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Wireless test report – 350995-2R1TRFWL

Applicant:

Eurotech SpA

Product name:

ReliaGATE 10-12

DynaGATE 10-12

Model:	Model variant:
REGATE-10-12-GS02	DYGATE-10-12-GS02

FCC ID:	IC Registration number:
UKMMRG1012	21442-MRG1012

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: October 12, 2018

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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.

Copyright notification

Table of contents

Table of contents **3**
Section 1. Report summary **4**
1.1 Applicant and manufacturer 4
1.2 Test specifications 4
1.3 Test methods 4
1.4 Statement of compliance 4
1.5 Exclusions 4
1.6 Test report revision history 4
Section 2. Summary of test results **5**
2.1 FCC Part 15 Subpart C, general requirements test results 5
2.2 FCC Part 15 Subpart C, intentional radiators test results for frequency hopping spread spectrum systems 5
2.3 FCC Part 15 Subpart C, intentional radiators test results for digital transmission systems (DTS) 5
2.4 ISED RSS-Gen, Issue 5, test results 6
2.5 ISED RSS-247, Issue 2, test results for frequency hopping spread spectrum systems (FHSS) 6
2.6 ISED RSS-247, Issue 2, test results for digital transmission systems (DTS) 6
Section 3. Equipment under test (EUT) details **7**
3.1 Sample information 7
3.2 EUT information 7
3.3 Technical information 7
3.4 Product description and theory of operation 8
3.5 EUT exercise details 8
3.6 EUT setup diagram 9
3.7 EUT sub assemblies 9
Section 4. Engineering considerations **10**
4.1 Modifications incorporated in the EUT 10
4.2 Technical judgment 10
4.3 Deviations from laboratory tests procedures 10
Section 5. Test conditions **11**
5.1 Atmospheric conditions 11
5.2 Power supply range 11
Section 6. Measurement uncertainty **12**
6.1 Uncertainty of measurement 12
Section 7. Test equipment **13**
7.1 Test equipment list 13
Section 8. Testing data **14**
8.1 FCC 15.31(e) Variation of power source 14
8.2 FCC 15.31(m) and RSS-Gen 6.9 Number of frequencies 15
8.3 FCC 15.203 and RSS-Gen, section 6.8 Antenna requirement 16
8.4 FCC 15.207(a) and RSS-Gen 8.8 AC power line conducted emissions limits 17
8.5 FCC 15.247(a)(2) and RSS-247 5.2(a) Minimum 6 dB bandwidth for DTS systems 21
8.6 FCC 15.247(b) and RSS-247 5.4 (d) Transmitter output power and e.i.r.p. requirements for DTS in 2.4 GHz 25
8.7 FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) unwanted emissions 28
8.8 FCC 15.247(e) and RSS-247 5.2(b) Power spectral density for digitally modulated devices 44
Section 9. Block diagrams of test set-ups **47**
9.1 Radiated emissions set-up for frequencies below 1 GHz 47
9.2 Radiated emissions set-up for frequencies above 1 GHz 47
9.3 Conducted emissions set-up 48
9.4 Antenna port set-up 48

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Eurotech SpA
Address	Via Fratelli Solari 3/a 33020 Amaro, UD, Italy

1.2 Test specifications

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

1.3 Test methods

558074 D01 DTS Meas Guidance v04 (April 5, 2017)	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
RSS-Gen, Issue 5, April 2018	General Requirements for Compliance of Radio Apparatus

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	September 14, 2018	Original report issued
R1	October 12, 2018	Report revised with additional antenna configuration

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	Pass
§15.31(e)	Variation of power source	Pass
§15.31(m)	Number of tested frequencies	Pass
§15.203	Antenna requirement	Pass

Notes: EUT is an AC powered 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	Not applicable
§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	Not applicable
§15.247(c)(1)	Fixed point-to-point operation with directional antenna gains greater than 6 dBi	Not applicable
§15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	Not applicable
§15.247(d)	Spurious emissions	Not applicable
§15.247(f)	Time of occupancy for hybrid systems	Not applicable

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	Not applicable

2.4 ISED RSS-Gen, Issue 5, test results

Table 2.4-1: *RSS-Gen results*

Part	Test description	Verdict
7.3	Receiver radiated emission limits	Not applicable
7.4	Receiver conducted emission limits	Not applicable
6.9	Operating bands and selection of test frequencies	Pass
8.8	AC power-line conducted emissions limits	Pass

Notes: [1] According to sections 5.2 and 5.3 of RSS-Gen, Issue 5 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.
EUT is an AC powered device.

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	Not applicable
5.1 (b)	Minimum channel spacing	Not applicable
5.1 (c)	Systems operating in the 902–928 MHz band	Not applicable
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
5.3	Hybrid Systems	Not applicable
5.3 (a)	Digital modulation turned off	Not applicable
5.3 (b)	Frequency hopping turned off	Not applicable
5.4	Transmitter output power and e.i.r.p. requirements	Not applicable
5.4 (a)	Systems operating in the 902–928 MHz band	Not applicable
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	Not applicable

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
5.3	Hybrid Systems	
5.3 (a)	Digital modulation turned off	Not applicable
5.3 (b)	Frequency hopping turned off	Not applicable
5.4	Transmitter output power and e.i.r.p. requirements	
5.4 (d)	Systems employing digital modulation techniques	Pass
5.4 (e)	Point-to-point systems in 2400–2483.5 MHz and 5725–5850 MHz band	Pass
5.4 (f)	Transmitters which operate in the 2400–2483.5 MHz band with multiple directional beams	Not applicable
5.5	Unwanted emissions	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	July 4, 2018
Nemko sample ID number	Item #1

3.2 EUT information

Product name	ReliaGATE 10-12 DynaGATE 10-12
Model	REGATE-10-12-GS02
Model variant	DYGATE-10-12-GS02
Serial number	Y117LQA0010

3.3 Technical information

Applicant IC company number	21442
IC UPN number	MRG1012
All used IC test site(s) Reg. number	2040G-5
RSS number and Issue number	RSS-247 Issue 2, Feb 2017
Frequency band	2400 to 2483.5 MHz
Frequency Min (MHz)	2412
Frequency Max (MHz)	2462
RF power Min (W), Conducted	N/A
RF power Max (W), Conducted	0.0347(15.4 dBm, 802.11b), 0.0251(14.0 dBm, 802.11g), .0.0120(13.0 dBm, 802.11n HT20), 0.0355(15.5 dBm, 802.11 HT40)
Field strength, Units @ distance	N/A
Measured BW (kHz) (6 dB)	1110(802.11b), 1632(802.11g), 1667(802.11n HT20), 3511(802.11 HT40)
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	802.11b/g/n
Emission classification (F1D, G1D, D1D)	W7D
Transmitter spurious, Units @ distance	53.93 dBµV/m at 2390MHz, @ 3 m
Power requirements	24 $V_{DC,}$ via 120 V_{AC} adapter or battery
Antenna information	The EUT uses a unique antenna coupling. EUT has 2 antenna configurations. The max antenna peak gain is 5.47 dBi at 2.4 GHz band and 7.07 dBi at 5 GHz WIFI bands. Linx Technologies ANT-DB1-RAF-RPS (2.5 dBi for 2.4 GHz, 4.6 dBi antenna for 5 GHz) Taoglas MA.950.W.A.LBICG.005 (5.47 dBi for 2.4GHz, 7.07 for 5GHz)

3.4 Product description and theory of operation

The ReliaGATE and DynaGATE 10-12 are IoT Edge Gateways that have been designed to deliver LTE connectivity (with 3G fallback) to industrial and lightly rugged applications. Based on the TI AM335x Cortex-A8 (Sitara) processor family, with 1 GB of RAM, 4 GB of eMMC and user-accessible MicroSD and dual Micro-SIM slots, the ReliaGATE and DynaGATE 10-12 are low power gateways suitable for demanding use cases. They support a 6 to 36 V power supply with transient protection and ignition sense, two protected RS-232/RS-485 serial ports, two CAN bus interfaces, three noise and surge protected USB ports, and four isolated digital interfaces

3.5 EUT exercise details

EUT was set to continuously transmit mode during tests, by test software provided by client.
The EUT runs a Linux operating system which allows for the testing to be performed using engineering test tools and scripts. Communication with the EUT is via a serial console or Ethernet connection which provides a Linux command line interface for execution of the test tools/scripts. These tools/scripts configure the radio modules to enable continuous transmission with the ability to adjust modulation, frequency and output power as required.

WiFi/BT – using a engineering test tool provided by the silicon vendor allowing for full radio control.
Cellular – using Linux scripts running AT command sequences provided by the cellular radio module vendor allowing for full radio control.

3.6 EUT setup diagram

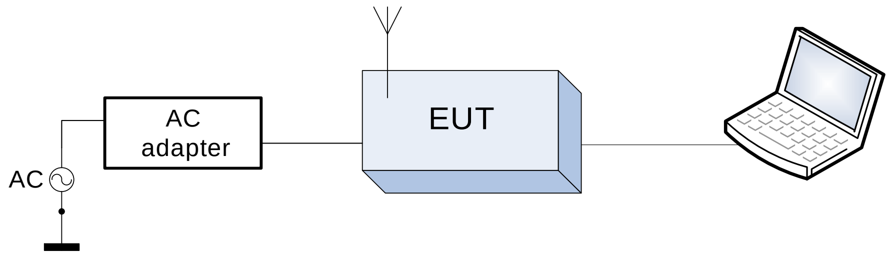


Figure 3.6-1: *Setup diagram*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
REGATE-10-12	Eurotech	REGATE-10-12-GS02	Y117LQA0010
AC adapter	Sunny	SYS15412424	None

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

Differences between the variants are as below. REGATE-10-12 was chosen as representative worst-case.

Model	ReliaGATE 10-12					DynaGATE 10-12				
Variant (Base Hardware) REGATE-10-12-xx	REGATE-10-12-GS02 (EMC Sample Unit)	REGATE-10-12-01	REGATE-10-12-02	REGATE-10-12-03	REGATE-10-12-05	DYGATE-10-12-GS02 (EMC Sample Unit)	DYGATE-10-12-01	DYGATE-10-12-02	DYGATE-10-12-03	DYGATE-10-12-05
OS SW Versions Refer Note 1.	-	REGATE-10-12-21 REGATE-10-12-31	REGATE-10-12-22 REGATE-10-12-32	REGATE-10-12-23 REGATE-10-12-33	REGATE-10-12-25 REGATE-10-12-35	-	DYGATE-10-12-21 DYGATE-10-12-31	DYGATE-10-12-22 DYGATE-10-12-32	DYGATE-10-12-23 DYGATE-10-12-33	DYGATE-10-12-25 DYGATE-10-12-35
GENERAL										
Processor	TI Sitara AM3352 1GHz									
DRAM	1GB DDR3									
STORAGE	4GB eMMC, micro SD slot accessible under service panel opening, 256kbit EEPROM									
PCB Design	Both models share the same PCB design with population differences as described below (8-layers PCB)									
Ethernet	2x 10-100Mbps on shielded RJ45									
Serial	Two identical 2-lines channels(RX/TX, RA+/RB-) available on 3.5mm terminal									
Debug	RS232 3.3V TTL debug port available under service panel opening									
CAN	Two identical Can bus ports available on 3.5mm terminal header with external power delivery 5V@100mA									
Digital I/O	2x Digital Input 36V, 1kV Opto-isolated, 2x Digital Output (40VDC), 500mA fuse protected, 1KHz Max Switching(optorelay)									
USB	3x Host 2.0 (Noise and Surge Protected) - Type A – Electrically identical to DynaGATE 10-12 Variants					3x Host 2.0 (Noise and Surge Protected) - High Retention Type A - Electrically identical to ReliaGATE 10-12 Variants				
Expansion	Yes, for Side Expansion Modules (24way 2mm/2row female header)									
WIRELESS										
LTE	TELIT LE910-NA1 LTE	None	None	TELIT LE910-NA1 LTE		TELIT LE910-NA1 LTE	None	None	TELIT LE910-NA1 LTE	
WiFi	Jorjin WG7833-B0	None	Jorjin WG7833-B0	None	Jorjin WG7833-B0	Jorjin WG7833-B0	None	Jorjin WG7833-B0	None	Jorjin WG7833-B0
GPS	U-Blox NEO M8 GPS	Optional U-Blox NEO-M8x GPS Receiver				Integrated U-Blox NEO-M8x GPS Receiver				
OTHER										
RTC	Yes (Lithium BR1225 battery backup)					Yes (Supercap backup)				
Sensors	Temperature, Accelerometer									
Buttons	1x RESET, 1x user programmable available under the service panel									
LEDs	1x Power, 1x Cellular, 4x Programmable									
TPM	Factory Option									
SIM slot	2x microSIM (User Accessible under the service panel)									
Power	6-36VDC, with Transient Protection, Vehicle Ignition Sense (2W typ.)									
ENVIRONMENT										
Operating temp. range	- 20 to +70°C					- 40 to +85°C				
Storage temp. range	- 40 to +85°C									
MECHANICAL										
Enclosure	ABS Plastic					Aluminium Sheetmetal				
Ingress	IP40									
Dimensions	138.9x115.0x46.2mm (LxWxH) - with mounting bracket and SMA connectors					138.9x118.2x51.6mm (LxWxH) - with mounting bracket and SMA connectors				

Note 1: Radio module firmware and operating system based radio firmware loaded during OS boot are identical across all REGATE-10-12-xx and DYGATE-10-12-xx variants.

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

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

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

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

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

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

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	FA002532	2 year	June 5/19
Flush mount turntable	Sunol	FM2022	FA002550	—	NCR
Controller	Sunol	SC104V	FA002551	—	NCR
Antenna mast	Sunol	TLT2	FA002552	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	Sept. 18/18
Bilog antenna (20–2000 MHz)	Sunol	JB1	FA002517	1 year	Dec. 6/18
Power sensor	Rohde & Schwarz	NRP18S	FA002730	1 year	Sep 26/19
Horn antenna (1–18 GHz)	EMCO	3115	FA001451	1 year	April 27/19
Pre-amplifier (0.5–18 GHz)	COM-POWER	PAM-118A	FA002561	1 year	Sept. 21/18
Horn antenna (18–40 GHz)	EMCO	3116	FA002487	2 year	Aug. 16/19
Pre-amplifier (0.5–18 GHz)	COM-POWER	PAM-118A	FA002561	1 year	Sept. 21/18
Pre-amplifier (18–40 GHz)	COM-POWER	PAM-840	FA002508	1 year	May 8/19
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	FA002831	—	VOU
50 Ω coax cable	C.C.A.	None	FA002607	—	VOU
50 Ω coax cable	Sucoflex	None	FA002563	—	VOU
2300-2583.5 MHz Notch Filter	Microwave Circuits	N0324413	FA002693	—	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	August 1, 2018

8.1.3 Observations, settings and special notes

None

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 6.9 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 test frequencies required	Location of measurement frequency inside the operating frequency range
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

Note: “near” means as close as possible to or at the centre / low end / high end of the frequency range over which the device operates.

8.2.2 Test date

Start date	July 18, 2018

8.2.3 Observations, settings and special notes

None

8.2.4 Test data

Table 8.2-2: *Test channels selection*

Modulation	Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz
802.11b/g/n HT20	2400	2483.5	83.5	2412	2437	2462
802.11n HT40	2400	2483.5	83.5	2422	2437	2452

8.3 FCC 15.203 and RSS-Gen, section 6.8 Antenna requirement

8.3.1 Definitions and limits

FCC:
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.

ISED:
The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report.

8.3.2 Test date

Start date	July 18, 2018

8.3.3 Observations, settings and special notes

None

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

8.4.1 Definitions and limits

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

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

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

Table 8.4-1: *Conducted emissions limit*

Frequency of emission, MHz	Conducted limit, dBµV	
	Quasi-peak	Average**
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

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

8.4.2 Test date

Start date	July 17, 2018

8.4.3 Observations, settings and special notes

The EUT was set up as tabletop configuration.

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

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

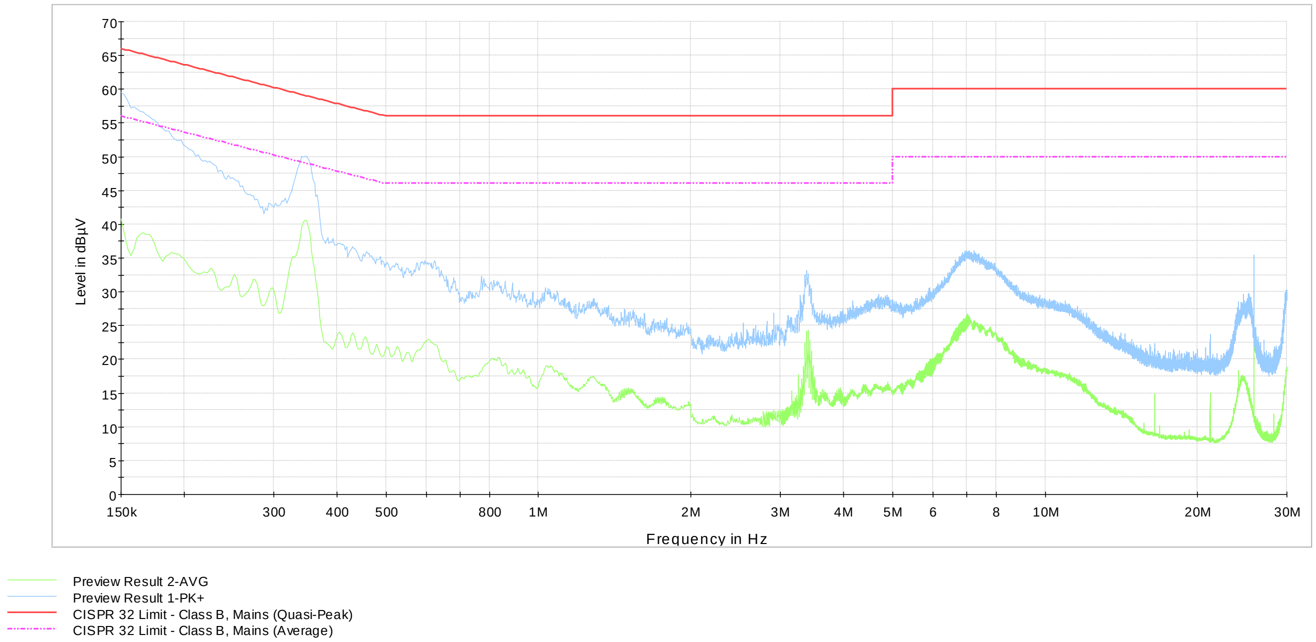
Receiver settings for preview measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Peak and Average
Trace mode	Max Hold
Measurement time	100 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	100 ms

8.4.4 Test data



Plot 8.4-1: *Conducted emissions on phase line*

Table 8.4-2: *Quasi-Peak conducted emissions results on phase line*

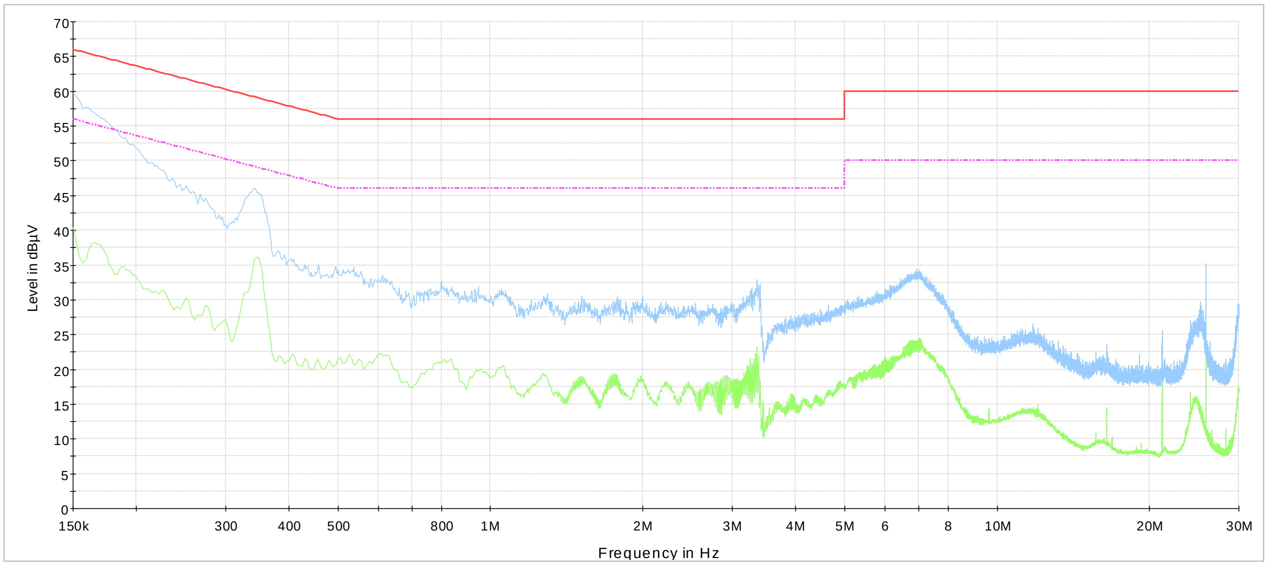
Frequency, MHz	Q-Peak result, dBµV	Correction, dB	Margin, dB	Limit, dBµV
0.150	57.5	9.4	8.5	66.0
0.348	47.0	9.4	12.0	59.0

Table 8.4-3: *Average conducted emissions results on phase line*

Frequency, MHz	Average result, dBµV	Correction, dB	Margin, dB	Limit, dBµV
0.346	40.5	9.4	8.6	49.1

Notes: [1] Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions have been recorded.

Sample calculation: 37.1 dBµV (result) = 26.6 dBµV (receiver reading) + 9.5 dB (Correction factor)



Plot 8.4-2: *Conducted emissions on neutral line*

Table 8.4-4: *Quasi-Peak conducted emissions results on neutral line*

Frequency, MHz	Q-Peak result, dBµV	Correction, dB	Margin, dB	Limit, dBµV
0.150	57.5	9.4	8.5	66.0

Notes: [1] Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions have been recorded.

Sample calculation: 37.1 dBµV (result) = 26.6 dBµV (receiver reading) + 9.5 dB (Correction factor)

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

8.5.1 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.

8.5.1 Test date

Start date	July 19, 2018

8.5.2 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	100 kHz
Video bandwidth	≥3 × RBW
Frequency span	30 MHz for 20 MHz channel; 80 MHz for 40 MHz channel
Detector mode	Peak
Trace mode	Max Hold

8.5.3 Test data

Table 8.5-1: *6 dB bandwidth results*

Modulation	Frequency, MHz	6 dB bandwidth, MHz	Limit, MHz	Margin, MHz
802.11b	2412	11.11	0.5	10.61
	2437	9.90	0.5	9.40
	2462	10.30	0.5	9.80
802.11g	2412	16.32	0.5	15.82
	2437	15.63	0.5	15.13
	2462	15.63	0.5	15.13
802.11n HT20	2412	16.67	0.5	16.17
	2437	15.33	0.5	14.83
	2462	15.15	0.5	14.65
802.11n HT40	2422	35.08	0.5	34.58
	2437	35.11	0.5	34.61
	2452	35.08	0.5	34.58

Table 8.5-2: *99% occupied bandwidth results*

Modulation	Frequency, MHz	99% occupied bandwidth, MHz
802.11b	2412	14.50
	2437	14.50
	2462	14.50
802.11g	2412	16.44
	2437	16.64
	2462	16.64
802.11n HT20	2412	17.95
	2437	17.80
	2462	17.80
802.11n HT40	2422	36.70
	2437	36.82
	2452	36.93

Note: there is no 99% occupied bandwidth limit in the standard's requirements, the measurement results provided for information purposes only.

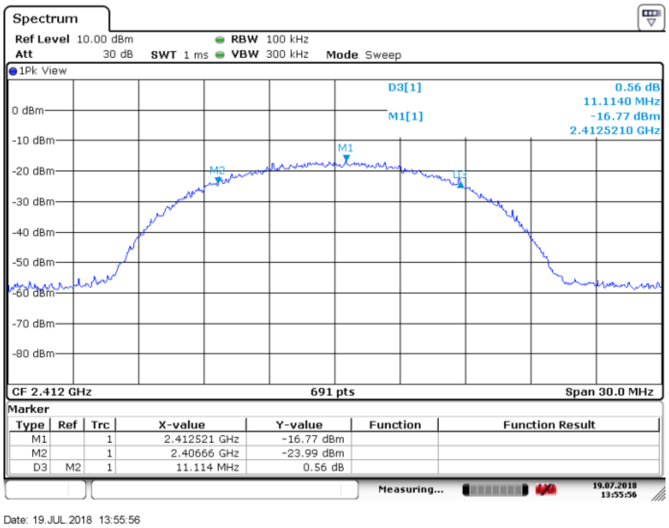


Figure 8.5-1: *6 dB bandwidth on 802.11b, sample plot*

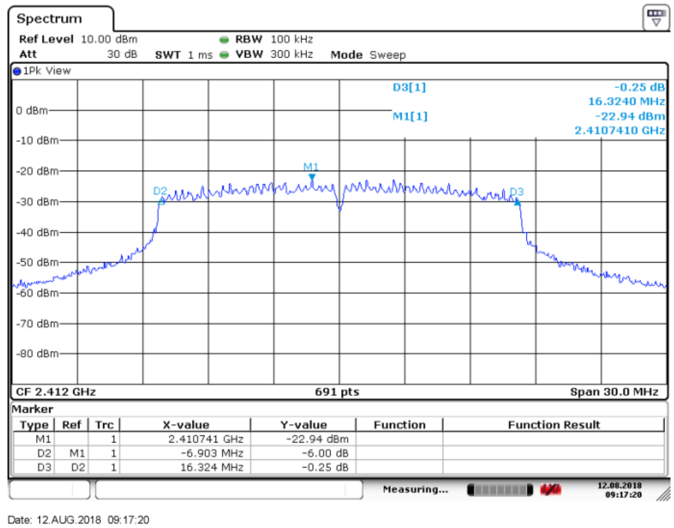


Figure 8.5-2: *6 dB bandwidth on 802.11g, sample plot*

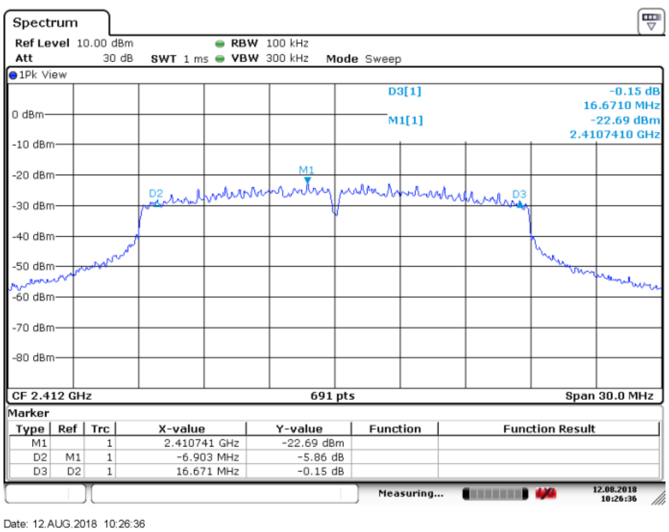


Figure 8.5-3: *6 dB bandwidth on 802.11n HT20, sample plot*

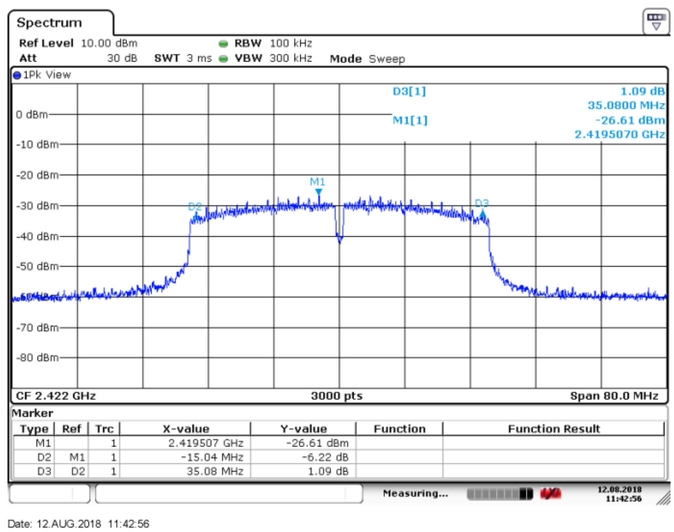


Figure 8.5-4: *6 dB bandwidth on 802.11n HT40, sample plot*

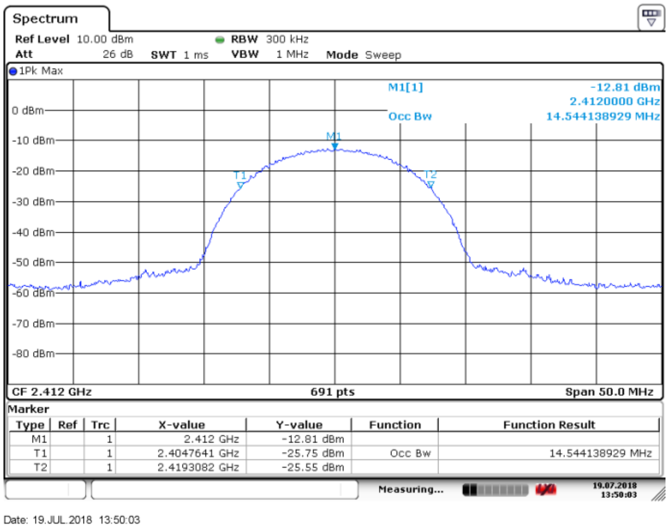


Figure 8.5-5: *99% bandwidth on 802.11b, sample plot*

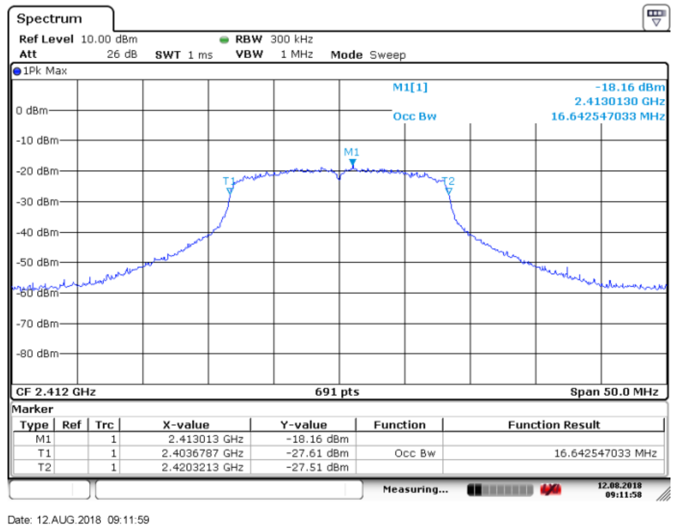


Figure 8.5-6: *99% bandwidth on 802.11g, sample plot*

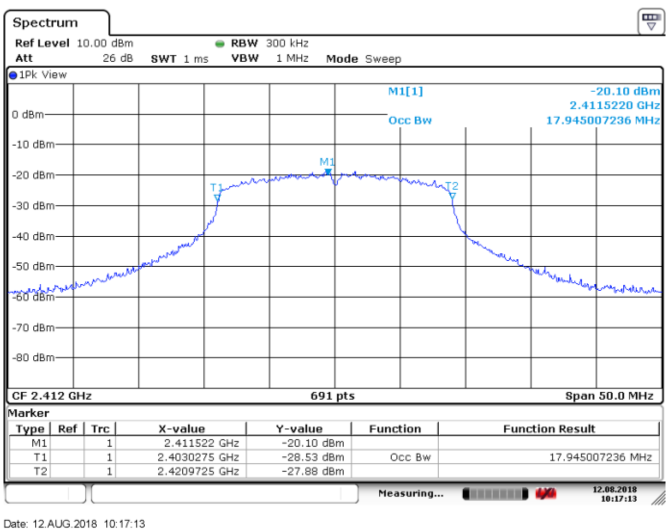


Figure 8.5-7: *99% bandwidth on 802.11n HT20, sample plot*

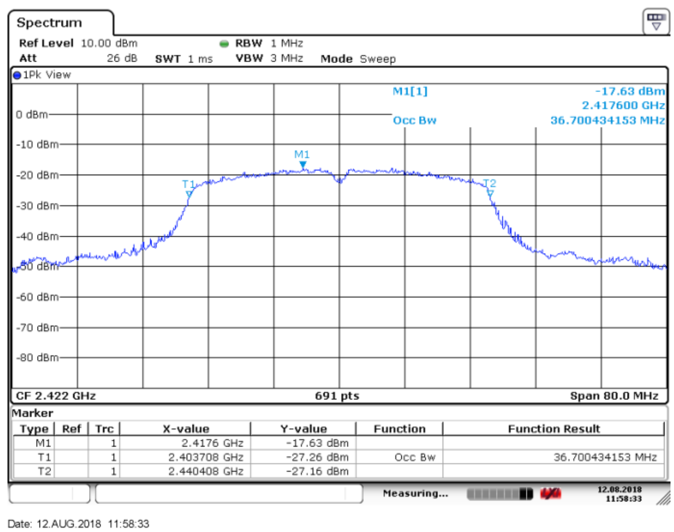


Figure 8.5-8: *99% bandwidth on 802.11n HT40, sample plot*

8.6 FCC 15.247(b) and RSS-247 5.4 (d) Transmitter output power and e.i.r.p. requirements for DTS in 2.4 GHz

8.6.1 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 2400–2483.5 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:
(i) Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.
(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.
(2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:
(i) Different information must be transmitted to each receiver.
(ii) If the transmitter employs an antenna system that emits multiple directional beams but does not do emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:
(A) The directional gain shall be calculated as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.
(B) A lower value for the directional gain than that calculated in paragraph (c)(2)(ii)(A) of this section will be accepted if sufficient evidence is presented, e.g., due to shading of the array or coherence loss in the beamforming.
(iii) If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the power limit specified in paragraph (c)(2)(ii) of this section. If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the limit specified in paragraph (c)(2)(ii) of this section. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the limit specified in paragraph (c)(2)(ii) of this section by more than 8 dB.
(iv) Transmitters that emit a single directional beam shall operate under the provisions of paragraph (c)(1) of this section.

ISED:
d. For DTSs employing digital modulation techniques operating in the 2400–2483.5 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.
e. Fixed point-to-point systems in the 2400–2483.5 MHz band are permitted to have an e.i.r.p. higher than 4 W provided that the higher e.i.r.p. is achieved by employing higher gain directional antennas and not higher transmitter output powers. Point-to-multipoint systems, omnidirectional applications and multiple co-located transmitters transmitting the same information are prohibited from exceeding an e.i.r.p. of 4 W.
f. Transmitters operating in the band 2400–2483.5 MHz, may employ antenna systems that emit multiple directional beams simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers, provided that the emissions comply with the following:

i Different information must be transmitted to each receiver.
ii If the transmitter employs an antenna system that emits multiple directional beams, but does not emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device (i.e. the sum of the power supplied to all antennas, antenna elements, staves, etc., and summed across all carriers or frequency channels) shall not exceed the applicable output power limit specified in sections 5.4(b) and 5.4(d). However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.
iii If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the applicable power limit specified in sections 5.4(b) and 5.4(d). If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the applicable limit specified in sections 5.4(b) and 5.4(d). In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the applicable limit specified in sections 5.4(b) and 5.4(d) by more than 8 dB.
iv Transmitters that transmit a single directional beam shall operate under the provisions of sections 5.4(b), 5.4(d) and 5.4(e).

8.6.1 Test date

Start date	July 19, 2018

8.6.2 Observations, settings and special notes

The test was performed using PKPM1 method of KDB 558074 . Tests were performed with highest and lowest data rates, only the worst cases were presented.

8.6.3 Test data

Table 8.6-1: *Output power measurements results, Taoglas Antenna configuration*

Modulation	Frequency, MHz	Conducted output power, dBm		Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
		Measured	Limit					
802.11b	2412	15.0	30	15.0	5.5	20.5	36	15.5
	2437	15.4	30	14.6	5.5	20.9	36	15.1
	2462	15.4	30	14.6	5.5	20.9	36	15.1
802.11g	2412	13.5	30	16.5	5.5	19	36	17.0
	2437	14.0	30	16.0	5.5	19.5	36	16.5
	2462	13.4	30	16.6	5.5	18.9	36	17.1
802.11n HT20	2412	12.7	30	17.3	5.5	18.2	36	17.8
	2437	13.0	30	17.0	5.5	18.5	36	17.5
	2462	12.8	30	17.2	5.5	18.3	36	17.7
802.11n HT40	2422	15.4	30	14.6	5.5	20.9	36	15.1
	2437	15.5	30	14.5	5.5	21.0	36	15.0
	2452	15.2	30	14.8	5.5	20.7	36	15.3

Table 8.6-2: *Output power measurements results, Linx Technology Antenna configuration*

Modulation	Frequency, MHz	Conducted output power, dBm		Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
		Measured	Limit					
802.11b	2412	15.0	30	15.0	2.5	17.5	36	18.5
	2437	15.4	30	14.6	2.5	17.9	36	18.1
	2462	15.4	30	14.6	2.5	17.9	36	18.1
802.11g	2412	13.5	30	16.5	2.5	16.0	36	20.0
	2437	14.0	30	16.0	2.5	16.5	36	19.5
	2462	13.4	30	16.6	2.5	15.9	36	20.1
802.11n HT20	2412	12.7	30	17.3	2.5	15.2	36	20.8
	2437	13.0	30	17.0	2.5	15.5	36	20.5
	2462	12.8	30	17.2	2.5	15.3	36	20.7
802.11n HT40	2422	15.4	30	14.6	2.5	17.9	36	18.1
	2437	15.5	30	14.5	2.5	18.0	36	18.0
	2452	15.2	30	14.8	2.5	17.7	36	18.3

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

8.7.1 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 8.7-1: *FCC §15.209 and RSS-Gen – Radiated emission limits*

Frequency, MHz	Field strength of emissions μV/m	Field strength of emissions dBμV/m	Measurement distance, m
0.009–0.490	2400/F	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 - 20 \times \log_{10}(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges.
For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test

Table 8.7-2: *ISED restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	12.57675–12.57725	399.9–410	7.25–7.75
0.495–0.505	13.36–13.41	608–614	8.025–8.5
2.1735–2.1905	16.42–16.423	960–1427	9.0–9.2
3.020–3.026	16.69475–16.69525	1435–1626.5	9.3–9.5
4.125–4.128	16.80425–16.80475	1645.5–1646.5	10.6–12.7
4.17725–4.17775	25.5–25.67	1660–1710	13.25–13.4
4.20725–4.20775	37.5–38.25	1718.8–1722.2	14.47–14.5
5.677–5.683	73–74.6	2200–2300	15.35–16.2
6.215–6.218	74.8–75.2	2310–2390	17.7–21.4
6.26775–6.26825	108–138	2483.5–2500	22.01–23.12
6.31175–6.31225	149.9–150.05	2655–2900	23.6–24.0
8.291–8.294	156.52475–156.52525	3260–3267	31.2–31.8
8.362–8.366	156.7–156.9	3332–3339	36.43–36.5
8.37625–8.38675	162.0125–167.17	3345.8–3358	Above 38.6
8.41425–8.41475	167.72–173.2	3500–4400	
12.29–12.293	240–285	4500–5150	
12.51975–12.52025	322–335.4	5350–5460	

Note: Certain frequency bands listed in Table 8.7-2 and above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

Table 8.7-3: *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			

8.7.1 Test date

Start date	July 19, 2018

8.7.2 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
EUT was set to transmit continuously. Tests were performed with EUT set to highest and lowest data rate, different antenna configurations and modulation schemes were investigated, only the worst case are presented.
Radiated measurements were performed at a distance of 3 m. Cabinet radiated emissions were performed with antenna port terminated with 50 Ω load.
Since fundamental power was tested using the maximum peak conducted output power procedure to demonstrate compliance, the spurious emissions limit is −20 dBc/100 kHz.

Spectrum analyzer settings for conducted spurious emissions measurements:

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

Spectrum analyzer 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 analyzer 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 analyzer settings for average conducted measurements within restricted bands above 1 GHz:

Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	power averaging (RMS)
Trace mode:	averaging (RMS)

Spectrum analyzer 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

8.7.4 Test data

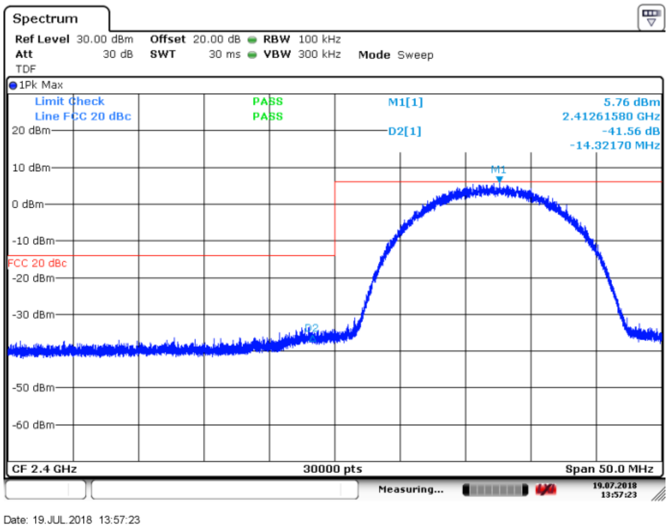


Figure 8.7-1: *Conducted spurious emission at band edge outside restricted band, low channel, 802.11b*

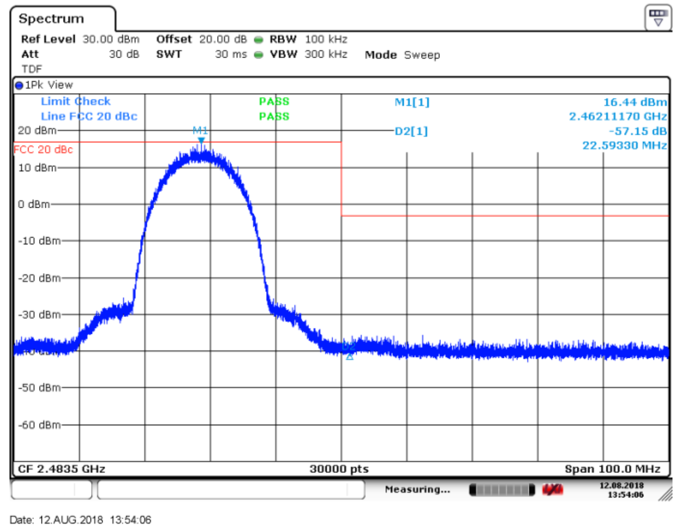


Figure 8.7-2: *Conducted spurious emissions at band edge outside restricted band, High channel, 802.11b*

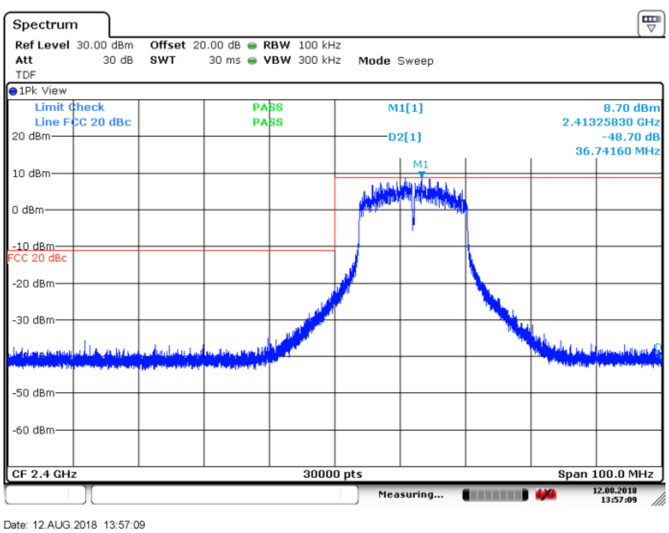


Figure 8.7-3: *Conducted spurious emission at band edge outside restricted band, low channel, 802.11g*

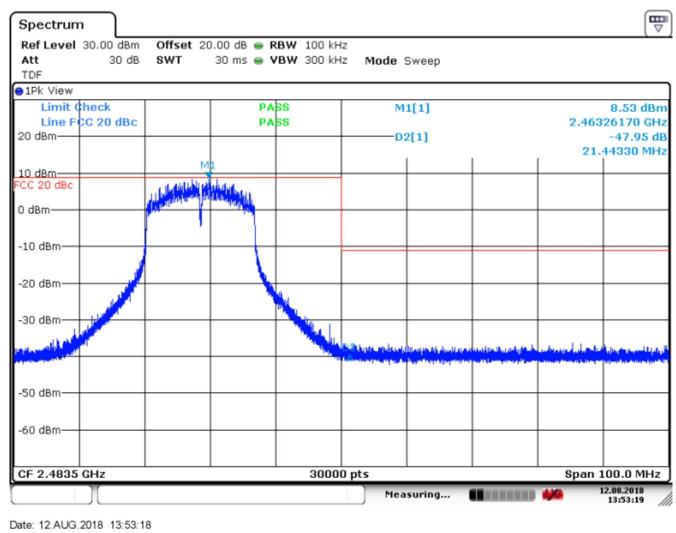


Figure 8.7-4: *Conducted spurious emissions at band edge outside restricted band, High channel, 802.11g*

8.7.4 Test data, continued

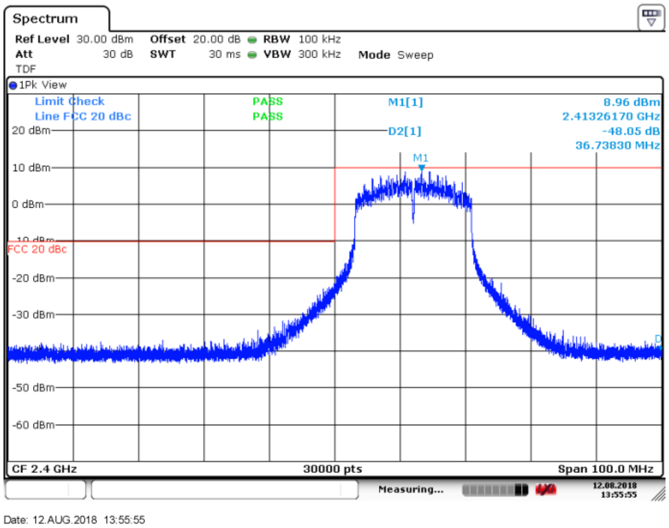


Figure 8.7-5: *Conducted spurious emission at band edge outside restricted band, low channel, 802.11n HT20*

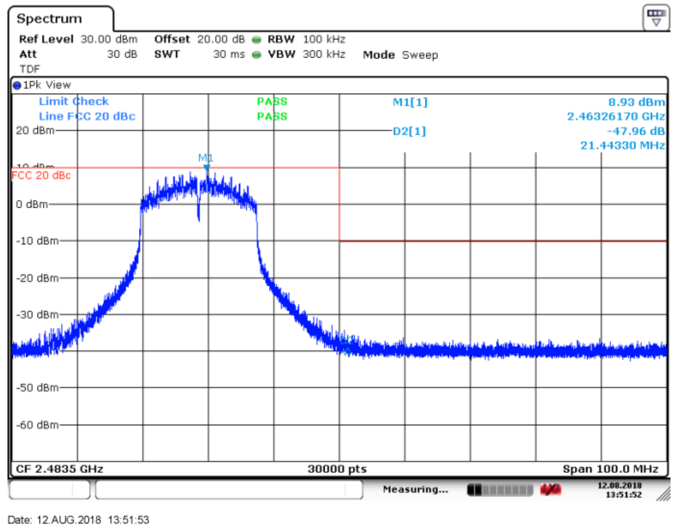


Figure 8.7-6: *Conducted spurious emissions at band edge outside restricted band, High channel, 802.11n HT20*

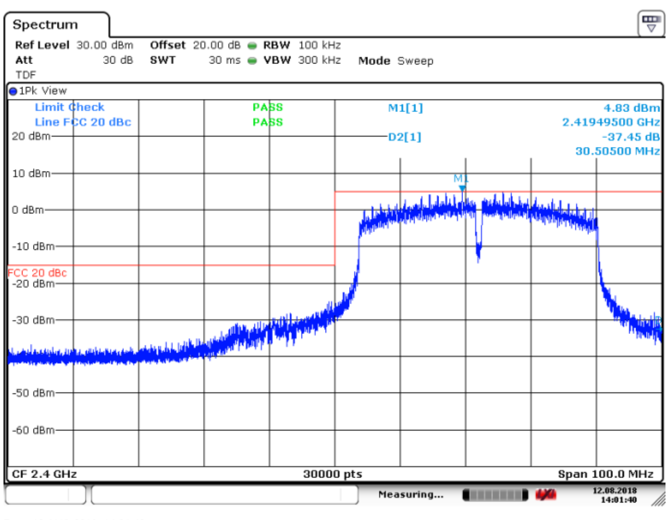


Figure 8.7-7: *Conducted spurious emission at band edge outside restricted band, low channel, 802.11n HT40*

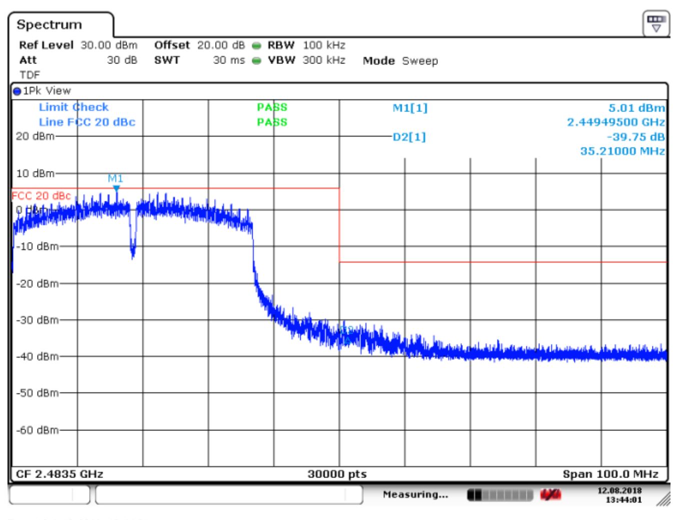


Figure 8.7-8: *Conducted spurious emissions at band edge outside restricted band, High channel, 802.11n HT40*

8.7.1 Test data, continued

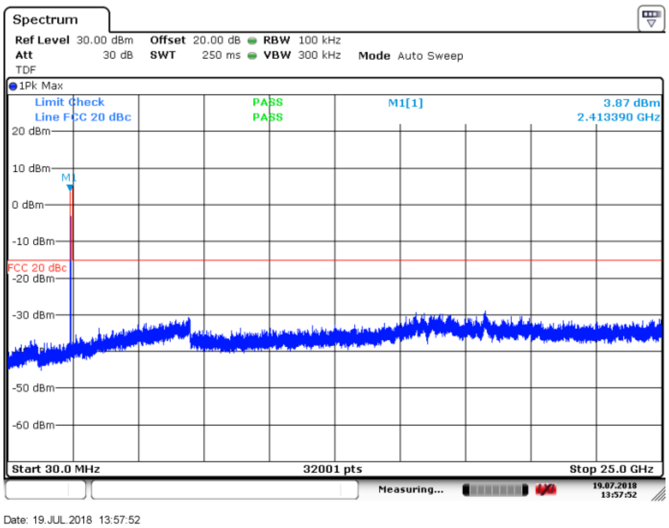


Figure 8.7-9: *Conducted spurious emissions outside restricted band, Low channel, 802.11b*

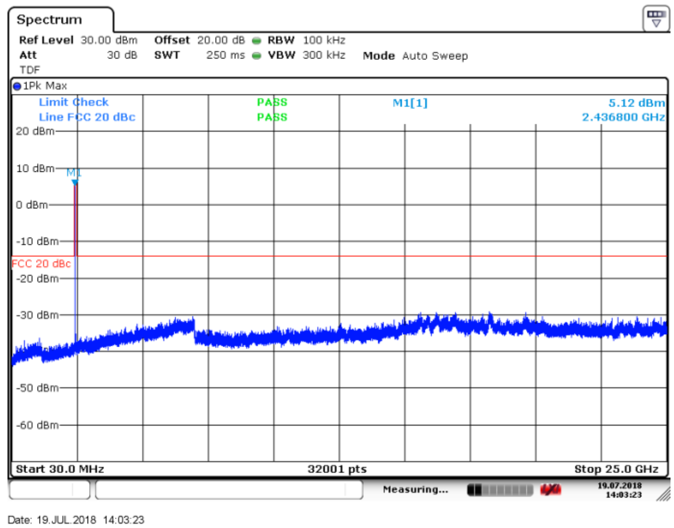


Figure 8.7-10: *Conducted spurious emissions outside restricted band, Mid channel, 802.11b*

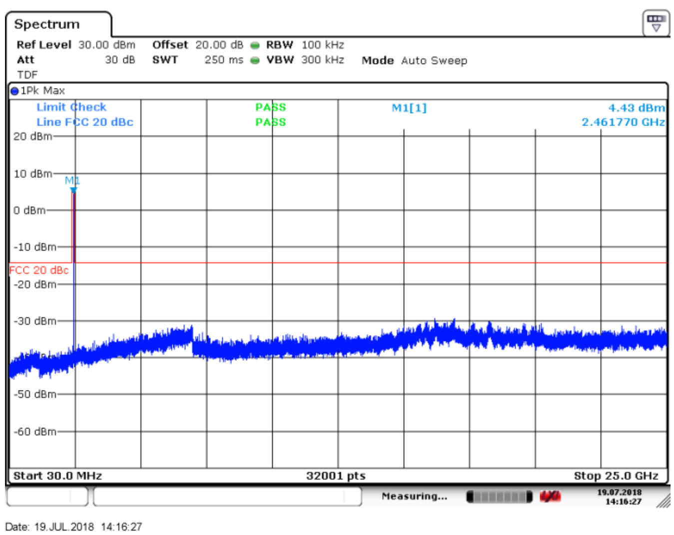


Figure 8.7-11: *Conducted spurious emissions outside restricted band, High channel, 802.11b*

8.7.1 Test data, continued

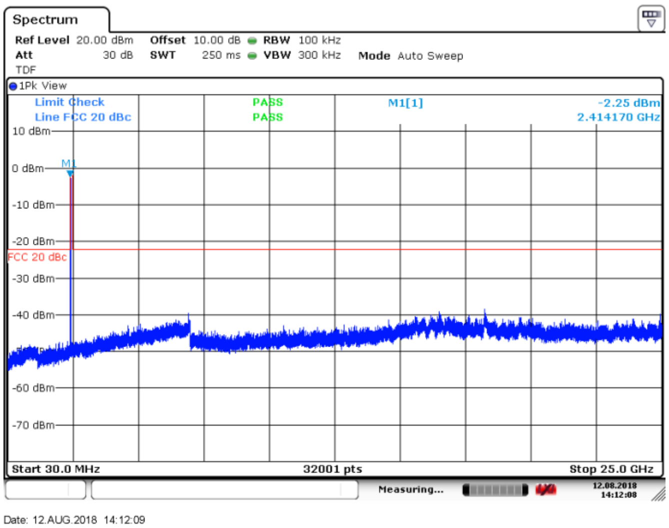


Figure 8.7-12: *Conducted spurious emissions outside restricted band, Low channel, 802.11g*

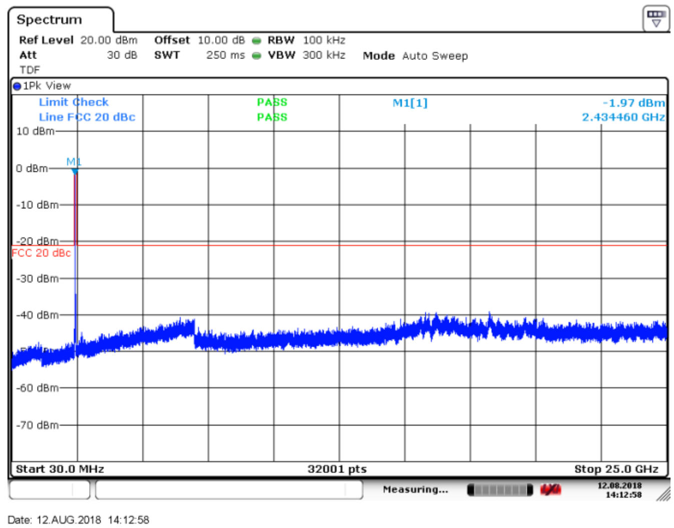


Figure 8.7-13: *Conducted spurious emissions outside restricted band, Mid channel, 802.11g*

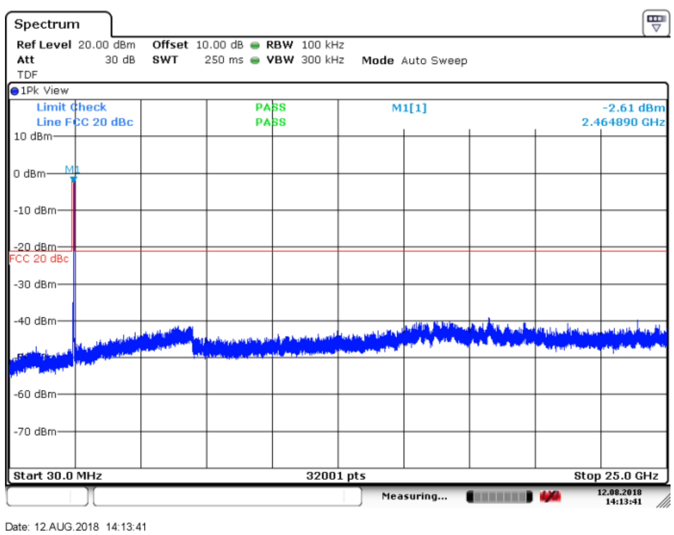


Figure 8.7-14: *Conducted spurious emissions outside restricted band, High channel, 802.11g*

8.7.1 Test data, continued

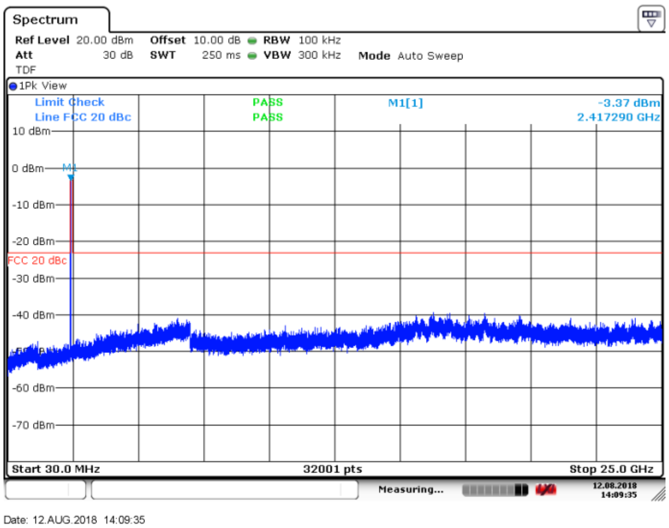


Figure 8.7-15: *Conducted spurious emissions outside restricted band, Low channel, 802.11n Ht20*

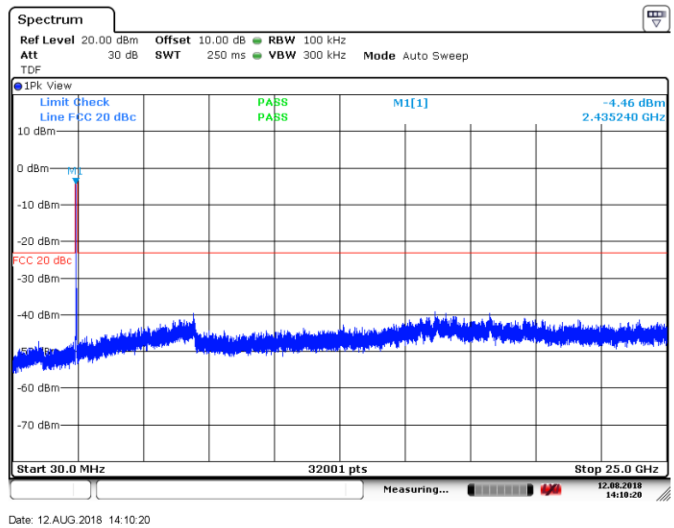


Figure 8.7-16: *Conducted spurious emissions outside restricted band, Mid channel, 802.11n Ht20*

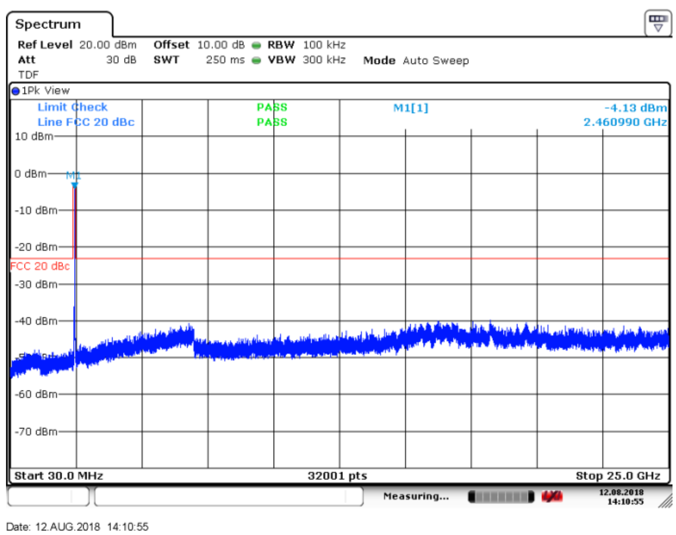


Figure 8.7-17: *Conducted spurious emissions outside restricted band, High channel, 802.11n Ht20*

8.7.1 Test data, continued

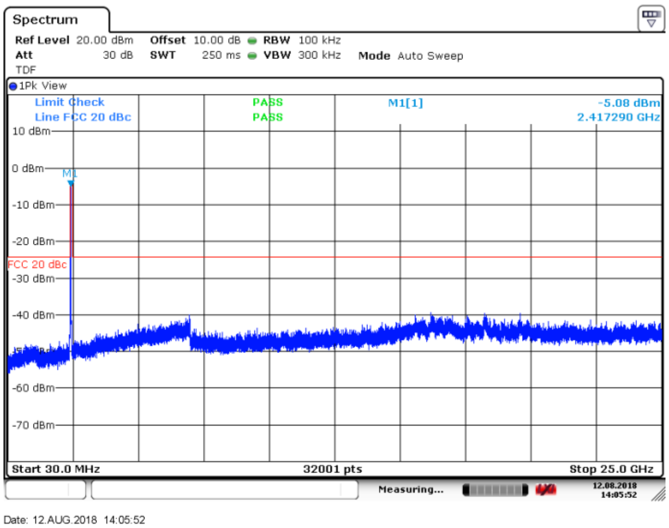


Figure 8.7-18: *Conducted spurious emissions outside restricted band, Low channel, 802.11n Ht40*

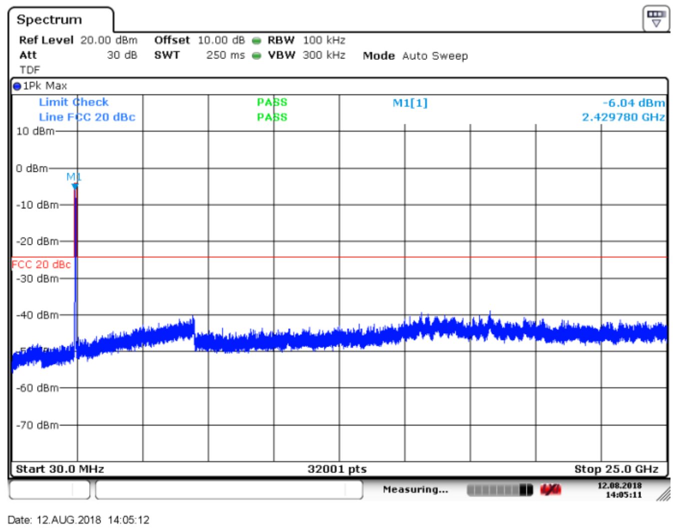


Figure 8.7-19: *Conducted spurious emissions outside restricted band, Mid channel, 802.11n Ht40*

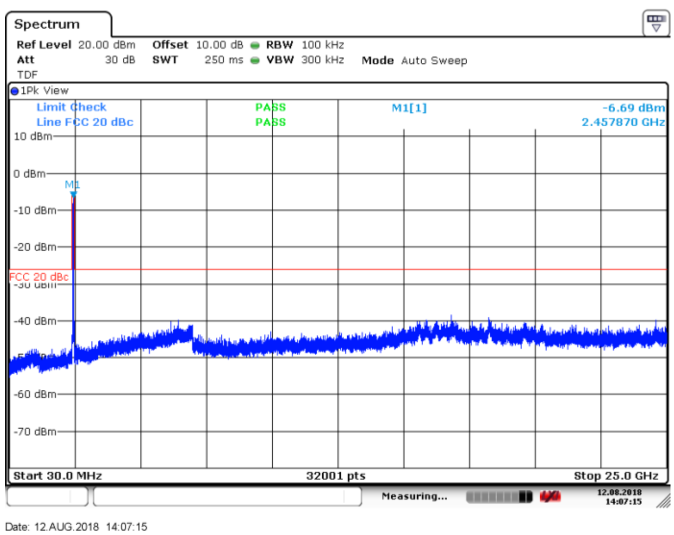
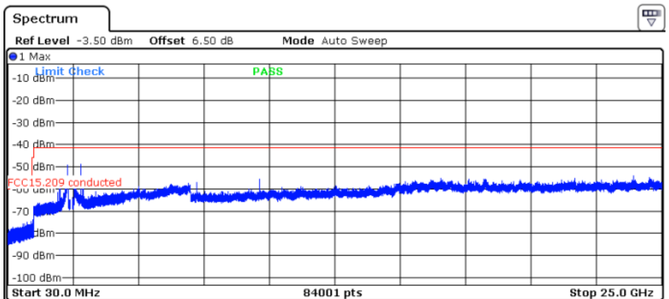


Figure 8.7-20: *Conducted spurious emissions outside restricted band, High channel, 802.11n Ht40*

8.7.4 Test data, continued



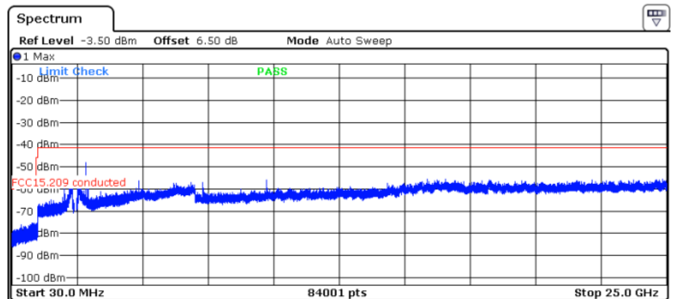
Spurious Emissions

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
30.000 MHz	1.000 GHz	100.000 kHz	904.68532 MHz	-74.57 dBm	-19.95 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.30875 GHz	-49.30 dBm	-8.07 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.01199 GHz	-54.51 dBm	-13.28 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.20589 GHz	-58.49 dBm	-17.26 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.81269 GHz	-48.95 dBm	-7.72 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.89497 GHz	-53.97 dBm	-12.74 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.61951 GHz	-57.02 dBm	-15.79 dB
4.500 GHz	25.000 GHz	1.000 MHz	23.91190 GHz	-54.07 dBm	-12.84 dB
4.500 GHz	25.000 GHz	1.000 MHz	21.67227 GHz	-55.26 dBm	-14.03 dB
4.500 GHz	25.000 GHz	1.000 MHz	16.57034 GHz	-55.34 dBm	-14.11 dB

Measuring... 12.08.2018 14:29:33

Date: 12.AUG.2018 14:29:33

Figure 8.7-21: *Conducted spurious emissions within restricted band, Low channel, 802.11b*



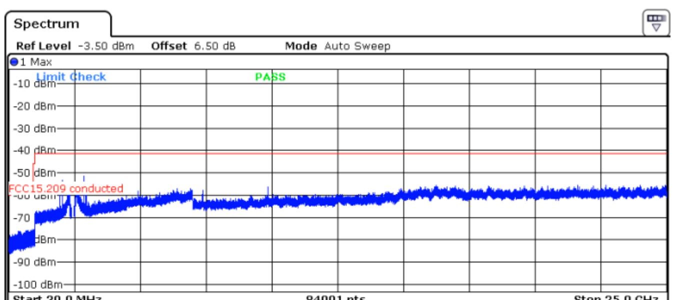
Spurious Emissions

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
30.000 MHz	1.000 GHz	100.000 kHz	81.02950 MHz	-79.73 dBm	-19.80 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.03006 GHz	-53.91 dBm	-12.68 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.33225 GHz	-55.54 dBm	-14.31 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.29583 GHz	-55.97 dBm	-14.74 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.84314 GHz	-48.11 dBm	-6.88 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.92461 GHz	-54.87 dBm	-13.64 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.64371 GHz	-56.29 dBm	-15.06 dB
4.500 GHz	25.000 GHz	1.000 MHz	16.55496 GHz	-55.45 dBm	-14.22 dB
4.500 GHz	25.000 GHz	1.000 MHz	15.85027 GHz	-55.49 dBm	-14.26 dB
4.500 GHz	25.000 GHz	1.000 MHz	24.84849 GHz	-55.74 dBm	-14.51 dB

Measuring... 12.08.2018 14:30:23

Date: 12.AUG.2018 14:30:23

Figure 8.7-22: *Conducted spurious emissions within restricted band, Mid channel, 802.11b*



Spurious Emissions

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
30.000 MHz	1.000 GHz	100.000 kHz	73.30005 MHz	-78.66 dBm	-18.73 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.05119 GHz	-53.48 dBm	-12.25 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.28221 GHz	-57.55 dBm	-16.32 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.25468 GHz	-57.98 dBm	-16.75 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.87158 GHz	-51.47 dBm	-10.24 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.57011 GHz	-54.01 dBm	-12.78 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.95445 GHz	-54.69 dBm	-13.46 dB
4.500 GHz	25.000 GHz	1.000 MHz	16.25899 GHz	-55.46 dBm	-14.23 dB
4.500 GHz	25.000 GHz	1.000 MHz	23.97660 GHz	-55.48 dBm	-14.25 dB
4.500 GHz	25.000 GHz	1.000 MHz	22.70112 GHz	-55.58 dBm	-14.35 dB

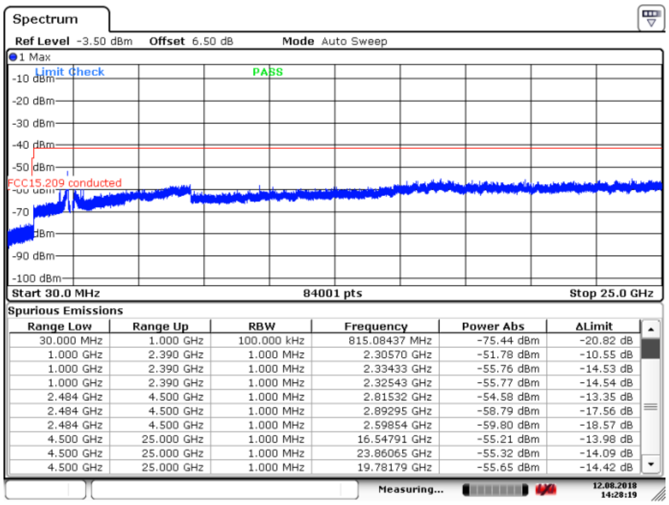
Measuring... 12.08.2018 14:31:05

Date: 12.AUG.2018 14:31:04

Figure 8.7-23: *Conducted spurious emissions within restricted band, High channel, 802.11b*

Note: EUT's antenna max gain and ground reflection factors below 1 GHz have been included in the factors of the plots above.

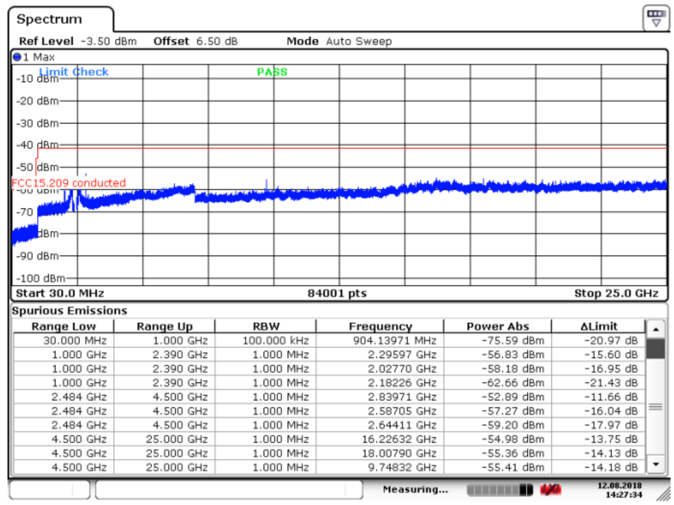
8.7.1 Test data, continued



Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
30.000 MHz	1.000 GHz	100.000 kHz	815.08437 MHz	-75.44 dBm	-20.82 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.30570 GHz	-51.78 dBm	-10.55 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.33433 GHz	-55.76 dBm	-14.53 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.32543 GHz	-55.77 dBm	-14.54 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.81532 GHz	-54.58 dBm	-13.35 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.89295 GHz	-58.79 dBm	-17.56 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.59854 GHz	-59.80 dBm	-18.57 dB
4.500 GHz	25.000 GHz	1.000 MHz	16.54791 GHz	-55.21 dBm	-13.98 dB
4.500 GHz	25.000 GHz	1.000 MHz	23.86065 GHz	-55.32 dBm	-14.09 dB
4.500 GHz	25.000 GHz	1.000 MHz	19.78179 GHz	-55.65 dBm	-14.42 dB

Date: 12.AUG.2018 14:28:19

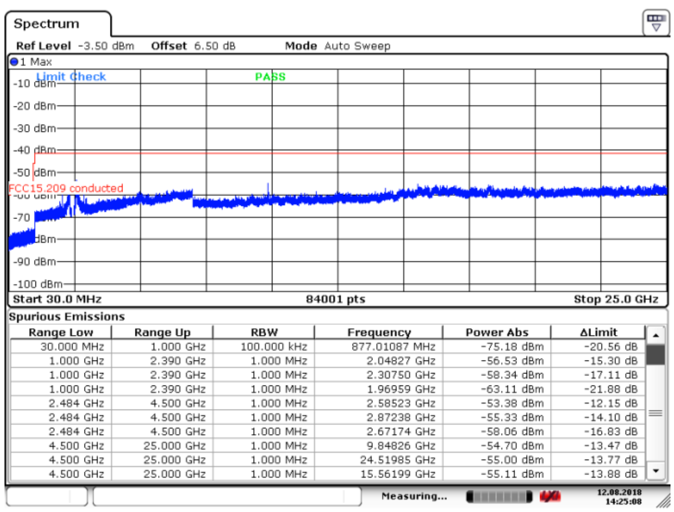
Figure 8.7-24: *Conducted spurious emissions within restricted band, Low channel, 802.11g*



Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
30.000 MHz	1.000 GHz	100.000 kHz	904.13971 MHz	-75.59 dBm	-20.97 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.29597 GHz	-56.83 dBm	-15.60 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.02770 GHz	-58.18 dBm	-16.95 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.18226 GHz	-62.66 dBm	-21.43 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.83971 GHz	-52.89 dBm	-11.66 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.58705 GHz	-57.27 dBm	-16.04 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.64411 GHz	-59.20 dBm	-17.97 dB
4.500 GHz	25.000 GHz	1.000 MHz	16.22632 GHz	-54.98 dBm	-13.75 dB
4.500 GHz	25.000 GHz	1.000 MHz	18.00790 GHz	-55.36 dBm	-14.13 dB
4.500 GHz	25.000 GHz	1.000 MHz	9.74832 GHz	-55.41 dBm	-14.18 dB

Date: 12.AUG.2018 14:27:34

Figure 8.7-25: *Conducted spurious emissions within restricted band, Mid channel, 802.11g*



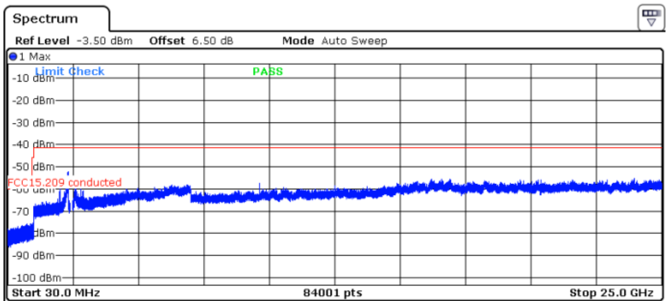
Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
30.000 MHz	1.000 GHz	100.000 kHz	877.01087 MHz	-75.18 dBm	-20.56 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.04827 GHz	-56.53 dBm	-15.30 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.30750 GHz	-58.34 dBm	-17.11 dB
1.000 GHz	2.390 GHz	1.000 MHz	1.96959 GHz	-63.11 dBm	-21.88 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.58523 GHz	-53.38 dBm	-12.15 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.87238 GHz	-55.33 dBm	-14.10 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.67174 GHz	-58.06 dBm	-16.83 dB
4.500 GHz	25.000 GHz	1.000 MHz	9.84826 GHz	-54.70 dBm	-13.47 dB
4.500 GHz	25.000 GHz	1.000 MHz	24.51985 GHz	-55.00 dBm	-13.77 dB
4.500 GHz	25.000 GHz	1.000 MHz	15.56199 GHz	-55.11 dBm	-13.88 dB

Date: 12.AUG.2018 14:25:07

Figure 8.7-26: *Conducted spurious emissions within restricted band, High channel, 802.11g*

Note: EUT's antenna max gain and ground reflection factors below 1 GHz have been included in the factors of the plots above.

8.7.1 Test data, continued



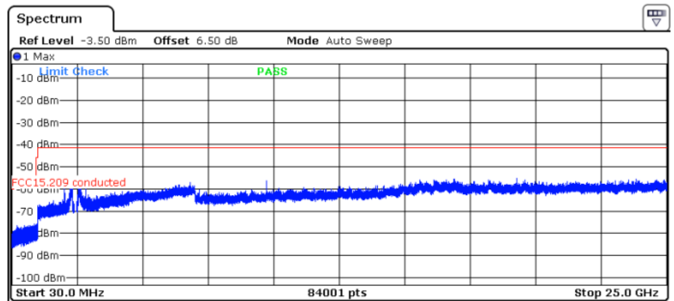
Spurious Emissions

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
30.000 MHz	1.000 GHz	100.000 kHz	76.33121 MHz	-78.71 dBm	-18.78 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.32307 GHz	-52.15 dBm	-10.92 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.31070 GHz	-52.50 dBm	-11.27 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.33419 GHz	-53.10 dBm	-11.87 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.80886 GHz	-54.56 dBm	-13.33 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.58564 GHz	-59.48 dBm	-18.25 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.89174 GHz	-60.79 dBm	-19.56 dB
4.500 GHz	25.000 GHz	1.000 MHz	23.94393 GHz	-55.29 dBm	-14.06 dB
4.500 GHz	25.000 GHz	1.000 MHz	16.90923 GHz	-55.55 dBm	-14.32 dB
4.500 GHz	25.000 GHz	1.000 MHz	20.37245 GHz	-55.76 dBm	-14.53 dB

Measuring... 12.08.2018 14:32:09

Date: 12.AUG.2018 14:32:08

Figure 8.7-27: *Conducted spurious emissions within restricted band, Low channel, 802.11n HT20*



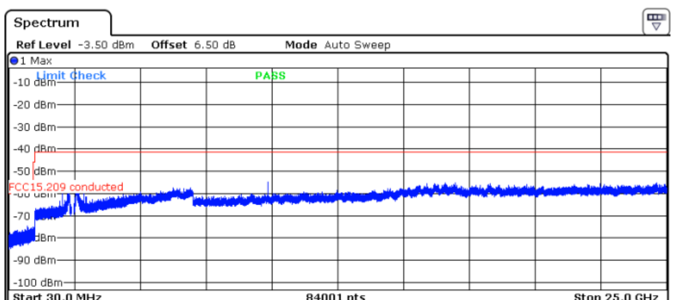
Spurious Emissions

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
30.000 MHz	1.000 GHz	100.000 kHz	59.87204 MHz	-79.76 dBm	-19.83 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.32808 GHz	-57.36 dBm	-16.13 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.27790 GHz	-57.74 dBm	-16.51 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.02992 GHz	-58.72 dBm	-17.49 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.84052 GHz	-53.88 dBm	-12.65 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.57414 GHz	-55.65 dBm	-14.42 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.60177 GHz	-56.94 dBm	-15.71 dB
4.500 GHz	25.000 GHz	1.000 MHz	19.29171 GHz	-55.36 dBm	-14.13 dB
4.500 GHz	25.000 GHz	1.000 MHz	16.89193 GHz	-55.57 dBm	-14.34 dB
4.500 GHz	25.000 GHz	1.000 MHz	23.82990 GHz	-55.61 dBm	-14.38 dB

Measuring... 12.08.2018 14:32:54

Date: 12.AUG.2018 14:32:54

Figure 8.7-28: *Conducted spurious emissions within restricted band, Mid channel, 802.11n HT20*



Spurious Emissions

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
30.000 MHz	1.000 GHz	100.000 kHz	727.02931 MHz	-74.80 dBm	-20.18 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.05438 GHz	-57.85 dBm	-16.62 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.30083 GHz	-58.66 dBm	-17.43 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.15836 GHz	-63.07 dBm	-21.84 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.87319 GHz	-54.05 dBm	-12.82 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.57515 GHz	-54.40 dBm	-13.17 dB
2.484 GHz	4.500 GHz	1.000 MHz	4.36600 GHz	-60.57 dBm	-19.34 dB
4.500 GHz	25.000 GHz	1.000 MHz	9.84826 GHz	-54.99 dBm	-13.76 dB
4.500 GHz	25.000 GHz	1.000 MHz	24.63388 GHz	-55.06 dBm	-13.83 dB
4.500 GHz	25.000 GHz	1.000 MHz	16.95663 GHz	-55.35 dBm	-14.12 dB

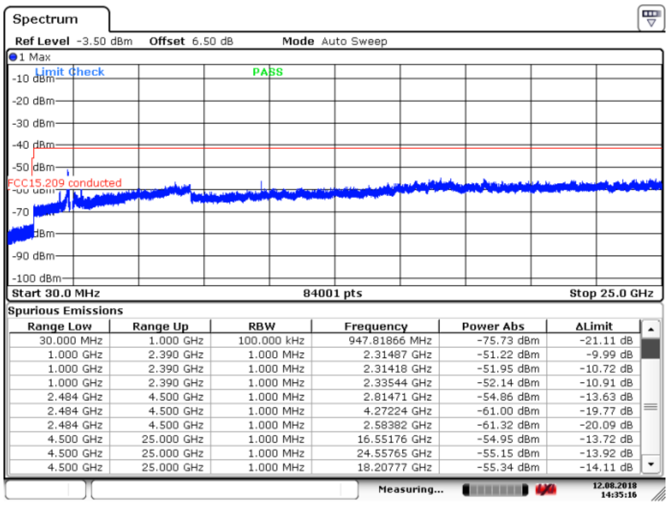
Measuring... 12.08.2018 14:34:04

Date: 12.AUG.2018 14:34:04

Figure 8.7-29: *Conducted spurious emissions within restricted band, High channel, 802.11n HT20*

Note: EUT's antenna max gain and ground reflection factors below 1 GHz have been included in the factors of the plots above.

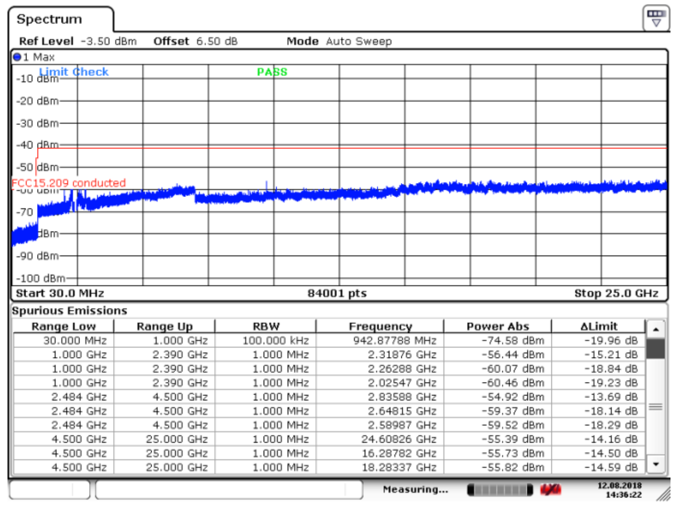
8.7.1 Test data, continued



Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
30.000 MHz	1.000 GHz	100.000 kHz	947.81866 MHz	-75.73 dBm	-21.11 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.31487 GHz	-51.22 dBm	-9.99 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.31418 GHz	-51.95 dBm	-10.72 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.33544 GHz	-52.14 dBm	-10.91 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.81471 GHz	-54.86 dBm	-13.63 dB
2.484 GHz	4.500 GHz	1.000 MHz	4.27224 GHz	-61.00 dBm	-19.77 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.58382 GHz	-61.32 dBm	-20.09 dB
4.500 GHz	25.000 GHz	1.000 MHz	16.55176 GHz	-54.95 dBm	-13.72 dB
4.500 GHz	25.000 GHz	1.000 MHz	24.55765 GHz	-55.15 dBm	-13.92 dB
4.500 GHz	25.000 GHz	1.000 MHz	18.20777 GHz	-55.34 dBm	-14.11 dB

Date: 12.AUG.2018 14:35:16

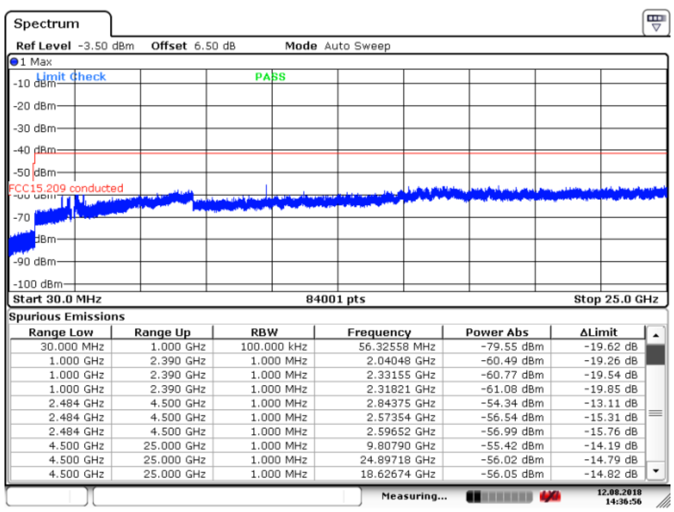
Figure 8.7-30: *Conducted spurious emissions within restricted band, Low channel, 802.11n HT40*



Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
30.000 MHz	1.000 GHz	100.000 kHz	942.87788 MHz	-74.58 dBm	-19.96 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.31876 GHz	-56.44 dBm	-15.21 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.26288 GHz	-60.07 dBm	-18.84 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.02547 GHz	-60.46 dBm	-19.23 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.83588 GHz	-54.92 dBm	-13.69 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.64815 GHz	-59.37 dBm	-18.14 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.58987 GHz	-59.52 dBm	-18.29 dB
4.500 GHz	25.000 GHz	1.000 MHz	24.60826 GHz	-55.39 dBm	-14.16 dB
4.500 GHz	25.000 GHz	1.000 MHz	16.28782 GHz	-55.73 dBm	-14.50 dB
4.500 GHz	25.000 GHz	1.000 MHz	18.28337 GHz	-55.82 dBm	-14.59 dB

Date: 12.AUG.2018 14:36:22

Figure 8.7-31: *Conducted spurious emissions within restricted band, Mid channel, 802.11n HT40*



Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
30.000 MHz	1.000 GHz	100.000 kHz	56.32558 MHz	-79.55 dBm	-19.62 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.04048 GHz	-60.49 dBm	-19.26 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.33155 GHz	-60.77 dBm	-19.54 dB
1.000 GHz	2.390 GHz	1.000 MHz	2.31821 GHz	-61.08 dBm	-19.85 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.84375 GHz	-54.34 dBm	-13.11 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.57354 GHz	-56.54 dBm	-15.31 dB
2.484 GHz	4.500 GHz	1.000 MHz	2.59652 GHz	-56.99 dBm	-15.76 dB
4.500 GHz	25.000 GHz	1.000 MHz	9.80790 GHz	-55.42 dBm	-14.19 dB
4.500 GHz	25.000 GHz	1.000 MHz	24.89718 GHz	-56.02 dBm	-14.79 dB
4.500 GHz	25.000 GHz	1.000 MHz	18.62674 GHz	-56.05 dBm	-14.82 dB

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Figure 8.7-32: *Conducted spurious emissions within restricted band, High channel, 802.11n HT40*

Note: EUT's antenna max gain and ground reflection factors below 1 GHz have been included in the factors of the plots above.

8.7.4 Test data, continued

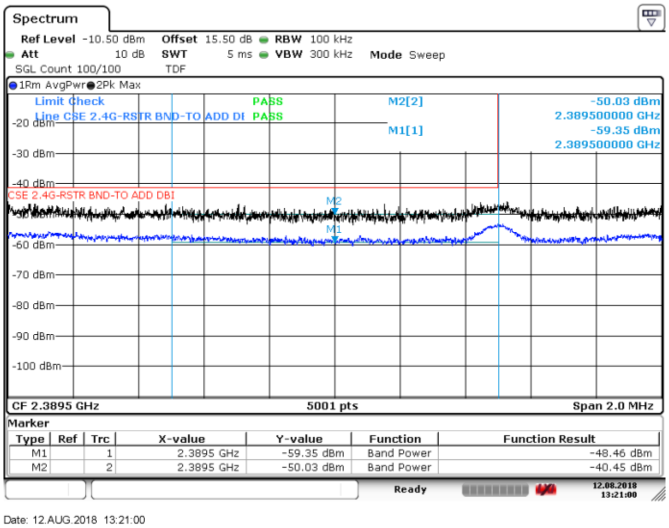


Figure 8.7-33: *Conducted spurious emission at band edge of restricted band, low channel, 802.11b*

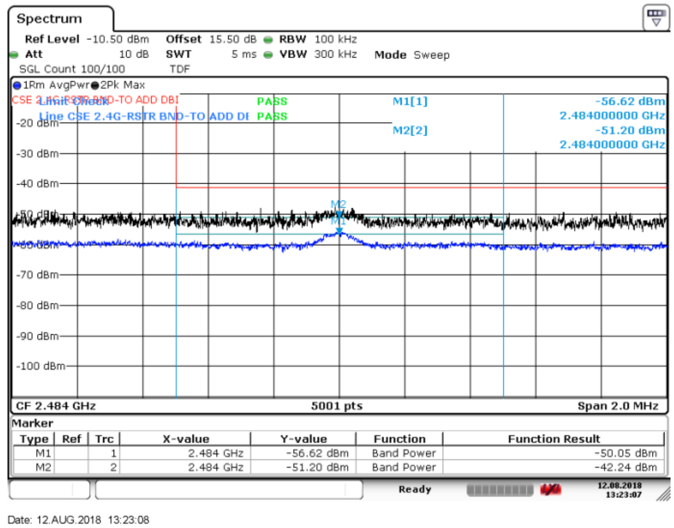


Figure 8.7-34: *Conducted spurious emissions at band edge of restricted band, High channel, 802.11b*

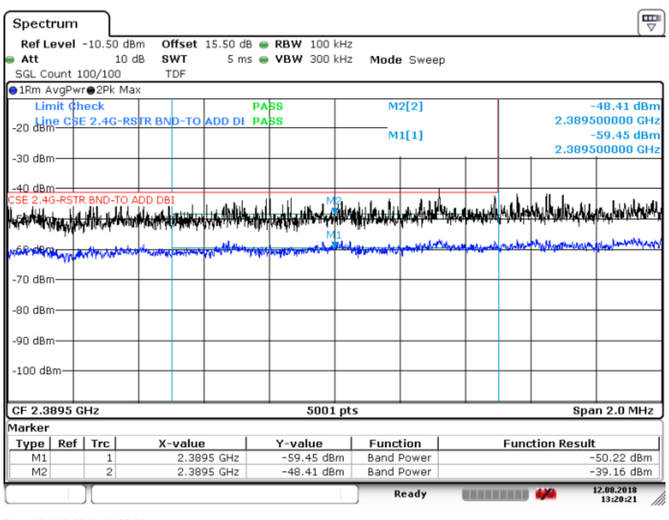


Figure 8.7-35: *Conducted spurious emission at band edge of restricted band, low channel, 802.11g*

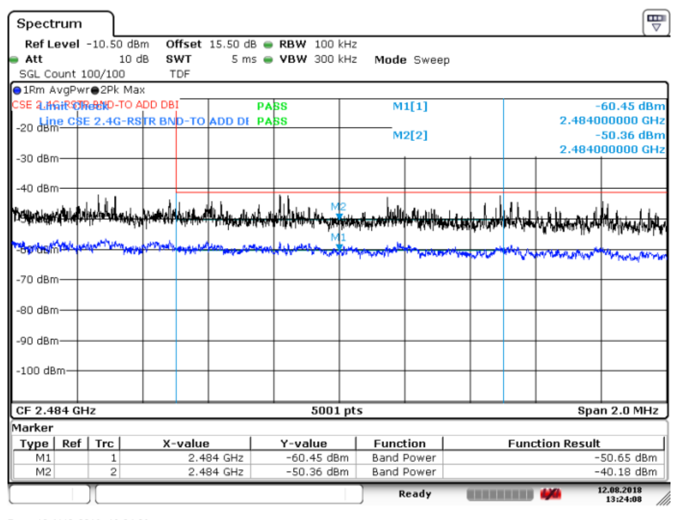


Figure 8.7-36: *Conducted spurious emissions at band edge of restricted band, High channel, 802.11g*

8.7.4 Test data, continued

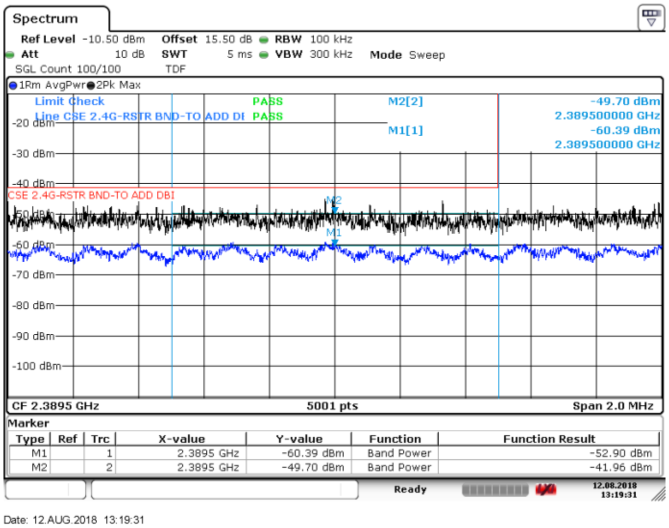


Figure 8.7-37: *Conducted spurious emission at band edge of restricted band, low channel, 802.11n HT20*

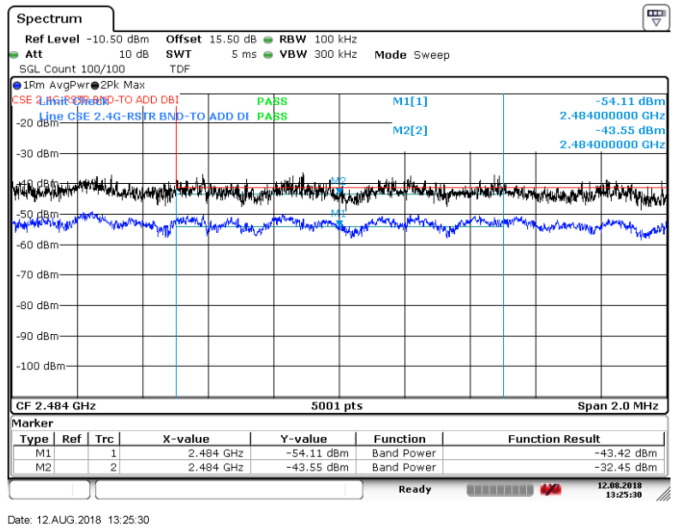


Figure 8.7-38: *Conducted spurious emissions at band edge of restricted band, High channel, 802.11n HT20*

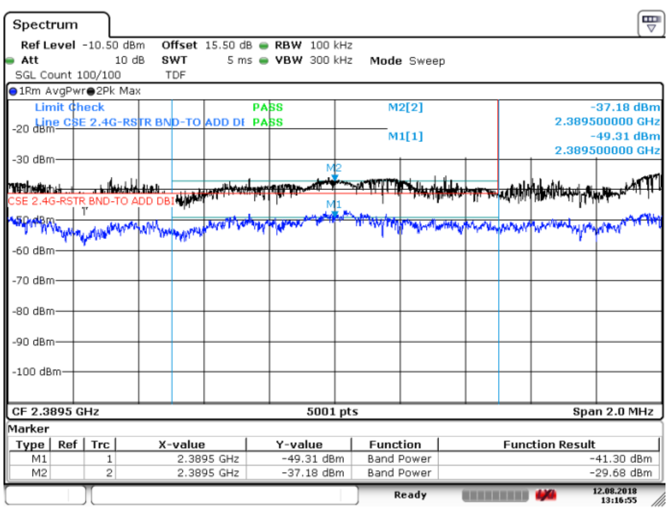


Figure 8.7-39: *Conducted spurious emission at band edge of restricted band, low channel, 802.11n HT40*

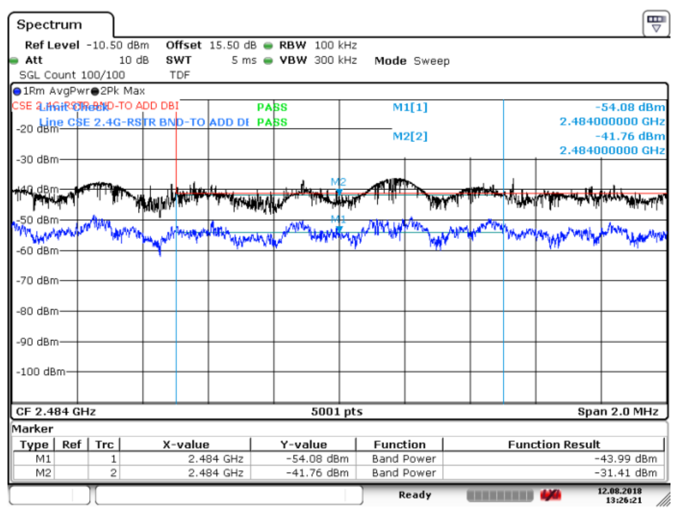


Figure 8.7-40: *Conducted spurious emissions at band edge of restricted band, High channel, 802.11n HT40*

Note: Transmitter spurious emission calculation as below:
E = EIRP – 20log D + 104.8 =-41.30 – 20Log 3 + 104.8 = 53.96 dBµV/m at 3m
margin of compliance = 54 – 42.85 = 11.15 dB
where:E = electric field strength in dBµV/m, EIRP = equivalent isotropic radiated power in dBm = -41.30 dBm
D = specified measurement distance in meters = 3 m
Average field strength limit = 54 dBµV/m at 3m

8.7.4 Test data, continued

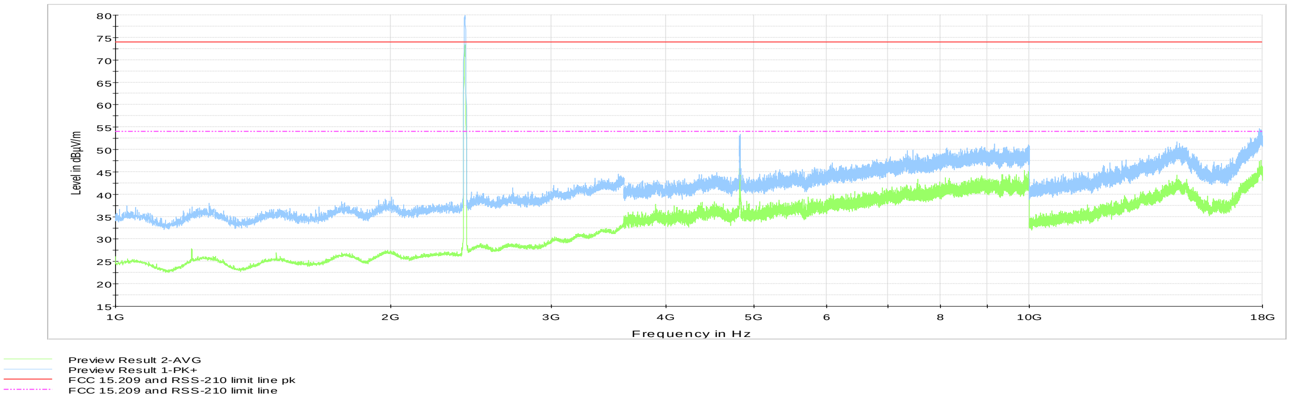


Figure 8.7-41: Cabinet Radiated spurious emissions 1 to18 GHz, Low channel

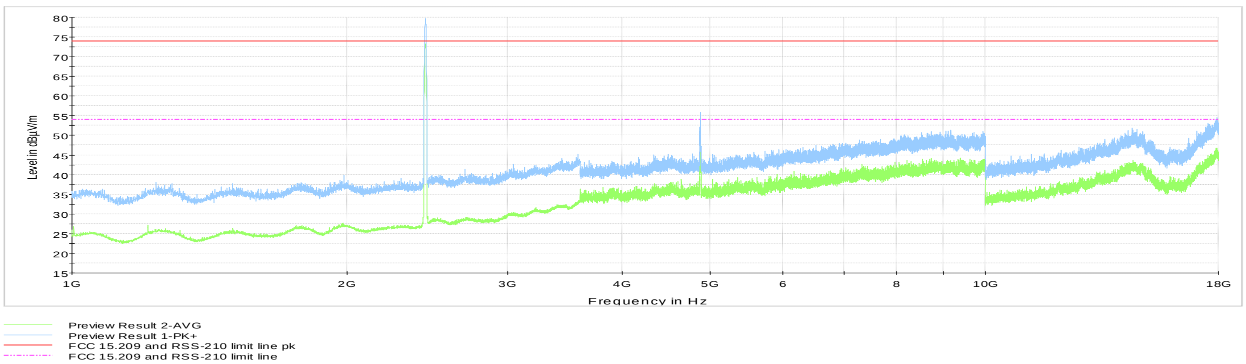


Figure 8.7-42: Cabinet Radiated spurious emissions 1 to18 GHz, mid channel

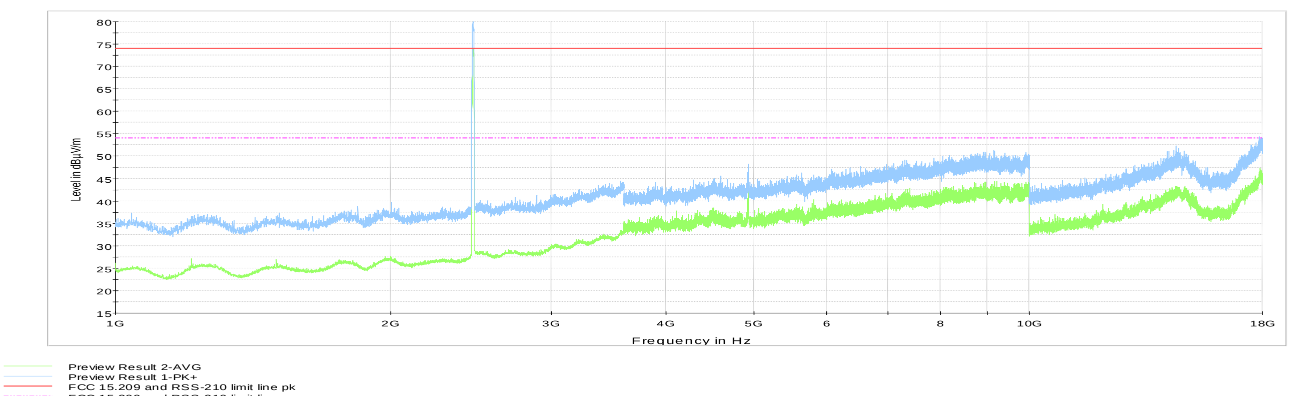


Figure 8.7-43: Cabinet Radiated spurious emissions 1 to18 GHz, High channel

Note: Spectrum was investigated from 30 MHz to 25 GHz. No spurious emission related to RF portion were detected within 6 dB below the limit

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

8.8.1 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).

8.8.1 Test date

Start date	July 19, 2018

8.8.2 Observations, settings and special notes

The test was performed using method PKPSD (peak PSD).
Spectrum analyser settings:

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

8.8.3 Test data

Table 8.8-1: *PSD measurements results*

Modulation	Frequency, MHz	PSD, dBm/3 kHz	PSD limit, dBm/3 kHz	Margin, dB
802.11b	2412	-9.1	8	17.1
	2437	-7.6	8	15.6
	2462	-9.1	8	17.1
802.11g	2412	-15.9	8	23.9
	2437	-16.3	8	24.3
	2462	-15.9	8	23.9
802.11n HT20	2412	-16.9	8	24.9
	2437	-16.6	8	24.6
	2462	-15.8	8	23.8
802.11n HT40	2422	-22.0	8	30.0
	2437	-21.8	8	29.8
	2457	-22.1	8	30.1

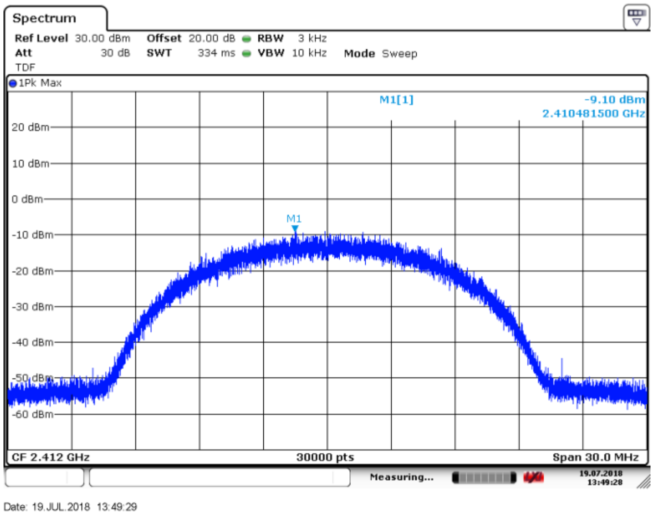


Figure 8.8-1: *PSD sample plot on 802.11b*

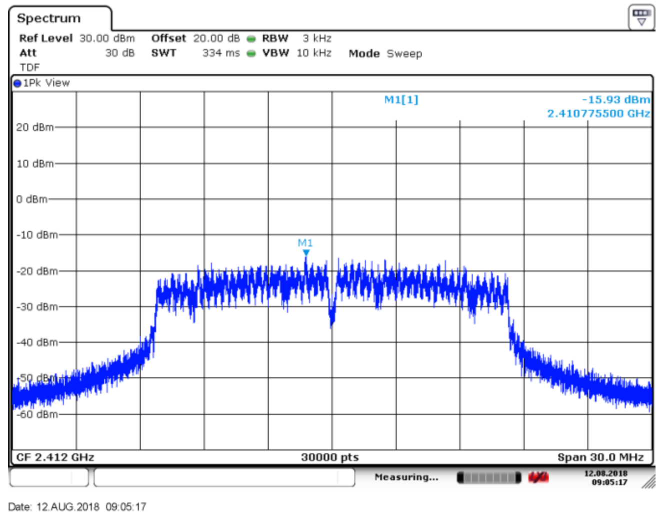


Figure 8.8-2: *PSD sample plot on 802.11g*

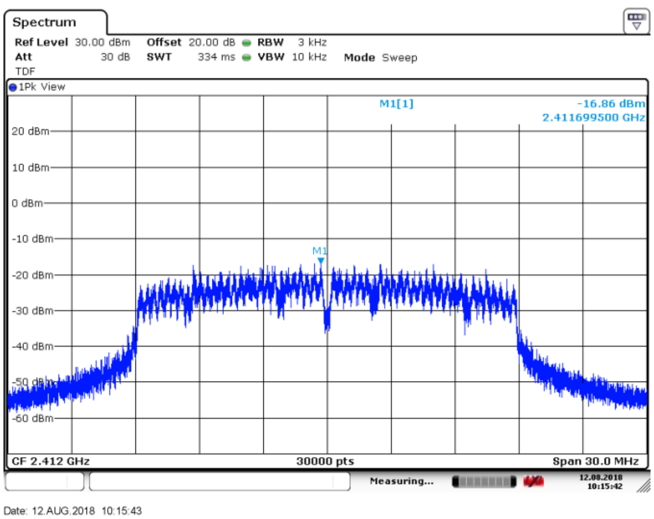


Figure 8.8-3: *PSD sample plot on 802.11n HT20*

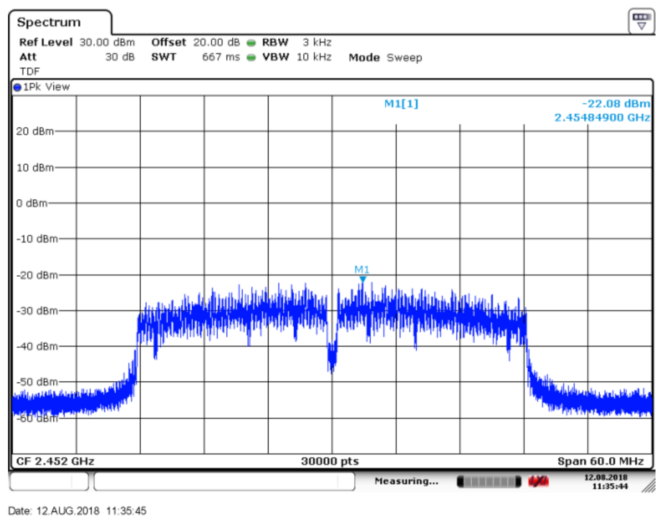
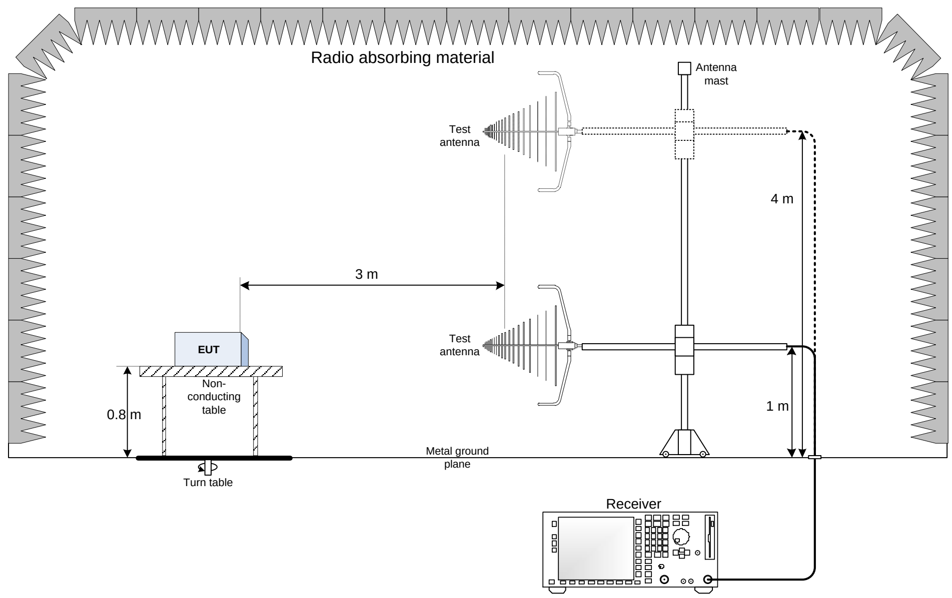


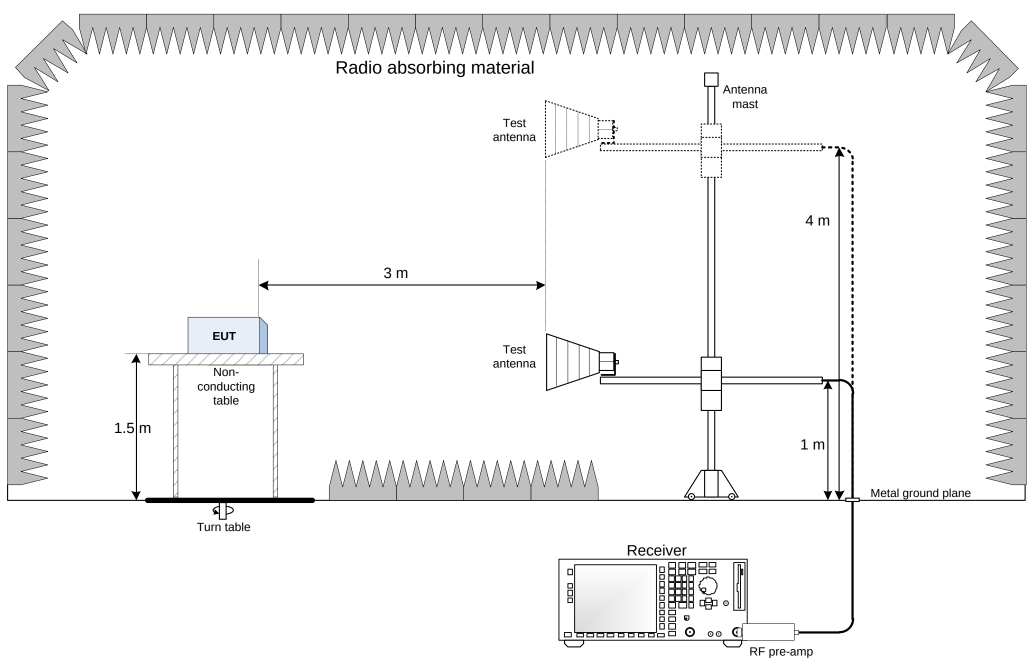
Figure 8.8-4: *PSD sample plot on 802.11n HT40*

Section 9. Block diagrams of test set-ups

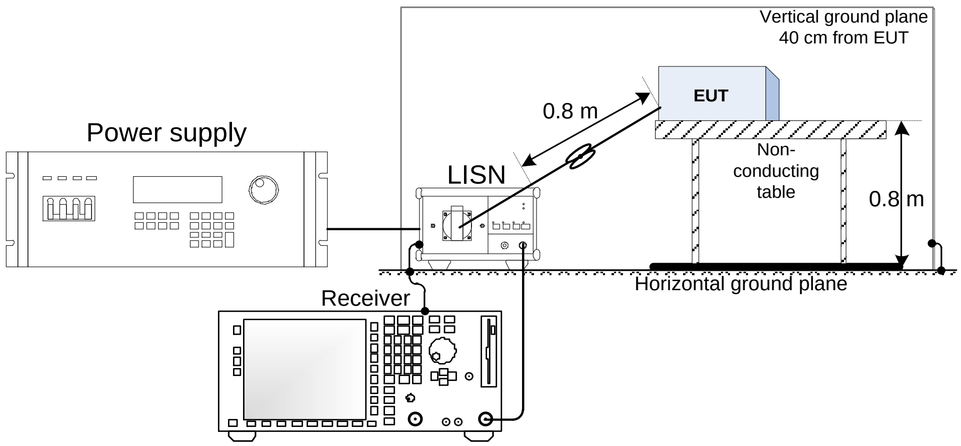
9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Conducted emissions set-up



9.4 Antenna port set-up