

# Test report

## 310407-1TRFWL

Date of issue: August 19, 2016

Applicant:

**GE Lighting Solutions LLC**

Product:

**WOLC Node (Wireless Outdoor Light Control Node)**

Model:

**ELWN0A7UXXAD**

FCC ID:

**PUU90003**

IC Registration number:

**10798A-PUU90003**


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, Section 5**  
Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs)  
and Licence-Exempt Local Area Network (LE-LAN) Devices

Test location

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Country	Canada
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Website	www.nemko.com
Site number	FCC: 722545; IC: 2040G-5 (3 m semi anechoic chamber)

Tested by	Yong Huang, Wireless/EMC Specialist
Reviewed by	Andrey Adelberg, Senior Wireless/EMC Specialist
Review date	August 19, 2016
Reviewer signature	

Limits of responsibility

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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

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### 1.1 Applicant and manufacturer

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Company name	GE Lighting Solutions LLC
Address	1975 Noble Road
City	East Cleveland
Province/State	Ohio
Postal/Zip code	44112-6300
Country	USA

### 1.2 Test specifications

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FCC 47 CFR Part 15, Subpart C, Clause 15.247	Operation in the 902–928 MHz, 2400–2483.5 MHz
RSS-247, Issue 1, May 2015, Section 5	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

### 1.3 Test methods

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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

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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

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None

### 1.6 Test report revision history

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Revision #	Details of changes made to test report
TRF	Original report issued

## Section 2. Summary of test results

### 2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.31(e)	Variation of power source	Pass <sup>1</sup>
§15.203	Antenna requirement	Pass <sup>2</sup>

Notes: <sup>1</sup> The EUT was with the supply voltage varied between 85% and 115% of the nominal rated supply voltage

<sup>2</sup> The Antenna is located within the enclosure of EUT and not user accessible.

### 2.2 FCC Part 15 Subpart C, intentional radiators test results

Part	Test description	Verdict
§15.247(a)(1)(i)	Frequency hopping systems operating in the 902–928 MHz band	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	Pass
§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	Pass

Notes: <sup>1</sup> 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 Transmission Systems (DTSs)	
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	Out-of-band emissions	Pass

Notes: None

## Section 3. Equipment under test (EUT) details

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### 3.1 Sample information

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Receipt date	July 19, 2016
Nemko sample ID number	133002259 and 133002262

### 3.2 EUT information

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Product name	WOLC Node (Wireless Outdoor Light Control Node)
Model	ELWN0A7UXXAD
Serial number	FG1625C00017 and FG1625C00052

### 3.3 Technical information

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Applicant IC company number	10798A
IC UPN number	PUU90003
All used IC test site(s) Reg. number	2040G-5
RSS number and issue number	RSS-247 Issue 1, May 2015
Frequency band	902–928 MHz
Frequency Min (MHz)	902.55
Frequency Max (MHz)	927.44
RF power Max (W), Conducted	0.316 (25.0 dBm)
Field strength, Units @ distance	N/A
Measured BW (kHz) (20 dB)	471.8
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	FSK
Emission classification (F1D, G1D, D1D)	F1D
Transmitter spurious, Units @ distance	38.3 dB $\mu$ V/m at 73.32 MHz Quasi-Peak@ 3 m
Power requirements	120 V <sub>AC</sub> to 277 V <sub>AC</sub>
Antenna information	Wire antenna with 2.7 dBi gain The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

### 3.4 Product description and theory of operation

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The GE LightGrid Controller is used to source power and dimming control signals to LED outdoor roadway luminaires. Also, it provides monitoring and diagnostic capability to the luminaires being controlled.

The Controller connects externally to the outdoor luminaire using an ANSI 7-pin twist-lock receptacle. The controller receives power from the fixture through two conductors in the receptacle and sources a switched input power to the luminaire using one conductor.

### 3.5 EUT exercise details

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EUT was powered and special mode of operation was set to transmit on selected channels with predefined power settings

**Instructions:**

Insert the standard IEC 3-prong power cord into the NEMA-to-IEC plug adapter base (B) and plug the other end into the power supply, insure the node is powered up by confirming blinking Red LED seen through translucent plastic Node (DUT) cover (A).

Lift Node cover (A) revealing internal PCB stack.

Locate the small tactile pushbutton on the edge of the upper PCB near the corner of the large IC; Press this button using a pencil eraser or similar stylus to switch unit between RF test modes.

Between each test, or any time power is interrupted, remove and reapply power and repeat the pushbutton configuration to insure the DUT is in the correct mode for the subsequent test.

Upon power up, the RF subsystem is in standby.

Button presses 1-3 enable listen only mode, on low, mid, and high channels respectively.

Button presses 4-6 enable continuous modulated transmission, at max power output, on low, mid, and high channels respectively.

Button presses 7 enables continuous CW transmission, at max power output, mid channel (915MHz).

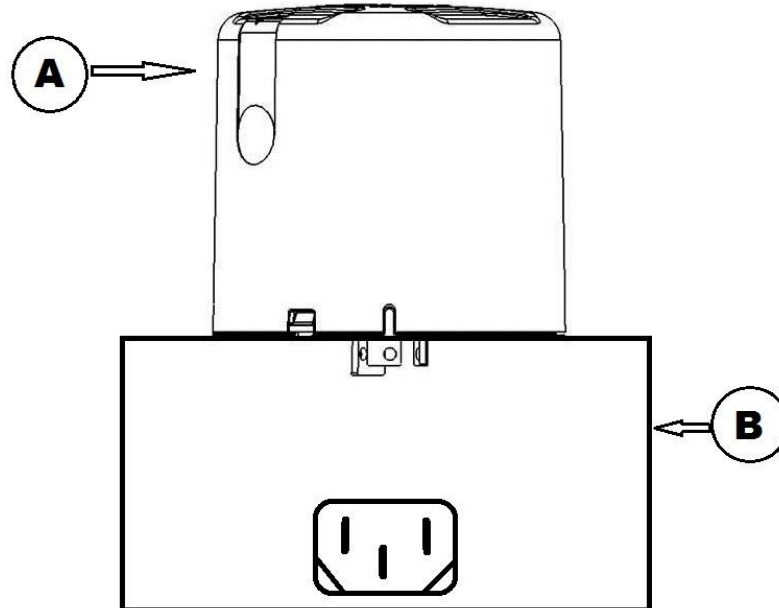
Button presses 8 enables simulated frequency hopping, at max power output and duty cycle, across all 50 channels.

Confirm the correct mode is selected via observation with a spectrum analyzer before proceeding with the current test.

Replace and fully seat the Node cover before beginning any testing. Insure it is always correctly installed during any test sequence.

### 3.6 EUT setup diagram

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*Figure 3.6-1: Setup diagram*



## Section 4. Engineering considerations

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### 4.1 Modifications incorporated in the EUT

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

### 4.2 Technical judgment

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None

### 4.3 Deviations from laboratory tests procedures

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No deviations were made from laboratory procedures.

## Section 5. Test conditions

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### 5.1 Atmospheric conditions

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

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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

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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

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### 6.1 Uncertainty of measurement

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Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of  $K = 2$  with 95% certainty.

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

## Section 7. Test equipment

### 7.1 Test equipment list

*Table 7.1-1: Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Aug. 25/16
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	March 23/17
Spectrum analyzer	Rohde & Schwarz	FSV 40	FA002731	1 year	Apr 06/17
Bilog antenna (20–2000 MHz)	Sunol	JB1	FA002517	1 year	Sept. 29/16
Horn antenna (1–18 GHz)	EMCO	3115	FA001451	1 year	Feb. 22/17
Pre-amplifier (0.5–18 GHz)	COM-POWER	PAM-118A	FA002561	1 year	May 6/17
50 Ω coax cable	C.C.A.	None	FA002603	—	VOU
50 Ω coax cable	C.C.A.	None	FA002605	—	VOU
50 Ω coax cable	C.C.A.	None	FA002607	—	VOU
High Pass Filter (> 1100 MHz)	Microwave Circuits	H1G212G1	FA002689	—	VOU
LISN	Rohde & Schwarz	ENV216	FA002514	1 year	Nov. 20/16
Single phase power system	TESEQ	ProfLine 2105	FA002824	1 Year	May 26/17

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

## Section 8. Testing data

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

#### 8.1.1 Definitions and limits

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

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

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

*Table 8.1-1: Conducted emissions limit*

Frequency of emission, MHz	Conducted limit, dB $\mu$ V	
	Quasi-peak	Average**
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

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

#### 8.1.2 Test summary

Test date	August 1, 2016	Temperature	23 °C
Test engineer	Yong	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	49 %

### 8.1.3 Observations, settings and special notes

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The EUT was set up as tabletop configuration. As per customer's instruction, ground is disconnected on EUT, and tests were performed when input voltages at 120 V<sub>AC</sub>, 230 V<sub>AC</sub>, and 277 V<sub>AC</sub>.

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

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

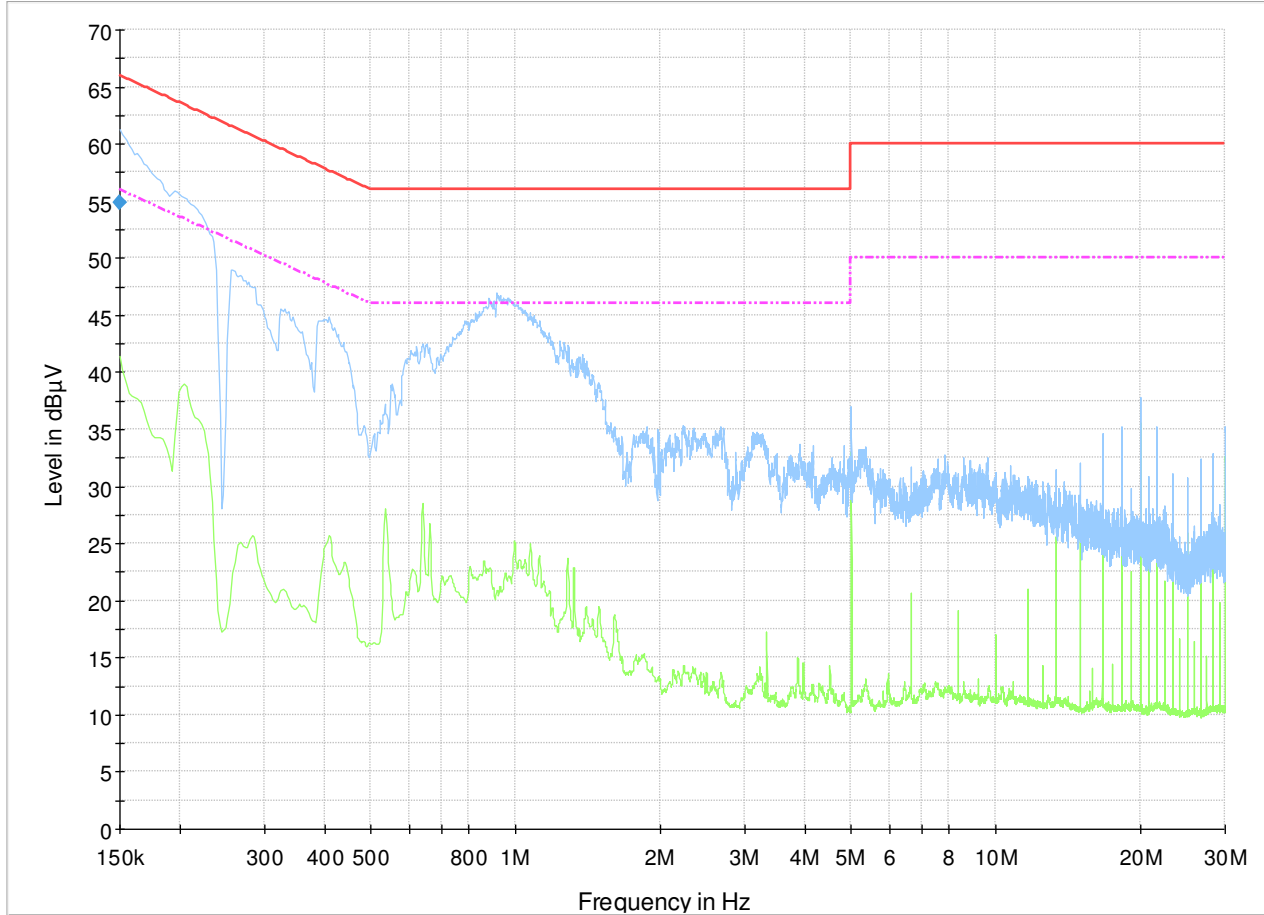
Receiver settings for preview measurements:

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

Receiver settings for final measurements:

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

8.1.4 Test data

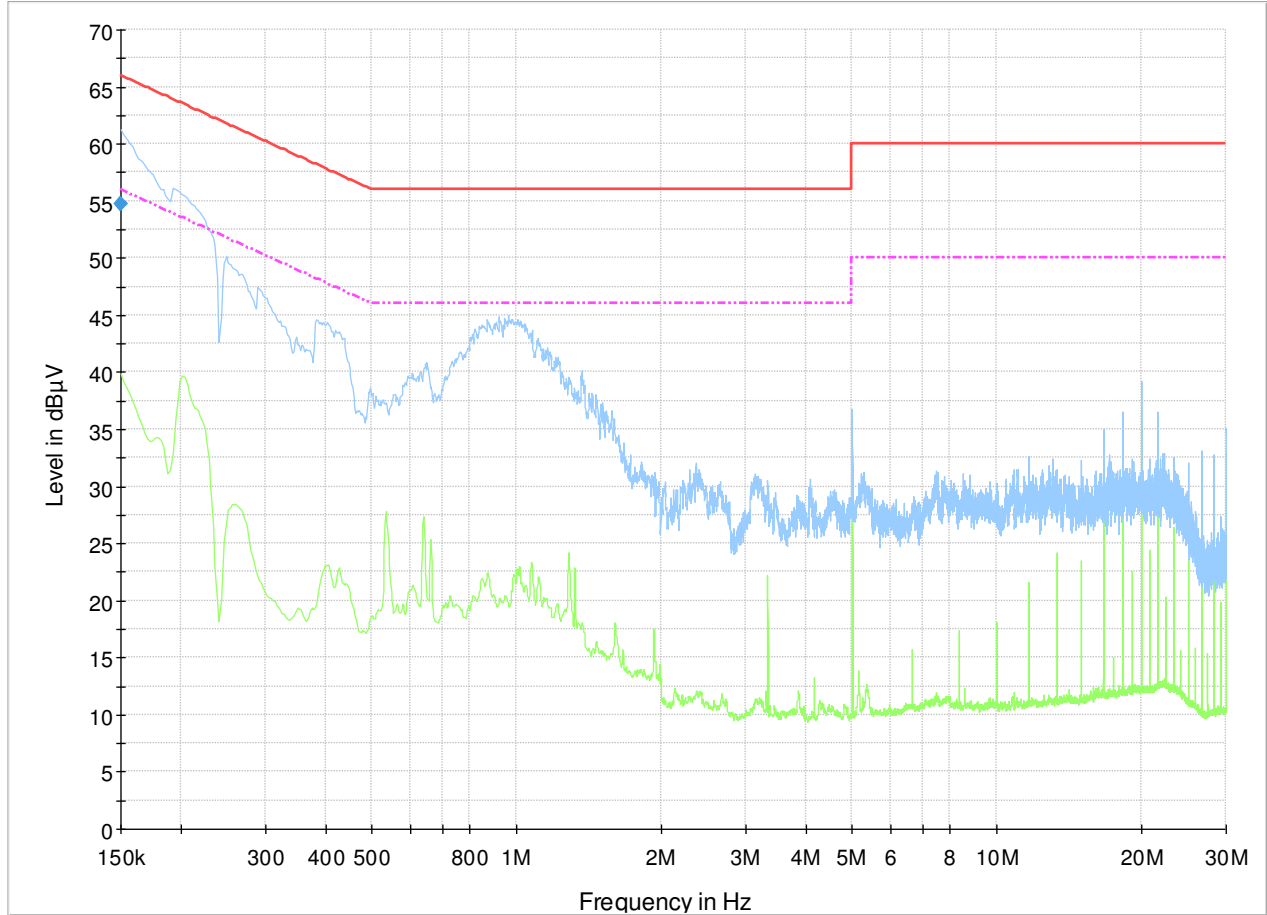


6R310407, PLCE-120 V-L1-no gnd

- Preview Result 2-AVG
- Preview Result 1-PK+
- CISPR 22 Limit - Class B, Mains (Quasi-Peak)
- - - CISPR 22 Limit - Class B, Mains (Average)
- ◆ Final\_Result QPK
- ◆ Final\_Result CAV

Plot 8.1-1: Conducted emissions on phase line

8.1.4 Test data, continued



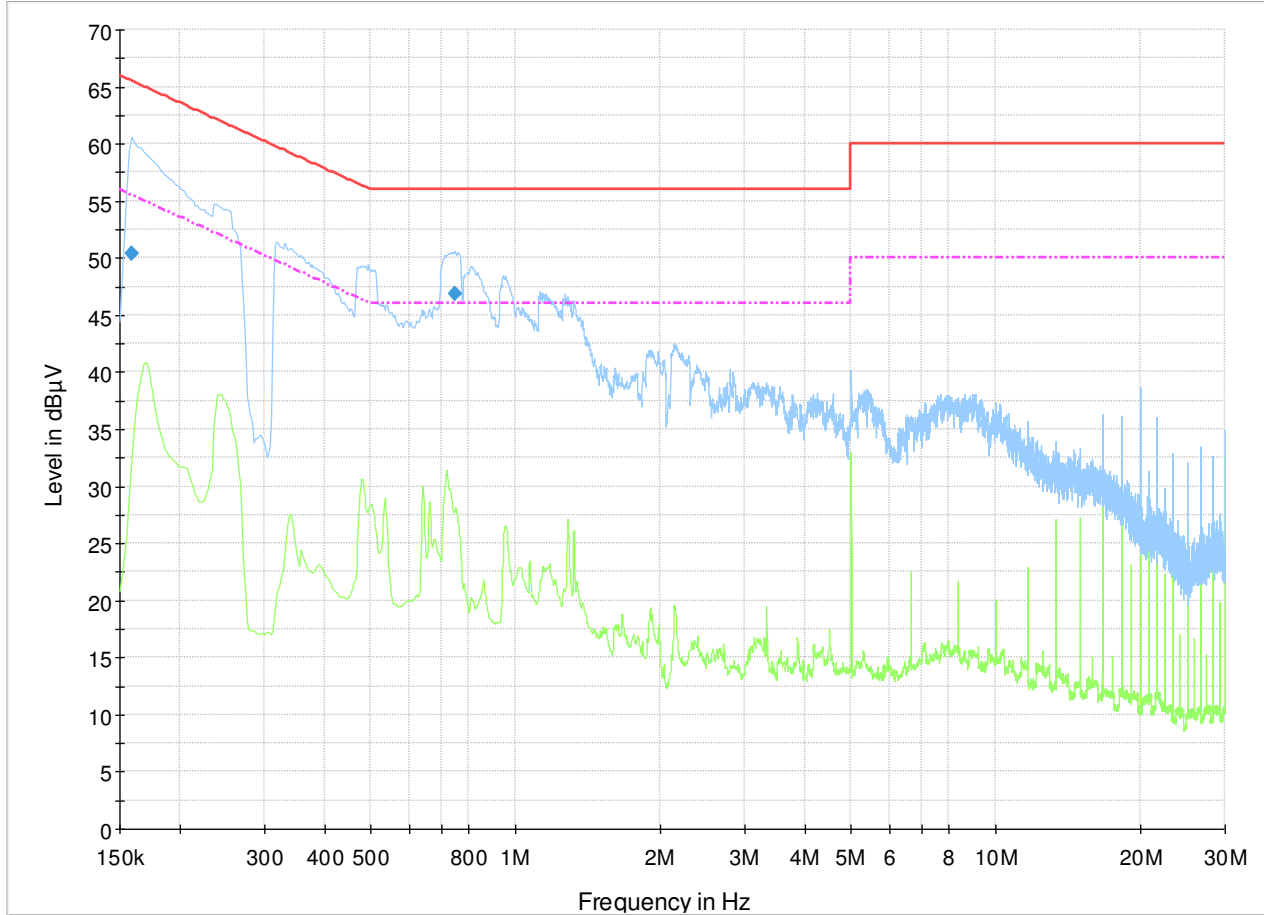
6R310407, PLCE-120 V-N-no gnd

- Preview Result 2-AVG
- Preview Result 1-PK+
- CISPR 22 Limit - Class B, Mains (Quasi-Peak)
- - - CISPR 22 Limit - Class B, Mains (Average)
- ◆ Final\_Result QPK
- ◆ Final\_Result CAV

Plot 8.1-2: Conducted emissions on neutral line



8.1.4 Test data

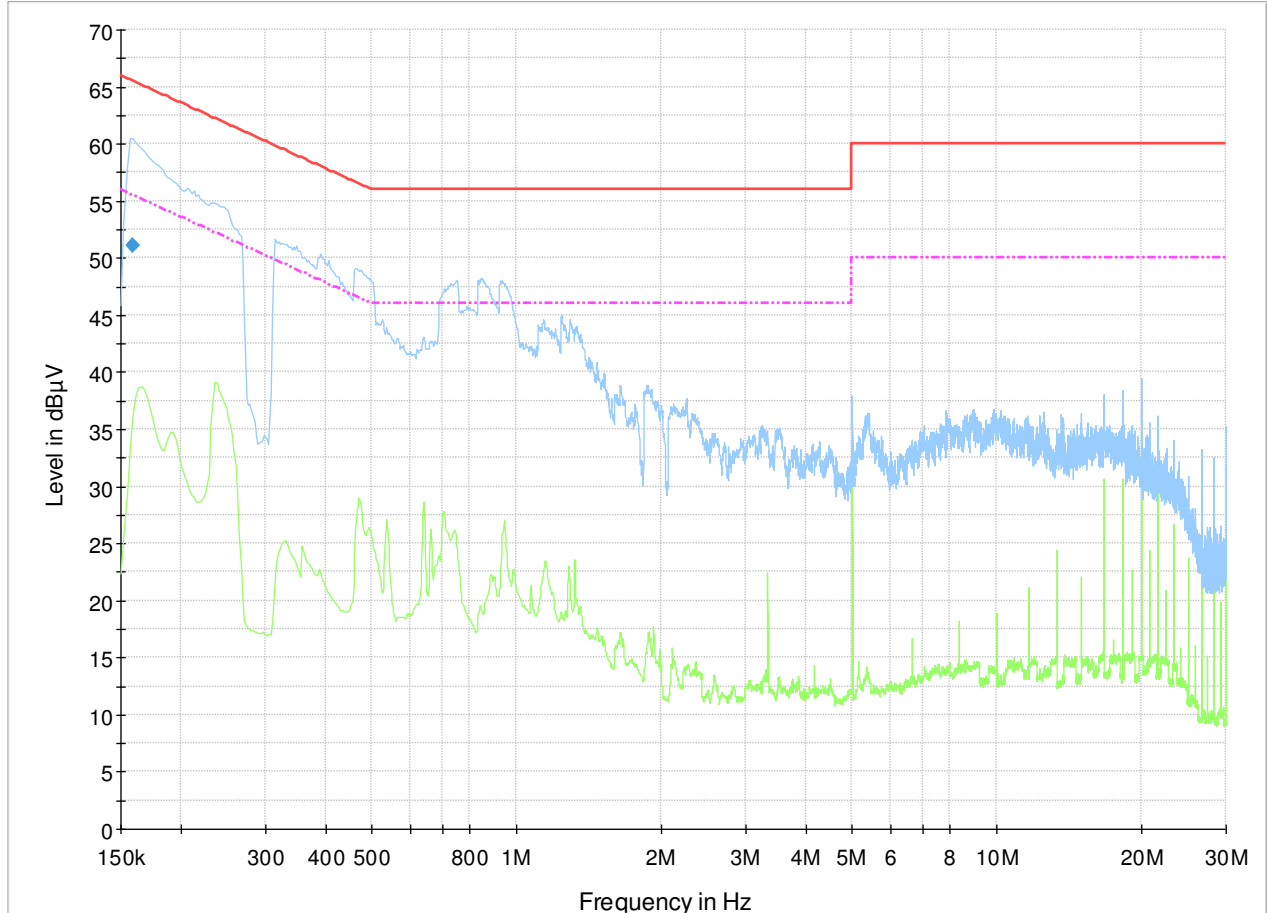


6R310407, PLCE-230 V-L1-no gnd

- Preview Result 2-AVG
- Preview Result 1-PK+
- CISPR 22 Limit - Class B, Mains (Quasi-Peak)
- - - CISPR 22 Limit - Class B, Mains (Average)
- ◆ Final\_Result QPK
- ◆ Final\_Result CAV

Plot 8.1-3: Conducted emissions on phase line

8.1.4 Test data, continued

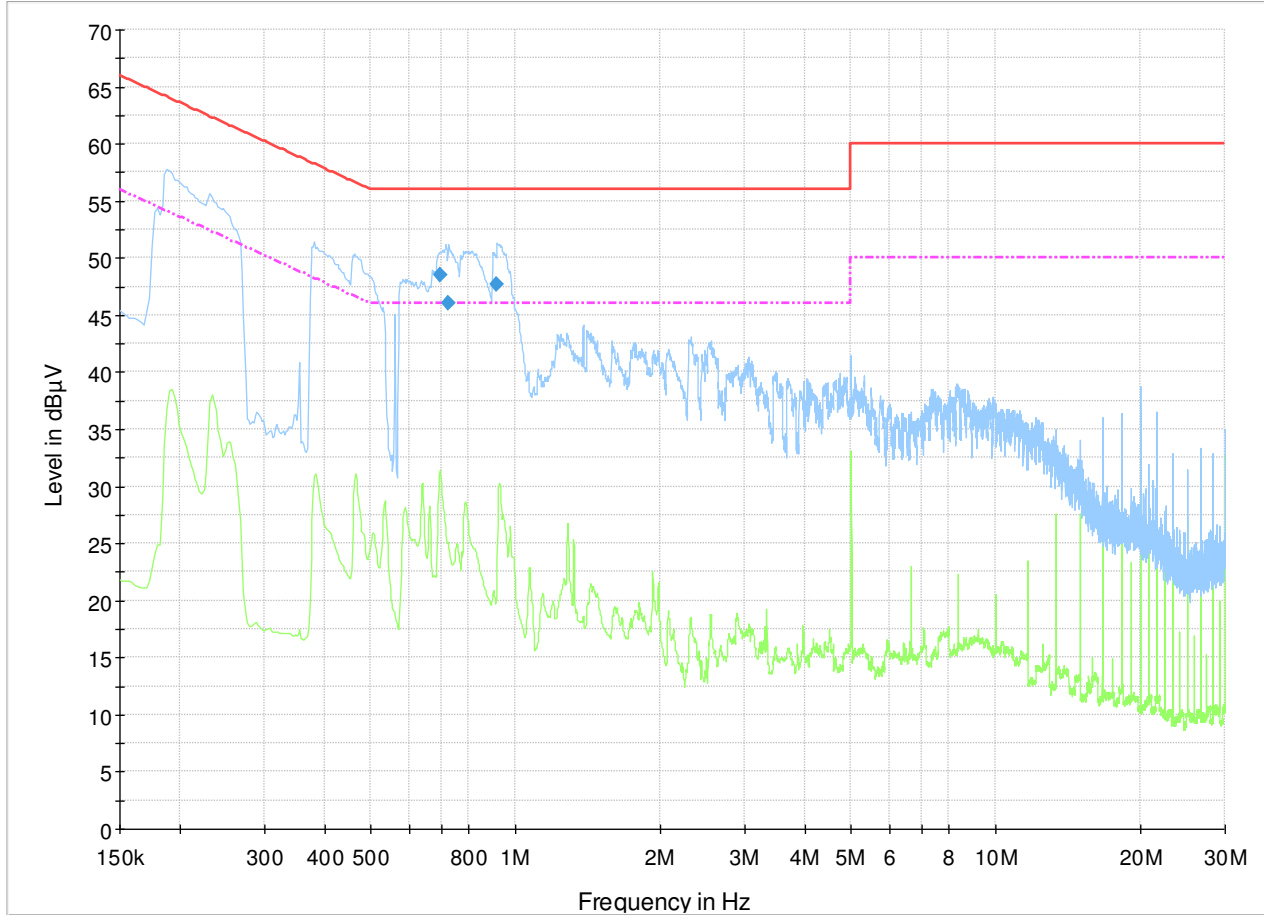


6R310407, PLCE-230 V-N-no gnd

- Preview Result 2-AVG
- Preview Result 1-PK+
- CISPR 22 Limit - Class B, Mains (Quasi-Peak)
- - - CISPR 22 Limit - Class B, Mains (Average)
- ◆ Final\_Result QPK
- ◆ Final\_Result CAV

**Plot 8.1-4:** Conducted emissions on neutral line

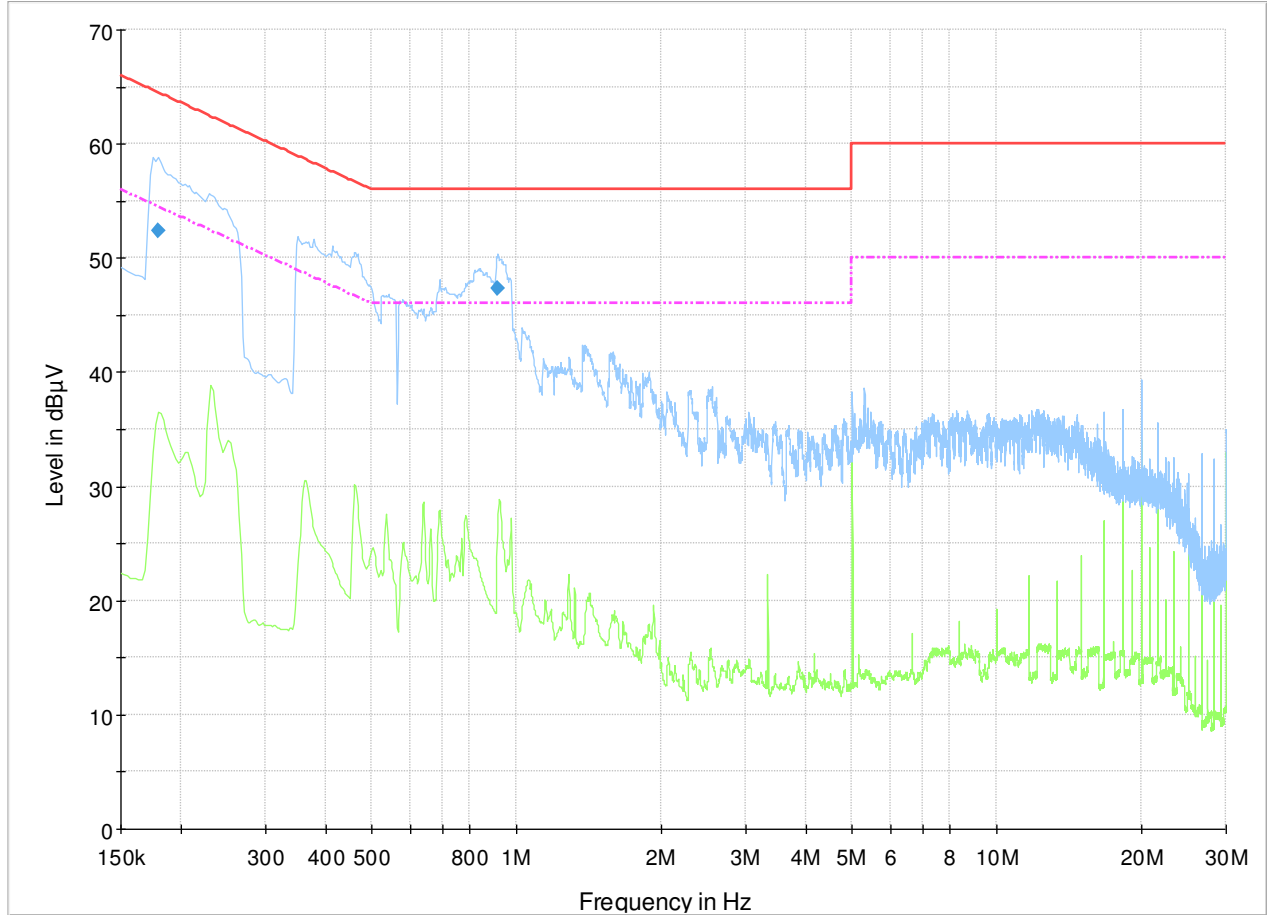
8.1.4 Test data



- 6R310407,PLCE-277V-L1 no gnd
- Preview Result 2-AVG
- Preview Result 1-PK+
- CISPR 22 Limit - Class B, Mains (Quasi-Peak)
- CISPR 22 Limit - Class B, Mains (Average)
- Final\_Result QPK
- Final\_Result CAV

Plot 8.1-5: Conducted emissions on phase line

8.1.4 Test data, continued



6R310407, PLCE-277 V-N-no gnd

- Preview Result 2-AVG
- Preview Result 1-PK+
- CISPR 22 Limit - Class B, Mains (Quasi-Peak)
- - - CISPR 22 Limit - Class B, Mains (Average)
- ◆ Final\_Result QPK
- ◆ Final\_Result CAV

Plot 8.1-6: Conducted emissions on neutral line

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

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### 8.2.1 Definitions and limits

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**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. 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.

**IC:**

1. 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 hopset shall be such that the near-term distribution of frequencies appears random, with sequential hops randomly distributed in both direction and magnitude of change in the hopset, whereas the long-term distribution appears evenly distributed.
2. FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the –20 dB bandwidth of the hopping channel, whichever is greater. 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.
3. 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.

### 8.2.2 Test summary

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Test date	July 19, 2016 to August 1, 2016	Temperature	23 °C
Test engineer	Yong	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	49 %

### 8.2.3 Observations, settings and special notes

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Spectrum analyzer settings for carrier frequency separation:

Resolution bandwidth	50 kHz
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	30 kHz
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	≤ channel spacing
Video bandwidth	≥ RBW
Frequency span	Zero span
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyser settings for 20 dB bandwidth:

Resolution bandwidth	1% to 5 % 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

8.2.4 Test data

*Table 8.2-1: 20 dB bandwidth results*

Frequency, MHz	20 dB bandwidth, kHz	Limit, kHz	Margin, kHz
902.55	471.8	500	28.2
914.74	463.1	500	36.9
927.44	463.1	500	36.9

*Table 8.2-2: Carrier frequency separation results*

Carrier frequency separation, kHz	Minimum limit, kHz	Margin, kHz
511.6	463.1	48.5

*Table 8.2-3: Number of hopping frequencies results*

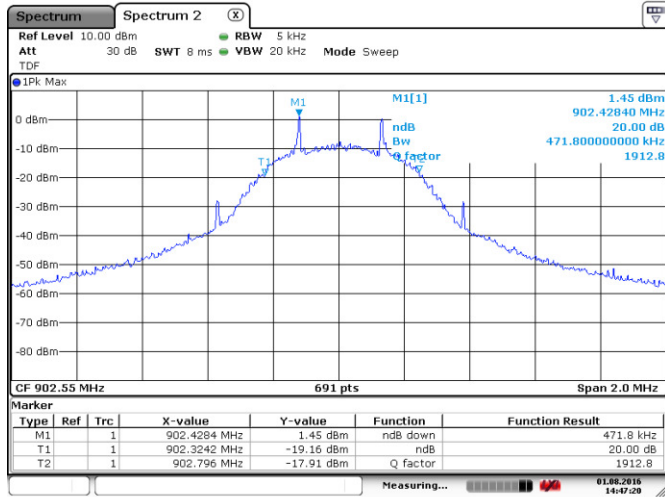
Number of hopping frequencies	Minimum limit	Margin
50	50	0

*Table 8.2-4: Average time of occupancy results*

Dwell time of each pulse, ms	Number of pulses within period	Total dwell time within period, ms	Limit, ms	Margin, ms
199.28	1	199.28	400.00	200.72

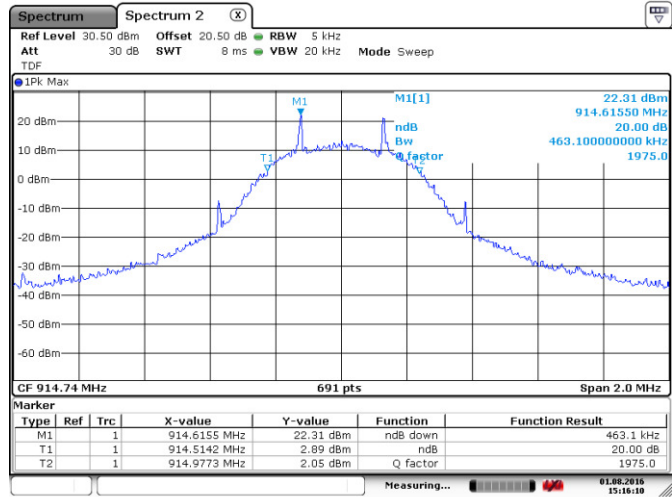
Measurement Period is 10 s

8.2.4 Test data, continued



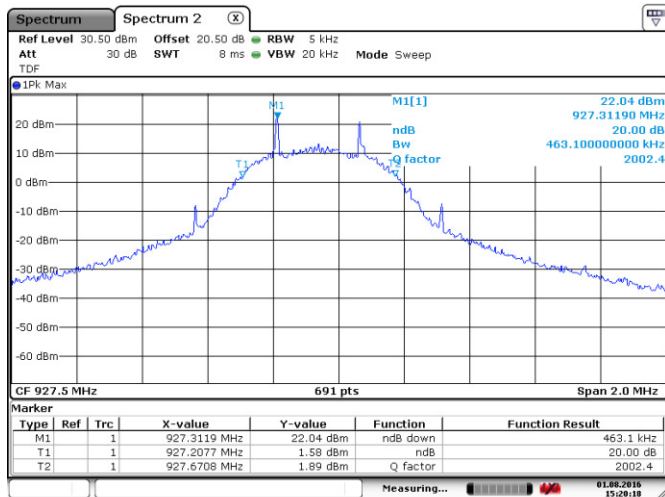
Date: 1.AUG.2016 14:47:20

Figure 8.2-1: 20 dB bandwidth on low channel



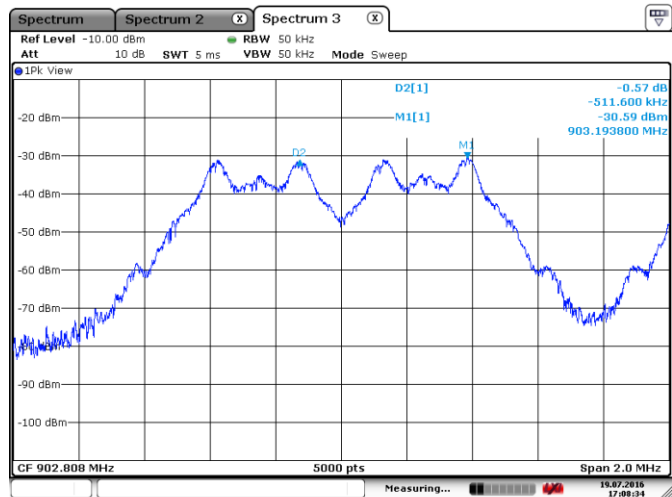
Date: 1.AUG.2016 15:16:11

Figure 8.2-2: 20 dB bandwidth on mid channel



Date: 1.AUG.2016 15:20:19

Figure 8.2-3: 20 dB bandwidth on high channel

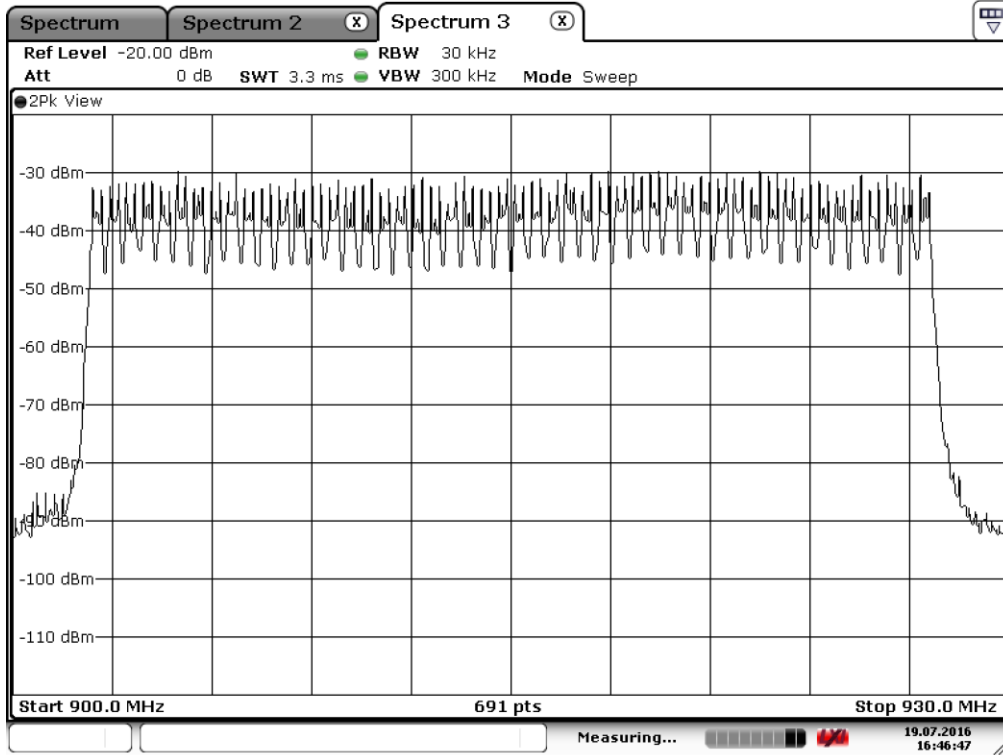


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Figure 8.2-4: Carrier frequency separation

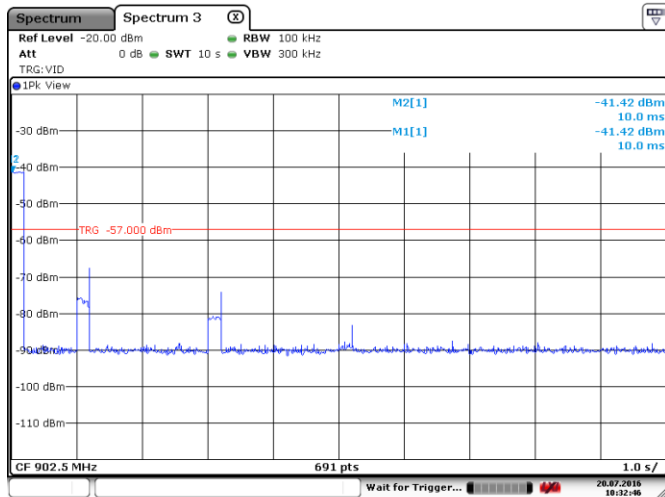


8.2.4 Test data



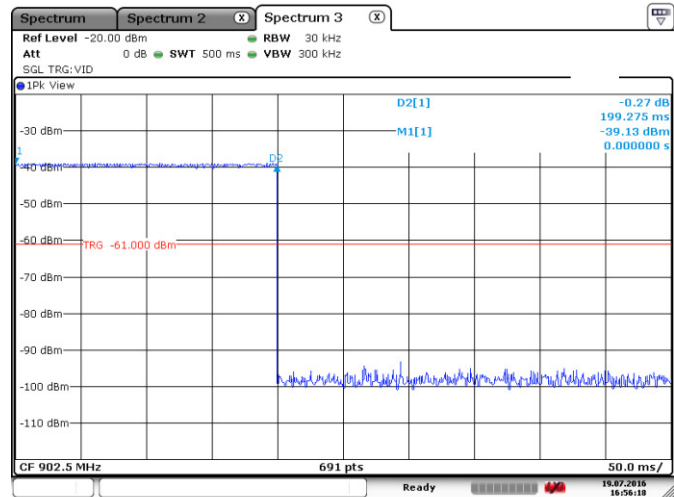
Date: 19.JUL.2016 16:46:48

Figure 8.2-5: Number of hopping channels, 50 channels



Date: 20.JUL.2016 10:32:45

Figure 8.2-6: Number of using of the channel within 10 seconds. Only once.



Date: 19.JUL.2016 16:56:18

Figure 8.2-7: Dwell time, 199.28 ms

## 8.3 FCC 15.247(b) and RSS-247 5.4 (1) Transmitter output power and e.i.r.p. requirements

### 8.3.1 Definitions and limits

**FCC:**

- (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:
- (2) For frequency hopping systems operating in the 902–928 MHz band: 1 watt (30 dBm) for systems employing at least 50 hopping channels; and, 0.25 watts (24 dBm) 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.

**IC:**

For FHSs operating in the band 902–928 MHz, the maximum peak conducted output power shall not exceed 1.0 W (30 dBm), and the e.i.r.p. shall not exceed 4 W (36 dBm) if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W (24 dBm) and the e.i.r.p. shall not exceed 1 W (30 dBm) if the hopset uses less than 50 hopping channels.

### 8.3.2 Test summary

Test date	July 19, 2016 to August 1, 2016	Temperature	23 °C
Test engineer	Yong	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	49 %

### 8.3.3 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

### 8.3.4 Test data

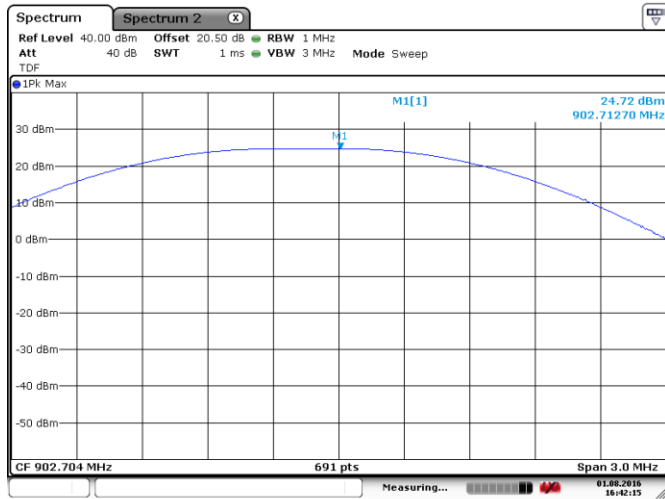
*Table 8.3-1: Output power and EIRP results*

Frequency, MHz	Input Voltage <sup>1</sup> , V	Output power, dBm	Output power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
902.55	102.0	24.7	30	5.3	2.7	27.4	36	8.6
902.55	230.0	24.5	30	5.6	2.7	27.2	36	8.9
902.55	318.5	24.7	30	5.3	2.7	27.4	36	8.6
914.74	102.0	25.0	30	5.0	2.7	27.7	36	8.3
914.74	230.0	24.8	30	5.2	2.7	27.5	36	8.5
914.74	318.5	25.0	30	5.1	2.7	27.7	36	8.4
927.44	102.0	24.7	30	5.3	2.7	27.4	36	8.6
927.44	230.0	24.5	30	5.5	2.7	27.2	36	8.8
927.44	318.5	24.6	30	5.4	2.7	27.3	36	8.7

Note: <sup>1</sup> As provided by customer, Variation of power source 85% and 115% of the nominal rated supply voltage(120 V<sub>AC</sub> to 277 V<sub>AC</sub>)

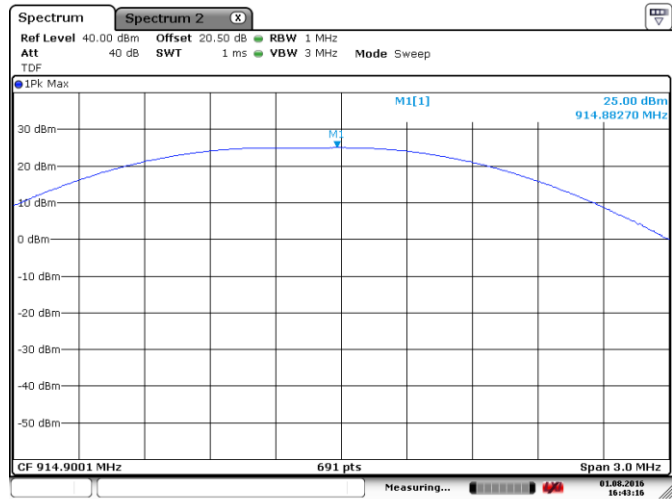
$$\text{EIRP} = \text{Output power} + \text{Antenna gain}$$

### 8.3.4 Test data, continued



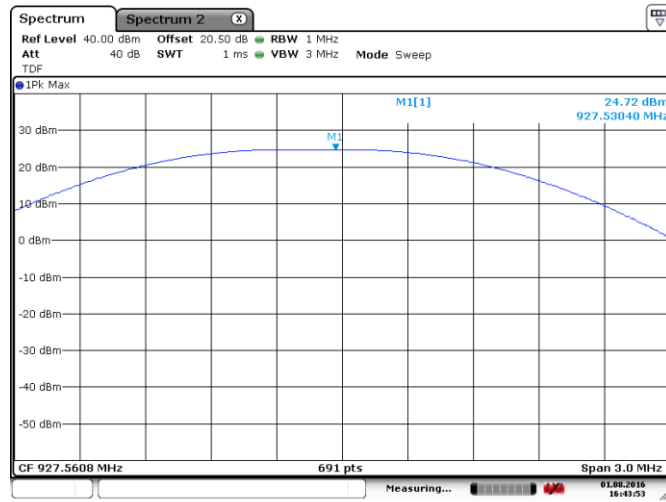
Date: 1.AUG.2016 16:42:15

Figure 8.3-1: Output power on low channel, 102 V<sub>AC</sub>



Date: 1.AUG.2016 16:43:16

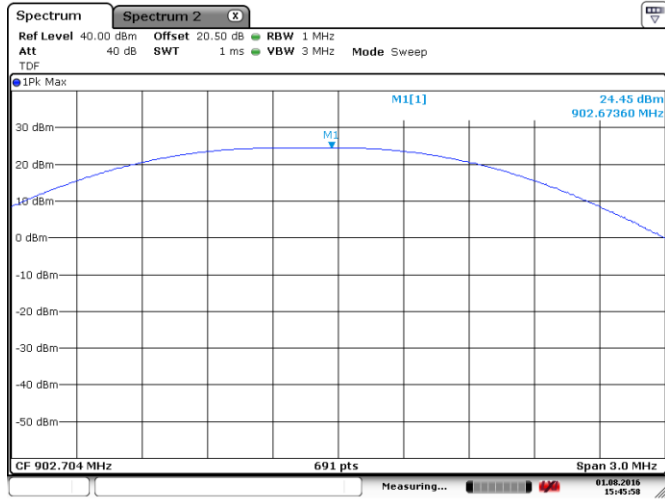
Figure 8.3-2: Output power on mid channel, 102 V<sub>AC</sub>



Date: 1.AUG.2016 16:43:54

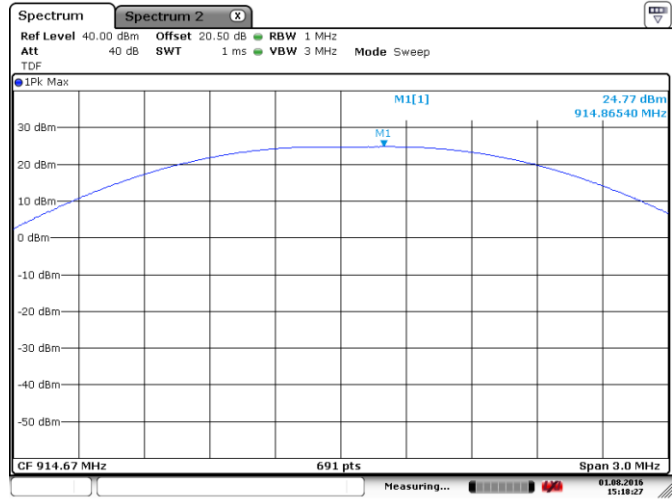
Figure 8.3-3: Output power on high channel, 102 V<sub>AC</sub>

8.3.1 Test data, continued



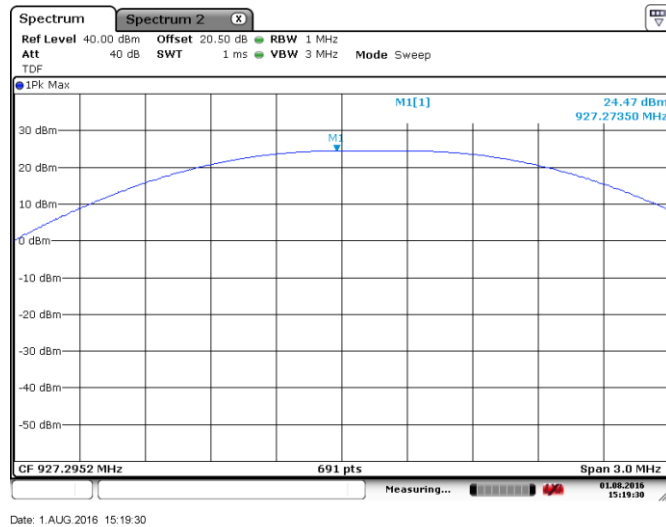
Date: 1.AUG.2016 15:45:58

Figure 8.3-4: Output power on low channel, 230 V<sub>AC</sub>



Date: 1.AUG.2016 15:18:27

Figure 8.3-5: Output power on mid channel, 230 V<sub>AC</sub>



Date: 1.AUG.2016 15:19:30

Figure 8.3-6: Output power on high channel, 230 V<sub>AC</sub>

8.3.4 Test data, continued

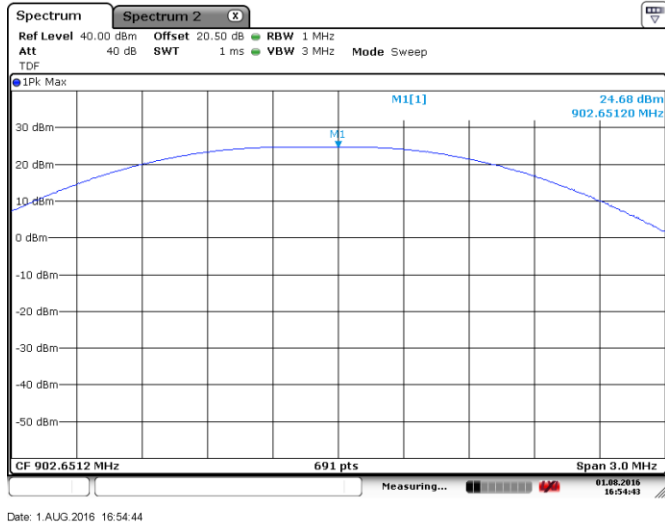


Figure 8.3-7: Output power on low channel, 318.5 V<sub>AC</sub>

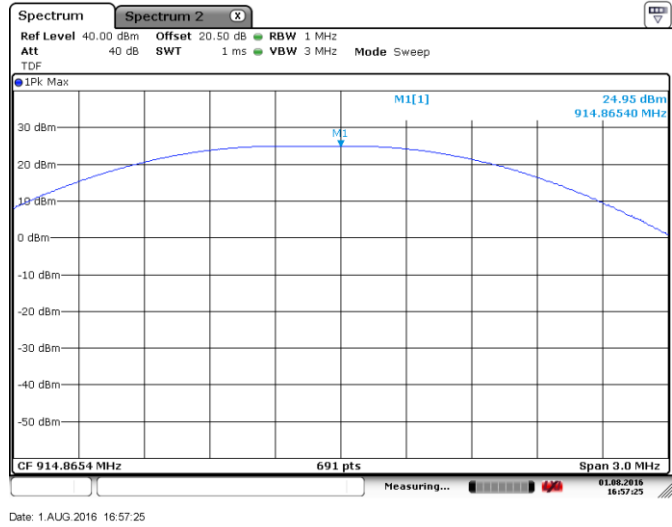


Figure 8.3-8: Output power on mid channel, 318.5 V<sub>AC</sub>

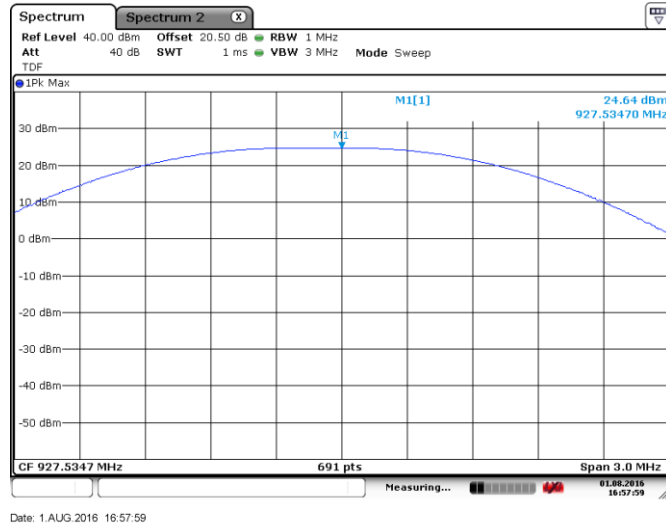


Figure 8.3-9: Output power on high channel, 318.5 V<sub>AC</sub>

## 8.4 FCC 15.247(d) and RSS-247 Section 5.5 Spurious (out-of-band) emissions

### 8.4.1 Definitions and limits

**FCC:**  
 In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. 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. Attenuation below the general field strength limits specified in RSS-Gen is not required.

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

Frequency, MHz	Field strength of emissions		Measurement distance, m
	µV/m	dBµV/m	
0.009–0.490	2400/F	67.6 – 20 × log <sub>10</sub> (F)	300
0.490–1.705	24000/F	87.6 – 20 × log <sub>10</sub> (F)	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges.

For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test

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

**Table 8.4-3: FCC restricted frequency bands**

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

#### 8.4.2 Test summary

Test date	July 19, 2016 to August 1, 2016	Temperature	23 °C
Test engineer	Yong	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	49 %

#### 8.4.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10<sup>th</sup> harmonic.  
 EUT was set to transmit with 100 % duty cycle.

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

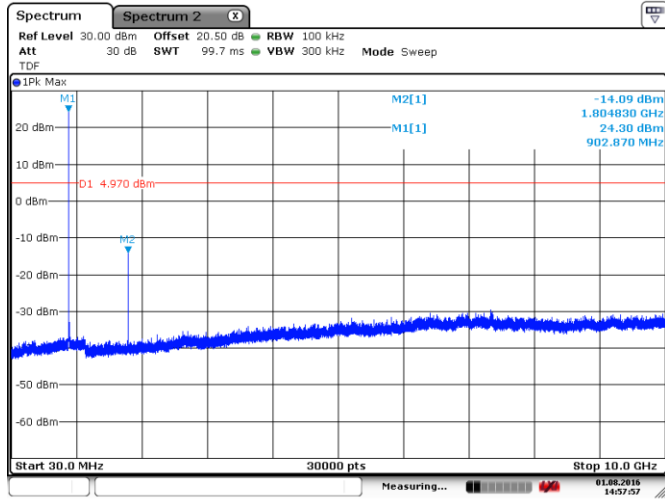
Spectrum analyser settings for average radiated measurements within restricted bands above 1 GHz:

Resolution bandwidth:	1 MHz
Video bandwidth:	10 Hz
Detector mode:	Peak
Trace mode:	Max Hold

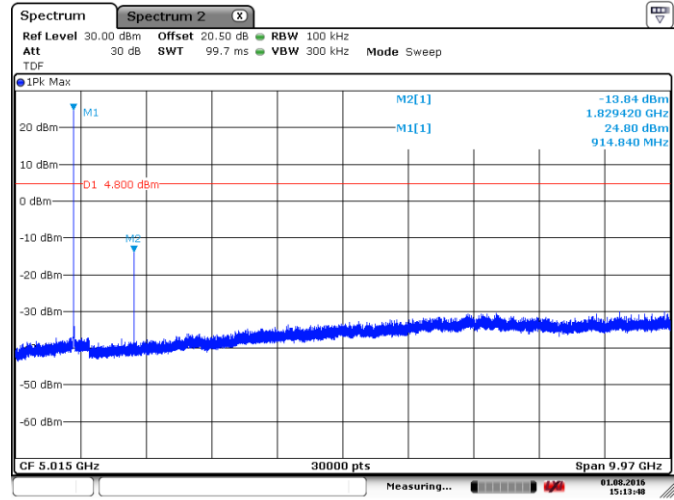
Spectrum analyser settings for conducted spurious emissions measurements:

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

### 8.4.4 Test data



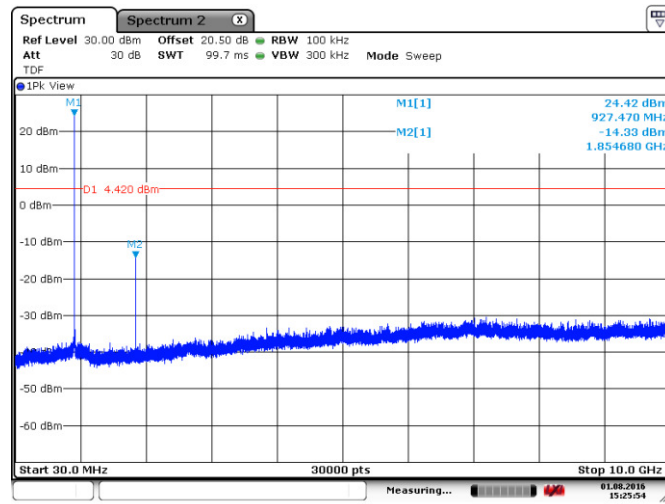
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Figure 8.4-1: Conducted spurious emissions for low channel

Figure 8.4-2: Conducted spurious emissions for mid channel



Date: 1.AUG.2016 15:25:54

Figure 8.4-3: Conducted spurious emissions for high channel



### 8.4.4 Test data, continued

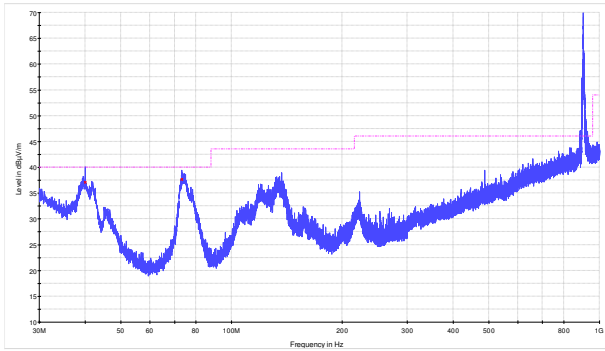


Figure 8.4-4: Radiated spurious emissions for low channel below 1 GHz for restricted band emissions

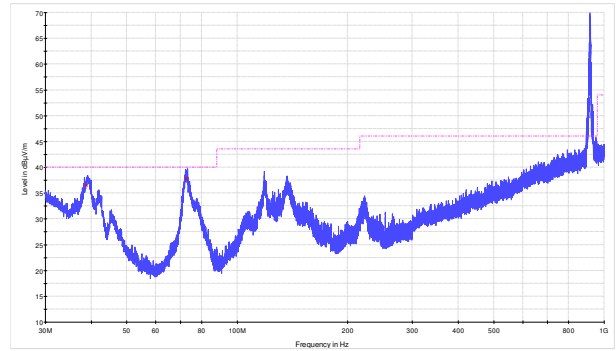


Figure 8.4-5: Radiated spurious emissions for mid channel below 1 GHz for restricted band emissions

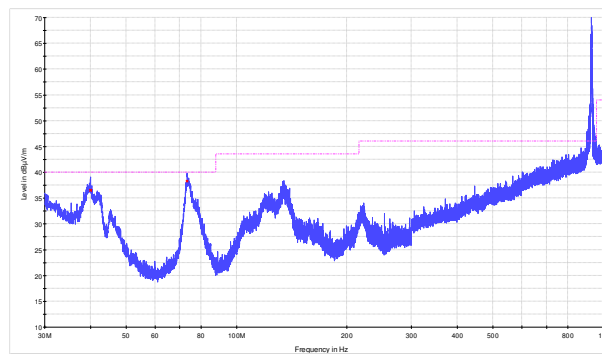


Figure 8.4-6: Radiated spurious emissions for high channel below 1 GHz for restricted band emissions

8.4.4 Test data, continued

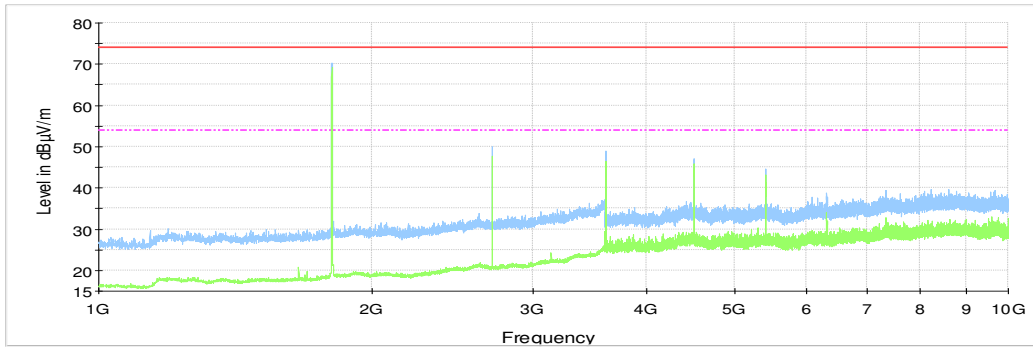


Figure 8.4-7: Radiated spurious emissions for low channel above 1 GHz for restricted band emissions

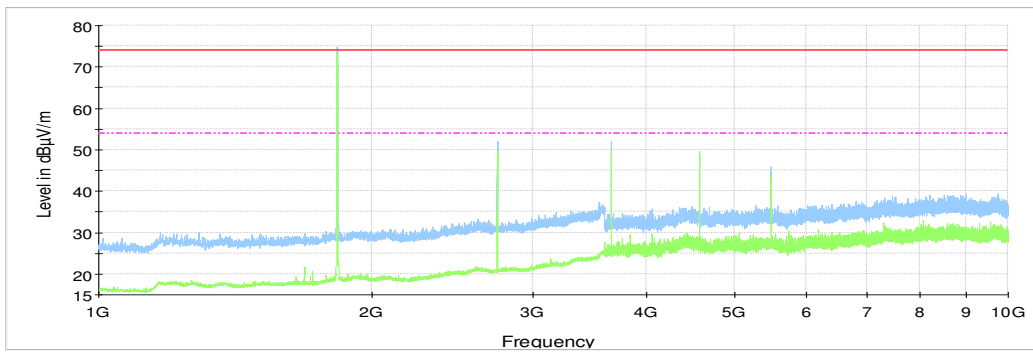


Figure 8.4-8: Radiated spurious emissions for mid channel above 1 GHz for restricted band emissions

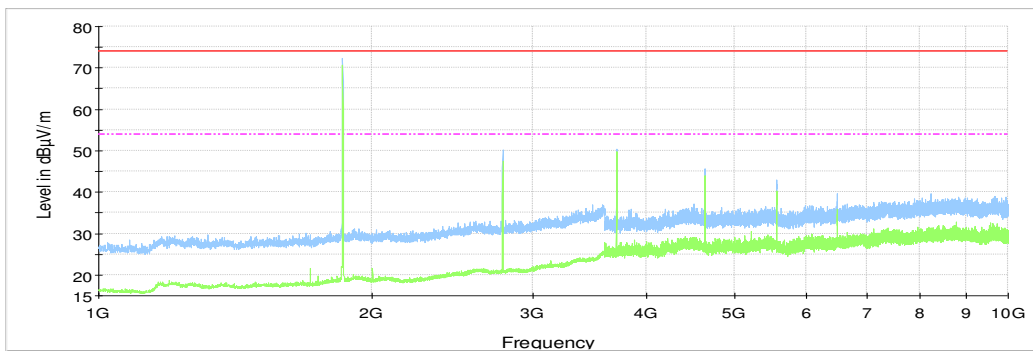


Figure 8.4-9: Radiated spurious emissions for high channel above 1 GHz for restricted band emissions

Note: 1.8 GHz emission is a second harmonic that falls outside restricted bands.

8.4.4 Test data, continued

**Table 8.4-4:** Radiated field strength measurement results below 1 GHz

Channel	Frequency, MHz	Q-peak field strength, dB $\mu$ V/m	3 m Quasi-Peak limit, dB $\mu$ V/m	Margin, dB
Low	73.28	37.7	40	2.4
Low	40.00	37.1	40	2.9
Mid	72.64	37.8	40	2.2
Mid	38.84	36.6	40	3.5
High	73.32	38.3	40	1.7
High	40.00	36.5	40	3.5

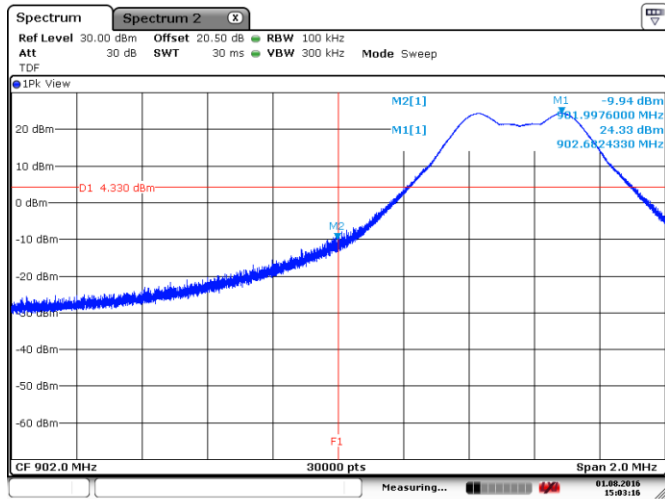
Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

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

Channel	Frequency, MHz	Peak Field strength, dB $\mu$ V/m		Margin, dB	Average Field strength, dB $\mu$ V/m		Margin, dB
		Measured	Limit		Measured	Limit	
Low	2708	49.9	74	24.1	47.8	54	6.2
Low	3611	49.1	74	24.9	46.5	54	7.5
Low	4514	47.1	74	26.9	45.9	54	8.1
mid	2745	52.1	74	21.9	49.5	54	4.5
mid	3660	52.1	74	21.9	49.5	54	4.5
mid	4574	49.6	74	24.4	49.1	54	4.9
high	2783	50.2	74	23.8	47.6	54	6.4
high	3710	50.5	74	23.5	50.1	54	3.9

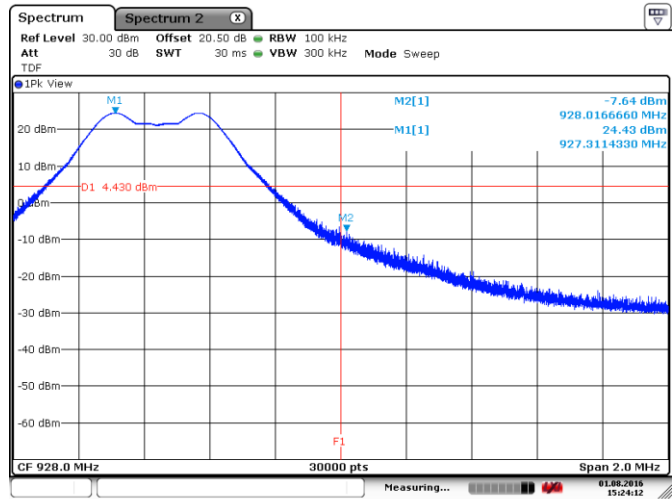
Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

8.4 Test data, continued



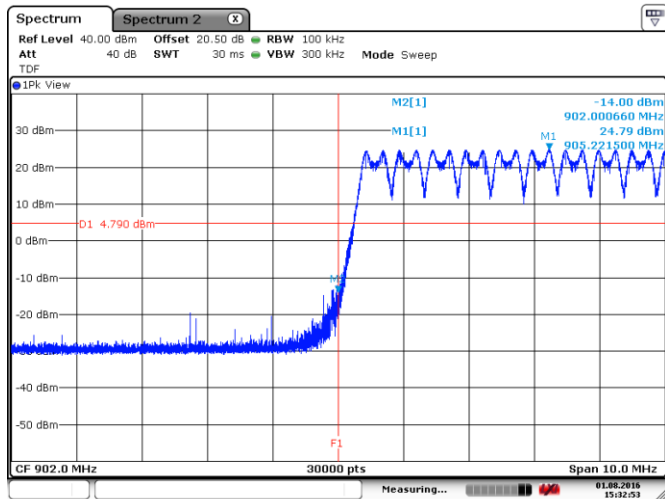
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Figure 8.4-10: Lower band edge emission, tx on low channel



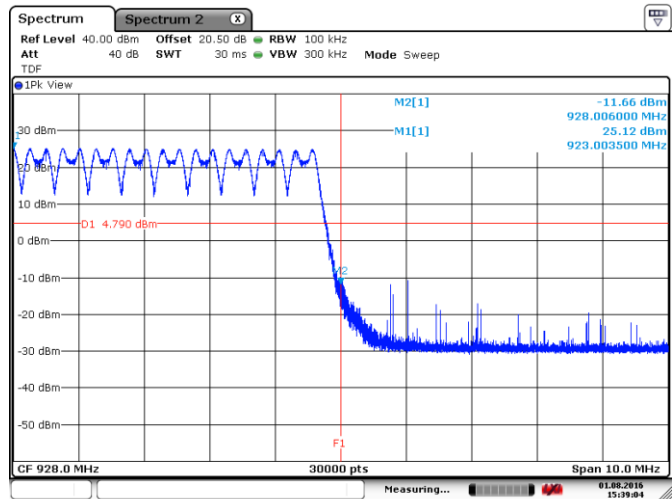
Date: 1.AUG.2016 15:24:13

Figure 8.4-11: Upper band edge emission, tx on high channel



Date: 1.AUG.2016 15:32:53

Figure 8.4-12: Lower band edge emission, tx hopping on

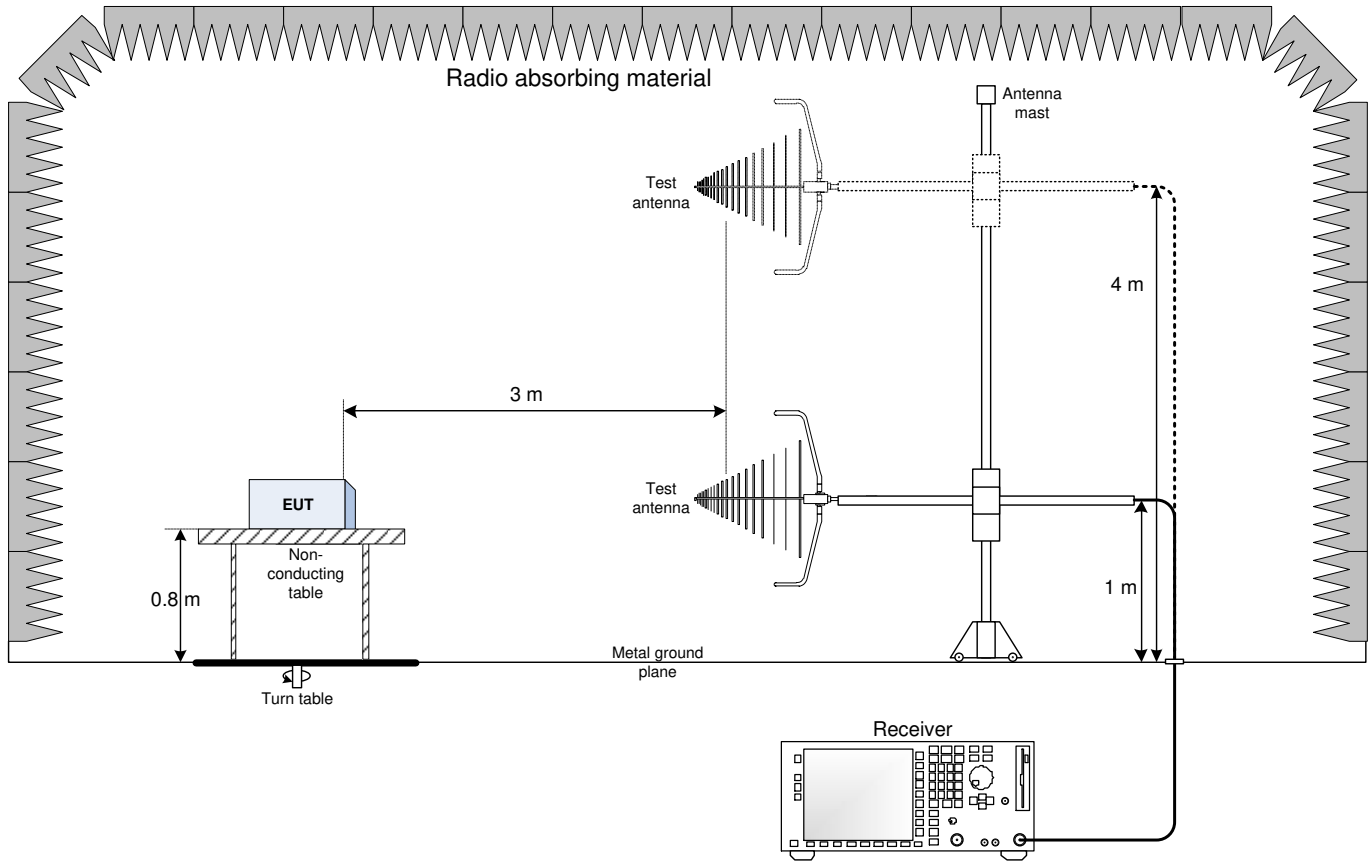


Date: 1.AUG.2016 15:39:04

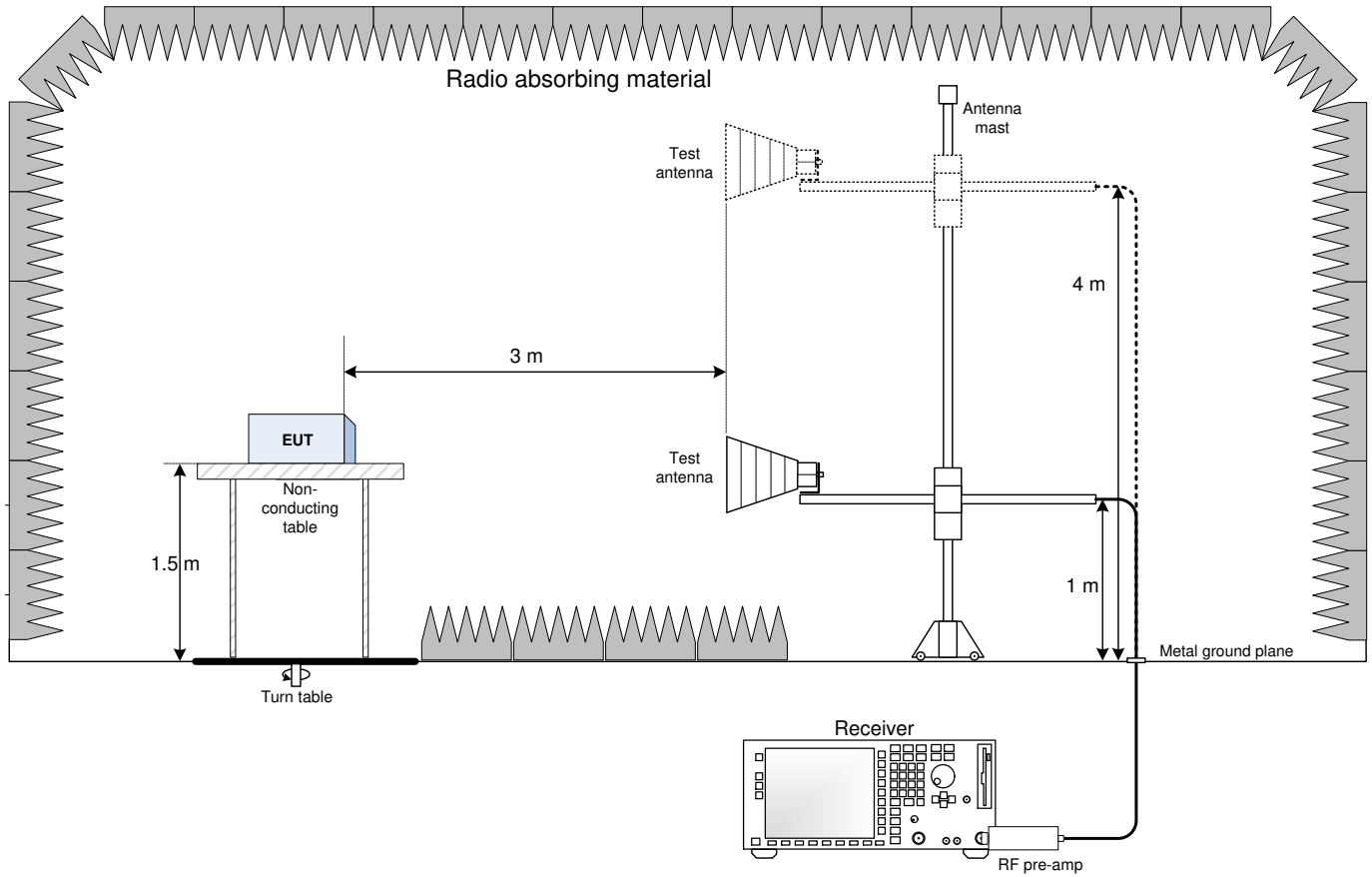
Figure 8.4-13: Upper band edge emission, tx hopping on

## Section 9. Block diagrams of test set-ups

### 9.1 Radiated emissions set-up



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Conducted emissions set-up

