RF - TEST REPORT

Report Number	: 4842020233500B	Date of Issue:	April 16, 2020
Model	: HEWRQU1, 0011800292X, KZW-W008		
Product Type	: Wi-Fi Module		
Applicant	: Hangzhou Tuya Information Technology Co., Ltd.		
Address	: Room701, Building3, More Center, No.87 GuDun Road, 310000 Hangzhou, Zhejiang, People's Republic of China		
Manufacturer	: Hangzhou Tuya Information Technology Co., Ltd.		
Address	: Room701, Building3, More Center, No.87 GuDun Road, 310000 Hangzhou, Zhejiang, People's Republic of China		
Test Result	: ■ **Positive** ☐ **Negative**		
Total pages including Appendices	: **45**		

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1 Report Version

Revision	Release Date	History/Memo.
1.0	Apr. 16, 2020	Initial Release

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2 General Information

2.1 Notes

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Prepared by Project Engineer	2020-04-16 Date	Dingpeng Xia Name	Dingpeng Xia Signature
Approved by Project Manager	2020-04-16 Date	Jun Bao Name	Jun Bao Signature

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2.2 Testing Laboratory

Site 1

Company name:	TÜV SÜD Certification and Testing (China) Co., Ltd. – EMC-Lab
Company Address:	10# Huaxia Road (M), Dongting, Wuxi, 214100 P. R. China
Telephone:	+86 510 8820 3737
Fax:	+86 510 8820 3636

2.3 Details of Applicant

Client:	Hangzhou Tuya Information Technology Co., Ltd.
Address:	Room701, Building3, More Center, No.87 GuDun Road, 310000 Hangzhou, Zhejiang, People's Republic of China
Product Description:	Wi-Fi Module
Submitted Model No.:	HEWRQU1, 0011800292X, KZW-W008

2.4 Application Details

Date of receipt of order:	2020-03-03
Date of receipt of test item:	2020-03-07
Date of test:	2020-03-07 to 2020-03-27

2.5 Applied Standard

APPLIED PRODUCT STANDARD	**ETSI EN 300 328 V2.2.2 (2019-07)** **EN 62311:2008**

2.6 Test Summary

Table1. Summary of results

Conformance requirement according to ETSI EN 300 328 V2.2.2 (2019-07)		**Result**	**Test Site**
Essential parameter	**Corresponding technical requirements**		
Transmitter requirements	4.3.1.2/4.3.2.2 RF output power	PASS	Site 1
	4.3.2.3 Power Spectral Density	PASS	Site 1
	4.3.1.3/4.3.2.4 Duty Cycle, Tx-sequence, Tx-gap**	N/A	N/A
	4.3.1.4 Dwell time, Minimum Frequency Occupation and Hopping Sequence*	N/A	N/A
	4.3.1.5 Hopping Frequency Separation*	N/A	N/A
	4.3.1.6/4.3.2.5Medium Utilisation (MU) factor**	N/A	N/A
	4.3.1.7/4.3.2.6 Adaptivity	PASS	Site 1
	4.3.1.8/4.3.2.7 Occupied Channel Bandwidth	PASS	Site 1
	4.3.1.9/4.3.2.8 Transmitter unwanted emissions in the out-of-band domain	PASS	Site 1
	4.3.1.10/4.3.2.9 Transmitter unwanted emissions in the spurious domain	PASS	Site 1
Receiver requirements	4.3.1.11/4.3.2.10 Receiver spurious emissions	PASS	Site 1
	4.3.1.12/4.3.2.11 Receiver Blocking	PASS	Site 1
	4.3.1.13/4.3.2.12 Geo-location capability***	N/A	N/A

NOTE1: Measurement taken is within the measurement uncertainty of measurement system.

NOTE2: "*" This requirement applies to all types of equipment using FHSS other than wide band modulations.

NOTE3: "**" This requirement does not apply to adaptive equipment unless operating in a non-adaptive mode.

NOTE4: "***" This requirement only applies to equipment with geo-location capability.

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3 Equipment Specification

3.1 General Description

The EUT is a WIFI Module. HEWRQU1, 0011800292X and KZW-W008 are exactly the same except for different model name. All tests were performed on HEWRQU1.

3.2 EUT Identity

NOTE: Unless otherwise noted in the report, the functional boards installed in the units shall be selected from the below list, but not means all the functional boards listed below shall be installed in one unit.

3.2.1 Technical data

Description:	Module
Models:	HEWRQU1
Hardware version	1.0.0
Software version	V1.0.9
Input Rated Voltage	DC 4.5-5.5V
Extreme Voltage	4.5VDC, 5.5VDC

Remark 1: The above EUT's information is declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

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3.3 Product Description –manufacturer description

3.3.1 Type of Tested Equipment

☐ Bluetooth	☒ IEEE 802.11	Other supply full details:_____	
☒ Stand-alone	☐ Plug-in radio	☐ Combined equipment	☐ Other

3.3.2 Extreme operating condition as declared by manufacturer

Power source description			
☐ **AC mains voltage**		☒ **DC voltage Nominal**	
Type of DC			
☐ Internal Power Supply	☒ External AC/DC Adapter	☐ Battery	☐ Other
EXTREME TEST VOLTAGE [manufacturer declared]			
VN = Nominal voltage [V]	VH = Max Voltage [V]	VL = Min Voltage [V]	
DC 4.5V	DC 5.5V	DC 5.0V	

EXTREME TEMPERATURE RANGE [manufacturer declared]			
Environment class /Operating Temperature	**TL = Minimum Temperature [°C]**	**TN = Normal Temperature [°C]**	**TH = Maximum Temperature [°C]**
☐ **Outdoor and indoor usage**	**-20**	**25**	**55**
☐ **Indoor usage only**	0	25	35
☒ **Other [declared by manufacturer in UM]**	-20	25	85

3.3.3 Type of adaptivity used

☐ **Non-adaptive**	☒ **Adaptive**	☒ **LBT**	☐ **Non LBT**
	☐ **The system can operate in more than one adaptive mode**	☐ **System can operate both adaptive & non-adaptive mode**	
	☐ **Frame Based Equipment**	☒ **Load Based Equipment**	
		CCA time implemented [uS]	>20
		q as referred by 4.3.2.5.2.2.2	4-32

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3.3.4 Antenna Assembles Profiles

Antenna Type	☒ **Integrated**	☐ **External**	
Temporary RF connector	☐ **Provided**	☒ **Not- provided**	
☒ **SISO - Single antenna equipment**		**Antenna gain [dBi] =**	**2 dBi**
☐ **MIMO - Multiple antenna without bean forming**		**Number of transmit antennas=**	**1**
☐ **MIMO/B - Multiple antenna with bean forming**		**Bean forming gain [dB] Y =**	**….**
Number of receive chains	**1**	☐ **Symmetrical power distribution**	
Number of transceive chains	**1**	☐ **Asymmetrical power distribution**	
☐ **Tx power control (TPC) (antenna connectorwith multiple power setting)**		**Nr. of different power level**	**…..**

3.4 Operating Frequency Range, Modulation and Throughput

Transmitter / Receiver Frequency Range (Tx/Rx)				
☒ **Range 1 : from : 2400 MHz To 2483.5 MHz**				
WLAN				
IEEE 802.11 WLAN Mode Supported	☒ **IEEE 802.11 b**	☒ **IEEE 802.11g**	☒ **HT20 802.11n**	☒ **HT40 802.11n**
Modulation type	**CCK DSSS**	**OFDM**	**OFDM**	**OFDM**
Channel Bandwidth [MHz]	**20**	**20**	**20**	**40**
Data Rate / Spatial Stream	**Single stream**		**Up to 4 spatial stream**	
IEEE 802.11 b	**1, 2, 5.5, 11 Mbps**			
IEEE 802.11g	**6, 9, 12, 18, 24, 36, 48, 54 Mbps**			
HT20 802.11n	**MCS0 to MCS7 (0-7=> 7.2 – 72.2 Mbps)**			
HT40 802.11n	**--**			

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3.5 Additional information

The transmitter can operate only:

☒ **Modulated**

☐ **Un-modulated**

ITU Class of emissions 1. 22

Duty Cycle: The transmitter is intended for

☐ **Continuous duty**

☐ **Intermittent duty**

☒ **Continuous operation possible for testing purposes**

About the EUT:

☒ **The equipment submitted are representative production models.**

☐ **If not, the equipment submitted are pre-production models.**

☐ **If preproduction equipment are submitted, the final production equipment will be identical in all respects with the equipment tested.**

☐ **If not, supply full details:**_____

3.6 Worst case operational mode as declared by supplier

Test	Operating mode
RF Output Power	802.11 B
Power spectral density	802.11 B
Duty cycle,Tx – Sequence, TX gap	N/A
Medium Utilisation	N/A
Adaptivity and receiver blocking	802.11B
Ocuppied Channel Bandwidth	HT20-802.11N
Transmiter unwantd emision in OOB domanin	802.11B
Transmiter unwantd emision in spurious domanin	802.11B
Receiver spurious domanin	802.11B

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4 General Test Conditions / Configurations

4.1 Test Sample

☐ The report applies to single model number.

☒ The report applies to several models. The practical measurements are performed using the model number of see 3.1

4.2 Test Modes

NOTE: Typical working modes for each IEEE 802.11 mode are selected to perform tests.

Test Mode	Test Modes Description
11B	IEEE 802.11b with data rate of 1 Mbps (TX and RX).
11G	IEEE 802.11g with data rate of 6 Mbps (TX and RX).
11N_20M_SISO	IEEE 802.11n with data rate of MCS0 and bandwidth of 20 MHz, using SISO mode (TX and RX).
11N_40M_SISO	IEEE 802.11n with data rate of MCS0 and bandwidth of 40 MHz, using SISO mode (TX and RX).

4.3 Frequencies under Test

Test Mode	RF Channel		
	Lowest/Bottom (B)	**Middle (M)**	**Highest/Top (T)**
11B, 11G, 11N_20M_SISO	Ch No. 1 / 2412 MHz	Ch No. 7 / 2442 MHz	Ch No. 13 / 2472 MHz
HT40-802.11N_SISO	Ch No. 3/ 2422 MHz	Ch No. 7 / 2442 MHz	Ch No. 11 / 2462 MHz

4.4 Test Setups

NOTE: See Appendix K for practical Test Setup Photos.

4.4.1 General Test Setup Configurations

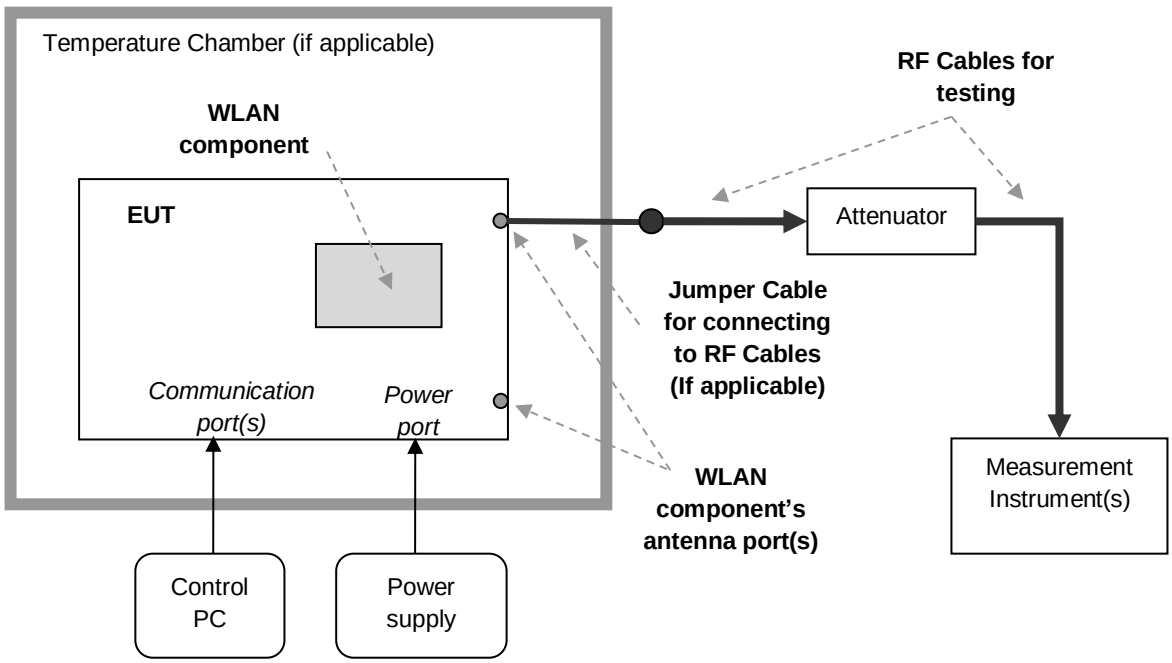
Configuration	Description
Test Antenna Ports	Until declared, all Transmitter tests are performed at all antenna ports of the EUT; all Receiver tests are performed at all antenna ports.
Multiple RF Sources	Other non-WLAN RF source(s) (if applicable) of the EUT are disabled or shutdown during measurements for WLAN RF source, which is considered in the present report.

4.4.2 Test Setup for Conducted Measurements

The EUT (WLAN unit) is placed in a Temperature Chamber (if applicable), and is powered by a Power Supplier. An external Control PC associated with special software(s) is used to configure the EUT (WLAN unit) with the purpose of fulfilling the test requirements by EN standard.

The antenna port(s) of the EUT (WLAN unit) are connected to the Measurement Instrument(s) through an appropriate Attenuator. For the antenna port(s) which are not tested, appropriate 50 Ohm terminations are used.

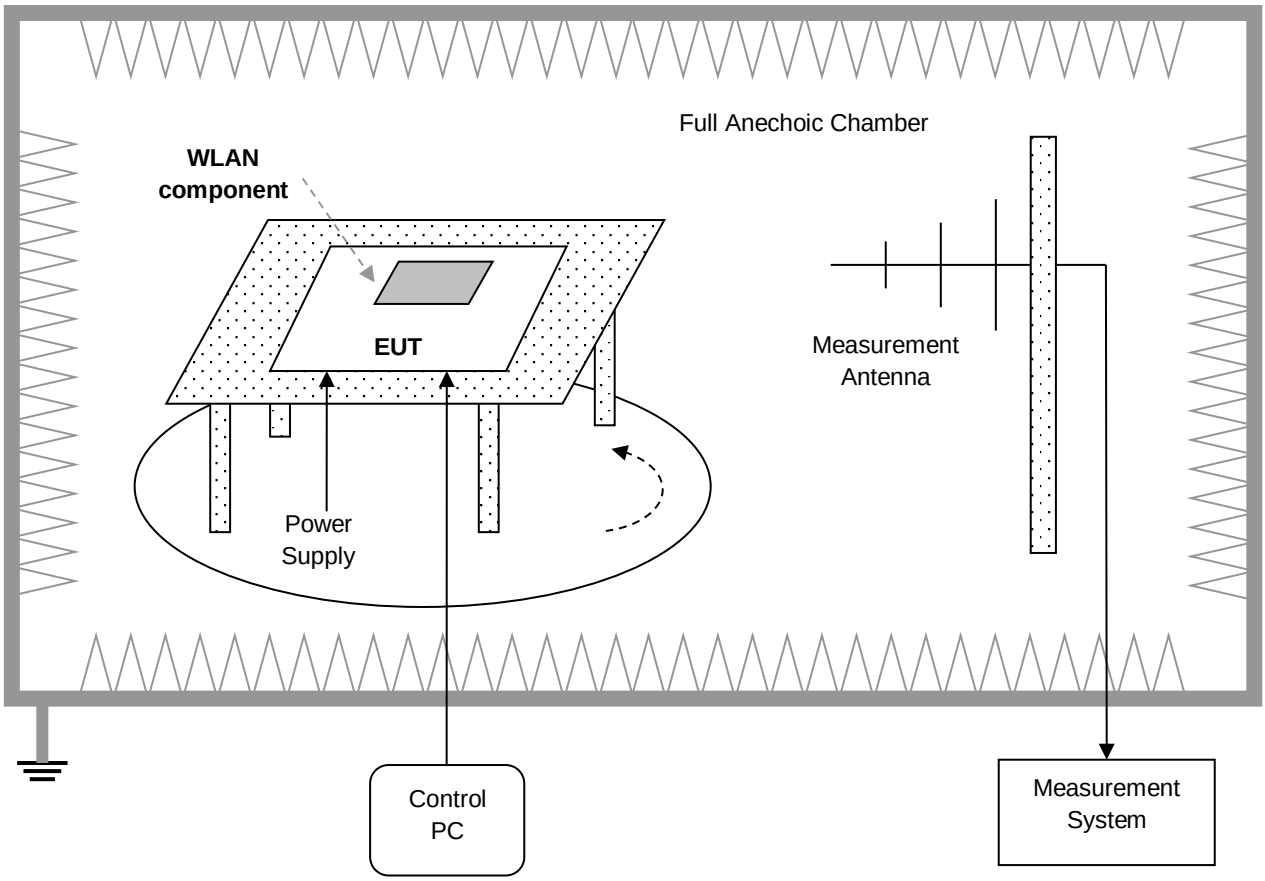
In addition, different setting options (e.g. Option 1) for Measurement Instrument(s) for conducted measurement methods can be used for some test items according to the EN standard. The selected option is specified in test conditions for each test case.



4.4.3 Test Setup for Radiated Measurements

The EUT (WLAN unit) is placed in a Fully Anechoic Chamber simulating the free-space conditions. The whole device is positioned on a non-conducting support and is powered by a Power Supplier. An external Control PC associated with special software(s) is used to configure the EUT (WLAN unit) with the purpose of fulfilling the test requirements by EN standards.

An appropriate Measurement Antenna (according to different test frequency ranges) with the distance of 3 m to the whole device is used to obtain maximum response from the whole device, which is rotated when measurement running. The measurement is performed with the Measurement Antenna in both horizontal and vertical polarization planes.



4.5 Test Conditions

Test Case	Test Conditions	
	Configuration	**Description**
Equivalent Isotropic Radiated Power (EIRP)	**Measurement Method**	Conducted
	Power Level	Highest
	Test Conditions	NTNV, LTNV, HTNV
	Smart Antenna Systems	Ant 1
	Test Modes	11B, 11G, 11N_20M_SISO, 11N_40M_SISO
	Test Frequency	L, M, H
Maximum EIRP Spectral Density	**Measurement Method**	Conducted, Option 1
	Power Level	Highest
	Test Conditions	NTNV
	Smart Antenna Systems	Ant 1
	Test Modes	11B, 11G, 11N_20M_SISO, 11N_40M_SISO
	TX ON time (>10µs)	Fulfilled
	Test Frequency	L, M, H
Adaptivity	**Measurement Method**	Conducted, Option 1
	Power Level	Highest, Lowest (if unable)
	Test Conditions	NTNV
	Smart Antenna Systems	Ant 1
	Test Modes	11B
	Transmitter Mode	Operating
	Test Frequency	L, H
	Measurement Method	Conducted, Option 1

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Test Case	Test Conditions	
	Configuration	**Description**
Occupied Channel Bandwidth	**Test Conditions**	NTNV
	Smart Antenna Systems	Ant 1
	Test Modes	11B, 11G, 11N_20M_SISO, 11N_40M_SISO
	Transmitter Mode	Operating
	Test Frequency	L, H
Transmitter unwanted emissions in the out-of-band domain	**Measurement Method**	Conducted, Option 1
	Test Conditions	NTNV
	Smart Antenna Systems	Ant 1
	Test Modes	11B, 11G, 11N_20M_SISO, 11N_40M_SISO
	Test Frequency	L, H
Transmitter unwanted emissions in the spurious domain	**Measurement Method**	Conducted, Option 1
	Test Conditions	NTNV
	Smart Antenna Systems	Ant 1
	Test Modes	11B, 11G, 11N_20M_SISO, 11N_40M_SISO
	Transmitter Mode	Operating
	Test Frequency	L, H
Receiver Spurious Emissions	**Measurement Method**	Conducted, Option 1
	Test Conditions	NTNV
	Smart Antenna Systems	Ant 1
	Test Modes	11B, 11G, 11N_20M_SISO, 11N_40M_SISO
	Receiver Mode	Continues Receiving
	Test Frequency	L, H

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Test Case	Test Conditions	
	Configuration	**Description**
Receiver Blocking	**Measurement Method**	Conducted, Option 1
	Power Level	Highest
	Test Conditions	NTNV
	Smart Antenna Systems	Ant 1
	Test Modes	11B, 11G, 11N_20M_SISO, 11N_40M_SISO
	Transmitter Mode	Operating
	Test Frequency	L, H

5 Test Results

No.	Test Item	Test Result
1	4.3.2.2 RF output power	Appendix A
2	4.3.2.3 Power Spectral Density	Appendix B
3	4.3.2.4 Duty Cycle, Tx-sequence, Tx-gap	N/A
4	4.3.2.5 Medium Utilisation (MU) factor	N/A
5	4.3.2.6 Adaptivity	Appendix C
6	4.3.2.7 Occupied Channel Bandwidth	Appendix D
7	4.3.2.8 Transmitter unwanted emissions in the out-of-band domain	Appendix E
8	4.3.2.9 Transmitter unwanted emissions in the spurious domain_Radiated	N/A
9	4.3.2.9 Transmitter unwanted emissions in the spurious domain_Conducted	Appendix G
10	4.3.2.10 Receiver spurious emissions_Radiated	N/A
11	4.3.2.10 Receiver spurious emissions_Conducted	Appendix I
12	4.3.2.11 Receiver Blocking	Appendix J

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6 Test Requirements

6.1 RF output power

The equivalent isotropic radiated power (as EIRP) shall be equal to or less than -10 dBW (= 20 dBm). This limit shall apply for any combination of power level and intended antenna assembly.

6.2 Maximum EIRP Spectral Density

For wide band modulations other than FHSS (e.g. DSSS, OFDM, etc.), the maximum e.i.r.p. spectral density (as PD) is limited to 10 mW per MHz (= 10 dBm/MHz).

6.3 Adaptivity

The equipment used Non-LBT based Detect and Avoid mechanism shall comply with the requirements defined in clause 4.3.2.6.2.2

LBT based Detect and Avoid mechanism: This mechanism defines 2 types of adaptive equipment using wide band modulations and that uses an LBT based Detect and Avoid mechanism: Frame Based Equipment and Load Based Equipment. The kind of the equipment shall comply with the requirements defined in clause 4.3.2.6.3.2

Short Control Signalling Transmissions: The transmissions used by adaptive equipment to send control signals (e.g. ACK/NACK signals, etc.) without sensing the operating channel for the presence of other signals. Adaptive equipment may or may not have Short Control Signalling Transmissions. If implemented, the limit of Short Control Signalling Transmissions of adaptive equipment using wide band modulations shall have a maximum duty cycle of 10 % within an observation period of 50 ms.

6.4 Occupied Channel Bandwidth

The Occupied Channel Bandwidth shall fall completely within the band given in table 1.

In addition, for non-adaptive equipment using wide band modulations other than FHSS and with e.i.r.p. greater than 10 dBm, the occupied channel bandwidth shall be less than 20 MHz.

Table 1: Service frequency bands

	Service frequency bands
Transmit	2 400 MHz to 2 483,5 MHz
Receive	2 400 MHz to 2 483,5 MHz

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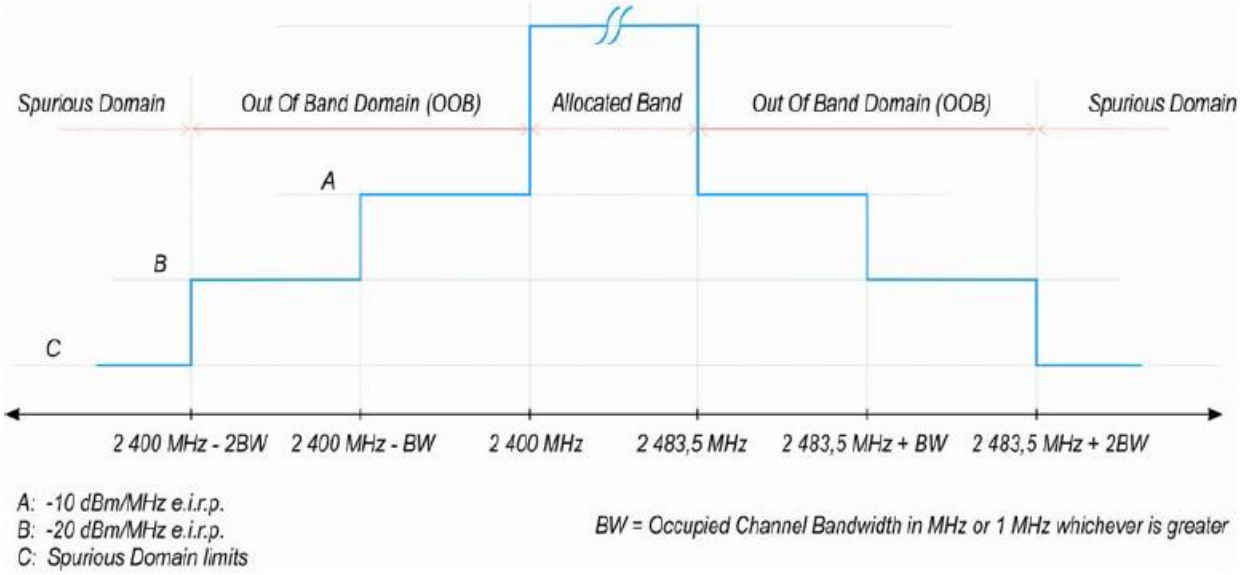
6.5 Transmitter unwanted emissions in the out-of-band domain

The transmitter unwanted emissions in the out-of-band domain but outside the allocated band, shall not exceed the values provided by the mask in below figure.



NOTE: Within the 2 400 MHz to 2 483.5 MHz band, the Out-of-band emissions are fulfilled by compliance with the Occupied Channel Bandwidth requirement in clause 4.3.2.7.

6.6 Transmitter Spurious Emissions

The spurious emissions of the transmitter shall not exceed the values in following tables in the indicated bands.

Frequency Range	Limit When Operating	Limit When in Standby
30MHz to 47MHz	-36dBm	-57 dBm
47MHz-74MHz	-54dBm	-57 dBm
74MHz-87.5MHz	-36dBm	-57 dBm
87.5MHZ-118MHz	-54dBm	-57 dBm
118MHz-174MHz	-36dBm	-57 dBm
174MHz-230MHz	-54dBm	-57 dBm
230MHz-470MHz	-36dBm	-57 dBm
470MHz-694MHz	-54dBm	-57 dBm
694MHz-1GHz	-36dBm	-57 dBm
Above 1GHz to 12.75GHz	-30dBm	-47 dBm

NOTE: The above limit values apply to narrowband emissions, e.g. as caused by local oscillator leakage. The measurement bandwidth for such emissions may be as small as necessary to achieve a reliable measurement result.

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6.7 Receiver Spurious Emissions

The spurious emissions of the receiver shall not exceed the values in following tables in the indicated bands.

Frequency Range	Limit
30 MHz to 1 GHz	-57 dBm
1 GHz to 12.75 GHz	-47 dBm

Note: The above limit values apply to narrowband emissions, e.g. as caused by local oscillator leakage. The measurement bandwidth for such emissions may be as small as necessary to achieve a reliable measurement result.

6.8 Receiver Blocking

While maintaining the minimum performance criteria as defined in clause 4.3.2.11.3, the blocking levels at specified frequency offsets shall be equal to or greater than the limits defined for the applicable receiver category provided in table 14, table 15 or table 16.

Table 14 contains the Receiver Blocking parameters for Receiver Category 1 equipment.

Table 14: Receiver Blocking parameters for Receiver Category 1 equipment

Wanted signal mean power from companion device (dBm) (see notes 1 and 4)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 4)	Type of blocking signal
(-133 dBm + 10 × $\log_{10}$(OCBW)) or -68 dBm whichever is less (see note 2)	2 380 2 504	-34	CW
(-139 dBm + 10 × $\log_{10}$(OCBW)) or -74 dBm whichever is less (see note 3)	2 300 2 330 2 360 2 524 2 584 2 674		

NOTE 1: OCBW is in Hz.
NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to P_{min} + 26 dB where P_{min} is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.
NOTE 3: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to P_{min} + 20 dB where P_{min} is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.
NOTE 4: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in clause 5.4.3.2.2.

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Table 15 contains the Receiver Blocking parameters for Receiver Category 2 equipment.

Table 15: Receiver Blocking parameters receiver Category 2 equipment

Wanted signal mean power from companion device (dBm) (see notes 1 and 3)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 3)	Type of blocking signal
(-139 dBm + 10 × $\log_{10}$(OCBW) + 10 dB) or (-74 dBm + 10 dB) whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW
NOTE 1: OCBW is in Hz. NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to P_{min} + 26 dB where P_{min} is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal. NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in clause 5.4.3.2.2.			

Table 16 contains the Receiver Blocking parameters for Receiver Category 3 equipment.

Table 16: Receiver Blocking parameters receiver Category 3 equipment

Wanted signal mean power from companion device (dBm) (see notes 1 and 3)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 3)	Type of blocking signal
(-139 dBm + 10 × $\log_{10}$(OCBW) + 20 dB) or (-74 dBm + 20 dB) whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW
NOTE 1: OCBW is in Hz. NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to P_{min} + 30 dB where P_{min} is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal. NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in clause 5.4.3.2.2.			

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7 Estimation of Exposure of Human to Electromagnetic Fields

According to EN 62311:2008, the criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified 1999/519/EC.

Reference levels for electric, magnetic and electromagnetic fields (0 Hz to 300 GHz, unperturbed rms values)

Frequency range	E-field strength (V/m)	H-field strength (A/m)	B-field (μT)	Equivalent plane wave power density S_{eq} (W/m²)
0-1 Hz	—	$3,2 \times 10^4$	4×10^4	—
1-8 Hz	10 000	$3,2 \times 10^4/f^2$	$4 \times 10^4/f^2$	—
8-25 Hz	10 000	4 000/f	5 000/f	—
0,025-0,8 kHz	250/f	4/f	5/f	—
0,8-3 kHz	250/f	5	6,25	—
3-150 kHz	87	5	6,25	—
0,15-1 MHz	87	0,73/f	0,92/f	—
1-10 MHz	$87/f^{1/2}$	0,73/f	0,92/f	—
10-400 MHz	28	0,073	0,092	2
400-2 000 MHz	$1,375\ f^{1/2}$	$0,0037\ f^{1/2}$	$0,0046\ f^{1/2}$	f/200
2-300 GHz	61	0,16	0,20	10

Notes:

1. f as indicated in the frequency range column.
2. For frequencies between 100 kHz and 10 GHz, S_{eq}, E^2, H^2, and B^2 are to be averaged over any six-minute period.
3. For frequencies exceeding 10 GHz, S_{eq}, E^2, H^2, and B^2 are to be averaged over any $68/f^{1.05}$ -minute period (f in GHz).
4. No E-field value is provided for frequencies < 1 Hz, which are effectively static electric fields. For most people the annoying perception of surface electric charges will not occur at field strengths less than 25 kV/m. Spark discharges causing stress or annoyance should be avoided.

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For the 2.4GHz band the reference level is E field strength 61V/m

The Formula

$$r = \frac{\sqrt{30PG(\theta,\phi)}}{E}$$

Whereas,

G=antenna gain relative to an isotropic antenna

Θ Φ= elevation and azimuth angles to point of investigation

r=distance from observation point to the antenna

P=the maximum output power of transmitter.

The maximum e.i.r.p of the transmitter is 17.6 dBm=57.544 mW=0.057544 W

Since e.i.r.p is used for this calculation, the antenna gain is assumed as dBi=2.0

The distance r=3.046 cm

The antenna of the product, under normal use condition is at least 3.046 cm away from the body of the user. Warning statement to the user for keeping at least 20 cm separation distance and the prohibition of operating to a person has been printed on the user's manual. So, this product under normal use is located on electromagnetic far field between the human body.

So the requirement is easily met for the user if only user is not close extremely to the product.

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8 Main Test Instruments

	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DUE DATE
C	Spectrum Analyzer	R&S	FSV40	N/A	2020/04/28
	Wideband Radio Communication Tester	R&S	CMW 270	N/A	2020/04/28
	ESG VECTOR GENERATOR	R&S	SMBV100A	N/A	2020/04/28
	SIGNAL GENARATOR	R&S	SMB 100A	N/A	2020/04/28
	OSP	R&S	OSP 150	N/A	2020/04/28

Conducted RF tests –C

- RF output power
- Power Spectral Density
- Adaptivity &Receiver Blocking
- Occupied Channel Bandwidth
- Transmitter unwanted emissions OOB
- Conducted unwanted emissions spurious TX
- Conducted unwanted emissions spurious RX

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9 System Measurement Uncertainty

For the test methods, according to the harmonized standard and conformance testing standard, the measurement uncertainty figures shall be calculated in accordance with TR 100 028 and shall correspond to an expansion factor (coverage factor) k = 1.96 (which provides a confidence level of 95 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)).

System Measurement Uncertainty	
Test Items	Extended Uncertainty
Uncertainty for Radiated Spurious Emission 30MHz-1000MHz	±3.49dB(Horizontal), ±3.50dB(Vertical)
Uncertainty for Conducted RF test	Power level test involved: 2.04dB Frequency test involved:1.1×10^{-7}

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10 Appendix A: RF output power

NOTE 1: In this Appendix, EIRP [dBm] = A [dBm] + 10*log (1/X) [dB] + G [dBi]. Where, A = Average Power, X = Duty Cycle and G = Antenna Gain. The Jumper Cable Loss (JCL) (if applicable) and Test Path Loss (TPL) were calculated into A.

NOTE 2: For measurements on smart antenna systems (devices with multiple transmit chains), the test is performed at each chain, and then combined into a final result. The result is the calculated linear sum of each chain (as Ant sum).

(1) Common Parameter

Test Mode	Power Level Setting defined by Manufacturer	X [%]	G [dBi]
11B	17.5dBm	100	2.0
11G	14.5dBm	100	2.0
11N_20M_SISO	13.5dBm	100	2.0
11N_40M_SISO	13.5dBm	100	2.0

(2) Test Result

Test Env.	Test Mode	RF Ch.	Ant.	EIRP [dBm]	Limit [dBm]	Verdict
NTNV	11B	L	Ant 1	16.9	< 20	Pass
		M	Ant 1	17.3	< 20	Pass
		H	Ant 1	17.6	< 20	Pass
	11G	L	Ant 1	16.3	< 20	Pass
		M	Ant 1	17.0	< 20	Pass
		H	Ant 1	17.1	< 20	Pass
	11N_20M_SISO	L	Ant 1	16.4	< 20	Pass
		M	Ant 1	16.7	< 20	Pass
		H	Ant 1	16.9	< 20	Pass
	11N_40M_SISO	L	Ant 1	14.5	< 20	Pass
		M	Ant 1	15.1	< 20	Pass
		H	Ant 1	14.8	< 20	Pass
LTLV	11B	L	Ant 1	17.0	< 20	Pass
		M	Ant 1	17.2	< 20	Pass
		H	Ant 1	17.5	< 20	Pass
	11G	L	Ant 1	16.2	< 20	Pass
		M	Ant 1	16.9	< 20	Pass
		H	Ant 1	17.0	< 20	Pass
	11N_20M_SISO	L	Ant 1	16.4	< 20	Pass
		M	Ant 1	16.6	< 20	Pass
		H	Ant 1	16.7	< 20	Pass
	11N_40M_SISO	L	Ant 1	14.4	< 20	Pass
		M	Ant 1	15.1	< 20	Pass
		H	Ant 1	14.7	< 20	Pass
LTHV	11B	L	Ant 1	17.0	< 20	Pass
		M	Ant 1	17.2	< 20	Pass
		H	Ant 1	17.6	< 20	Pass
	11G	L	Ant 1	16.0	< 20	Pass
		M	Ant 1	16.7	< 20	Pass
		H	Ant 1	16.9	< 20	Pass
	11N_20M_SISO	L	Ant 1	16.4	< 20	Pass
		M	Ant 1	16.5	< 20	Pass
		H	Ant 1	16.6	< 20	Pass

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Test Env.	Test Mode	RF Ch.	Ant.	EIRP [dBm]	Limit [dBm]	Verdict
	11N_40M_SISO	L	Ant 1	14.6	< 20	Pass
		M	Ant 1	15.2	< 20	Pass
		H	Ant 1	14.8	< 20	Pass
HTLV	11B	L	Ant 1	17.0	< 20	Pass
		M	Ant 1	17.4	< 20	Pass
		H	Ant 1	17.8	< 20	Pass
	11G	L	Ant 1	16.4	< 20	Pass
		M	Ant 1	17.2	< 20	Pass
		H	Ant 1	17.2	< 20	Pass
	11N_20M_SISO	L	Ant 1	16.5	< 20	Pass
		M	Ant 1	16.8	< 20	Pass
		H	Ant 1	16.9	< 20	Pass
	11N_40M_SISO	L	Ant 1	14.6	< 20	Pass
		M	Ant 1	15.3	< 20	Pass
		H	Ant 1	14.9	< 20	Pass
HTHV	11B	L	Ant 1	17.1	< 20	Pass
		M	Ant 1	17.4	< 20	Pass
		H	Ant 1	17.8	< 20	Pass
	11G	L	Ant 1	16.5	< 20	Pass
		M	Ant 1	17.3	< 20	Pass
		H	Ant 1	17.2	< 20	Pass
	11N_20M_SISO	L	Ant 1	16.6	< 20	Pass
		M	Ant 1	16.8	< 20	Pass
		H	Ant 1	17.0	< 20	Pass
	11N_40M_SISO	L	Ant 1	14.6	< 20	Pass
		M	Ant 1	15.3	< 20	Pass
		H	Ant 1	15.0	< 20	Pass

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11 Appendix B: Maximum EIRP Spectral Density

NOTE 1: In this Appendix, PD [dBm/MHz] = D [dBm/MHz] + 10*log (1/X) [dB] + G [dBi]. Where, D = Spectral Power Density, X = Duty Cycle and G = Antenna Gain. The Jumper Cable Loss (JCL) (if applicable) and Test Path Loss (TPL) were calculated into D.

NOTE 2: For measurements on smart antenna systems (devices with multiple transmit chains), the test is performed at each chain, and then combined into a final result. The result is the calculated linear sum of each chain (as Ant sum).

(1) Common Parameter

Test Mode	Power Level Setting defined by Manufacturer	X [%]	G [dBi]
11B	17.5dBm	100	2.0
11G	14.5dBm	100	2.0
11N_20M_SISO	13.5dBm	100	2.0
11N_40M_SISO	13.5dBm	100	2.0

(2) Test Result

Test Mode	RF Ch.	Ant.	PD [dBm/MHz]	Limit [dBm/MHz]	Verdict
11B	L	Ant 1	8.256	< 10	PASS
	M	Ant 1	8.707	< 10	PASS
	H	Ant 1	8.960	< 10	PASS
11G	L	Ant 1	4.613	< 10	PASS
	M	Ant 1	5.224	< 10	PASS
	H	Ant 1	5.359	< 10	PASS
11N_20M_SISO	L	Ant 1	4.451	< 10	PASS
	M	Ant 1	4.792	< 10	PASS
	H	Ant 1	5.001	< 10	PASS
11N_40M_SISO	L	Ant 1	-0.347	< 10	PASS
	M	Ant 1	0.177	< 10	PASS
	H	Ant 1	0.014	< 10	PASS

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12 Appendix C: Adaptivity & Receiver Blocking

Test result:

	Test Compliance
Adaptivity for Non-LBT based Detect and Avoid Equipment	N/A
Adaptivity for Frame Based Equipment	N/A
Adaptivity for Load Based Equipment	PASS

	Lowest channel Adding Interference Signal	Highest channel Adding Interference Signal
CCA check	PASS	PASS
Extended CCA check	PASS	PASS
Maximum channel occupancy time	PASS	PASS
Energy detecting Threshold level(TL)	< -60 dBm/MHz	< -60 dBm/MHz
Short control signalling transmissions in 50ms below 10% duty cycle	< 10%	< 10%

Note1: TL = TL = -70 dBm/MHz + 10 × $\log_{10}$ (100 mW / Pout) (Pout in mW e.i.r.p.)
Note2: The EUT performs a Clear Channel Assessment (CCA) check using energy detect.

Adaptivity data and plot:

Operational Mode	Low frequency (MHz)	High frequency (MHz)	Result
802.11B	2412	2472	PASS

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Adaptivity (2412 MHz; 15.000 dBm; 20 MHz)

Summary

Result	Threshold (dBm)
PASS	-2.6

Normal Operation

DutyCycle DUT (all ports) (%)	Monitoring Length (ms)	COT Max (ms)	Limit Max (ms)	COT Min (ms)	Number of COTs	CCA Time Min (ms)	CCA Time Max (ms)	CCA Time Limit Min (ms)
100.000	10000.000	1.298	13.000	0.066	103	0.116	101.101	0.020

(continuation of the "Normal Operation" table from column 9 ...)

DutyCycle DUT (all ports) (%)	Result
100.000	PASS

Reaction on Interferer and Blocker

DC in max DC Evaluation Window (%)	Limit Max (%)	Result	Length of max DC Evaluation Window (ms)	Start of max DC Evaluation Window (ms)
0.000	10.000	PASS	122987.000	1013.000

(continuation of the "Reaction on Interferer and Blocker" table from column 5 ...)

DC in max DC Evaluation Window (%)	Stop of max DC Evaluation Window (ms)	Interferer On (ms)	Blocker On (ms)	Monitoring Offset (ms)	Monitoring Start (ms)
0.000	124000.000	1000.000	62000.000	13.000	1013.000

(continuation of the "Reaction on Interferer and Blocker" table from column 10 ...)

DC in max DC Evaluation Window (%)	Monitoring Length (ms)
0.000	121987.000

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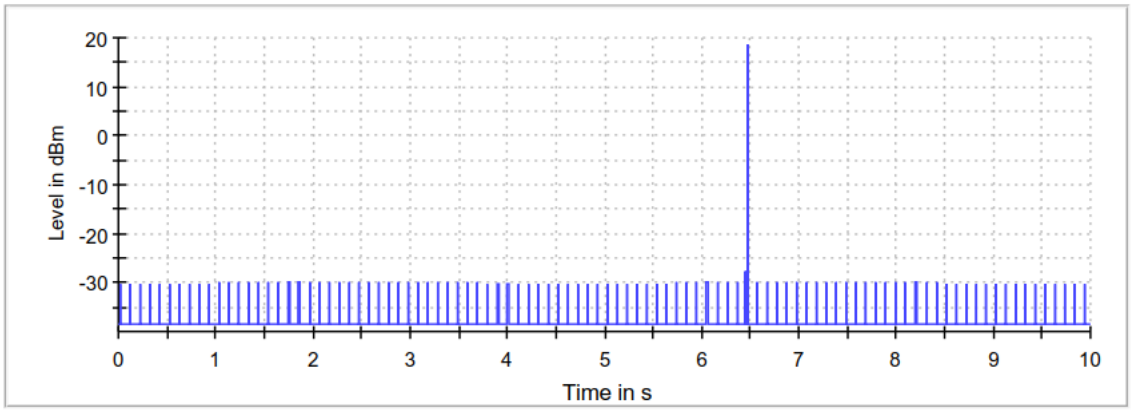
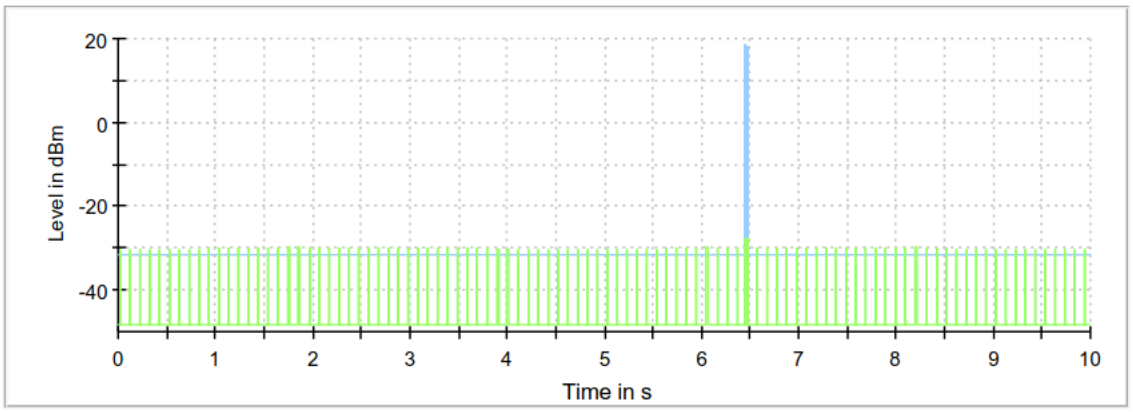
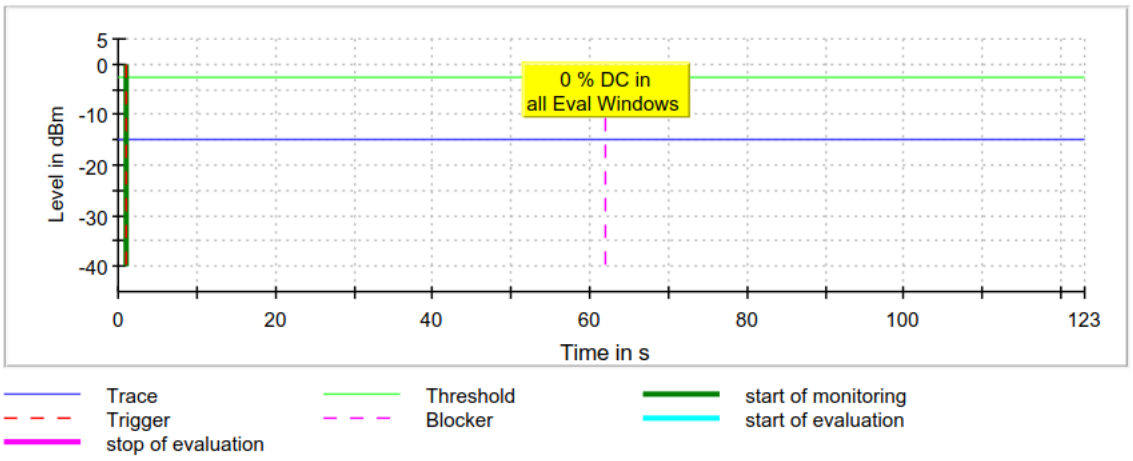
Normal Operation



Normal Operation_Comp_DUT



Interferer on



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Adaptivity (2472 MHz; 15.000 dBm; 20 MHz)

Summary

Result	Threshold (dBm)
PASS	-2.7

Normal Operation

DutyCycle DUT (all ports) (%)	Monitoring Length (ms)	COT Max (ms)	Limit Max (ms)	COT Min (ms)	Number of COTs	CCA Time Min (ms)	CCA Time Max (ms)	CCA Time Limit Min (ms)
100.000	10000.000	1.298	13.000	1.297	97	63.355	101.101	0.020

(continuation of the "Normal Operation" table from column 9 ...)

DutyCycle DUT (all ports) (%)	Result
100.000	PASS

Reaction on Interferer and Blocker

DC in max DC Evaluation Window (%)	Limit Max (%)	Result	Length of max DC Evaluation Window (ms)	Start of max DC Evaluation Window (ms)
0.000	10.000	PASS	122987.000	1013.000

(continuation of the "Reaction on Interferer and Blocker" table from column 5 ...)

DC in max DC Evaluation Window (%)	Stop of max DC Evaluation Window (ms)	Interferer On (ms)	Blocker On (ms)	Monitoring Offset (ms)	Monitoring Start (ms)
0.000	124000.000	1000.000	62000.000	13.000	1013.000

(continuation of the "Reaction on Interferer and Blocker" table from column 10 ...)

DC in max DC Evaluation Window (%)	Monitoring Length (ms)
0.000	121987.000

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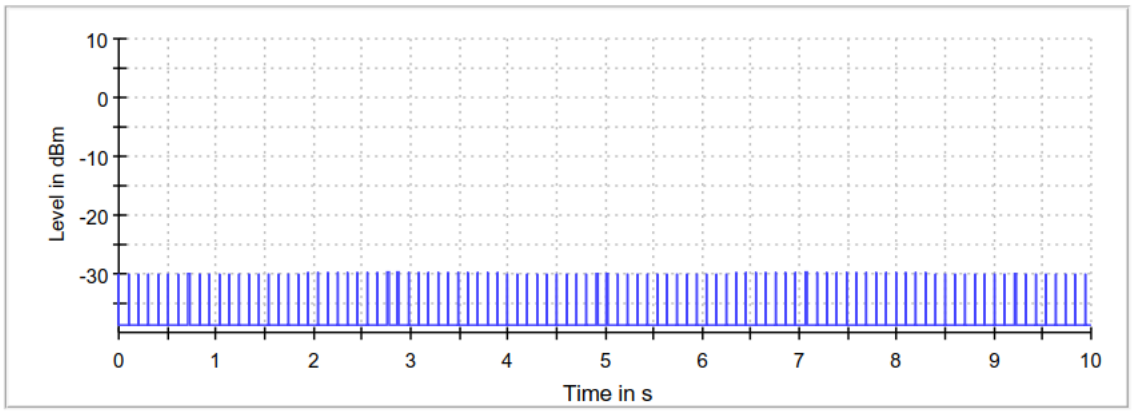
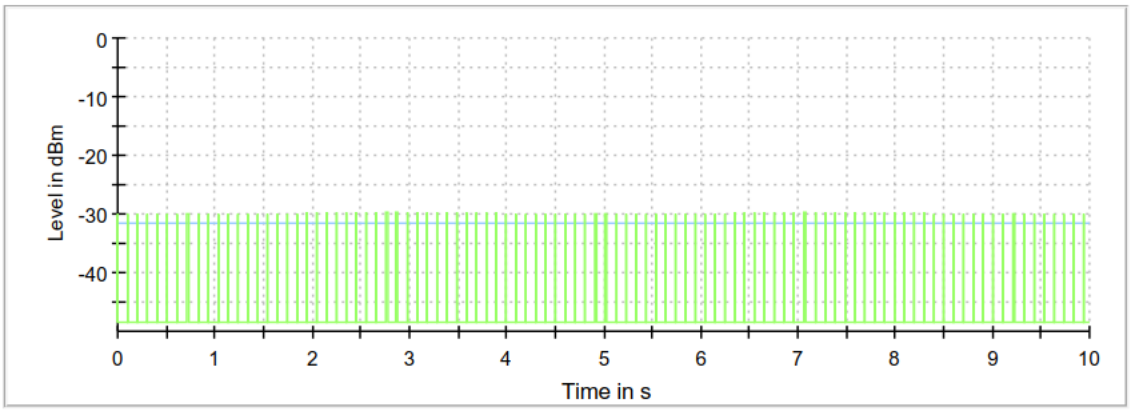
Normal Operation



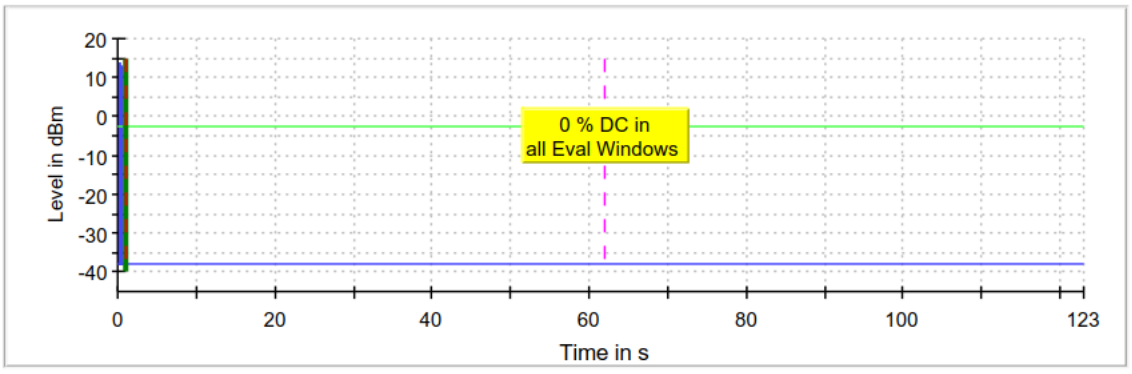
Trace

Normal Operation_Comp_DUT



DUT Companion

Interferer on



Trace Threshold start of monitoring
Trigger Blocker start of evaluation
stop of evaluation

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13 Appendix D: Occupied Channel Bandwidth

802.11B

Channel	Frequency	Occupied Channel Bandwidth (MHz)	Measured Frequency		Limit
			FL(MHz)	FH(MHz)	
1	2412	14.906832	2404.546584	--	FL>2400MHz and FH<2483.5MHz
13	2472	14.906832	--	2479.453416	

802.11G

Channel	Frequency	Occupied Channel Bandwidth (MHz)	Measured Frequency		Limit
			FL(MHz)	FH(MHz)	
1	2412	16.645963	2403.801242	--	FL>2400MHz and FH<2483.5MHz
13	2472	16.645963	--	2480.447205	

802.11N20

Channel	Frequency	Occupied Channel Bandwidth (MHz)	Measured Frequency		Limit
			FL(MHz)	FH(MHz)	
1	2412	17.888198	2403.055901	--	FL>2400MHz and FH<2483.5MHz
13	2472	17.888198	--	2480.944099	

802.11N40

Channel	Frequency	Occupied Channel Bandwidth (MHz)	Measured Frequency		Limit
			FL(MHz)	FH(MHz)	
3	2422	35.776398	2404.111801	--	FL>2400MHz and FH<2483.5MHz
11	2462	35.776398	--	2479.888199	

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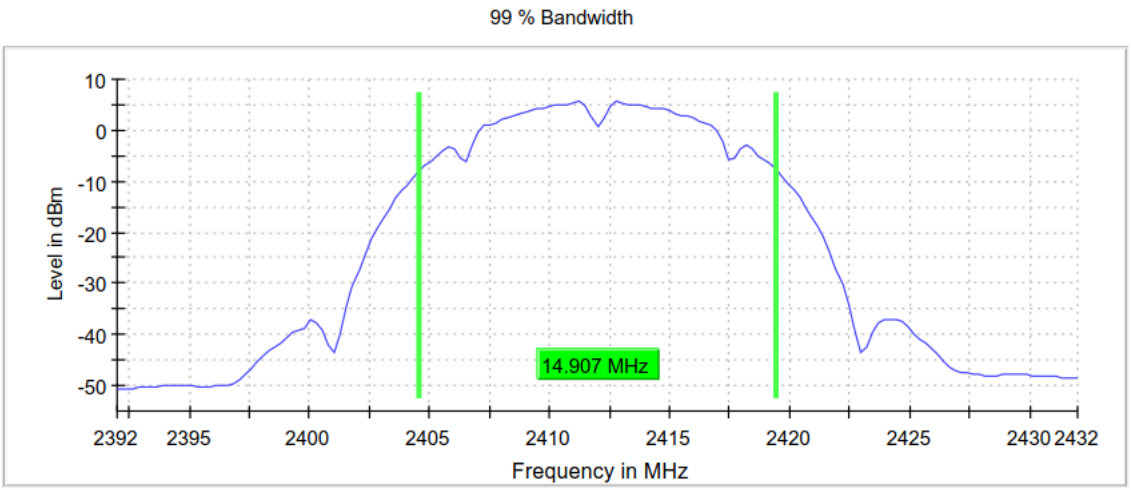
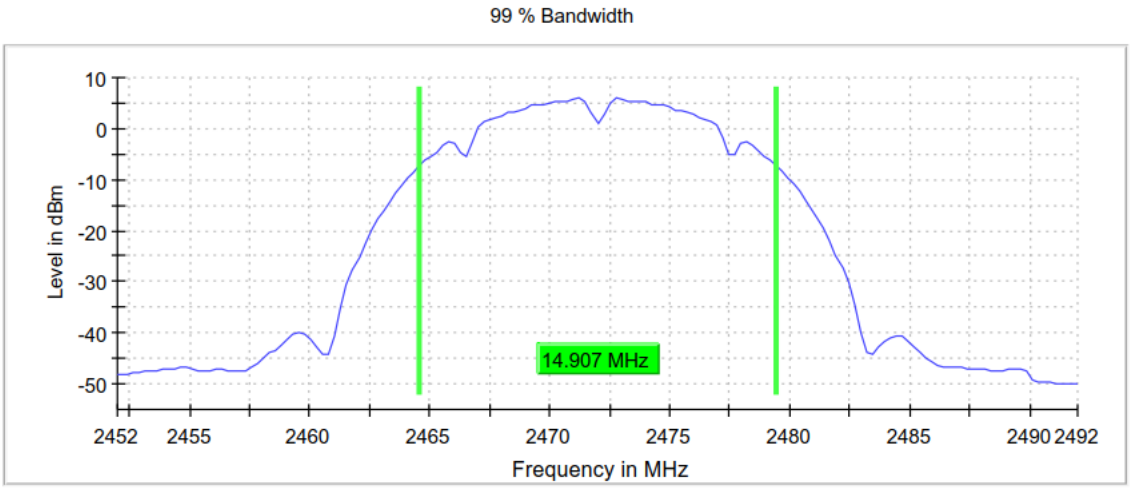
802.11 B: 2412MHz



802.11 B: 2472MHz



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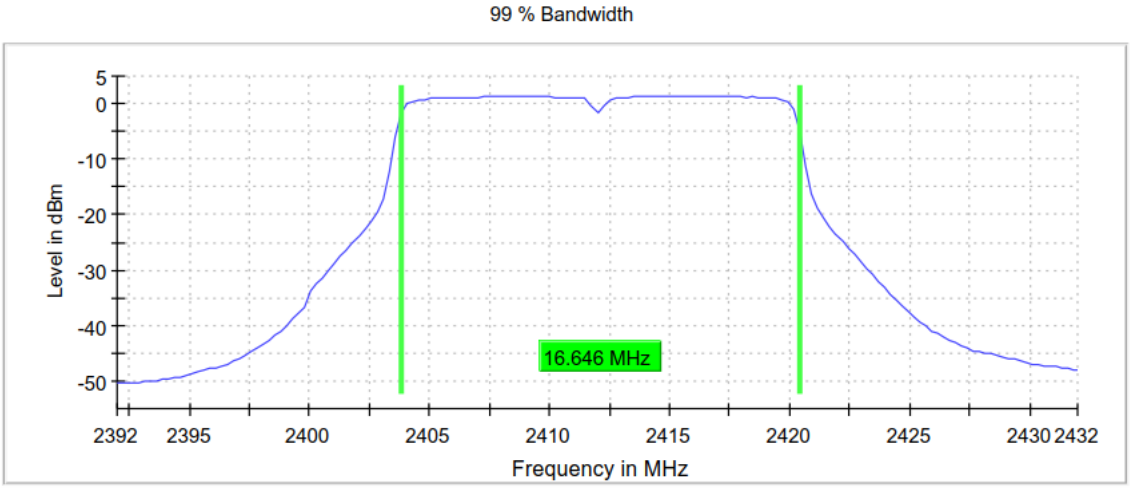
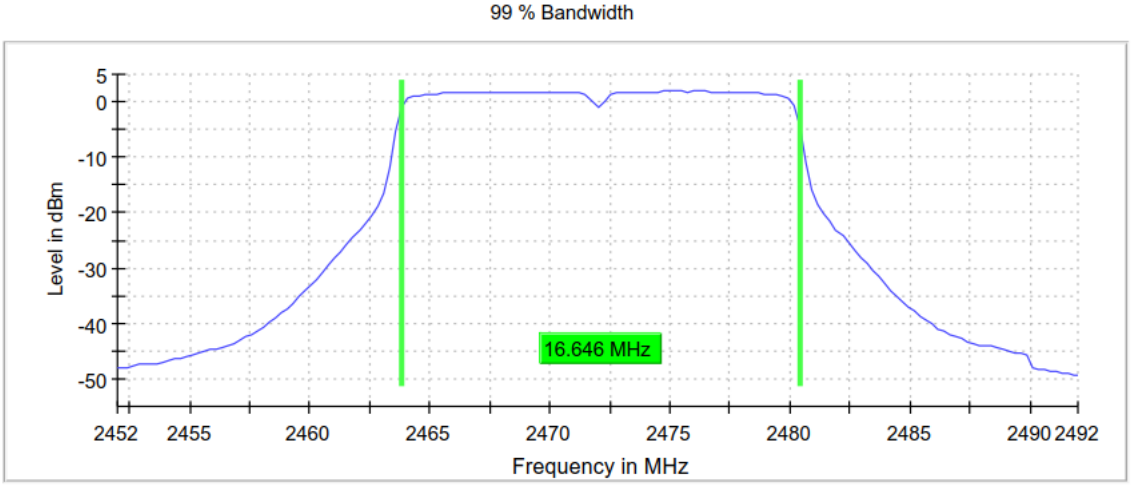
802.11 G: 2412MHz



802.11 G: 2472MHz



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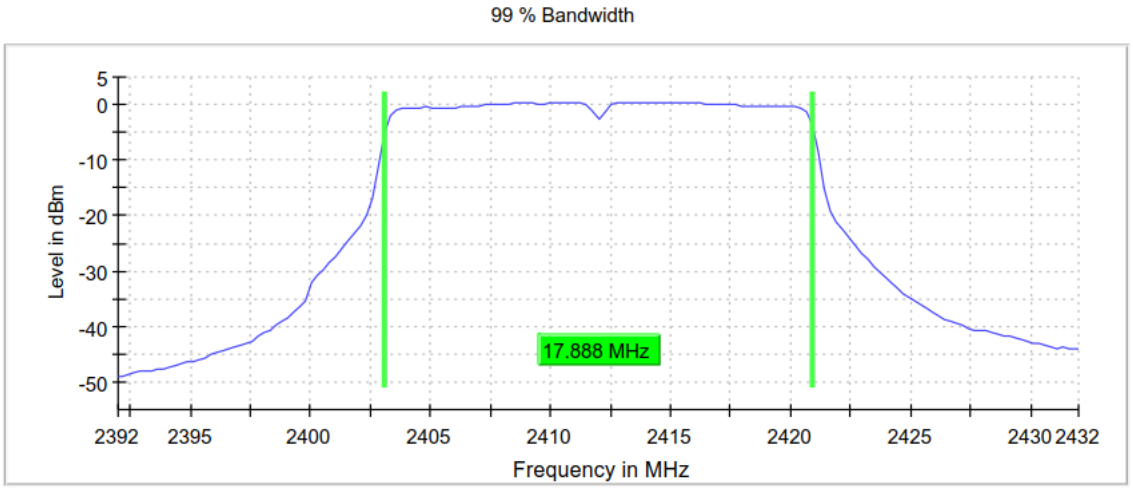
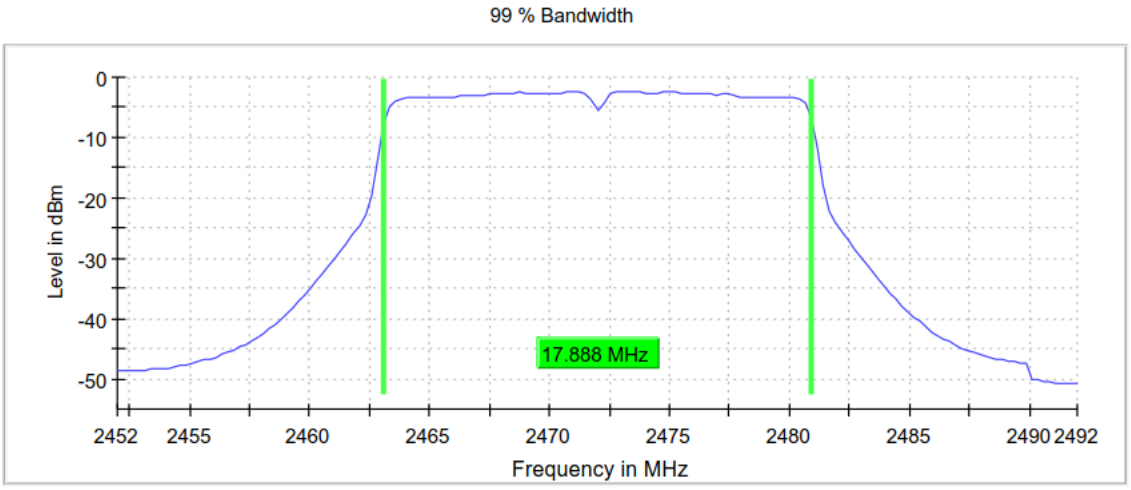
802.11 N HT-20: 2412MHz



802.11 N HT-20: 2472MHz



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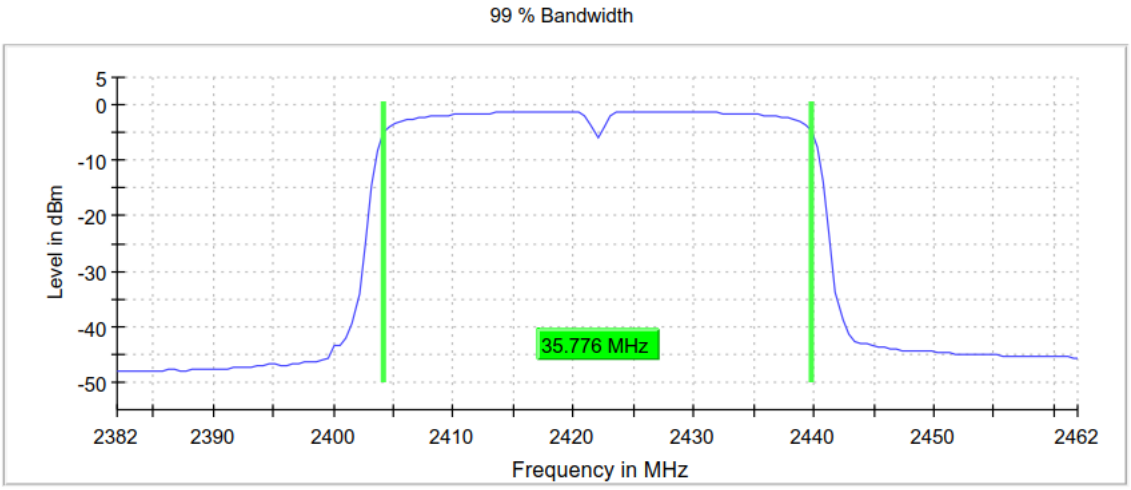
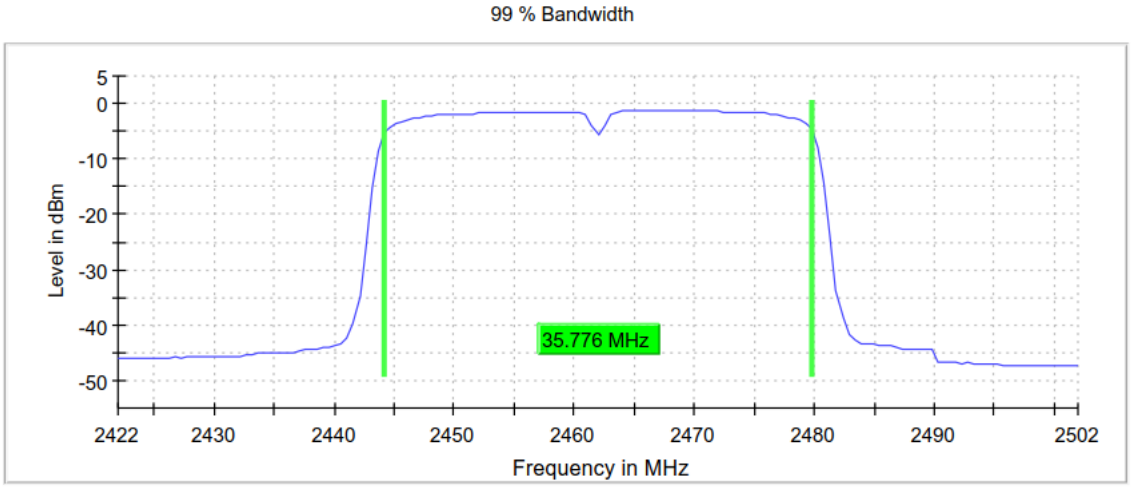
802.11 N HT-40: 2422MHz



802.11 N HT-40: 2462MHz



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14 Appendix E: Transmitter unwanted emissions in the out-of-band domain

802.11B

Test condition:	Test frequency (MHz)	Test segment (MHz)	Max. Reading (dBm/MHz)	Limit (dBm/MHz)
NTNV	2412	2400-BW to 2400	-36.7	-10
		2400-2BW to 2400-BW	-49.2	-20
	2472	2483.5 to 2483.5+BW	-39.0	-10
		2483.5+BW to 2483.5+2BW	-48.0	-20

802.11G

Test condition:	Test frequency (MHz)	Test segment (MHz)	Max. Reading (dBm/MHz)	Limit (dBm/MHz)
NTNV	2412	2400-BW to 2400	-35.5	-10
		2400-2BW to 2400-BW	-49.0	-20
	2472	2483.5 to 2483.5+BW	-30.5	-10
		2483.5+BW to 2483.5+2BW	-48.1	-20

802.11N20

Test condition:	Test frequency (MHz)	Test segment (MHz)	Max. Reading (dBm/MHz)	Limit (dBm/MHz)
NTNV	2412	2400-BW to 2400	-34.2	-10
		2400-2BW to 2400-BW	-49.0	-20
	2472	2483.5 to 2483.5+BW	-29.9	-10
		2483.5+BW to 2483.5+2BW	-48.1	-20

802.11N40

Test condition:	Test frequency (MHz)	Test segment (MHz)	Max. Reading (dBm/MHz)	Limit (dBm/MHz)
NTNV	2422	2400-BW to 2400	-46.5	-10
		2400-2BW to 2400-BW	-49.5	-20
	2462	2483.5 to 2483.5+BW	-44.1	-10
		2483.5+BW to 2483.5+2BW	-48.9	-20

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15 Appendix G: Transmitter Spurious Emissions – Conducted Mode

NOTE 1: The whole testing range is from “30 MHz to 12.75 GHz” is divided into 2 parts according to the test site settings, which are:
- Part 1: Test range of “30 MHz to 1GHz”,
- Part 2: Test range of “1 GHz to 12.75 GHz”.

NOTE 2: In this Appendix, X = Duty Cycle and G = Antenna Gain. The test path transducer was directly calculated into results for each test range.

(1) Common Parameter

Test Mode	Power Level Setting defined by Manufacturer	X [%]	G [dBi]
11B	17.5dBm	100	2.0
11G	14.5dBm	100	2.0
11N_20M_SISO	13.5dBm	100	2.0
11N_40M_SISO	13.5dBm	100	2.0

(2) Test Result

Note: The test results for testing range of “30 MHz to 12.75 GHz” showed as below is **the WORST case for all Test Modes and Channels**.The detected values which are noise floor or below the limit 20dB will not be recorded.

Operating Condition: Tx 2412MHz, lowest Channel
Mode: 802.11B

Invested Frequency Range(MHz)	Frequency (MHz)	Maximum Emission Observed (dBm)	Detector	Limit (dBm)	Margin (dB)
30-1000	618.9	-62.42	RMS	-54	-8.42
1000-12750	N/A	N/A	N/A	N/A	<-20

Operating Condition: Tx 2472MHz, Highest Channel
Mode: 802.11B

Invested Frequency Range(MHz)	Frequency (MHz)	Maximum Emission Observed (dBm)	Detector	Limit (dBm)	Margin (dB)
30-1000	679.2	-57.64	RMS	-54	-3.64
1000-12750	N/A	N/A	N/A	N/A	<-20

Operating Condition: Tx 2412MHz, lowest Channel
Mode: 802.11G

Invested Frequency Range(MHz)	Frequency (MHz)	Maximum Emission Observed (dBm)	Detector	Limit (dBm)	Margin (dB)
30-1000	506.6	-55.05	RMS	-54	-1.05
1000-12750	N/A	N/A	N/A	N/A	<-20

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Operating Condition: Tx 2472MHz, Highest Channel
Mode: 802.11G

Invested Frequency Range(MHz)	Frequency (MHz)	Maximum Emission Observed (dBm)	Detector	Limit (dBm)	Margin (dB)
30-1000	550.1	-57.03	RMS	-54	-3.03
1000-12750	N/A	N/A	N/A	N/A	<-20

Operating Condition: Tx 2412MHz, lowest Channel
Mode: 802.11n-HT20

Invested Frequency Range(MHz)	Frequency (MHz)	Maximum Emission Observed (dBm)	Detector	Limit (dBm)	Margin (dB)
30-1000	620.3	-59.77	RMS	-54	-5.77
1000-12750	N/A	N/A	N/A	N/A	<-20

Operating Condition: Tx 2472MHz, Highest Channel
Mode: 802.11n-HT20

Invested Frequency Range(MHz)	Frequency (MHz)	Maximum Emission Observed (dBm)	Detector	Limit (dBm)	Margin (dB)
30-1000	530.4	-66.24	RMS	-54	-12.24
1000-12750	N/A	N/A	N/A	N/A	<-20

Operating Condition: Tx 2422MHz, lowest Channel
Mode: 802.11n-HT40

Invested Frequency Range(MHz)	Frequency (MHz)	Maximum Emission Observed (dBm)	Detector	Limit (dBm)	Margin (dB)
30-1000	200.6	-74.41	RMS	-54	-20.41
1000-12750	N/A	N/A	N/A	N/A	<-20

Operating Condition: Tx 2462MHz, Highest Channel
Mode: 802.11n-HT40

Invested Frequency Range(MHz)	Frequency (MHz)	Maximum Emission Observed (dBm)	Detector	Limit (dBm)	Margin (dB)
30-1000	200.6	-74.30	RMS	-54	-20.30
1000-12750	N/A	N/A	N/A	N/A	<-20

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16 Appendix I: Receiver Spurious Emissions-Conducted Mode

NOTE 1: The whole testing range is from “30 MHz to 12.75 GHz” is divided into 2 parts according to the test site settings, which are:
- Part 1: Test range of “30 MHz to 1 GHz”,
- Part 2: Test range of “1 GHz to 12.75 GHz”.

NOTE 2: In this Appendix, X = Duty Cycle and G = Antenna Gain. The test path transducer was directly calculated into results for each test range.

(1) Common Parameter

Test Mode	Power Level Setting defined by Manufacturer	X [%]	G [dBi]
11B	17.5dBm	100	2.0
11G	14.5dBm	100	2.0
11N_20M_SISO	13.5dBm	100	2.0
11N_40M_SISO	13.5dBm	100	2.0

(2) Test Result

Operating Condition: Rx 2412MHz, lowest Channel
Mode: 802.11B

Invested Frequency Range(MHz)	Frequency(MHz)	Maximum Emission Observed(dBm)	Detector	Limit (dBm)	Margin (dB)
30-1000	N/A	N/A	N/A	N/A	<-20
1000-12750	N/A	N/A	N/A	N/A	<-20

Operating Condition: Rx 2472MHz, Highest Channel
Mode: 802.11B

Invested Frequency Range(MHz)	Frequency(MHz)	Maximum Emission Observed(dBm)	Detector	Limit (dBm)	Margin (dB)
30-1000	N/A	N/A	N/A	N/A	<-20
1000-12750	N/A	N/A	N/A	N/A	<-20

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17 Appendix J: Receiver Blocking

Receiver Category 1

Test Condition	Test Mode	Test Channel	Ant	Wanted signal Level[dBm]	Freq [MHz]	CW Level [dBm]	PER [%]	Limit [%]	Verdict
NTNV	11B	2412	Ant1	-68	2380	-34	1.67	<=10	PASS
NTNV	11B	2412	Ant1	-74	2300	-34	0.89	<=10	PASS
NTNV	11B	2412	Ant1	-74	2330	-34	1.12	<=10	PASS
NTNV	11B	2412	Ant1	-74	2360	-34	1.88	<=10	PASS
NTNV	11B	2472	Ant1	-68	2504	-34	1.75	<=10	PASS
NTNV	11B	2472	Ant1	-74	2524	-34	2.01	<=10	PASS
NTNV	11B	2472	Ant1	-74	2584	-34	2.38	<=10	PASS
NTNV	11B	2472	Ant1	-74	2674	-34	1.74	<=10	PASS
NTNV	11G	2412	Ant1	-68	2380	-34	0.67	<=10	PASS
NTNV	11G	2412	Ant1	-74	2300	-34	0.79	<=10	PASS
NTNV	11G	2412	Ant1	-74	2330	-34	0.32	<=10	PASS
NTNV	11G	2412	Ant1	-74	2360	-34	0.68	<=10	PASS
NTNV	11G	2472	Ant1	-68	2504	-34	1.19	<=10	PASS
NTNV	11G	2472	Ant1	-74	2524	-34	1.22	<=10	PASS
NTNV	11G	2472	Ant1	-74	2584	-34	1.37	<=10	PASS
NTNV	11G	2472	Ant1	-74	2674	-34	1.29	<=10	PASS
NTNV	11N	2412	Ant1	-68	2380	-34	1.56	<=10	PASS
NTNV	11N	2412	Ant1	-74	2300	-34	1.49	<=10	PASS
NTNV	11N	2412	Ant1	-74	2330	-34	1.33	<=10	PASS
NTNV	11N	2412	Ant1	-74	2360	-34	1.31	<=10	PASS
NTNV	11N	2472	Ant1	-68	2504	-34	1.67	<=10	PASS
NTNV	11N	2472	Ant1	-74	2524	-34	2.13	<=10	PASS
NTNV	11N	2472	Ant1	-74	2584	-34	2.45	<=10	PASS
NTNV	11N	2472	Ant1	-74	2674	-34	1.96	<=10	PASS

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18 Appendix K: Test Setup Photos

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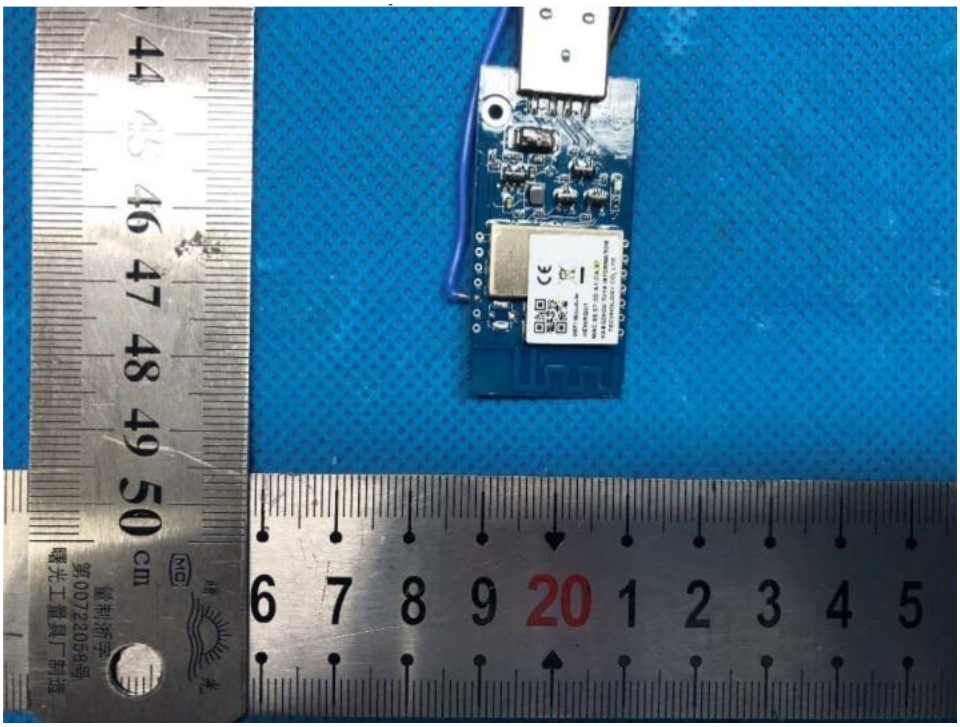
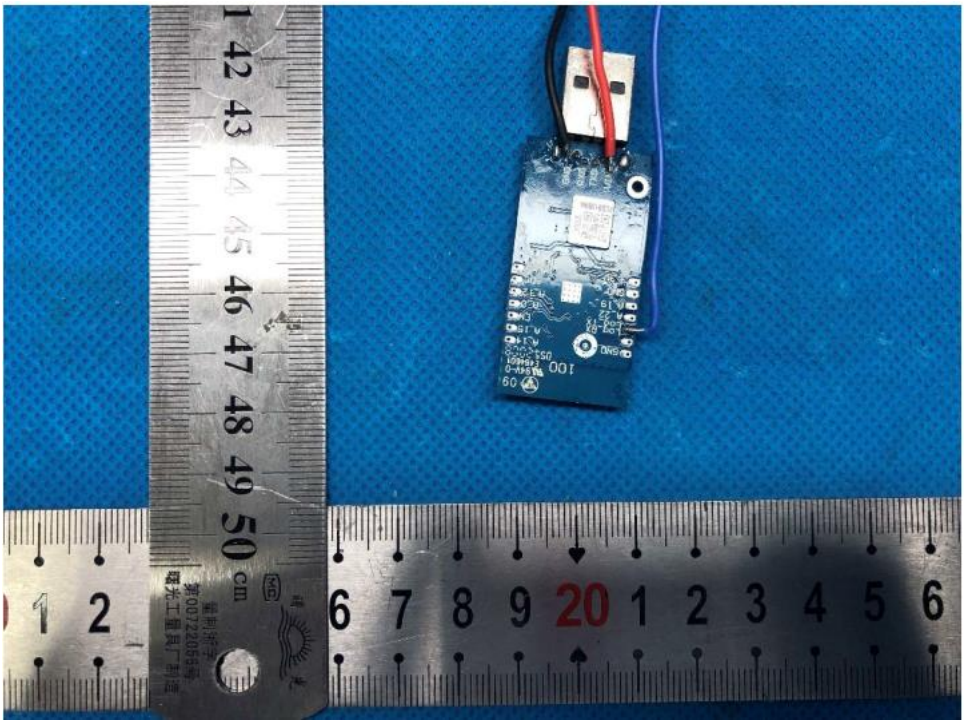
19 Appendix L: Photographs of EUT





THE END

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