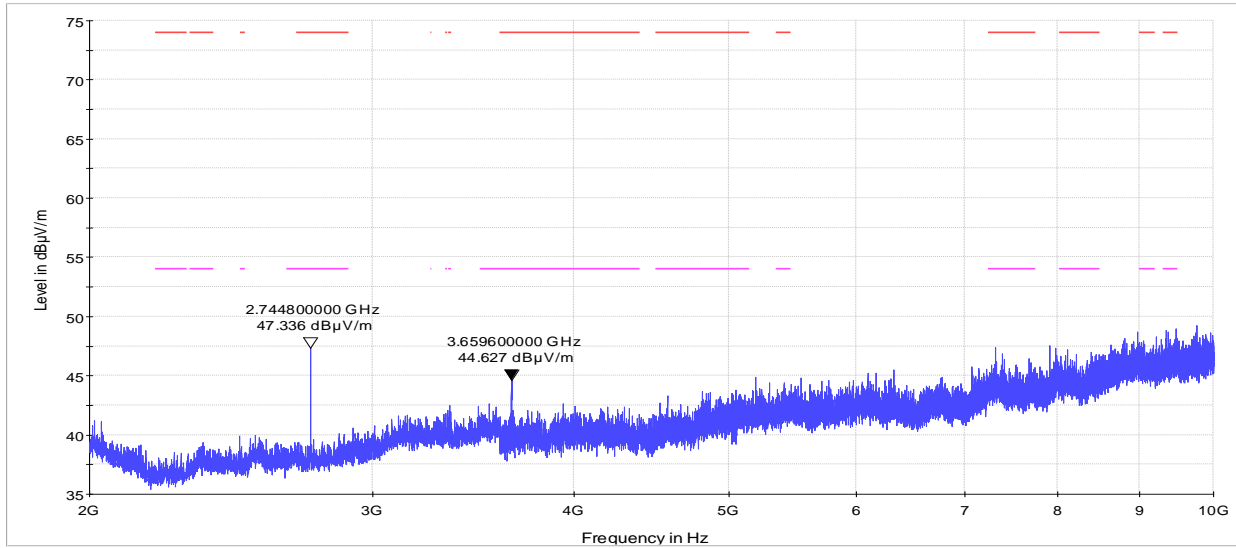
Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.209 and RSS-Gen RB peak limit
 FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-52: Radiated spurious emissions within 2–10 GHz for FHSS DRO, low channel, internal antenna



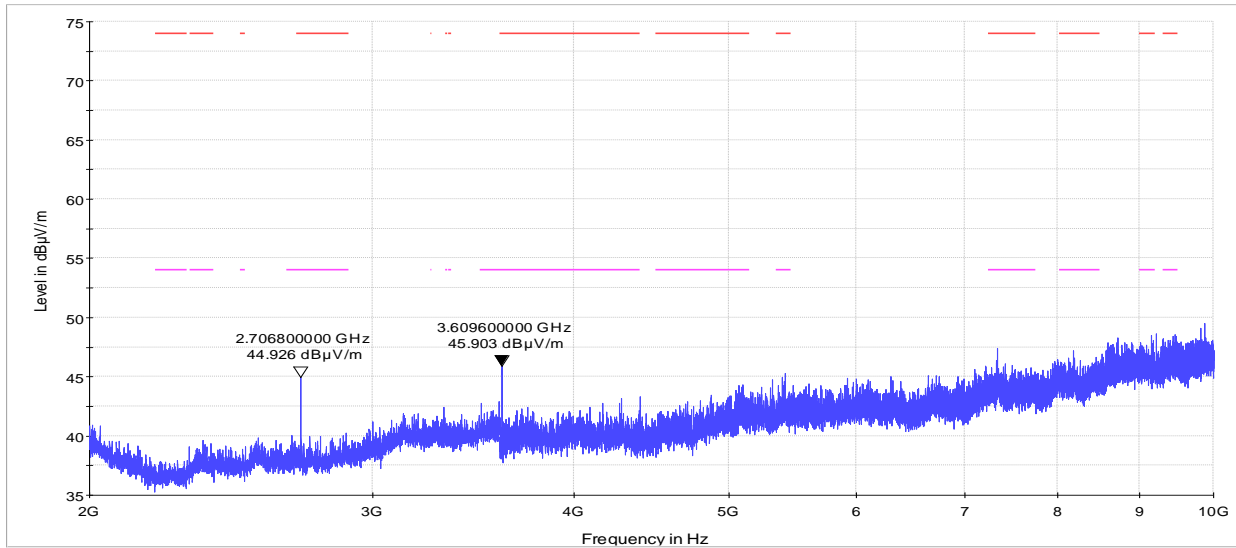
Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.209 and RSS-Gen RB peak limit
 FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-53: Radiated spurious emissions within 2–10 GHz for FHSS DRO, mid channel, internal antenna



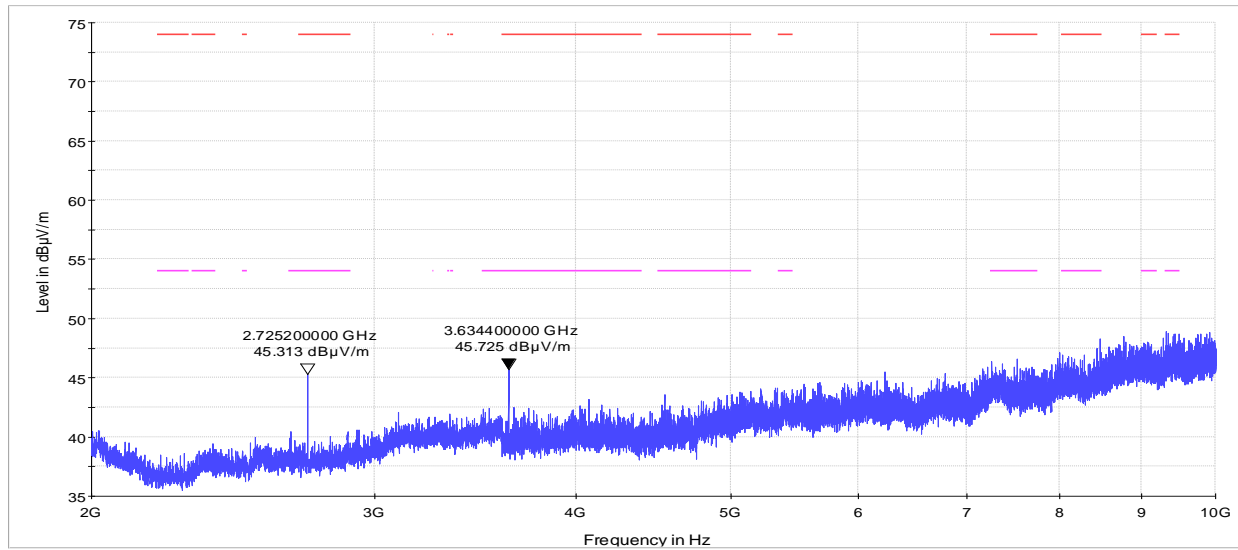
— Radiated spurious emissions
— Peak Max-Hold scan
— FCC 15.209 and RSS-Gen RB peak limit
— FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-54: Radiated spurious emissions within 2–10 GHz for FHSS DR0, high channel, internal antenna



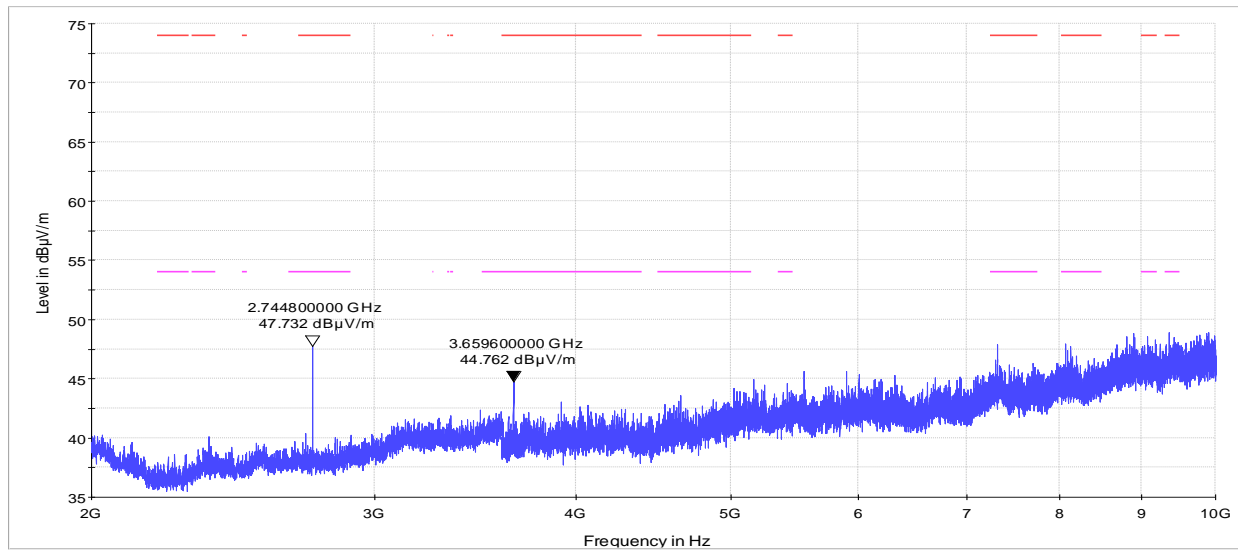
— Radiated spurious emissions
— Peak Max-Hold scan
— FCC 15.209 and RSS-Gen RB peak limit
— FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-55: Radiated spurious emissions within 2–10 GHz for FHSS DR3, low channel, internal antenna



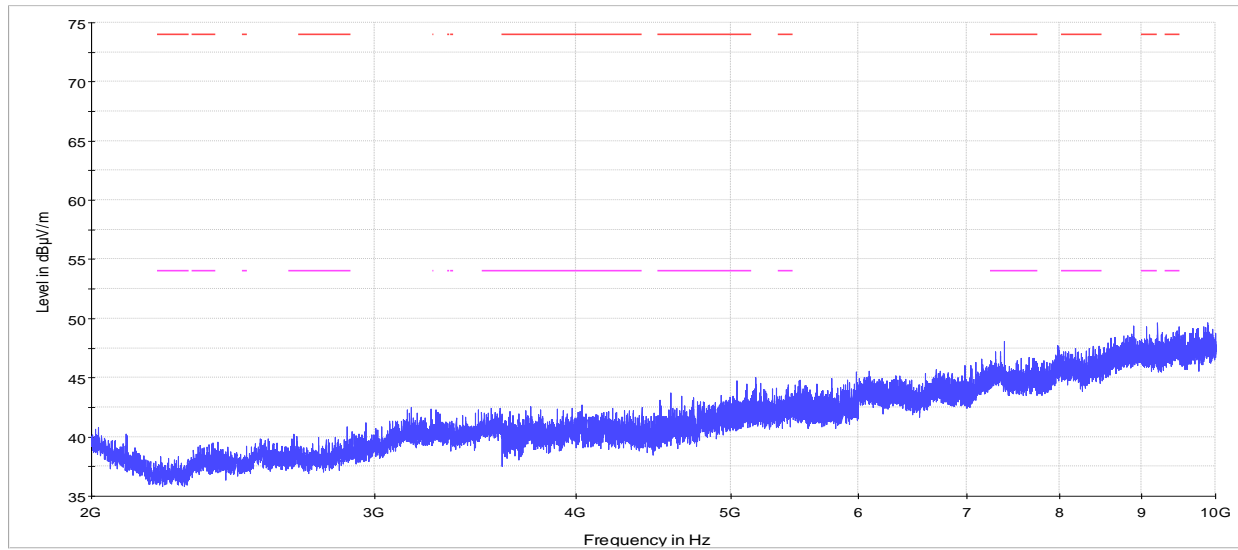
Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.209 and RSS-Gen RB peak limit
 FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-56: Radiated spurious emissions within 2–10 GHz for FHSS DR3, mid channel, internal antenna



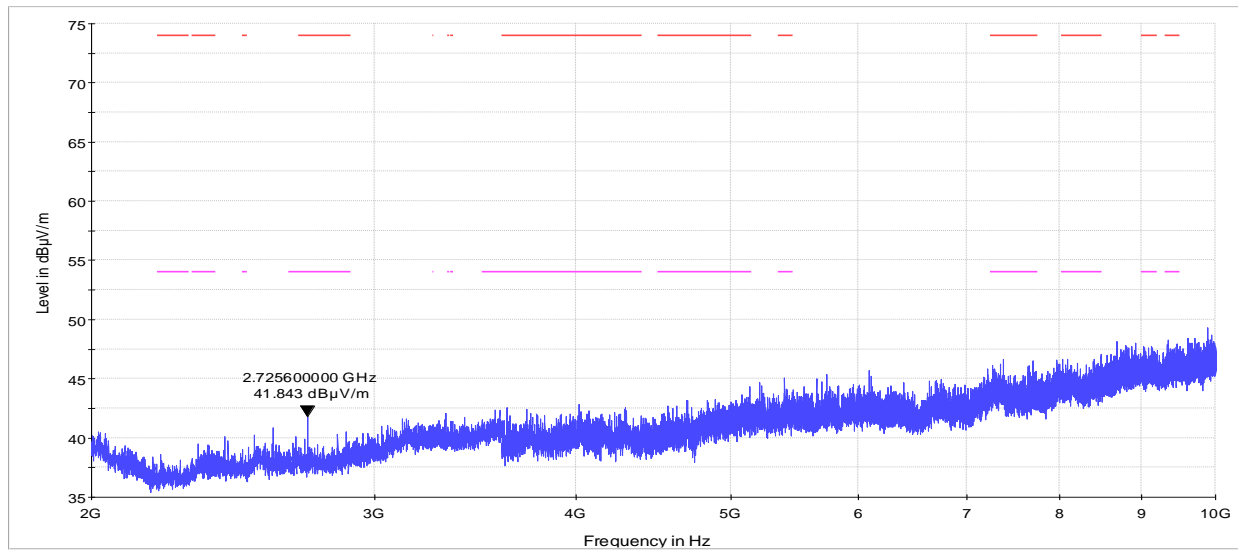
Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.209 and RSS-Gen RB peak limit
 FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-57: Radiated spurious emissions within 2–10 GHz for FHSS DR3, high channel, internal antenna



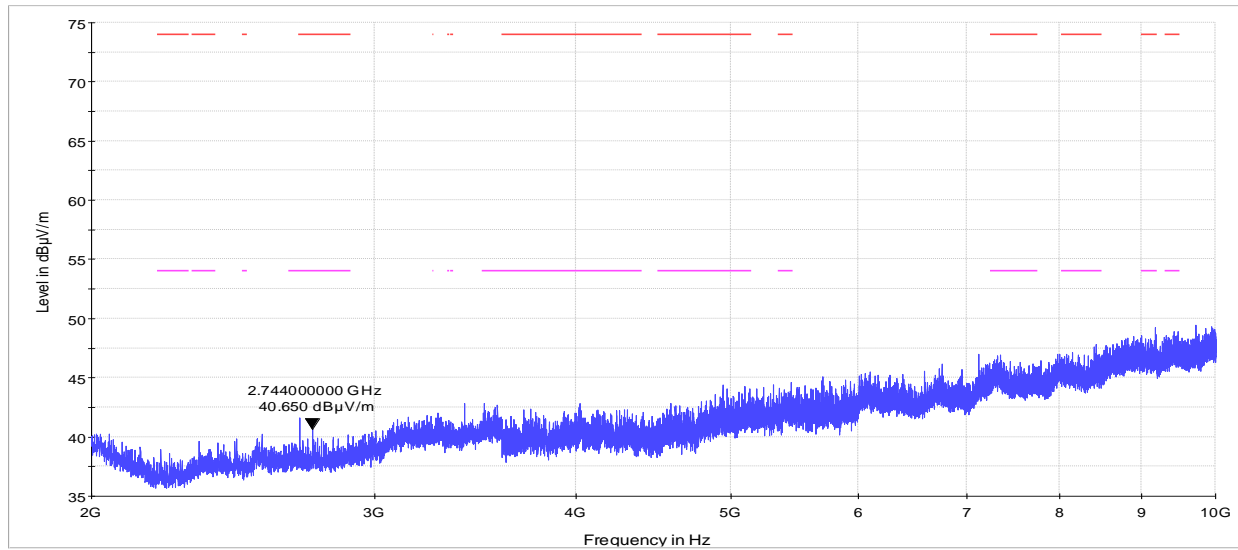
— Radiated spurious emissions
— Peak Max-Hold scan
— FCC 15.209 and RSS-Gen RB peak limit
— FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-58: Radiated spurious emissions within 2–10 GHz for FHSS DRO, low channel, external antenna



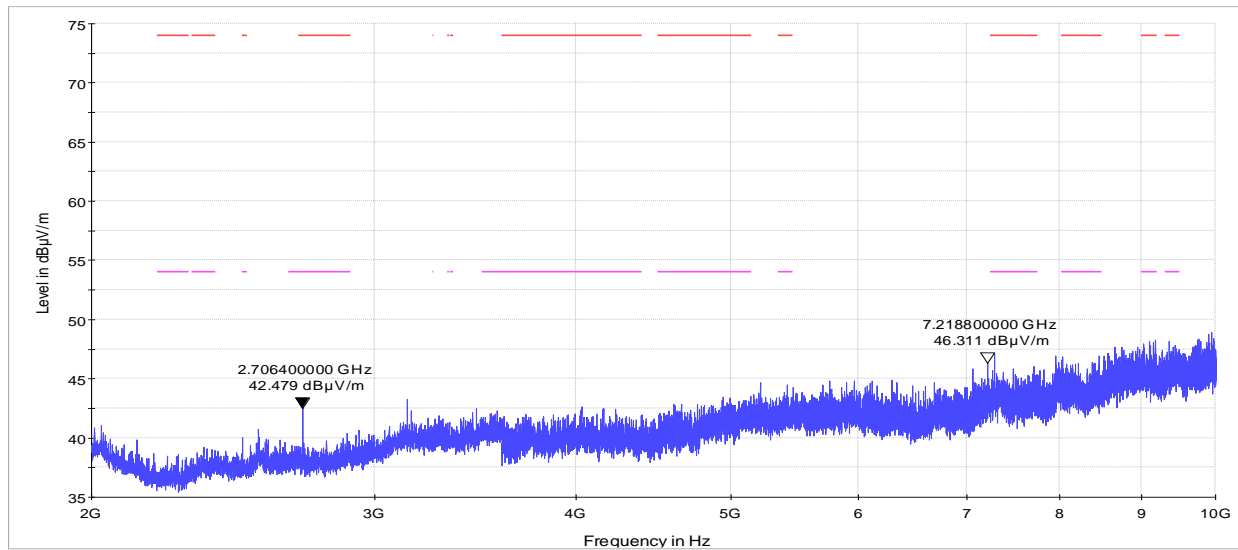
— Radiated spurious emissions
— Peak Max-Hold scan
— FCC 15.209 and RSS-Gen RB peak limit
— FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-59: Radiated spurious emissions within 2–10 GHz for FHSS DRO, mid channel, external antenna



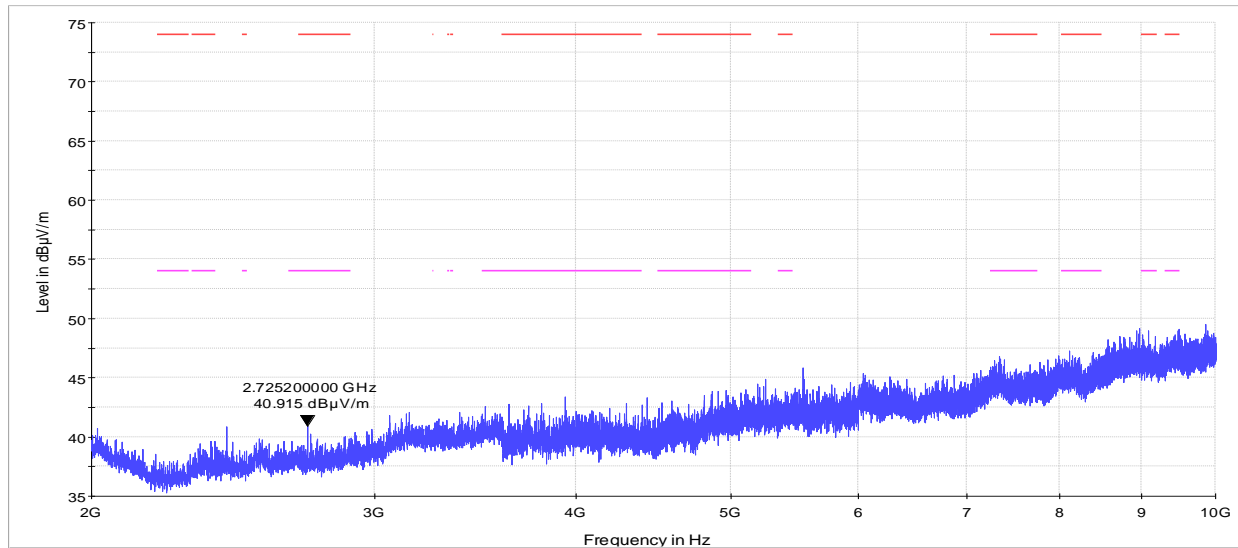
Radiated spurious emissions
— Peak Max-Hold scan
— FCC 15.209 and RSS-Gen RB peak limit
— FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-60: Radiated spurious emissions within 2–10 GHz for FHSS DR0, high channel, external antenna



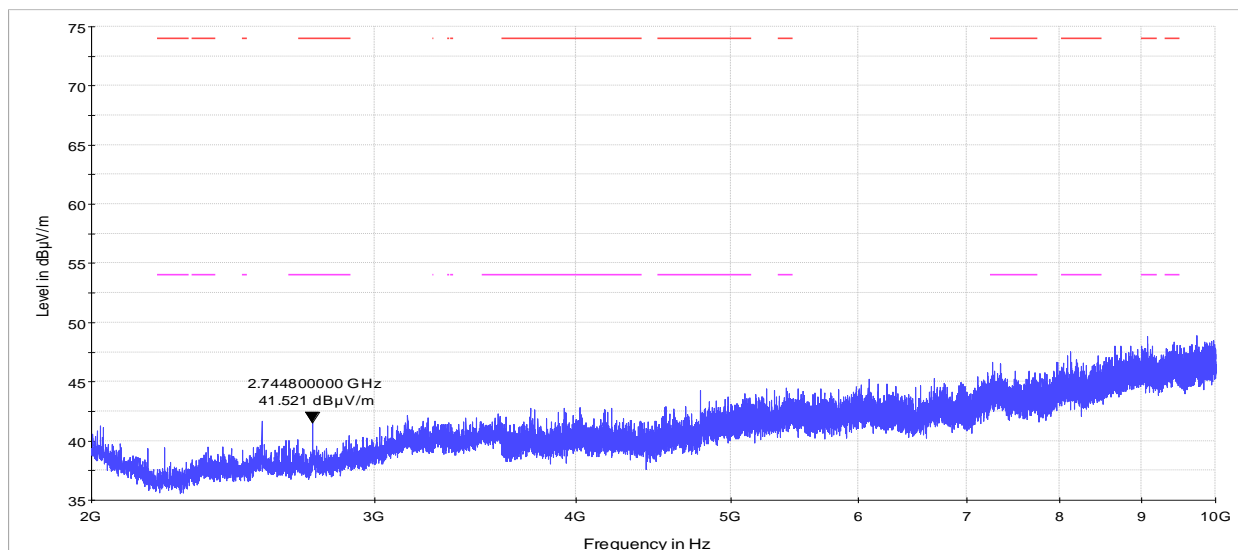
Radiated spurious emissions
— Peak Max-Hold scan
— FCC 15.209 and RSS-Gen RB peak limit
— FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-61: Radiated spurious emissions within 2–10 GHz for FHSS DR3, low channel, external antenna



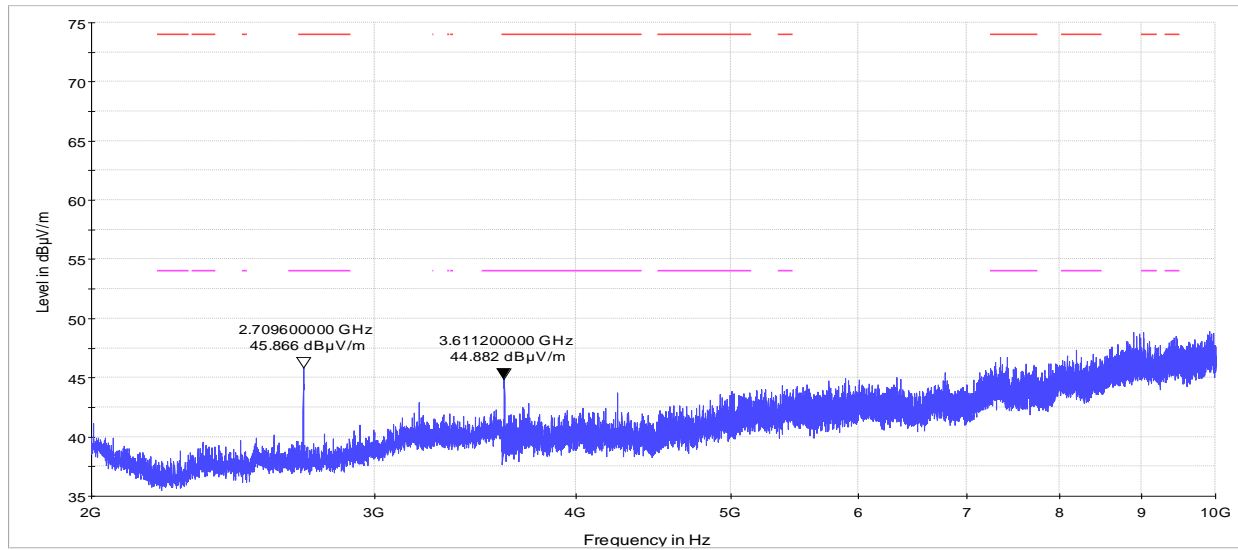
Radiated spurious emissions
Peak Max-Hold scan
FCC 15.209 and RSS-Gen RB peak limit
FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-62: Radiated spurious emissions within 2–10 GHz for FHSS DR3, mid channel, external antenna



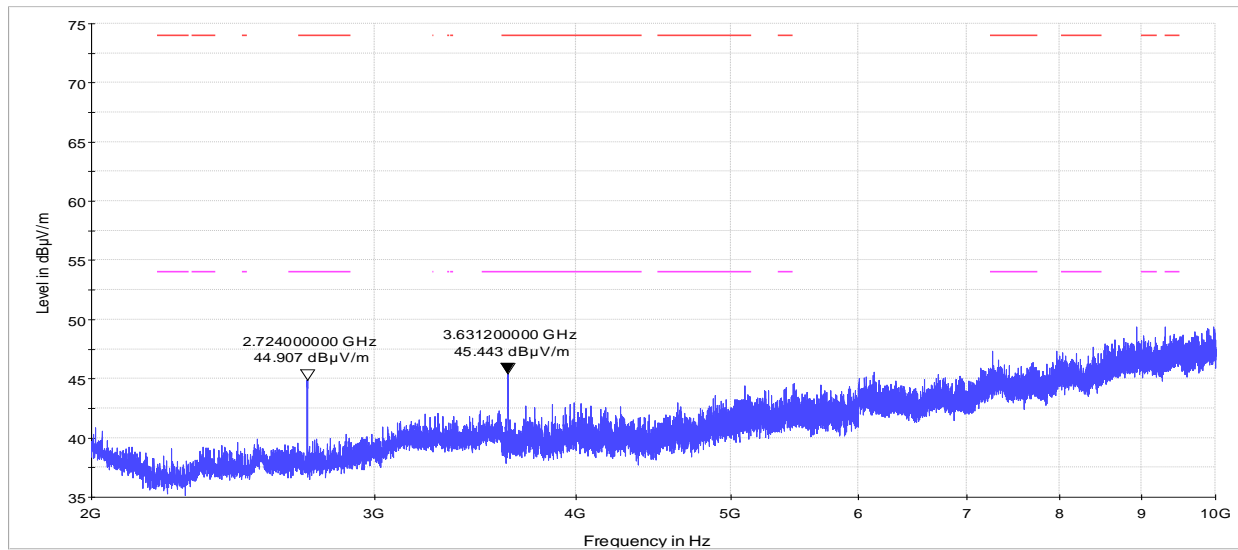
Radiated spurious emissions
Peak Max-Hold scan
FCC 15.209 and RSS-Gen RB peak limit
FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-63: Radiated spurious emissions within 2–10 GHz for FHSS DR3, high channel, external antenna



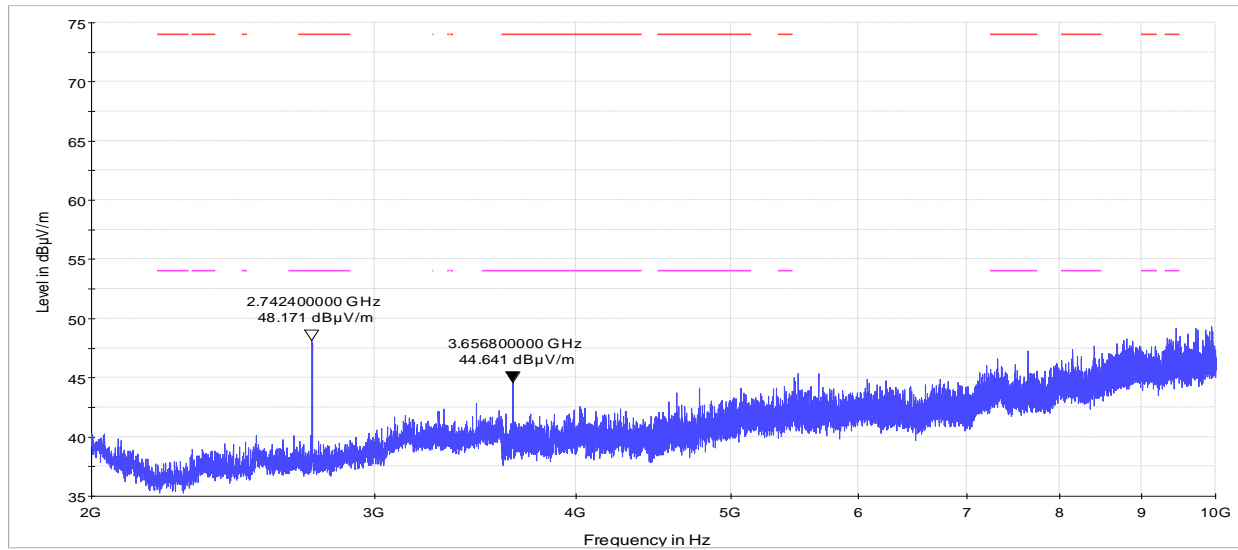
Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.209 and RSS-Gen RB peak limit
 FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-64: Radiated spurious emissions within 2–10 GHz for DTS, low channel, internal antenna



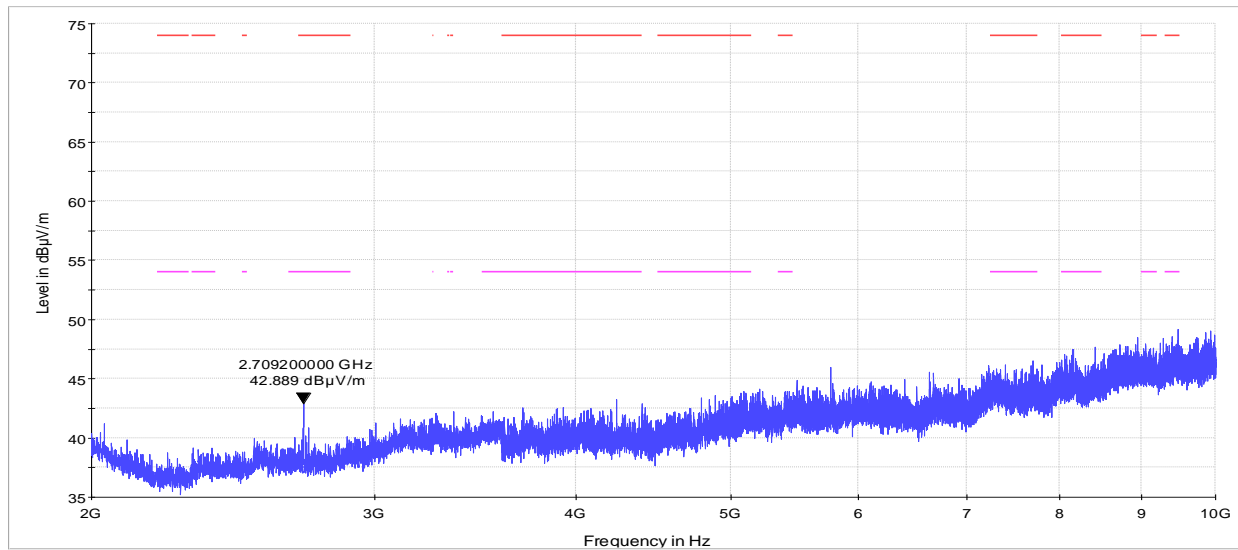
Radiated spurious emissions
 Peak Max-Hold scan
 FCC 15.209 and RSS-Gen RB peak limit
 FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-65: Radiated spurious emissions within 2–10 GHz for DTS, mid channel, internal antenna



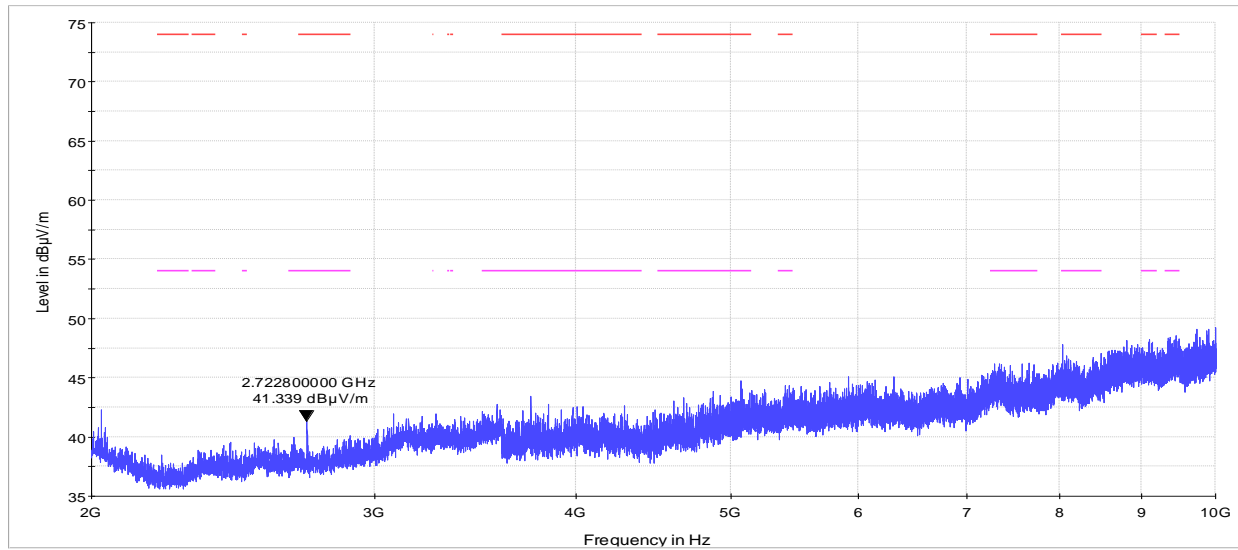
Radiated spurious emissions
Peak Max-Hold scan
FCC 15.209 and RSS-Gen RB peak limit
FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-66: Radiated spurious emissions within 2–10 GHz for DTS, high channel, internal antenna



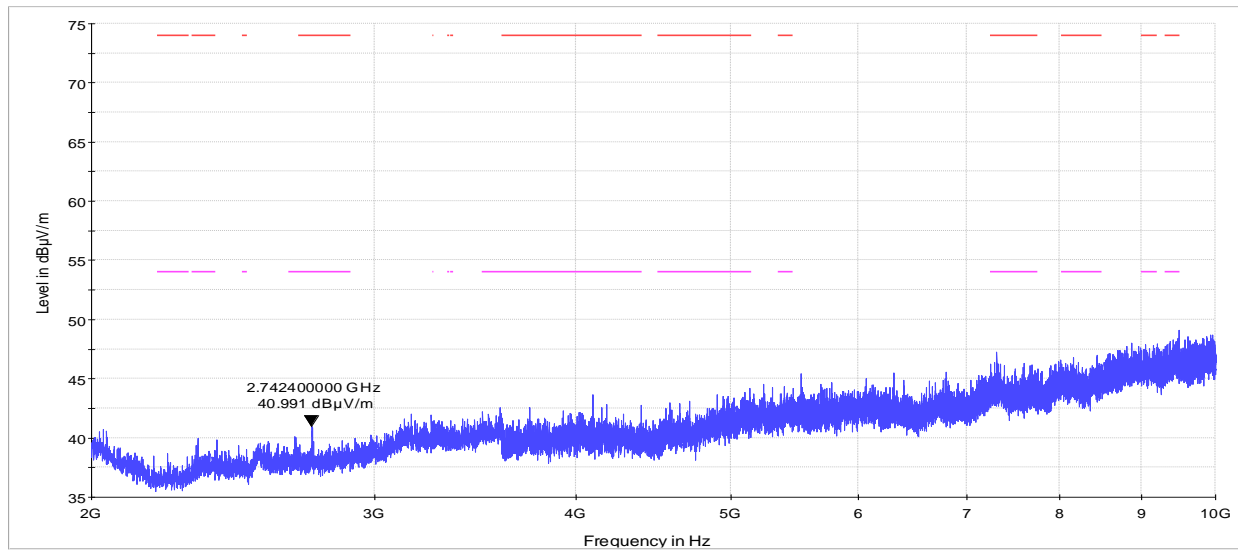
Radiated spurious emissions
Peak Max-Hold scan
FCC 15.209 and RSS-Gen RB peak limit
FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-67: Radiated spurious emissions within 2–10 GHz for DTS, low channel, external antenna



Radiated spurious emissions
Peak Max-Hold scan
FCC 15.209 and RSS-Gen RB peak limit
FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-68: Radiated spurious emissions within 2–10 GHz for DTS, mid channel, external antenna



Radiated spurious emissions
Peak Max-Hold scan
FCC 15.209 and RSS-Gen RB peak limit
FCC 15.205 and RSS-Gen Restricted bands limits

Figure 8.8-69: Radiated spurious emissions within 2–10 GHz for DTS, high channel, external antenna

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

8.9.1 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).

8.9.1 Test date

Start date March 28, 2018

8.9.2 Observations, settings and special notes

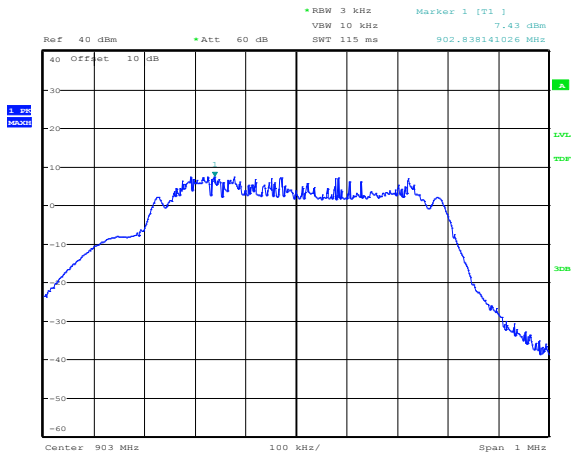
The test was performed using peak method.
Spectrum analyser settings:

Resolution bandwidth:	3 kHz
Video bandwidth:	$\geq 3 \times \text{RBW}$
Frequency span:	1 MHz
Detector mode:	Peak
Trace mode:	Max-hold

8.9.3 Test data

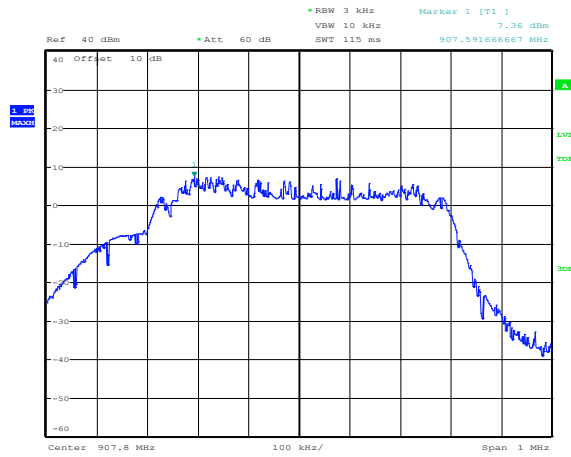
Table 8.9-1: PSD measurements results

Frequency, MHz	PSD, dBm/3 kHz	PSD limit, dBm/3 kHz	Margin, dB
903.0	7.43	8.00	0.57
907.8	7.36	8.00	0.64
914.2	7.33	8.00	0.67



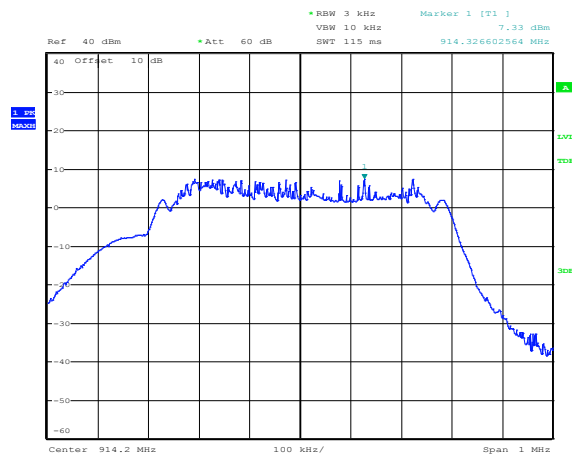
Date: 28.MAR.2018 12:41:13

Figure 8.9-1: PSD sample plot on low channel



Date: 28.MAR.2018 12:44:26

Figure 8.9-2: PSD sample plot on mid channel

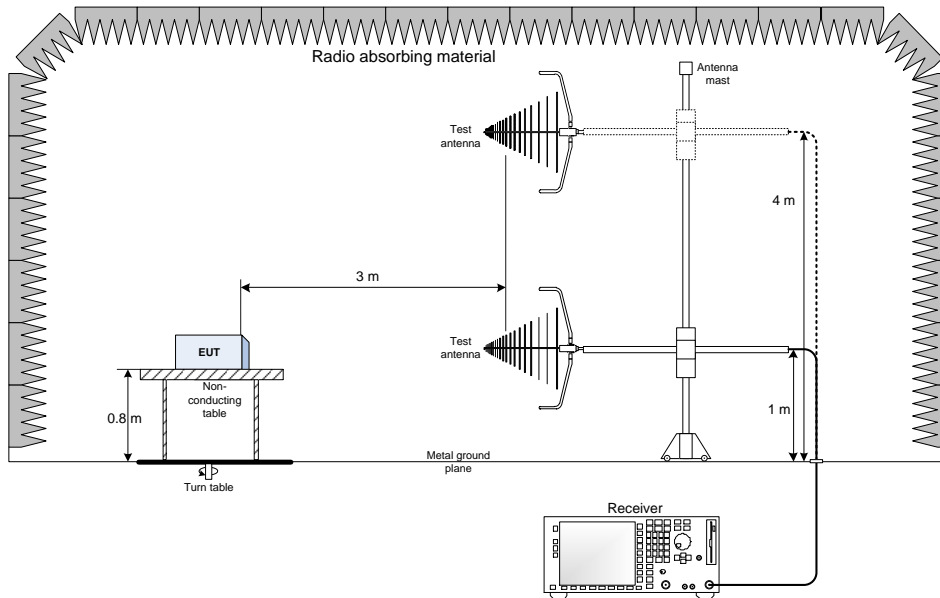


Date: 28.MAR.2018 12:45:30

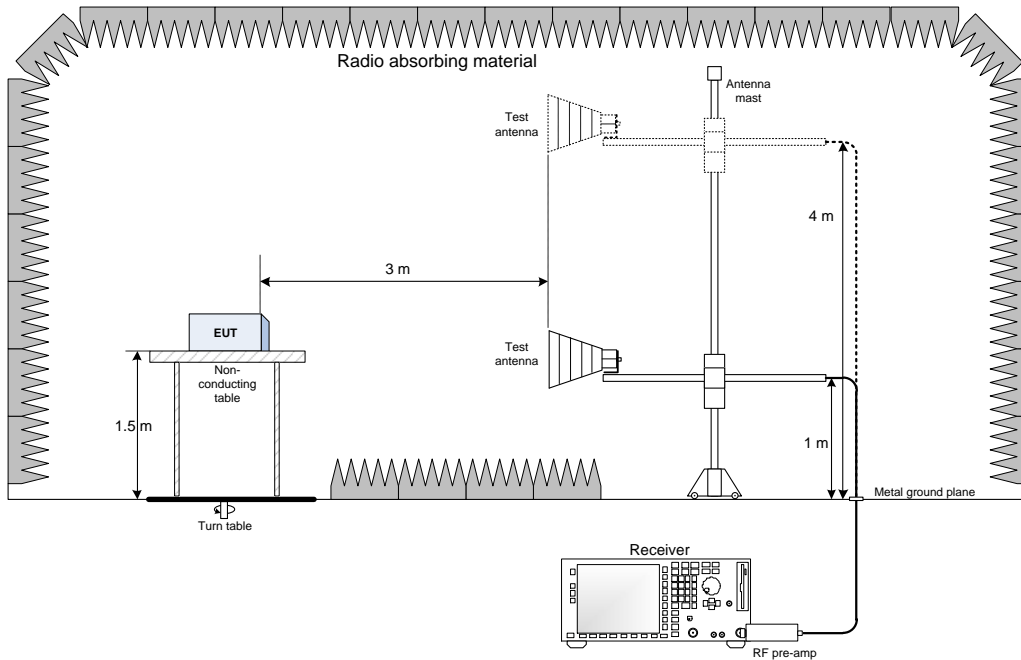
Figure 8.9-3: PSD sample plot on high channel

Section 9. Block diagrams of test set-ups

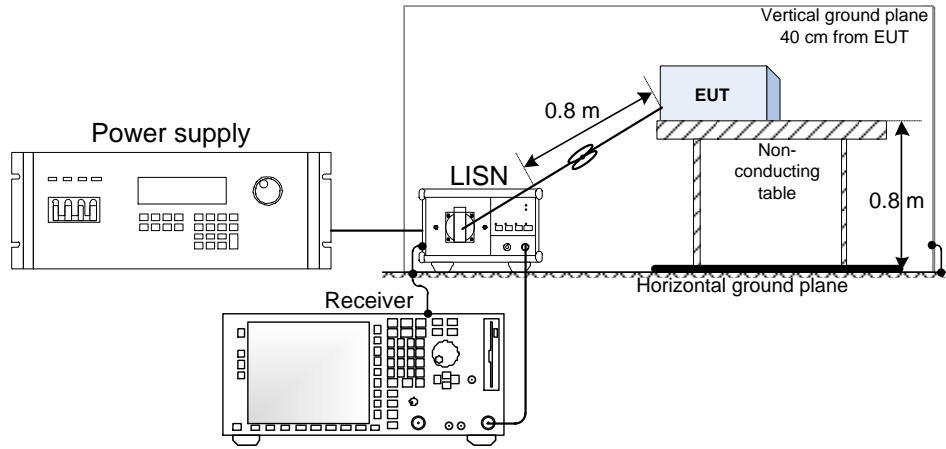
9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Conducted emissions set-up



9.4 Antenna port set-up

