

TEST REPORT

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Date: 2020-11-27

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Applicant : Leica Geosystems AG
Address of Applicant : Heinrich-Wild-Strasse, CH-9435 Heerbrugg

Product Name : Rugged Windows Field Controller
Model No. : CS30 LTE
Sample No. : E20090001-01#01
E20090001-01#02
FCC ID : RFD-CS30
ISED Number : 3177A-CS30

Standards : FCC CFR47 Part 15, Subpart C
RSS-Gen (Issue 5, March 2019)
RSS-247 (Issue 2, February 2017)

Date of Receipt : 2020-09-03
Date of Test : 2020-09-22 ~ 2020-11-26
Date of Issue : 2020-11-27

Remark:

This report details the results of the testing carried out on one sample, the results contained in this report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

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Revision Record

Version	Date	Revisions	Revised By
1.0	2019-10-31	Original	--

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1 General Information

1.1 Testing Laboratory

Company Name	ICAS Testing Technology Service (Shanghai) Co., Ltd.
Address	No.1298 Pingan Rd, Minhang District, Shanghai, China
Telephone	0086 21-51682999
Fax	0086 21-54711112
Homepage	www.icasiso.com

1.2 Details of Application

Company Name	Leica Geosystems AG
Address	Heinrich-Wild-Strasse, CH-9435 Heerbrugg
Contact Person	Tero Huhtala
Telephone	+41 71 727 3422
Email	tero.huhtala@leica-geosystems.com

1.3 Details of EUT

Product Name	Rugged Windows Field Controller
Brand Name	Leica
Model No.	CS30 LTE
FCC ID	RFD-CS30
ISED Number	3177A-CS30
Mode of Operation	WLAN 802.11b/g/n(HT20/40)
Frequency Range	2400MHz ~ 2483.5MHz
Channel Separation	5 MHz
Modulation Type	DSSS, OFDM
Antenna Type	Internal Antenna
Antenna Gain	2.57 dBi
Extreme Temperature Range	-20°C ~ +60°C
Test Voltage	DC 11.1V
Hardware version	PCB V0.4
Software version	R.ED.00.02.03
Test SW Version	BL410_R
RF power setting in TEST SW	DRTU

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1.4 Test Methodology

47 CFR Part 15, Subpart C (10-1-16 Edition)	Miscellaneous Wireless Communications Services
KDB Publication 558074 D01 v05r02	15.247 Meas Guidance.
KDB Publication 662911 D01 v02r01	Emissions Testing of Transmitters with Multiple Outputs in the Same Band (e.g., MIMO, Smart Antenna, etc)
RSS-Gen (Issue 5, March 2019)	General Requirements for Compliance of Radio Apparatus
RSS-247 (Issue 2, February 2017)	Digital Transmission Systems (DTSSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices

Note(s):

All test items were verified and recorded according to the standards and without any addition/deviation/exclusion during the test.

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2 Test Condition

2.1 Test Facility

2.2 Environmental conditions

Temperature (°C)	18-25
Humidity (%RH)	40-65
Barometric Pressure (mbar)	960-1060

2.3 Equipment List

Name of Equipment	Manufacturer	Model	Serial No.	Cal. Due Date
Spectrum Analyzer	Keysight	N9020B	MY59260184	2021-08-18
Spectrum Analyzer	Rohde & Schwarz	FSV40N	101450	2021-06-08
EMI Test Receiver	Rohde & Schwarz	ESPI3	100173	2021-06-08
EMI Test Receiver	Rohde & Schwarz	ESR 7	101911	2021-06-08
V-network	SCHWARZBECK	NSLK 8127	8127-902	2021-02-20
Wideband Radio Communication Tester	Rohde & Schwarz	CMW 500	100687	2021-08-18
Broadband Antenna	SCHWARZBECK	VULB9163	9163-1037	2021-06-08
Horn Antenna-18G	SCHWARZBECK	BBHA9120D	9120D-1775	2021-06-08
Loop Antenna	SCHWARZBECK	FMZB 1513	N/A	2021-03-19
Horn Antenna-40G	YINGLIAN	LB-180400-KF	N/A	2021-07-26
EMC chamber 9*6*6 (L*W*H)	CHANGNING	966	N/A	2021-06-08
Shielded Enclosure 8*5*4 (L*W*H)	CHANGNING	854	N/A	2021-06-08
Test Software	BL	BL410_E	N/A	N/A

2.4 Measurement Uncertainty

Parameter	Frequency	Uncertainty
Antenna Port Conducted Emission	< 1GHz	± 1.5 dB
	> 1GHz	± 1.5 dB
Radiated Emission	30 MHz – 1 GHz	± 3 dB
	> 1GHz	± 3 dB

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3 Test Set-up and Operation Modes

3.1 Details of Test Mode

Using test software was control EUT work in continuous transmitter and receiver mode. Select test channel as below:

For 802.11b/g/n (HT20)

Channel	Frequency
The lowest channel(CH1)	2412MHz
The middle channel(CH6)	2437MHz
The Highest channel(CH11)	2462MHz

For 802.11n(HT40)

Channel	Frequency
The lowest channel(CH3)	2422MHz
The middle channel(CH6)	2437MHz
The Highest channel(CH9)	2452MHz

Through Pre-scan under all rate at lowest channel, the data rate as below table described is the worst case, so we choose these data rate for test.

Type	Data rate
802.11b	11Mbps
802.11g	54Mbps
802.11n(20M)	MCS4
802.11n(40M)	MCS4

The basic operation modes are:

- A. On
 - 1. WLAN mode
 - a. Transmitting
 - i. Low Channel
 - ii. Middle Channel
 - iii. High Channel
 - b. Receiving
- B. Standby
- C. Off

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3.2 Special Accessories and Auxiliary Equipment

Description	Manufacturer	Model No.	Serial No.
Laptop	Lenovo	TP00083A	N/A

3.3 Support Software

Description	Manufacturer	Software Name
Software	Intel	DRTU

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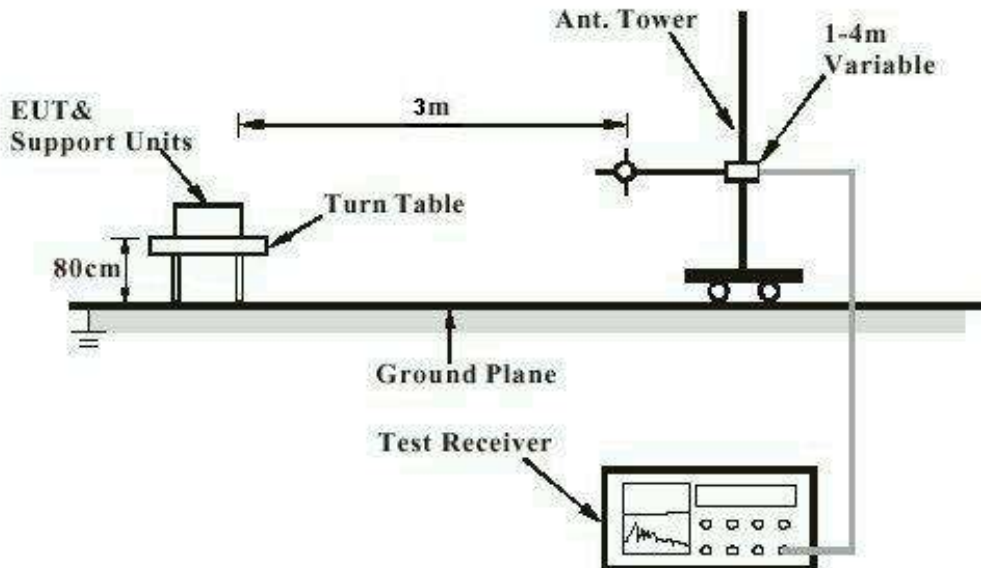
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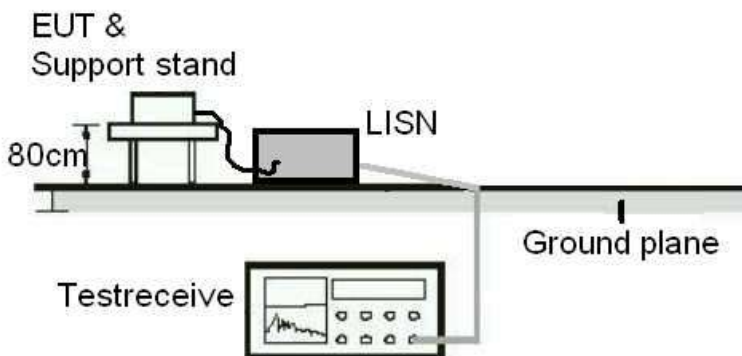
3.4 Test Setup Diagram

Diagram of Measurement Configuration for Radiation Test



Note: Measurements above 1GHz are done with a table height of 1.5m. In addition, there is RF absorbing material on the floor of the test site for above 1GHz measurement.

Diagram of Measurement Equipment Configuration for Conduction Measurement



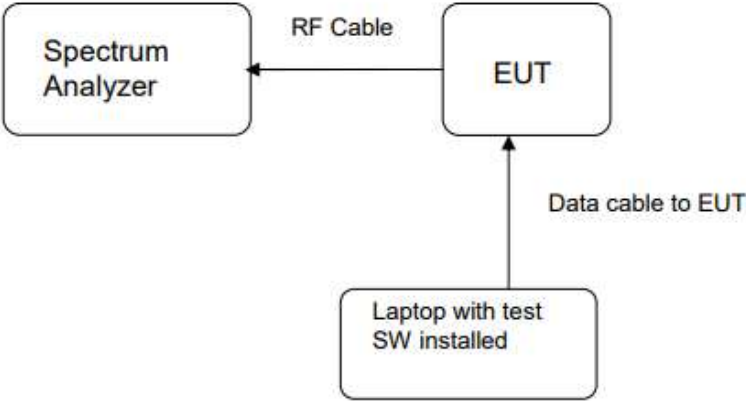
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Diagram of Measurement Equipment Configuration for Transmitter Measurement



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4 Test Results

4.1 Transmitter Requirement & Test Suites

4.1.1 Antenna Requirement

RESULT:

PASS

Test standard : FCC Part 15.247(b)(4), Part 15.203
RSS-247 5.4(6)

Requirement : The use of approved antennas only with directional gains that do not exceed 6dBi

According to the manufacturer declaration, the EUT has an antenna with a directional gain of 2.57dBi. The antenna is an internal antenna with no possibility of replacement with a non-approved antenna by the end-user.

Therefore, the EUT is considered to comply with this provision.

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4.1.2 Peak Output Power and E.I.R.P

RESULT:

PASS

Test standard : FCC Part 15.247(b)(3)
 RSS-247 5.4(4)
 Requirement : ANSI C63.10-2013, KDB 558074
 Kind of test site : Shielded room

Test setup

Test Channel : Low/Middle/High
 Operation Mode : A.1.a
 Ambient temperature : 23°C
 Relative humidity : 52%

Table 1: Peak Output Power

Test Mode	Test Channel (MHz)	Measured Peak Power		Limit (W)
		(dBm)	(mW)	
802.11b	2412	14.52	28.31	< 1
	2437	14.20	26.30	
	2462	14.51	28.25	
802.11g	2412	13.52	22.49	
	2437	14.12	25.82	
	2462	14.44	27.80	
802.11n(HT20)	2412	13.65	23.17	
	2437	13.74	23.66	
	2462	14.08	25.59	
802.11n(HT40)	2422	13.18	20.80	
	2437	13.51	22.44	
	2452	13.77	23.82	

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Table 2: E.I.R.P

Test Mode	Test Channel (MHz)	Measured Peak Power		Limit (W)
		(dBm)	(mW)	
802.11b	2412	17.09	51.17	< 4
	2437	16.77	47.53	
	2462	17.08	51.05	
802.11g	2412	16.09	40.64	
	2437	16.69	46.67	
	2462	17.01	50.23	
802.11n(HT20)	2412	16.22	41.88	
	2437	16.31	42.76	
	2462	16.65	46.24	
802.11n(HT40)	2422	15.75	37.58	
	2437	16.08	40.55	
	2452	16.34	43.05	

Duty cycle factor = $10 \cdot \log(1/\text{duty cycle})$

802.11b > 98%



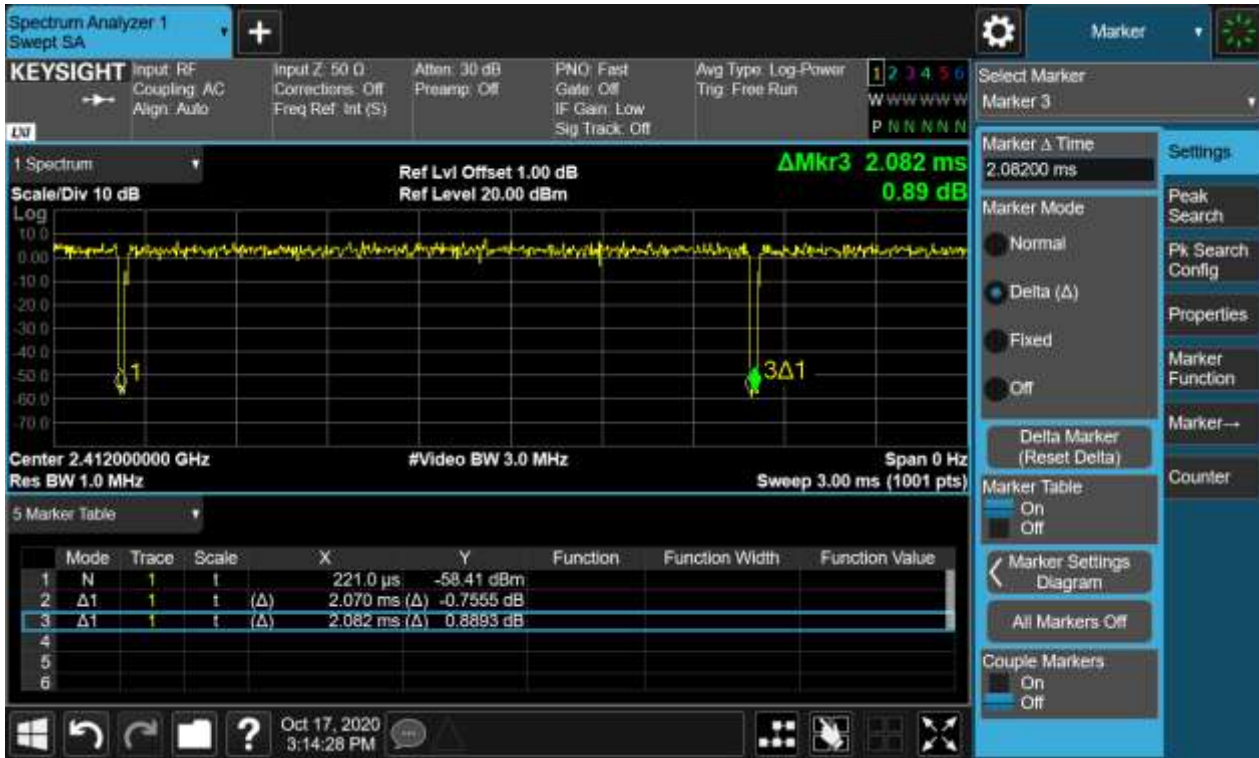
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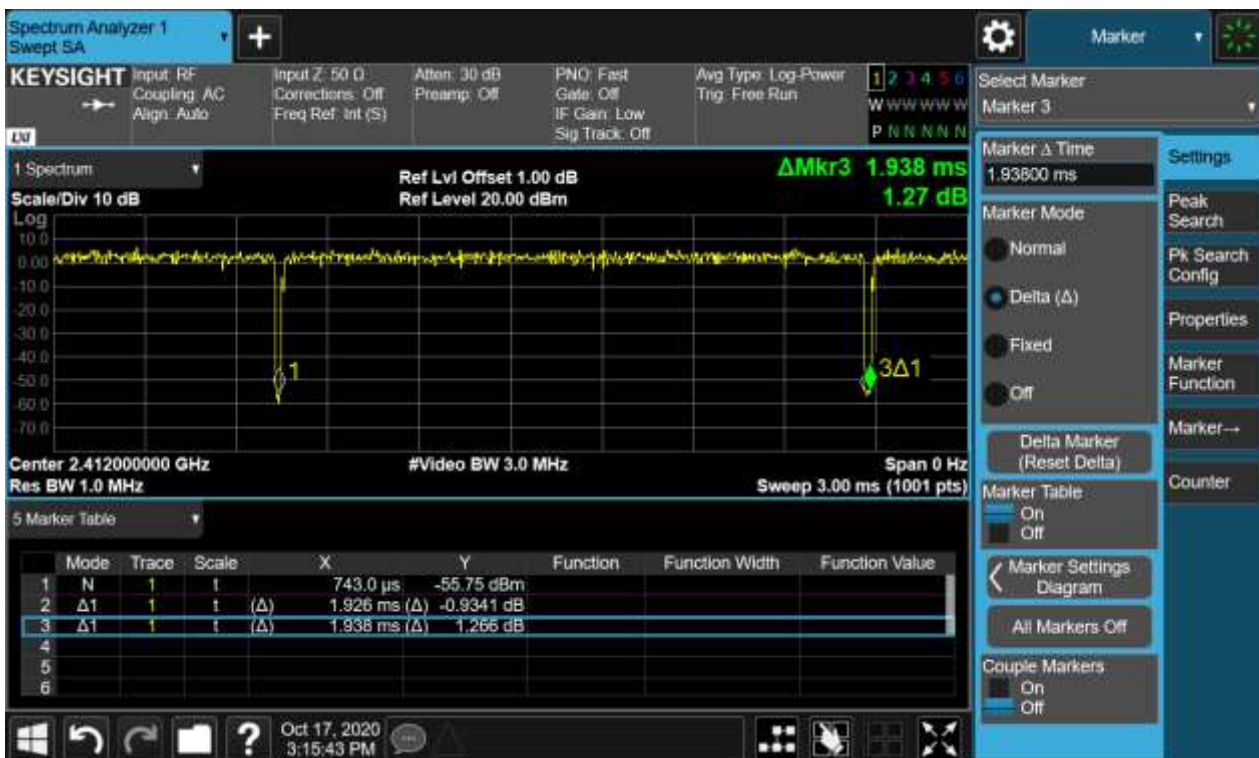
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802.11g >98%



802.11n20>98%



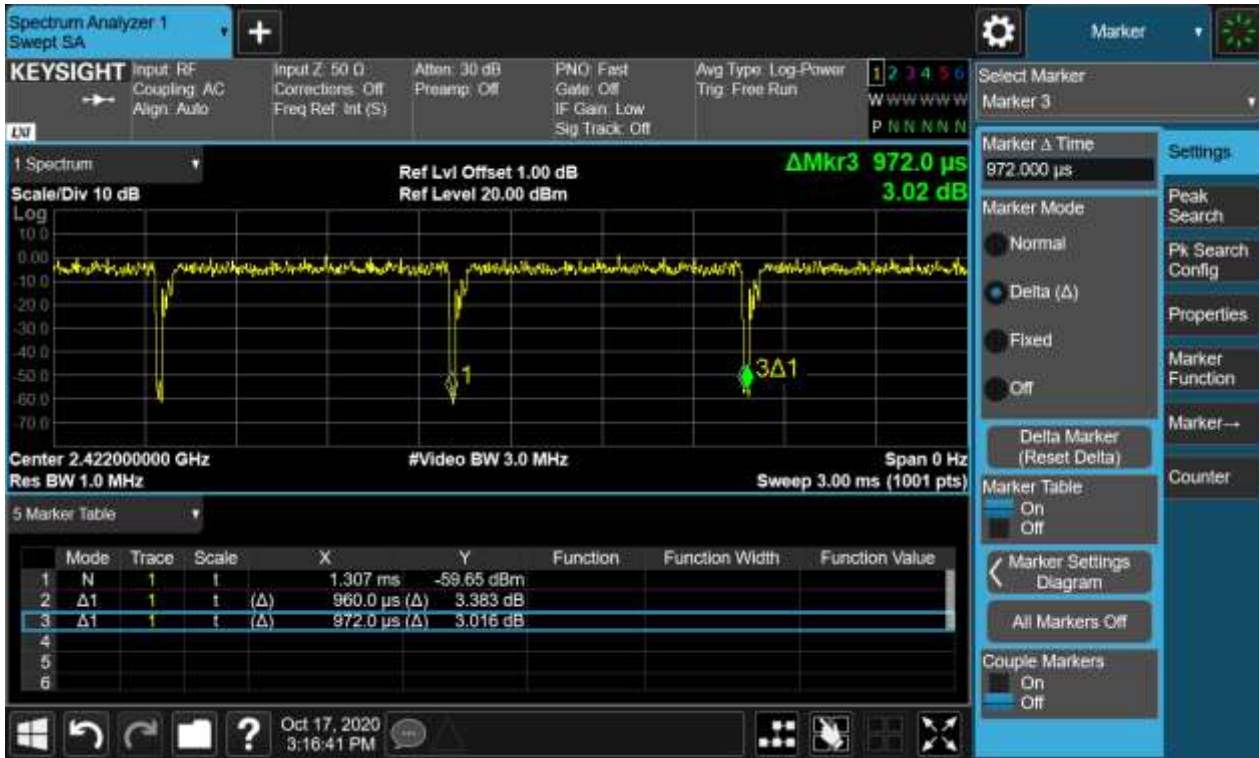
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802.11n40>98%



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4.1.3 6dB Bandwidth and 99% Bandwidth

RESULT:

PASS

Test standard : FCC Part 15.247(a)(2)
 RSS-247 5.2(1)
 RSS-Gen 6.6

Requirement : ANSI C63.10-2013, KDB 558074

Kind of test site : Shielded room

Test setup

Test Channel : Low/Middle/High

Operation Mode : A.1.a

Ambient temperature : 23°C

Relative humidity : 52%

Table 3: 6dB Bandwidth and 99% Bandwidth

Test Mode	Test Channel (MHz)	6dB Bandwidth (MHz)	99% Bandwidth (MHz)	6 dB Bandwidth Limit (MHz)
802.11b	2412	9.061	12.705	0.5
	2437	9.212	12.729	
	2462	9.612	12.848	
802.11g	2412	15.169	16.695	
	2437	16.770	16.625	
	2462	15.169	16.793	
802.11n(HT20)	2412	15.219	17.823	
	2437	15.419	17.811	
	2462	15.119	17.896	
802.11n(HT40)	2422	35.172	36.107	
	2437	35.172	36.062	
	2452	35.172	36.148	

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Figure 1: 6dB Bandwidth and 99% Bandwidth, 802.11b, 2412MHz



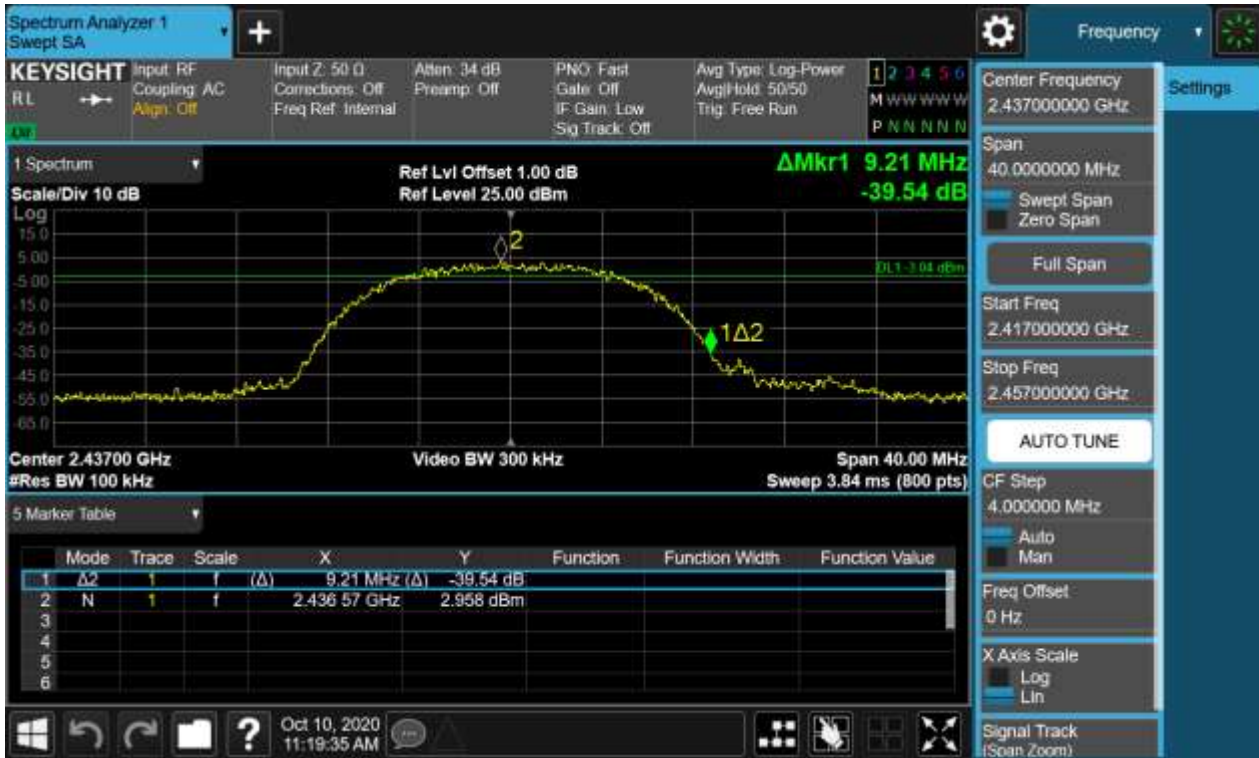
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Figure 2: 6dB Bandwidth and 99% Bandwidth, 802.11b, 2437MHz



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Figure 3: 6dB Bandwidth and 99% Bandwidth, 802.11b, 2462MHz



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Figure 4: 6dB Bandwidth and 99% Bandwidth, 802.11g, 2412MHz



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Figure 5: 6dB Bandwidth and 99% Bandwidth, 802.11g, 2437MHz



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Figure 6: 6dB Bandwidth and 99% Bandwidth, 802.11g, 2462MHz



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Figure 7: 6dB Bandwidth and 99% Bandwidth, 802.11n(HT20), 2412MHz



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Figure 8: 6dB Bandwidth and 99% Bandwidth, 802.11n(HT20), 2437MHz



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Figure 9: 6dB Bandwidth and 99% Bandwidth, 802.11n(HT20), 2462MHz



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Figure 10: 6dB Bandwidth and 99% Bandwidth, 802.11n(HT40), 2422MHz



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Figure 11: 6dB Bandwidth and 99% Bandwidth, 802.11n(HT40), 2437MHz



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Figure 12: 6dB Bandwidth and 99% Bandwidth, 802.11n(HT40), 2452MHz



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4.1.4 Power Spectral Density

RESULT:

PASS

Test standard : FCC Part 15.247(e)
RSS-247 5.2(2)
Requirement : ANSI C63.10-2013, KDB 558074
Kind of test site : Shielded room

Test setup

Test Channel : Low/Middle/High
Operation Mode : A.1.a
Ambient temperature : 23°C
Relative humidity : 52%

Table 4: Power Spectral Density

Test Mode	Test Channel (MHz)	Measured Result (dBm/3kHz)	Limit (dBm/3kHz)
802.11b	2412	-11.23	8
	2437	-11.77	
	2462	-10.65	
802.11g	2412	-11.98	
	2437	-12.10	
	2462	-10.84	
802.11n(HT20)	2412	-12.76	
	2437	-12.69	
	2462	-12.02	
802.11n(HT40)	2422	-15.07	
	2437	-14.44	
	2452	-14.73	

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Figure 13: Power Spectral Density, 802.11b, 2412MHz



Figure 14: Power Spectral Density, 802.11b, 2437MHz



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Figure 15: Power Spectral Density, 802.11b, 2462MHz



Figure 16: Power Spectral Density, 802.11g, 2412MHz



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Figure 17: Power Spectral Density, 802.11g, 2437MHz



Figure 18: Power Spectral Density, 802.11g, 2462MHz



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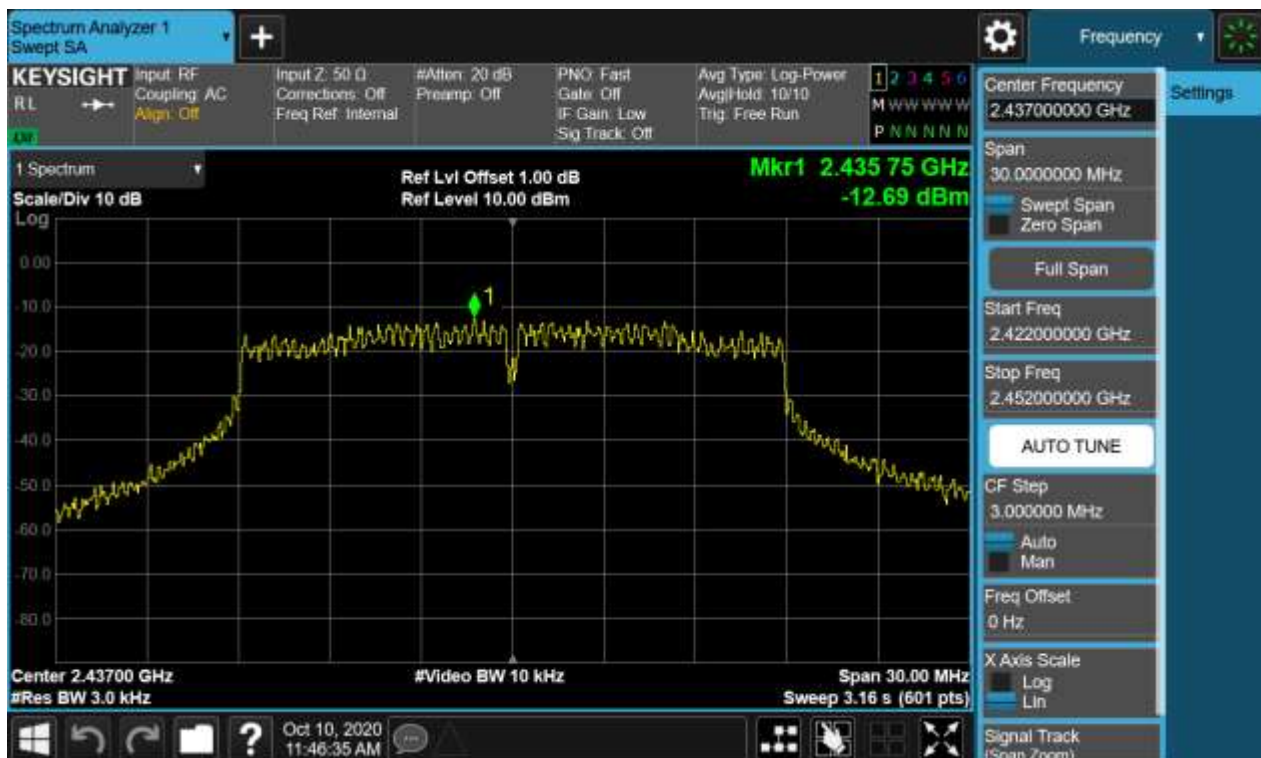
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Figure 19: Power Spectral Density, 802.11n(HT20), 2412MHz



Figure 20: Power Spectral Density, 802.11n(HT20), 2437MHz



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Figure 21: Power Spectral Density, 802.11n(HT20), 2462MHz



Figure 22: Power Spectral Density, 802.11n(HT40), 2422MHz



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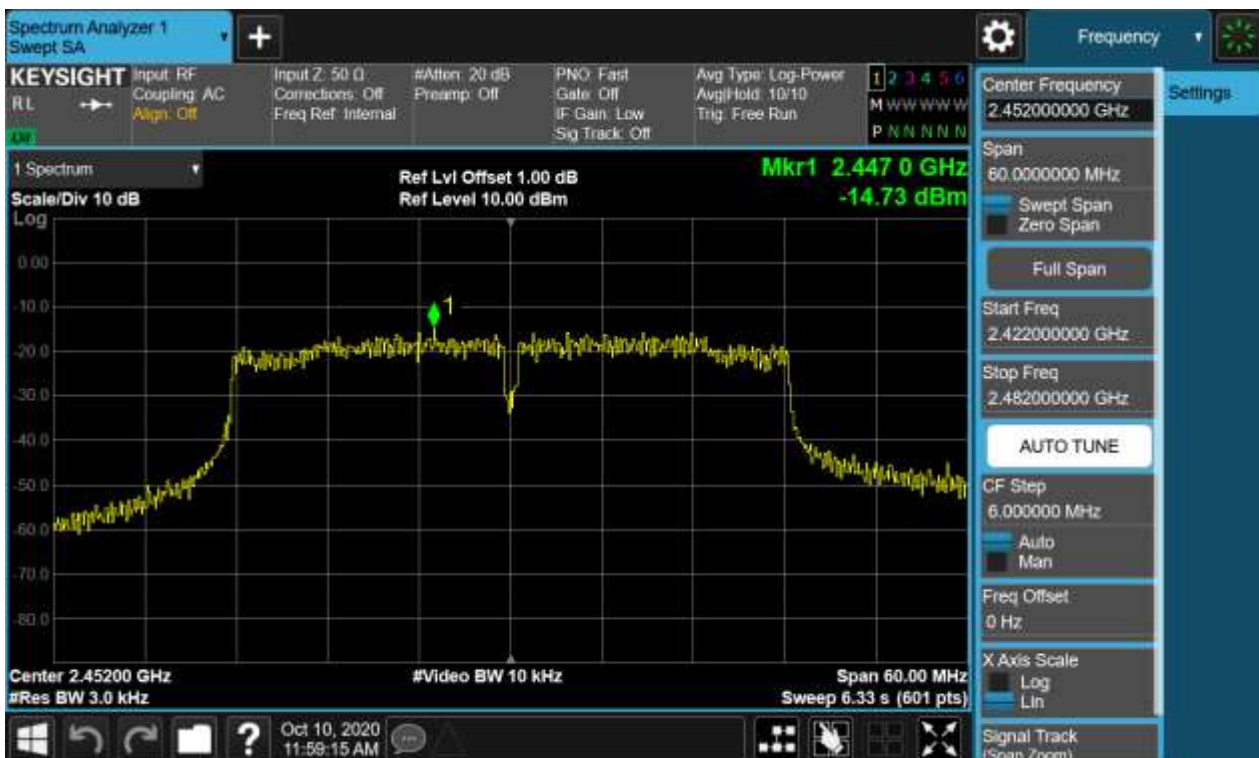
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Figure 23: Power Spectral Density, 802.11n(HT40), 2437MHz



Figure 24: Power Spectral Density, 802.11n(HT40), 2452MHz



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4.1.5 Conducted Spurious Emission & Authorized-band band-edge

RESULT:

PASS

Test standard : FCC Part 15.247(d), 15.209
RSS-247 5.5
RSS-Gen 8.9
Requirement : ANSI C63.10-2013, KDB 558074
Kind of test site : Shielded room

Test setup

Test Channel : Low/Middle/High for spurious, Low/High for Band
Edge
Operation Mode : A.1.a
Ambient temperature : 23°C
Relative humidity : 52%

For details refer to following test plot.

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Figure 25: Conducted Spurious Emission & Authorized-band band-edge, 802.11b, 2412MHz Carrier Level



Band Edge



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Conducted spurious emissions 30MHz-25GHz



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Figure 26: Conducted Spurious Emission & Authorized-band band-edge, 802.11b, 2437MHz Carrier Level



Conducted spurious emissions 30MHz-25GHz



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Figure 27: Conducted Spurious Emission & Authorized-band band-edge, 802.11b, 2462MHz Carrier Level



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Band Edge



Conducted spurious emissions 30MHz-25GHz



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Figure 28: Conducted Spurious Emission & Authorized-band band-edge, 802.11g, 2412MHz Carrier Level



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Band Edge



Conducted spurious emissions 30MHz-25GHz



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Figure 29: Conducted Spurious Emission & Authorized-band band-edge, 802.11g, 2437MHz Carrier Level



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Conducted spurious emissions 30MHz-25GHz



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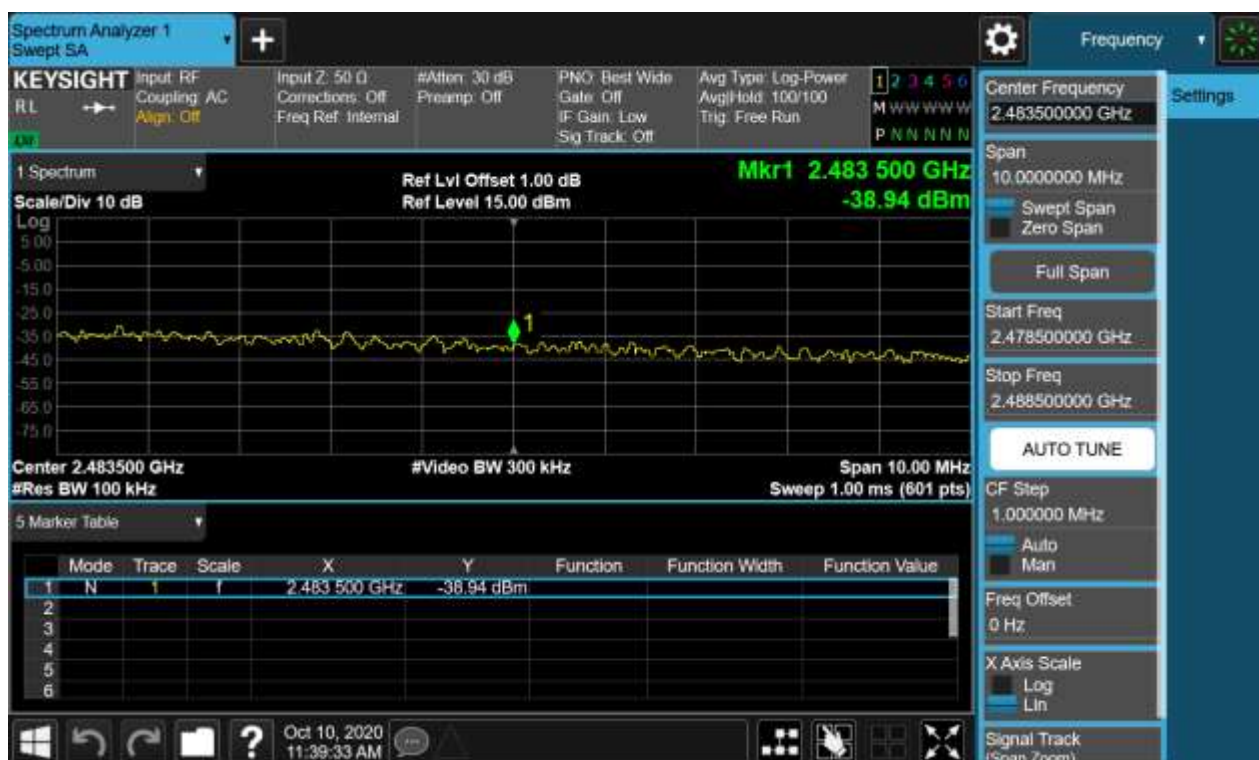
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Figure 30: Conducted Spurious Emission & Authorized-band band-edge, 802.11g, 2462MHz Carrier Level



Band Edge



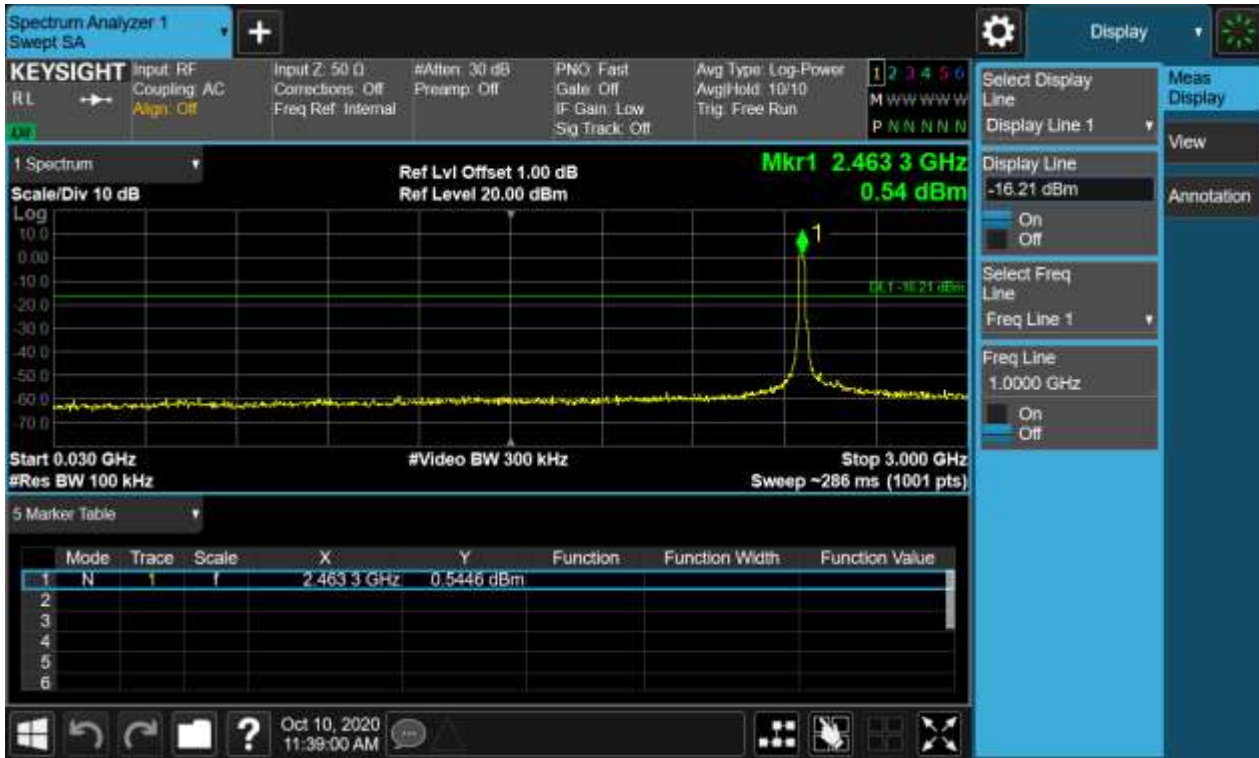
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Conducted spurious emissions 30MHz-25GHz



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Figure 31: Conducted Spurious Emission & Authorized-band band-edge, 802.11n(HT20), 2412MHz Carrier Level



Band Edge



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Conducted spurious emissions 30MHz-25GHz



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Figure 32: Conducted Spurious Emission & Authorized-band band-edge, 802.11n(HT20), 2437MHz Carrier Level



Conducted spurious emissions 30MHz-25GHz



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Figure 33: Conducted Spurious Emission & Authorized-band band-edge, 802.11n(HT20), 2462MHz Carrier Level



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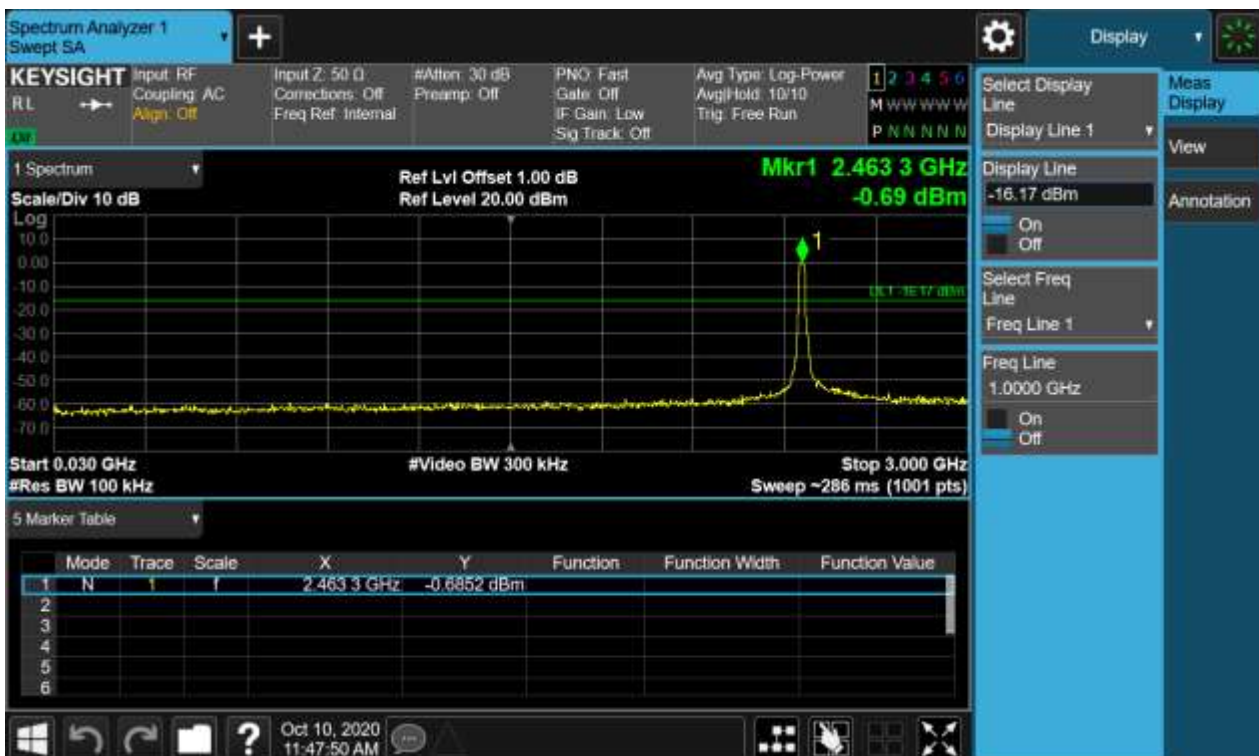
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Band Edge



Conducted spurious emissions 30MHz-25GHz



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Figure 34: Conducted Spurious Emission & Authorized-band band-edge, 802.11n(HT40), 2422MHz Carrier Level



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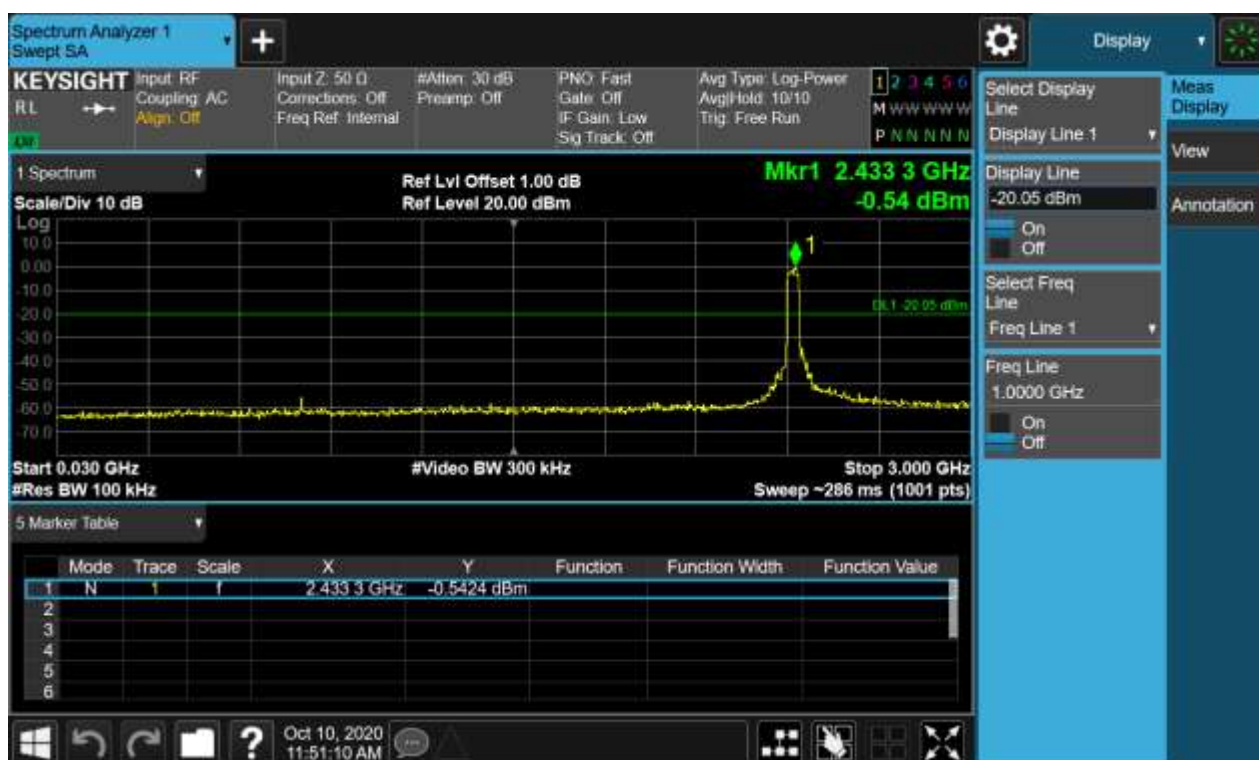
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Band Edge



Conducted spurious emissions 30MHz-25GHz



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Figure 35: Conducted Spurious Emission & Authorized-band band-edge, 802.11n(HT40), 2437MHz Carrier Level



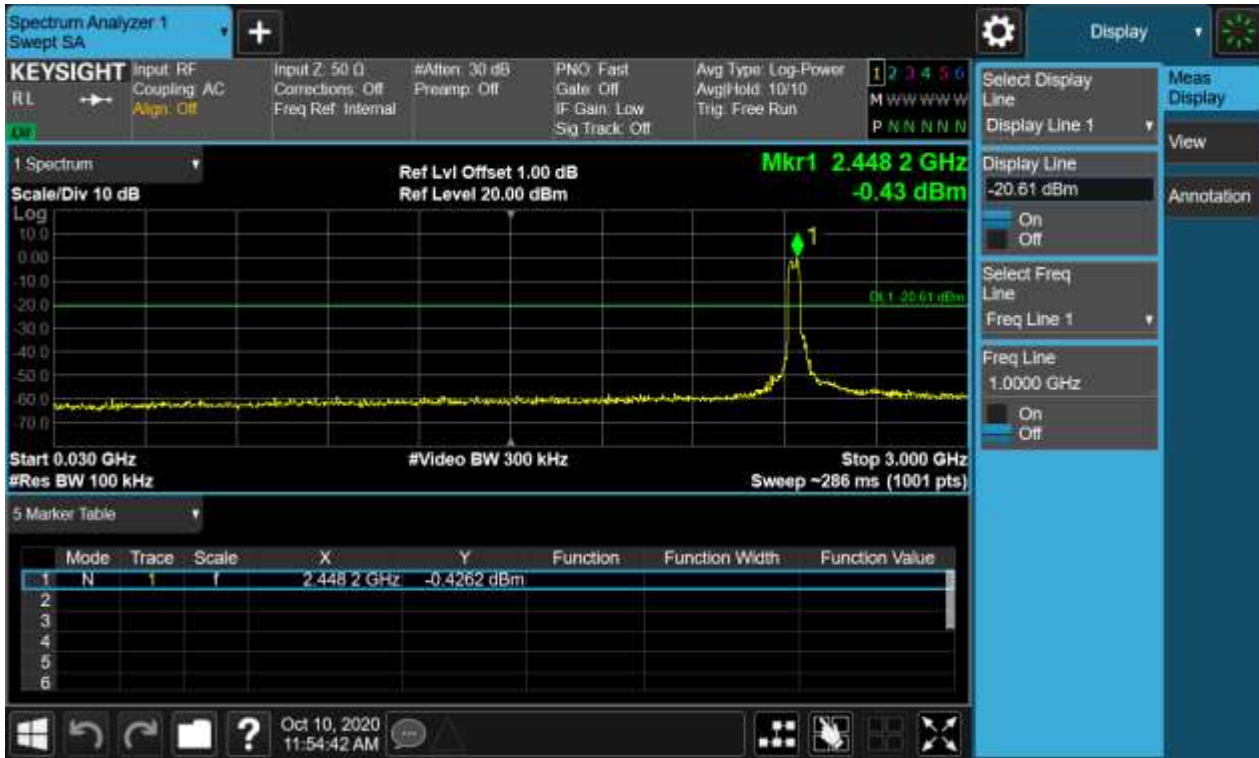
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Conducted spurious emissions 30MHz-25GHz



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Figure 36: Conducted Spurious Emission & Authorized-band band-edge, 802.11n(HT40), 2452MHz Carrier Level



Band Edge



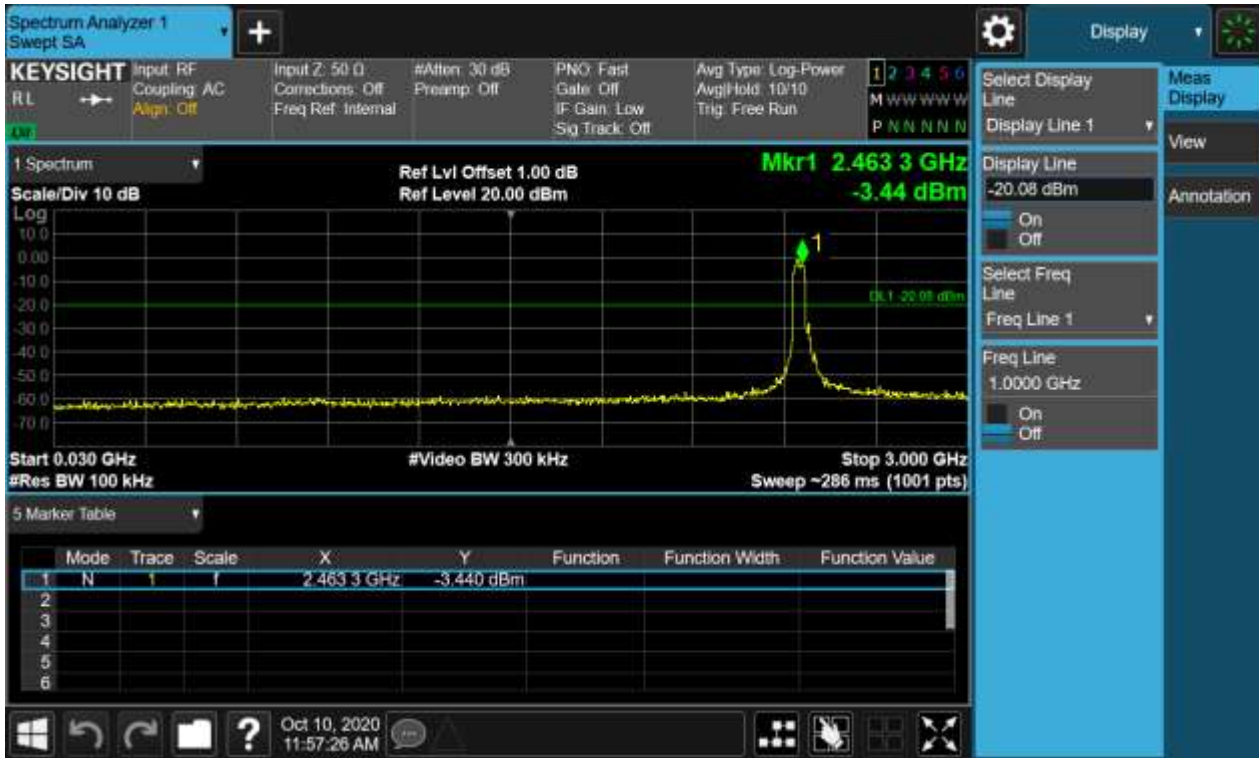
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Conducted spurious emissions 30MHz-25GHz



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4.1.6 Spurious Emission

RESULT:

PASS

Test standard : FCC Part 15.247(d), 15.205, 15.209
RSS-247 5.5
Requirement : ANSI C63.10-2013, KDB 558074
Kind of test site : 3m Semi-Anechoic Chamber

Test setup

Test Channel : Low/Middle/High
Operation Mode : A
Ambient temperature : 23°C
Relative humidity : 52%

Notes

Test plots please refer to the annex document "WIFI 2.4GHz-TX EXHIBIT A of SHE20090001-02GE".

1. For 9 kHz ~ 30 MHz, the amplitude of spurious emissions that are attenuated by more than 20dB below the permissible. The value has no need to be reported.
2. The spurious above 18GHz is noise only and 20dB below the limit. The value has no need to be reported.
3. The EUT is working in the Normal link mode below 1 GHz.

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4.1.7 Band Edge (Restricted-band band-edge)

RESULT:

PASS

Test standard : FCC Part 15.247(d), 15.205, 15.209
RSS-247 5.5
Requirement : ANSI C63.10-2013, KDB 558074
Kind of test site : 3m Semi-Anechoic Chamber

Test setup

Test Channel : Low/Middle/High
Operation Mode : A.1
Ambient temperature : 23°C
Relative humidity : 52%

Notes:

Test plots please refer to the annex document "WIFI 2.4GHz-TX EXHIBIT A of SHE20090001-02GE".

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4.2 Mains Emissions

4.2.1 Conducted Emission on AC Mains

RESULT:

PASS

Test standard : FCC Part 15.207(a)
RSS-Gen 8.8
Requirement : ANSI C63.10-2013
Kind of test site : Shielded room

Test setup

Input Voltage : AC 120V, 60Hz; AC 240V, 50Hz
Operation Mode : A
Earthing : Not Connected
Ambient temperature : 23°C
Relative humidity : 52%

For details refer to following test plot.

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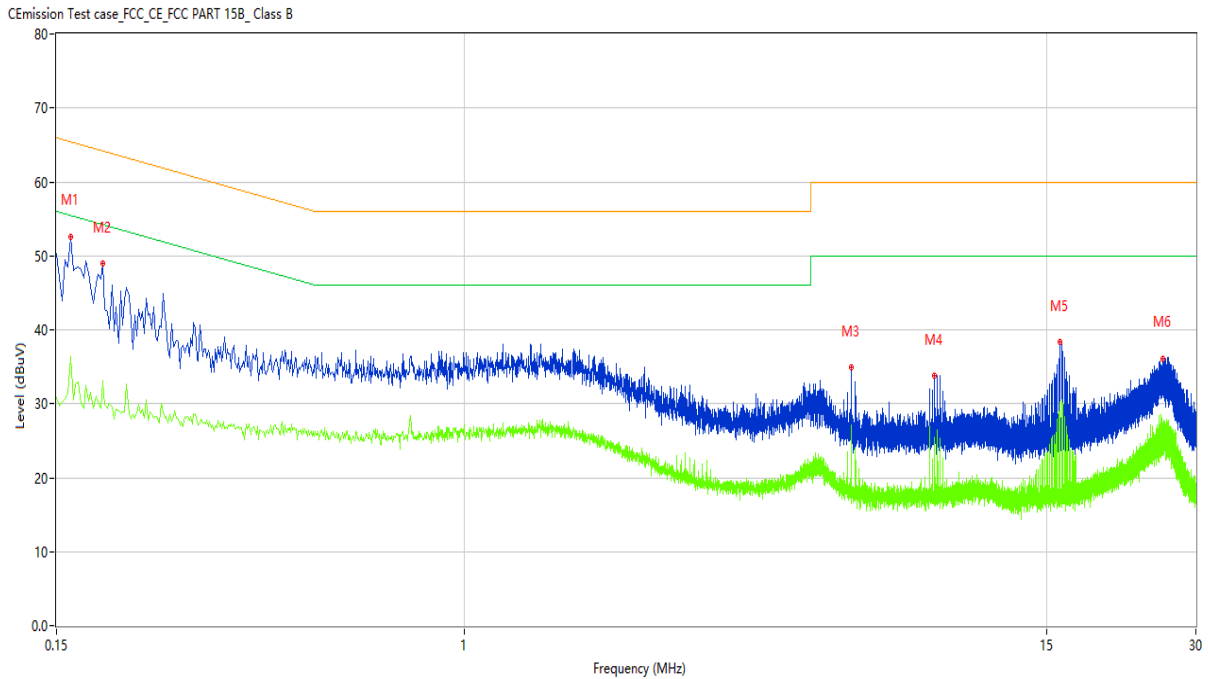
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Note:

The all configurations were tested respectively, but only the worst configuration shown here.

Figure 37: Conducted Emission on AC Mains, L Phase



No.	Frequency (MHz)	Results (dBUV)	Factor (dB)	Limit (dBUV)	Over Limit (dB)	Detector	Line	Verdict
1	0.154	53.90	10.15	65.78	-11.88	Peak	L	Pass
1*	0.154	45.74	10.15	65.78	-20.04	QP	L	Pass
1**	0.154	30.15	10.15	55.78	-25.63	AV	L	Pass
2	0.186	50.03	10.15	64.21	-14.18	Peak	L	Pass
2*	0.186	42.00	10.15	64.21	-22.21	QP	L	Pass
2**	0.186	33.20	10.15	54.21	-21.01	AV	L	Pass
3	6.050	24.32	10.28	60.00	-35.68	Peak	L	Pass
3*	6.050	17.80	10.28	60.00	-42.20	QP	L	Pass
3**	6.050	26.98	10.28	50.00	-23.02	AV	L	Pass
4	8.910	23.31	10.35	60.00	-36.69	Peak	L	Pass
4*	8.910	16.62	10.35	60.00	-43.38	QP	L	Pass
4**	8.910	25.30	10.35	50.00	-24.70	AV	L	Pass
5	15.964	24.60	10.44	60.00	-35.40	Peak	L	Pass
5*	15.964	17.24	10.44	60.00	-42.76	QP	L	Pass
5**	15.964	30.27	10.44	50.00	-19.73	AV	L	Pass
6	25.714	36.47	10.52	60.00	-23.53	Peak	L	Pass
6*	25.714	30.81	10.52	60.00	-29.19	QP	L	Pass
6**	25.714	27.50	10.52	50.00	-22.50	AV	L	Pass

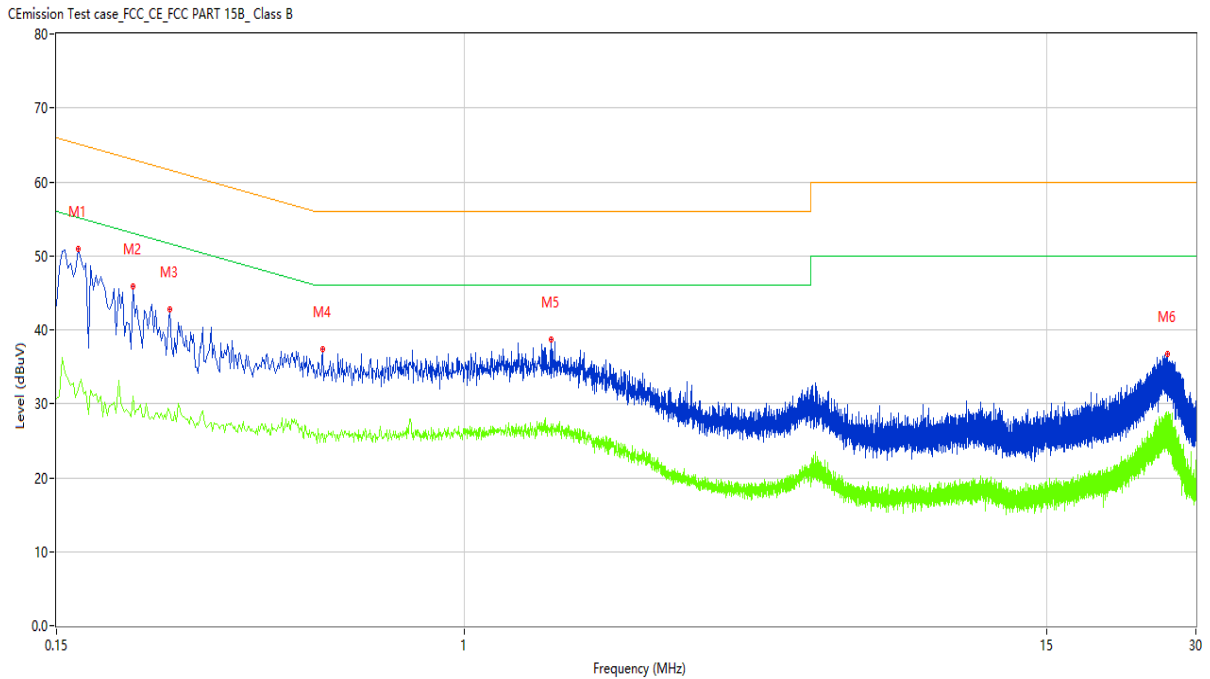
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Figure 38: Conducted Emission on AC Mains, N Phase



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Over Limit (dB)	Detector	Line	Verdict
1	0.166	52.01	10.15	65.16	-13.15	Peak	N	Pass
1*	0.166	46.30	10.15	65.16	-18.86	QP	N	Pass
1**	0.166	32.00	10.15	55.16	-23.16	AV	N	Pass
2	0.214	46.26	10.15	63.05	-16.79	Peak	N	Pass
2*	0.214	38.98	10.15	63.05	-24.07	QP	N	Pass
2**	0.214	31.06	10.15	53.05	-21.99	AV	N	Pass
3	0.254	43.03	10.14	61.63	-18.60	Peak	N	Pass
3*	0.254	34.84	10.14	61.63	-26.79	QP	N	Pass
3**	0.254	28.93	10.14	51.63	-22.70	AV	N	Pass
4	0.518	32.48	10.15	56.00	-23.52	Peak	N	Pass
4*	0.518	22.97	10.15	56.00	-33.03	QP	N	Pass
4**	0.518	25.97	10.15	46.00	-20.03	AV	N	Pass
5	1.498	33.96	10.16	56.00	-22.04	Peak	N	Pass
5*	1.498	23.82	10.16	56.00	-32.18	QP	N	Pass
5**	1.498	27.33	10.16	46.00	-18.67	AV	N	Pass
6	26.352	36.87	10.52	60.00	-23.13	Peak	N	Pass
6*	26.352	31.53	10.52	60.00	-28.47	QP	N	Pass
6**	26.352	28.39	10.52	50.00	-21.61	AV	N	Pass

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5 Appendixes

5.1 Photographs of the Sample



Front of the sample



Rear of the sample

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5.2 Set-up for Conducted Emissions



5.3 Set-up for Conducted RF test at Antenna Port



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5.4 Set-up for Spurious Emissions below 1GHz



Below 1 GHz

5.5 Set-up for Spurious Emissions above 1GHz



Above 1GHz

End of the report