

FCC PART 15.247

TEST REPORT

For

Xiamen Milesight IoT Co., Ltd.

4/F,NO. 63-2 Wanghai Road, 2nd Software Park,Xiamen, China

FCC ID: 2AYHY-UG65

Report Type: Original Report	Product Type: LoRaWAN Gateway
Report Number: RXM200911054-00C	
Report Date: 2021-02-03	
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	LoRaWAN Gateway
Tested Model	UG65-L00AF-915M-EA
Multiple Model	UG65-L00AF-915M,UG65-915M-EA,UG65-915M, UG65-L04AF-915M-EA,UG65-L04AF-915M
Model Differences	Refer to the DoS letter
Frequency Range	Wi-Fi: 2412-2462MHz/2422-2452MHz LoRa: 923.3-927.5MHz
Maximum Conducted Peak Output Power	Wi-Fi: 17.80dBm(802.11b), 16.69dBm(802.11g), 16.81dBm(802.11n-HT20), 16.90dBm(802.11n-HT40) LoRa: 11.47dBm
Modulation Technique	Wi-Fi: DSSS, OFDM LoRa: FSK
Antenna Specification*	Wi-Fi antenna: 1.5dBi, Lora External antenna: 1.5dBi, Lora Internal antenna: 0dBi (It is provided by the applicant)
Voltage Range	DC 12V from adapter or DC 48V from POE
Date of Test	2020-10-10 to 2021-02-03
Sample serial number	RXM200911054-RF-S1 (Assigned by BACL, Shenzhen)
Received date	2020-09-11
Sample/EUT Status	Good condition
Adapter information	Model: OH-1015A1201000U3-UL Input: AC 100-240V, 50/60Hz, 350mA Output: DC 12V, 1000mA

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission's rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

And KDB 558074 D01 15.247 Meas Guidance v05r02.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Shenzhen). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		±5%
RF Output Power with Power meter		±0.73dB
RF conducted test with spectrum		±1.6dB
AC Power Lines Conducted Emissions		±1.95dB
Emissions, Radiated	Below 1GHz	±4.75dB
	Above 1GHz	±4.88dB
Temperature		±1 °C
Humidity		±6%
Supply voltages		±0.4%

Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Test Facility

The test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 342867, the FCC Designation No.: CN1221.

The test site has been registered with ISED Canada under ISED Canada Registration Number 3062B.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

For LoRa mode, 8 channels are provided to testing:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	923.3	5	925.7
2	923.9	6	926.3
3	924.5	7	926.9
4	925.1	8	927.5

EUT was tested with Channel 1 and 8.

For 802.11b, 802.11g and 802.11n-HT20 mode, 11 channels are provided to testing:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2412	8	2447
2	2417	9	2452
3	2422	10	2457
4	2427	11	2462
5	2432	/	/
6	2437	/	/
7	2442	/	/

For 802.11b, 802.11g, 802.11n-HT20 mode, EUT was tested with Channel 1, 6 and 11.

For 802.11n-HT40, EUT was tested with Channel 3, 6 and 9.

Equipment Modifications

No modification was made to the EUT tested.

EUT Exercise Software

“PUTTY”* exercise software was used for 2.4G Wi-Fi and “Putty”* exercise software was used for LoRa.

The device was tested with the worst case was performed as below:

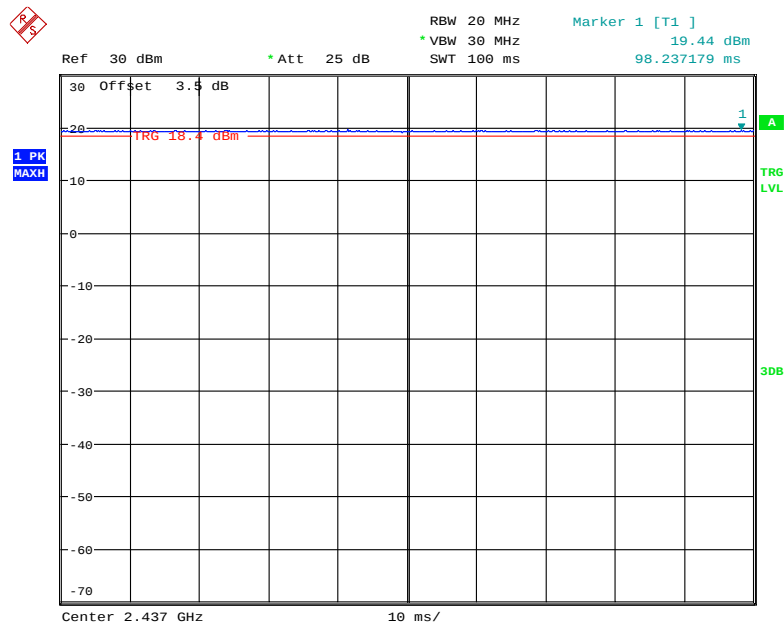
Mode	Data rate	Power level*		
		Low channel	Middle channel	High channel
802.11b	2 Mbps	30	30	30
802.11g	12 Mbps	30	30	30
802.11n-HT20	128 Mbps	30	30	30
802.11n-HT40	128 Mbps	30	30	30
LoRa	Default	11	11	11

The worse-case data rates are determined to be as follows for each mode based upon investigations by measuring the average power and PSD across all data rated bandwidths, and modulations.

The software and power level was provided by the applicant.

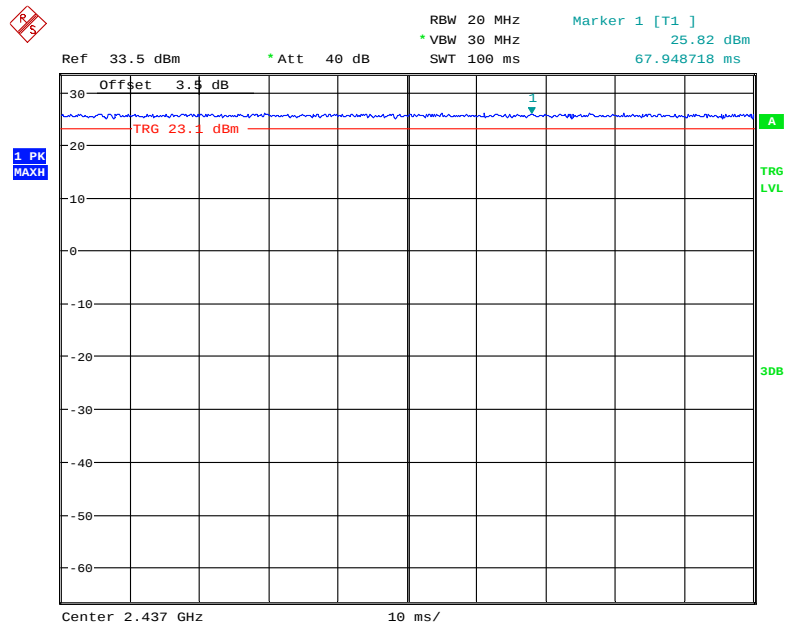
Duty cycle

802.11b mode



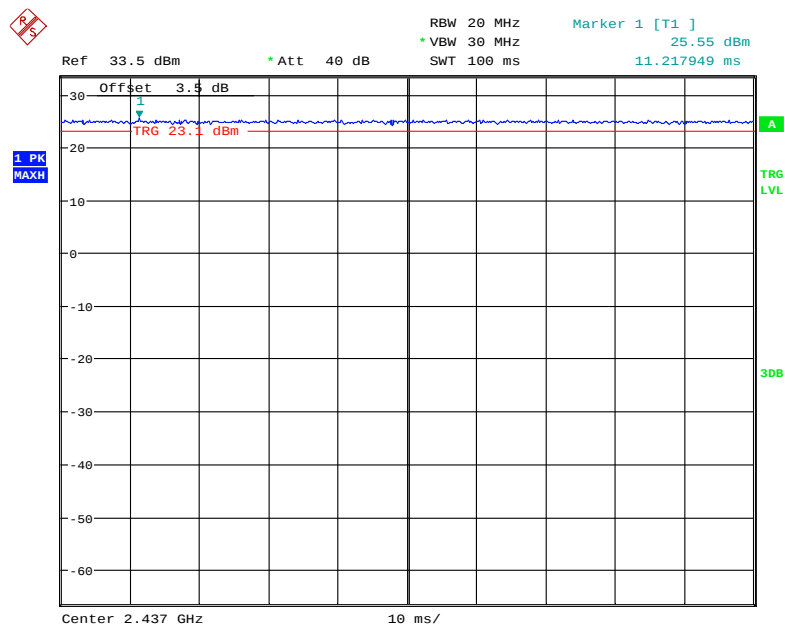
Date: 13.OCT.2020 15:04:37

802.11g mode



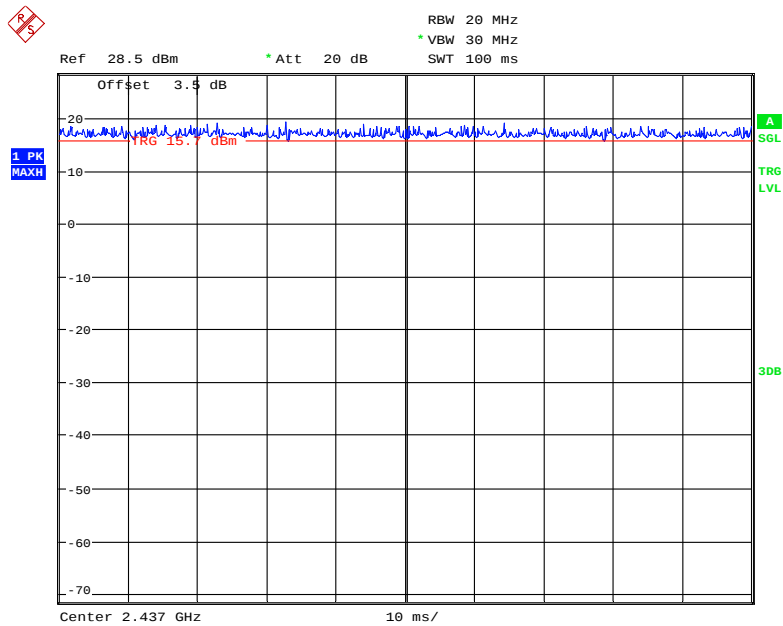
Date: 13.OCT.2020 15:06:10

802.11n-HT20 Mode



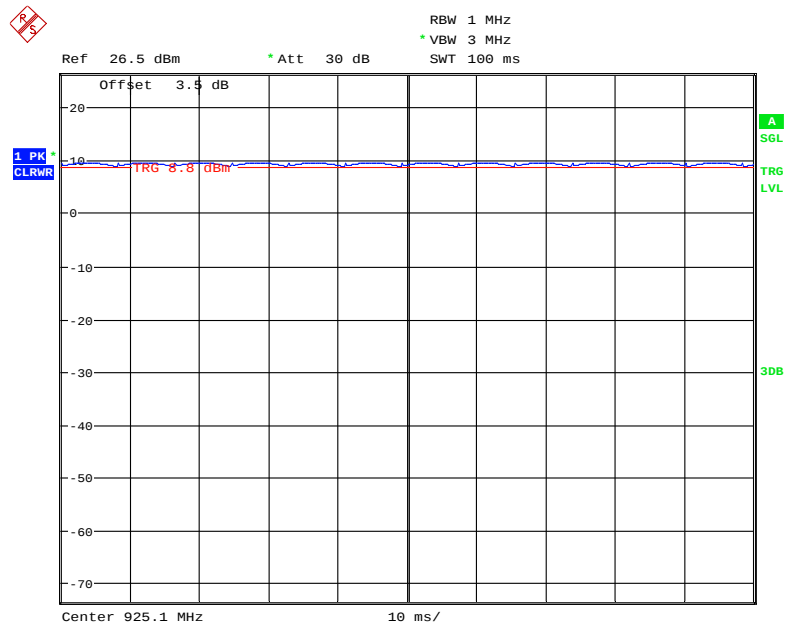
Date: 13.OCT.2020 15:06:46

802.11n-HT40 Mode



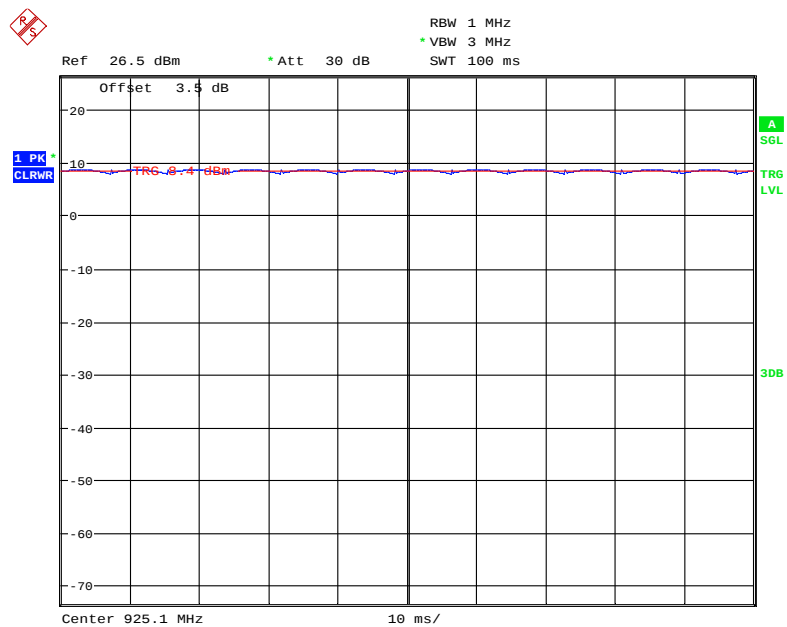
Date: 29.JAN.2021 16:28:06

LoRa Mode-Internal Tx



Date: 3.FEB.2021 19:12:15

LoRa Mode-External Tx



Date: 3.FEB.2021 19:12:53

Mode	T _{on} (ms)	T _{on+off} (ms)	Duty Cycle (%)
802.11b	-	-	100
802.11g	-	-	100
802.11n-HT20	-	-	100
802.11n-HT40	-	-	100
LoRa-1TX0RX	-	-	100
LoRa-0TX1RX	-	-	100

Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
SHENZHEN GOSPELL DIGITAL TECHNOLOGY CO.,LTD.	POE	G0720-480-050	G0720-480-050
DELL	Laptop	Latitude E5430	11429208685

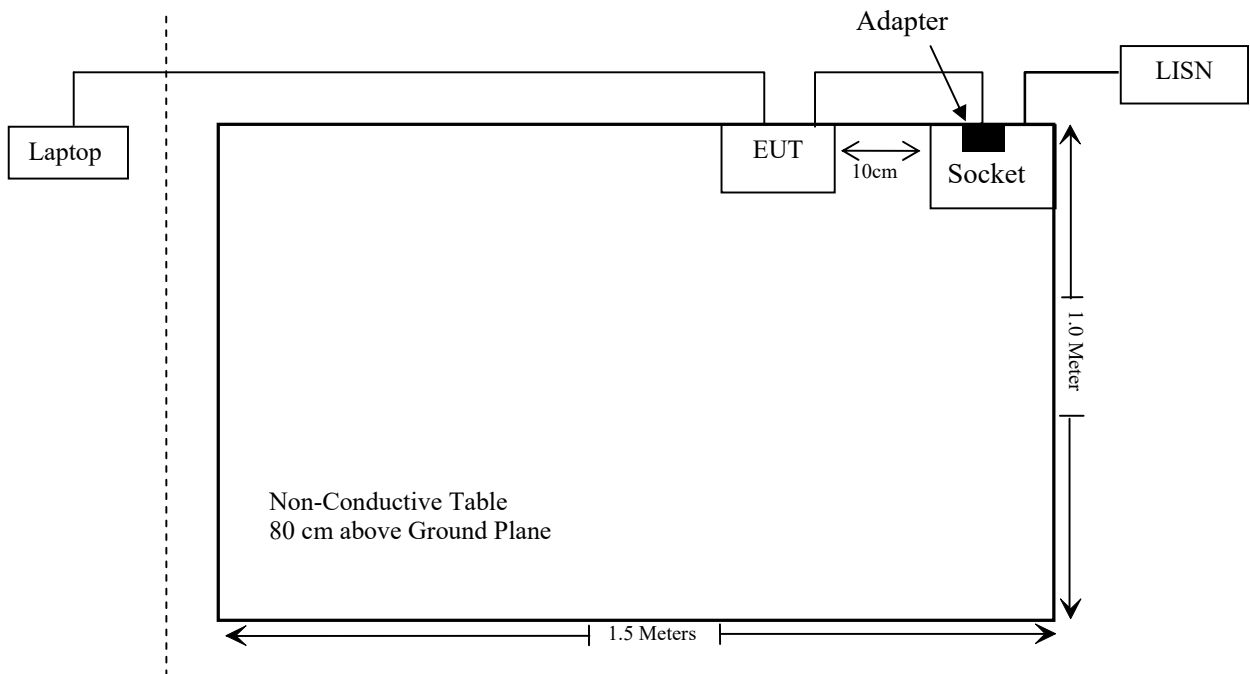
External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielding Un-Detachable AC Cable	1.0	Socket	LISN
Un-shielding Detachable AC Cable	1.2	POE	LISN
Un-shielding Un-Detachable DC Cable	2.5	Adapter	EUT
Un-Shielding Detachable RJ45 Cable	8.0	EUT/ POE	Laptop
Un-Shielding Detachable RJ45 Cable	1.0	EUT	POE

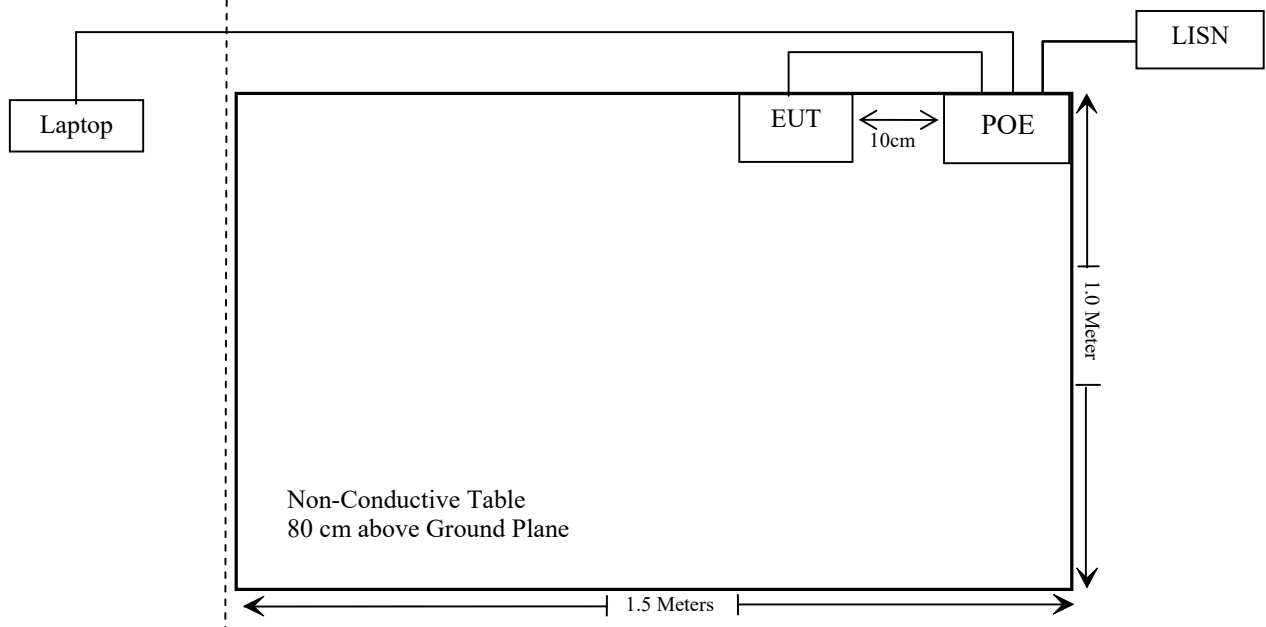
Block Diagram of Test Setup

For conducted emission:

Powered by adapter



Powered by POE



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i), §2.1091	Maximum Permissible Exposure(MPE)	Compliance
§15.203	Antenna Requirement	Compliance
§15.207 (a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliance
§15.247 (a)(2)	6 dB Emission Bandwidth	Compliance
§15.247(b)(3)	Maximum Conducted Output Power	Compliance
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliance
§15.247(e)	Power Spectral Density	Compliance

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emissions Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	101120	2020/08/04	2021/08/03
Rohde & Schwarz	LISN	ENV216	101613	2020/08/04	2021/08/03
Rohde & Schwarz	Transient Limitor	ESH3Z2	DE25985	2019/11/29	2020/11/28
Unknown	CE Cable	CE Cable	UF A210B-1-0720-504504	2019/11/29	2020/11/28
Rohde & Schwarz	CE Test software	EMC 32	V8.53.0	NCR	NCR
Radiated Emission Test					
R&S	EMI Test Receiver	ESR3	102455	2020/08/04	2021/08/03
Sonoma instrument	Pre-amplifier	310 N	186238	2020/08/04	2021/08/03
Sunol Sciences	Broadband Antenna	JB1	A040904-1	2017/12/22	2020/12/21
Unknown	Cable 2	RF Cable 2	F-03-EM197	2019/11/29	2020/11/28
Unknown	Cable	Chamber Cable 1	F-03-EM236	2019/11/29	2020/11/28
Rohde & Schwarz	Auto test software	EMC 32	V9.10	NCR	NCR
Rohde & Schwarz	Spectrum Analyzer	FSV40-N	102259	2020/08/04	2021/08/03
COM-POWER	Pre-amplifier	PA-122	181919	2019/11/29	2020/11/28
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2019/11/29	2020/11/28
Sunol Sciences	Horn Antenna	DRH-118	A052604	2017/12/22	2020/12/21
Unknown	RF Cable	W1101-EQ1 OUT	F-19-EM005	2019/11/29	2020/11/28
SNSD	Band Reject filter	BSF2402-2480MN-0898-001	2.4G filter	2020/04/20	2021/04/20
Ducommun Technologies	Horn antenna	ARH-4223-02	1007726-02 1304	2017/12/06	2020/12/05

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF Conducted Test					
Agilent	USB Wideband Power Sensor	U2021XA	MY54250003	2020/08/04	2021/08/03
Rohde & Schwarz	SPECTRUM ANALYZER	FSU26	200120	2020/04/03	2021/04/02
WEINSCHTEL	3dB Attenuator	Unknown	F-03-EM121	2019/11/29	2020/11/28
WEINSCHTEL	3dB Attenuator	Unknown	F-03-EM121	2020/11/29	2021/11/28
Unknown	RF Cable	Unknown	2301 276	2019/11/29	2020/11/28
Unknown	RF Cable	Unknown	2301 276	2020/11/29	2021/11/28

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC §15.247 (i) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247 (i) and subpart 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

Limits for General Population/Uncontrolled Exposure

Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (Minutes)
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

Result

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm²)

P = power input to the antenna (in appropriate units, e.g., mW).

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

Mode	Frequency (MHz)	Antenna Gain		Tune up conducted power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
		(dBi)	(numeric)	(dBm)	(mW)			
Wi-Fi	2412-2462	1.5	1.41	18.0	63.10	20	0.018	1.0
LoRa(External transmit antenna)	923.3-927.5	1.5	1.41	12.0	15.85	20	0.0044	0.6
LoRa(Internal transmit antenna)	923.3-927.5	0	1	12.0	15.85	20	0.0032	0.6
WCDMA B2	1850-1910	1.5	1.41	23	200	20	0.056	1.0
WCDMA B4	1710-1755	1.5	1.41	23	200	20	0.056	1.0
WCDMA B5	824-849	1.5	1.41	23	200	20	0.056	0.549
LTE B2	1850-1910	1.5	1.41	23.5	223.87	20	0.063	1.0
LTE B4	1710-1755	1.5	1.41	23.5	223.87	20	0.063	1.0
LTE B5	824-849	1.5	1.41	23.5	223.87	20	0.063	0.549
LTE B12	699-716	1.5	1.41	23.5	223.87	20	0.063	0.466
LTE B13	777-787	1.5	1.41	23.5	223.87	20	0.063	0.518
LTE B14	788-798	1.5	1.41	23.5	223.87	20	0.063	0.525
LTE B66	1710-1780	1.5	1.41	23.5	223.87	20	0.063	1.0
LTE B71	663-698	1.5	1.41	23.5	223.87	20	0.063	0.422

Note: 1. The tune up conducted power was declared by the applicant
 2. LoRa, Wi-Fi and LTE can transmit simultaneously for this device..

So the worst simultaneous transmitting consideration:

The ratio= $MPE_{LoRa}/limit + MPE_{Wi-Fi}/limit + MPE_{LTE}/limit$
 $=0.018/1.0+0.0044/0.6+0.063/0.422=0.175<1.0$

To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

Result: Compliance

FCC §15.203 - ANTENNA REQUIREMENT

Applicable Standard

According to § 15.203, 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 user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

- a. Antenna must be permanently attached to the unit.
- b. Antenna must use a unique type of connector to attach to the EUT.

Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Antenna Connector Construction

The EUT has one internal transmit antenna(antenna gain: 0dBi), one external antenna (antenna gain: 1.5dBi) and one internal receive antenna(antenna gain: 0dBi) for LoRa, and one internal antennas for Wi-Fi(antenna gain: 1.5dBi), which the internal antenna were permanently attached, fulfill the requirement of this section. Please refer to the EUT photos. And the external antenna has N-type antenna connector, the applicant declared that EUT is professionally installed, please refer to the declaration letter.

For Lora antennas, the model UG65-L00AF-915M-EA, UG65-L04AF-915M-EA, UG65-915M-EA has both the external antenna, internal transmit antenna and internal receiver antenna, the model UG65-L00AF-915M, UG65-L04AF-915M, UG65-915M only has internal transmit antenna and internal receiver antenna, the external antenna has been removed.

For the internal transmit and external antenna of Lora, only one of them will active to transmit according to the User's setting.

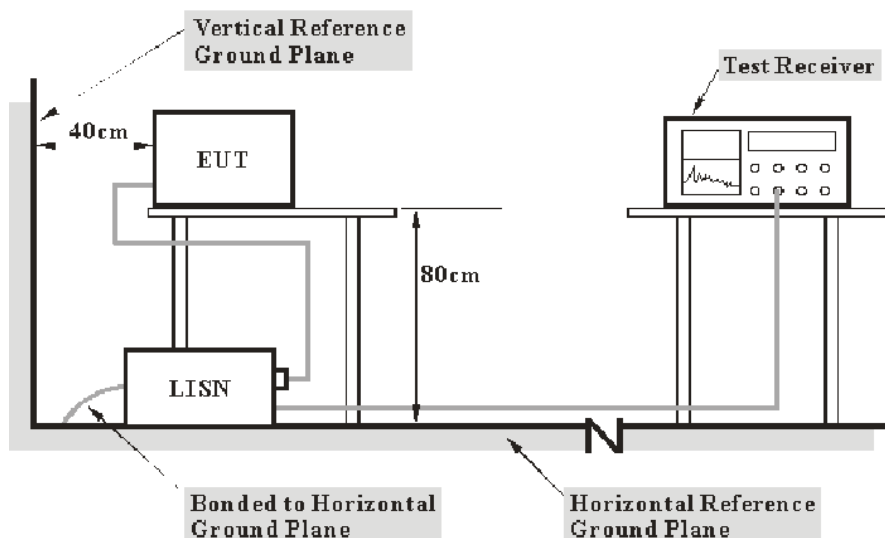
Result: Compliance.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC§15.207

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 limits.

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

$$\text{Correction Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

Test Data

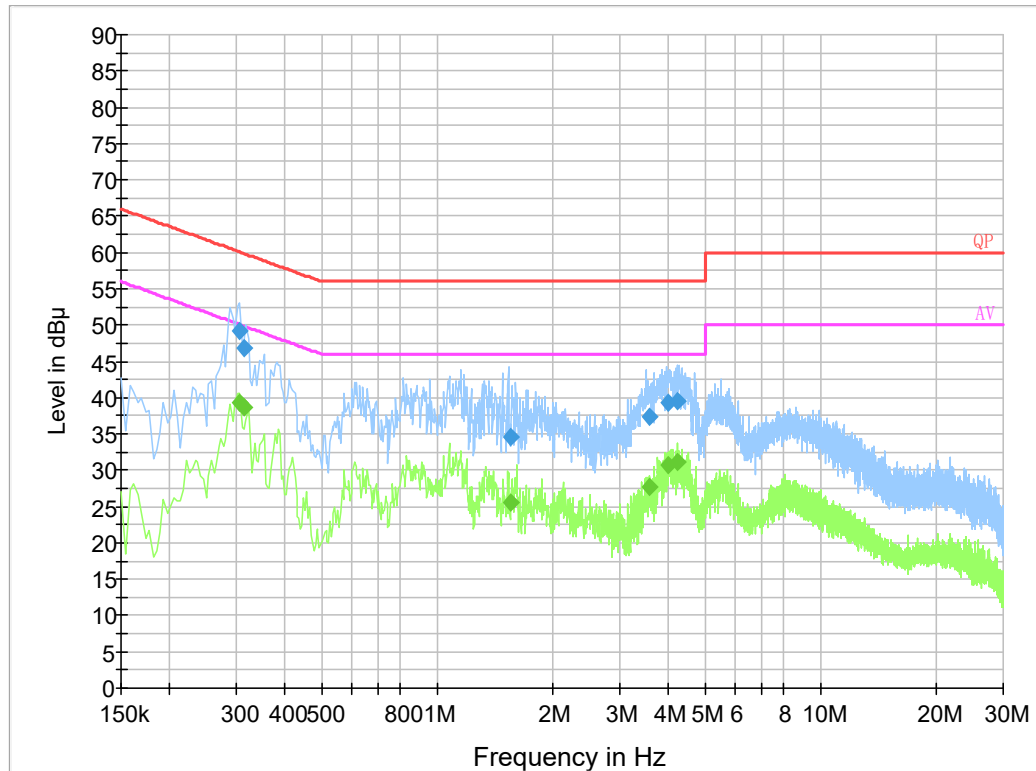
Environmental Conditions

Temperature:	25 °C
Relative Humidity:	65 %
ATM Pressure:	101.0 kPa

The testing was performed by Haiguo Li on 2020-10-10.

EUT operation mode: Transmitting (worst case)

Wi-Fi Mode:
Powered by adapter:
AC 120V/60 Hz, Line

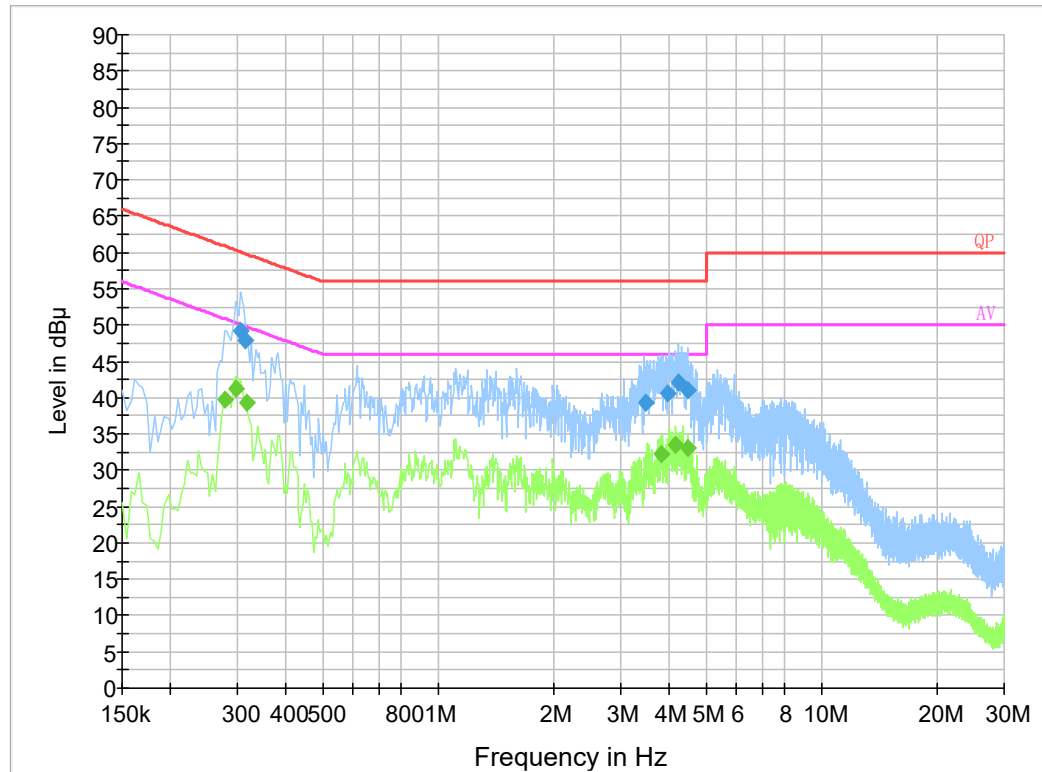


Final Result 1

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.305410	49.1	9.000	L1	19.7	11.0	60.1
0.313230	46.8	9.000	L1	19.8	13.1	59.9
1.550930	34.5	9.000	L1	19.8	21.5	56.0
3.578890	37.4	9.000	L1	19.9	18.6	56.0
4.010450	39.3	9.000	L1	19.9	16.7	56.0
4.242550	39.5	9.000	L1	19.9	16.5	56.0

Final Result 2

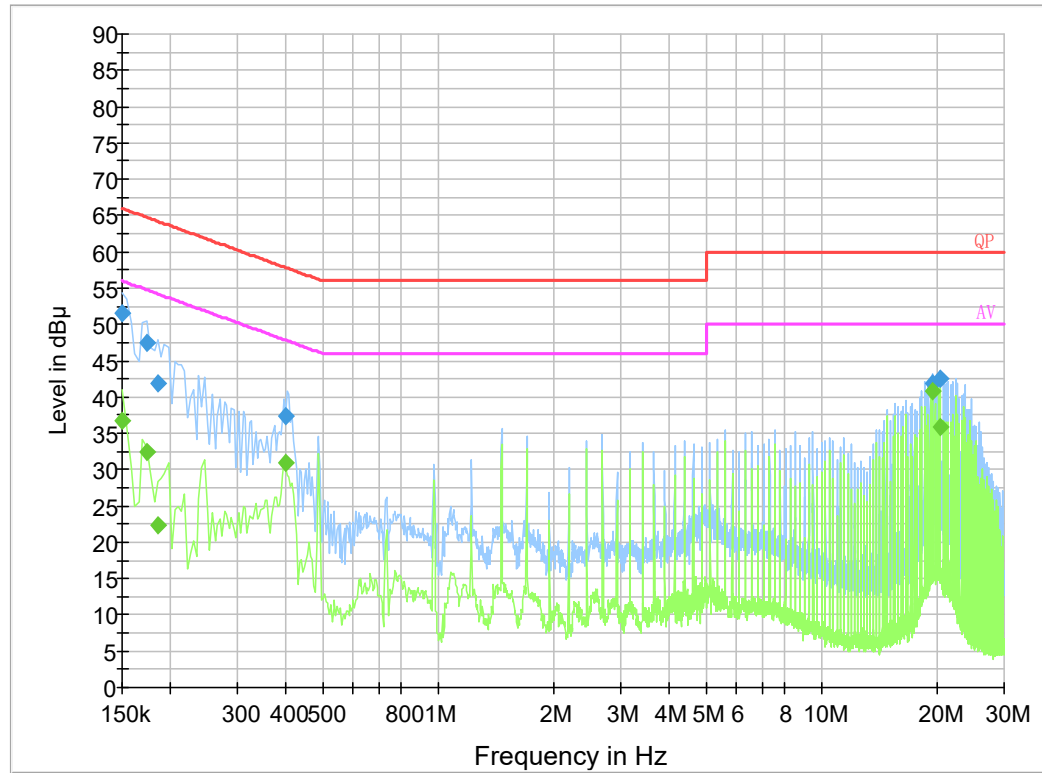
Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.305410	39.3	9.000	L1	19.7	10.8	50.1
0.313230	38.6	9.000	L1	19.8	11.3	49.9
1.550930	25.6	9.000	L1	19.8	20.4	46.0
3.578890	27.8	9.000	L1	19.9	18.2	46.0
4.010450	30.7	9.000	L1	19.9	15.3	46.0
4.242550	31.1	9.000	L1	19.9	14.9	46.0

AC 120V/60 Hz, Neutral**Final Result 1**

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.305410	49.3	9.000	N	19.7	10.8	60.1
0.313230	48.0	9.000	N	19.7	11.9	59.9
3.486010	39.4	9.000	N	19.9	16.6	56.0
3.954030	40.5	9.000	N	19.9	15.5	56.0
4.254430	42.1	9.000	N	19.9	13.9	56.0
4.490950	41.1	9.000	N	19.9	14.9	56.0

Final Result 2

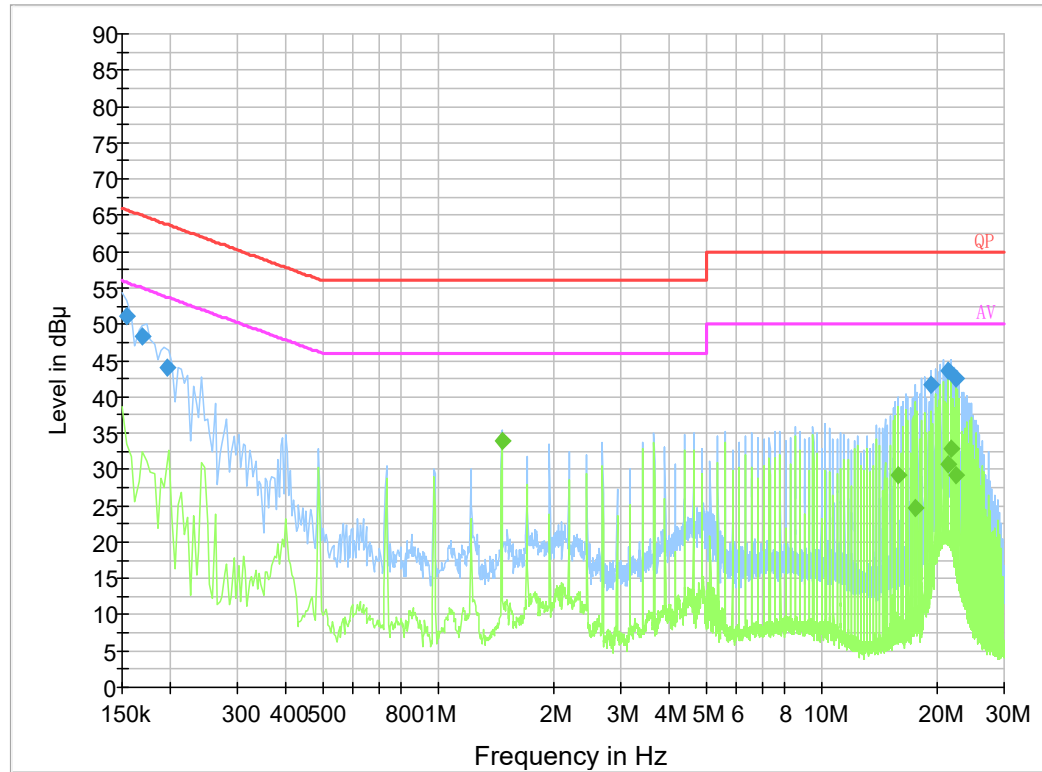
Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.278000	39.8	9.000	N	19.7	11.1	50.9
0.298000	41.2	9.000	N	19.7	9.1	50.3
0.318000	39.2	9.000	N	19.7	10.6	49.8
3.842000	32.3	9.000	N	19.9	13.7	46.0
4.178000	33.5	9.000	N	19.9	12.5	46.0
4.470000	33.0	9.000	N	19.9	13.0	46.0

Powered by POE:**AC 120V/60 Hz, Line****Final Result 1**

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.150000	51.6	0.200	L1	19.8	14.4	66.0
0.173500	47.4	9.000	L1	19.9	17.4	64.8
0.185500	41.9	9.000	L1	19.8	22.3	64.2
0.399910	37.3	9.000	L1	19.9	20.5	57.9
19.532930	41.9	9.000	L1	20.5	18.1	60.0
20.510290	42.5	9.000	L1	20.5	17.5	60.0

Final Result 2

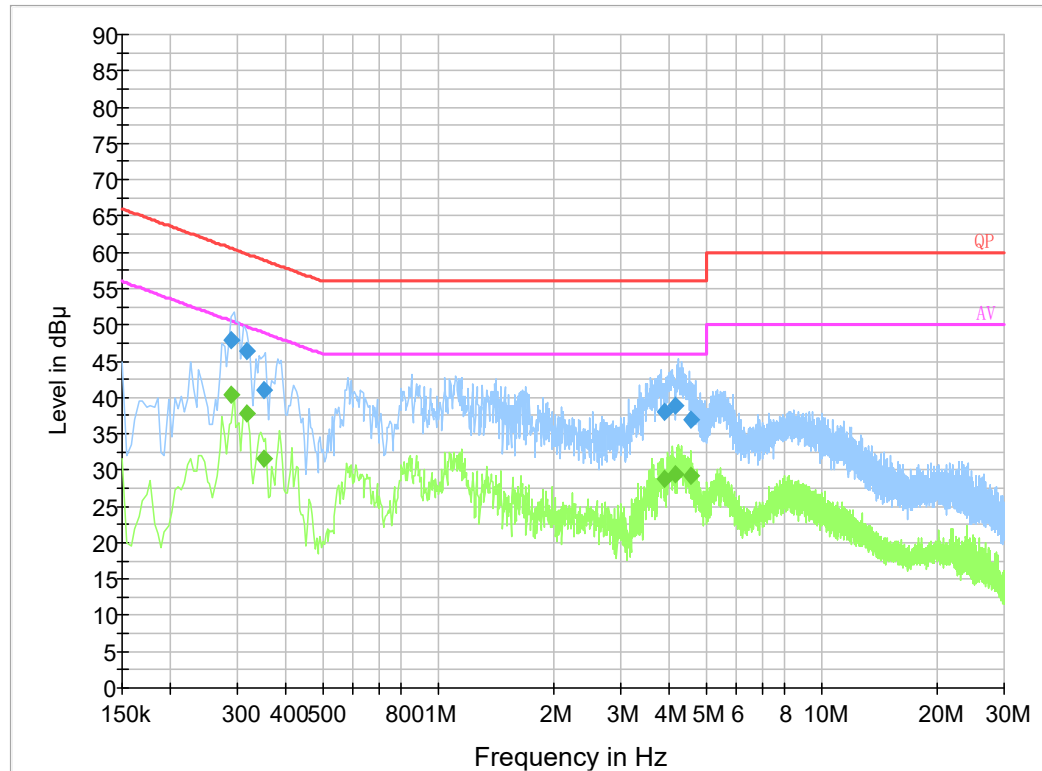
Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.150000	36.6	9.000	L1	19.8	19.4	56.0
0.173500	32.4	9.000	L1	19.9	22.4	54.8
0.185500	22.4	9.000	L1	19.8	31.9	54.2
0.399910	30.8	9.000	L1	19.9	17.0	47.9
19.532930	40.8	9.000	L1	20.5	9.2	50.0
20.510290	35.9	9.000	L1	20.5	14.1	50.0

AC 120V/60 Hz, Neutral**Final Result 1**

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.154000	51.2	9.000	N	19.8	14.6	65.8
0.169500	48.3	9.000	N	19.8	16.7	65.0
0.197500	44.1	9.000	N	19.8	19.6	63.7
19.296470	41.6	9.000	N	20.4	18.4	60.0
21.495810	43.7	9.000	N	20.4	16.3	60.0
22.472490	42.5	9.000	N	20.3	17.5	60.0

Final Result 2

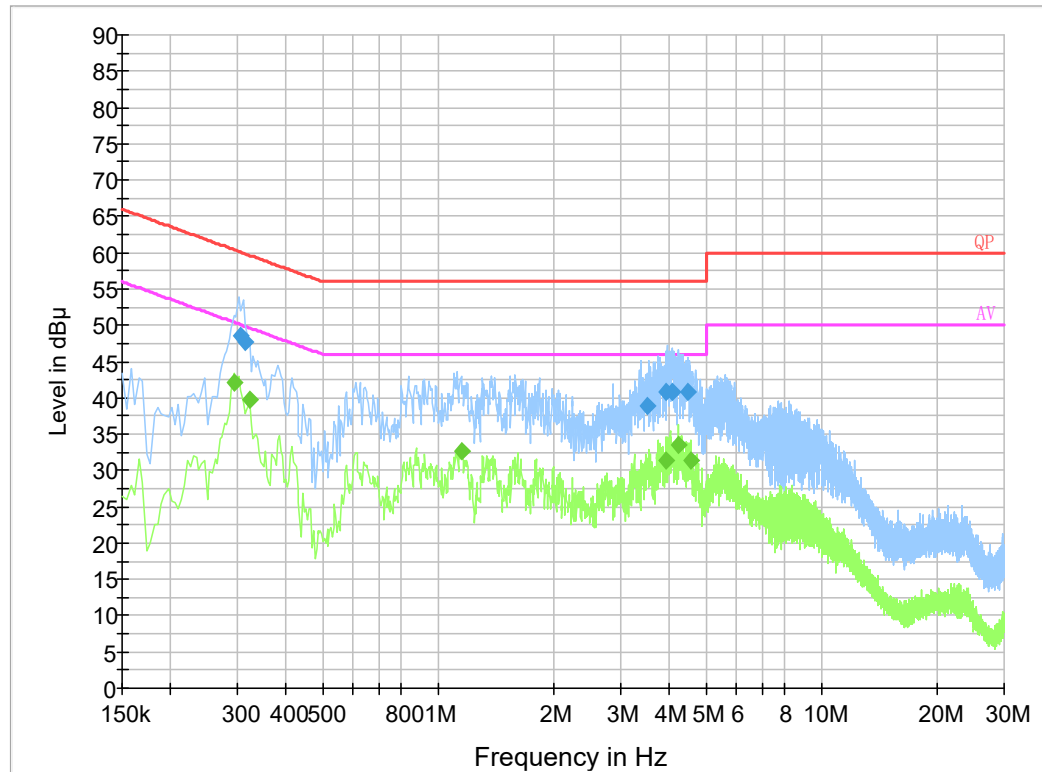
Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
1.466000	34.0	9.000	N	19.8	12.0	46.0
15.882000	29.2	9.000	N	20.0	20.8	50.0
17.594000	24.8	9.000	N	20.2	25.2	50.0
21.502000	30.6	9.000	N	20.4	19.4	50.0
21.746000	32.8	9.000	N	20.4	17.2	50.0
22.478000	29.3	9.000	N	20.3	20.7	50.0

LoRa Mode (External Antenna):**Powered by adapter:****AC 120V/60 Hz, Line****Final Result 1**

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.289500	48.0	9.000	L1	19.7	12.5	60.5
0.317230	46.4	9.000	L1	19.8	13.4	59.8
0.352690	41.0	9.000	L1	19.9	17.9	58.9
3.884430	37.9	9.000	L1	19.9	18.1	56.0
4.162610	38.8	9.000	L1	19.9	17.2	56.0
4.562110	37.0	9.000	L1	19.9	19.0	56.0

Final Result 2

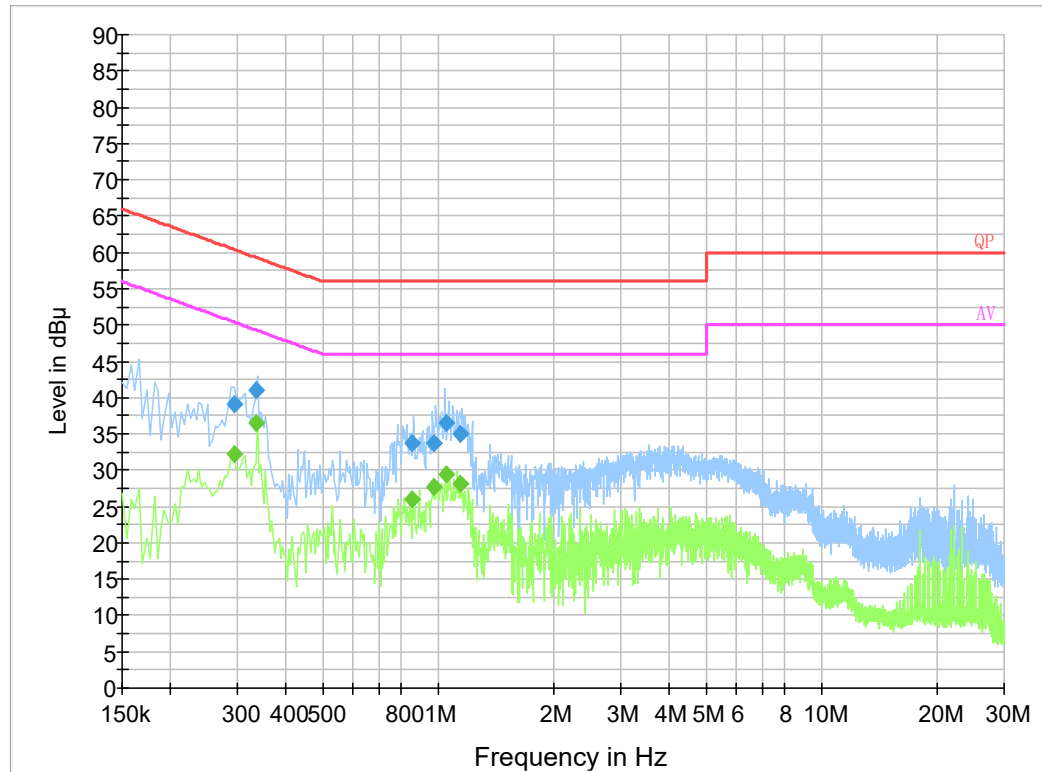
Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.289500	40.3	9.000	L1	19.7	10.2	50.5
0.317230	37.8	9.000	L1	19.8	12.0	49.8
0.352690	31.6	9.000	L1	19.9	17.3	48.9
3.884430	28.8	9.000	L1	19.9	17.2	46.0
4.162610	29.5	9.000	L1	19.9	16.5	46.0
4.562110	29.1	9.000	L1	19.9	16.9	46.0

AC 120V/60 Hz, Neutral**Final Result 1**

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.305470	48.6	9.000	N	19.7	11.5	60.1
0.313230	47.8	9.000	N	19.7	12.1	59.9
3.520870	38.9	9.000	N	19.9	17.1	56.0
3.942690	40.8	9.000	N	19.9	15.2	56.0
4.096590	40.9	9.000	N	19.9	15.1	56.0
4.494530	40.8	9.000	N	19.9	15.2	56.0

Final Result 2

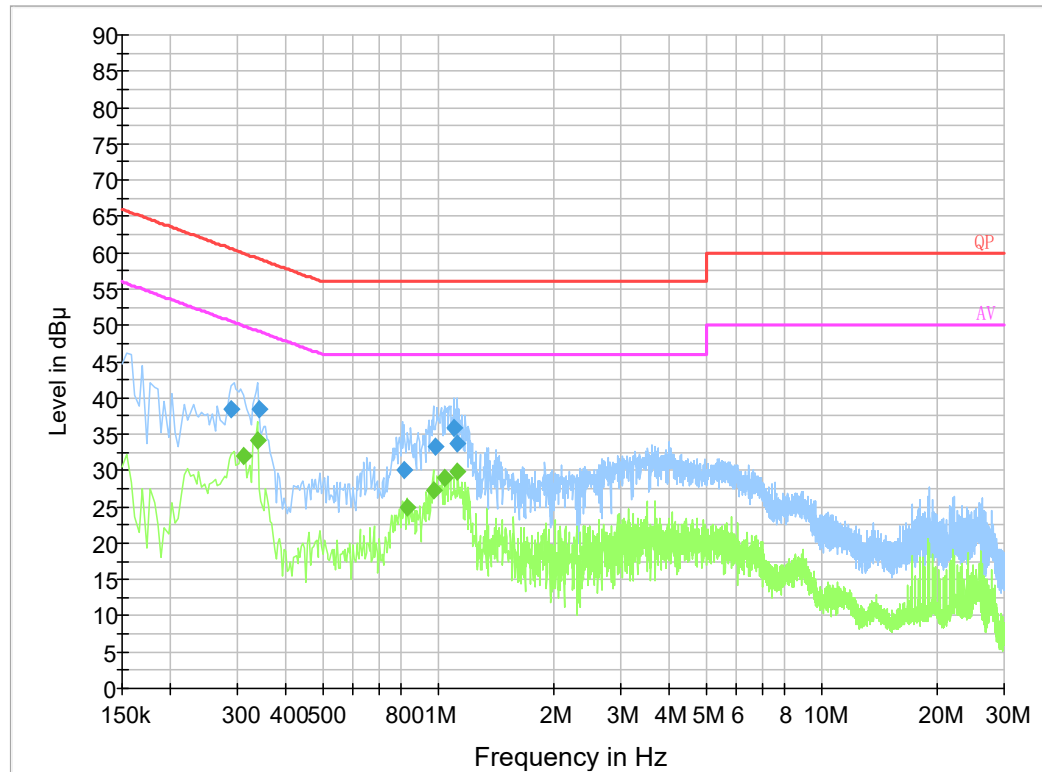
Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.294000	42.0	9.000	N	19.7	8.4	50.4
0.322000	39.8	9.000	N	19.8	9.9	49.7
1.150000	32.6	9.000	N	19.8	13.4	46.0
3.946000	31.3	9.000	N	19.9	14.7	46.0
4.250000	33.5	9.000	N	19.9	12.5	46.0
4.554000	31.3	9.000	N	19.9	14.7	46.0

Powered by POE:**AC 120V/60 Hz, Line****Final Result 1**

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.293500	39.0	9.000	L1	19.7	21.4	60.4
0.336930	40.9	9.000	L1	19.8	18.4	59.3
0.857010	33.7	9.000	L1	19.8	22.3	56.0
0.975210	33.8	9.000	L1	19.9	22.2	56.0
1.050370	36.6	9.000	L1	19.9	19.4	56.0
1.148690	35.1	9.000	L1	19.8	20.9	56.0

Final Result 2

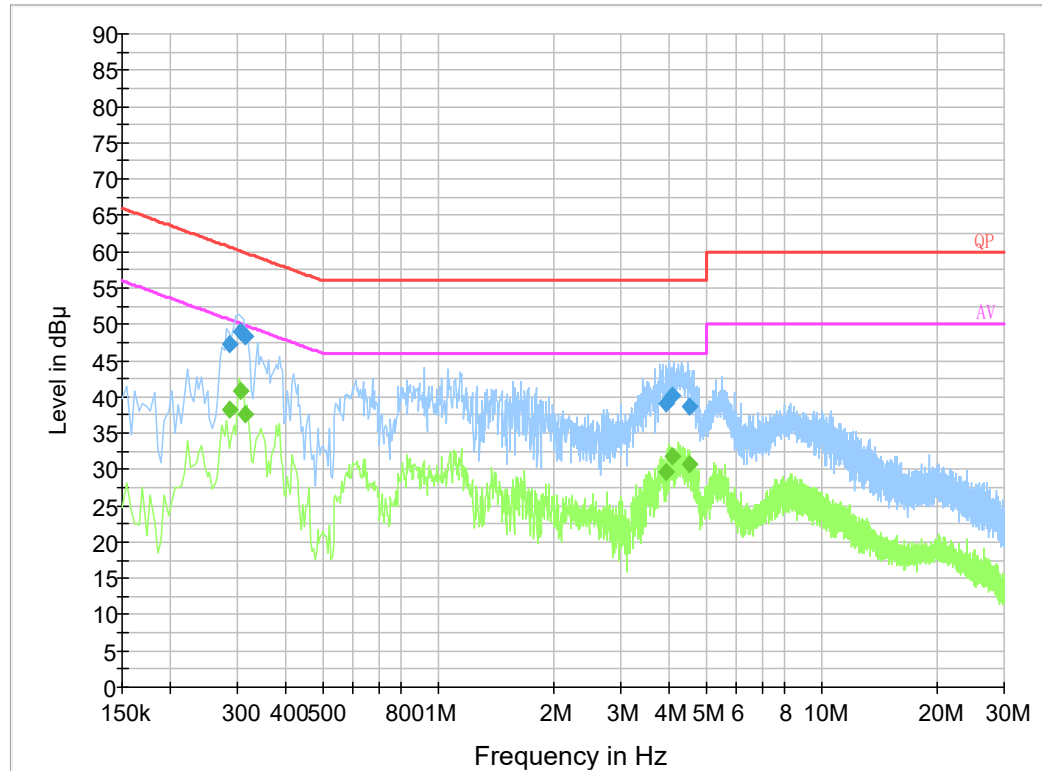
Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.293500	32.3	9.000	L1	19.7	18.1	50.4
0.336930	36.4	9.000	L1	19.8	12.9	49.3
0.857010	26.0	9.000	L1	19.8	20.0	46.0
0.975210	27.7	9.000	L1	19.9	18.3	46.0
1.050370	29.4	9.000	L1	19.9	16.6	46.0
1.148690	28.2	9.000	L1	19.8	17.8	46.0

AC 120V/60 Hz, Neutral**Final Result 1**

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.289500	38.4	9.000	N	19.7	22.1	60.5
0.340930	38.5	9.000	N	19.8	20.7	59.2
0.813910	30.0	9.000	N	19.8	26.0	56.0
0.988610	33.3	9.000	N	19.8	22.7	56.0
1.097470	35.9	9.000	N	19.8	20.1	56.0
1.121110	33.7	9.000	N	19.8	22.3	56.0

Final Result 2

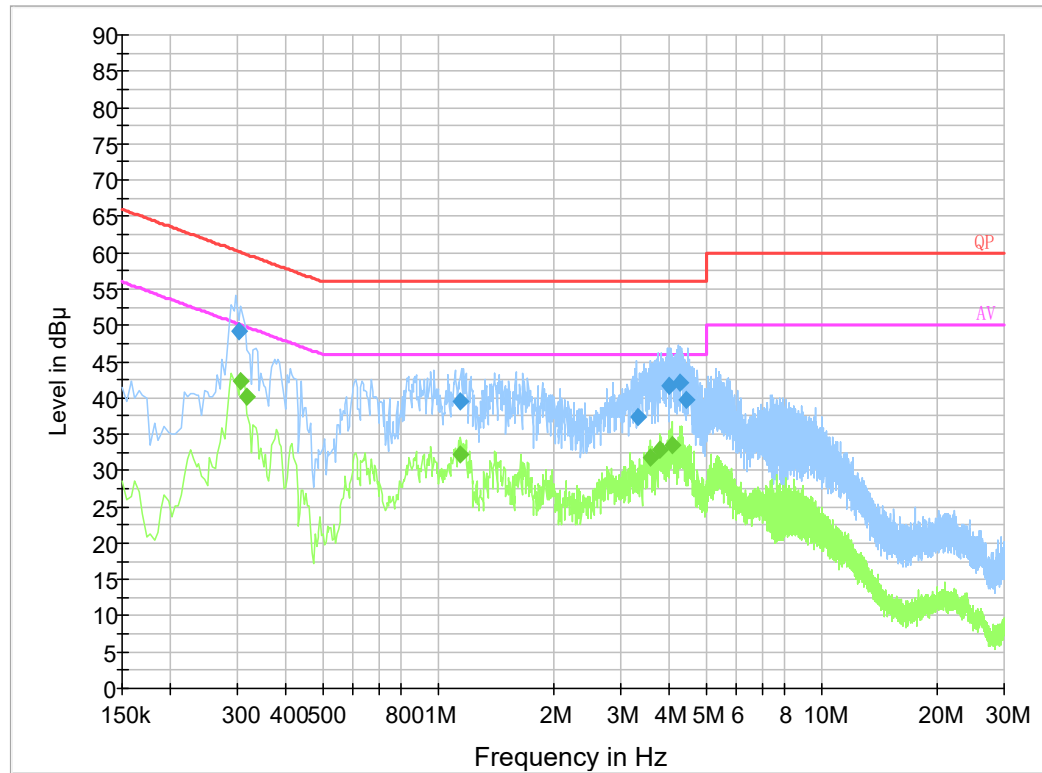
Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.310000	32.1	9.000	N	19.7	17.9	50.0
0.338000	34.1	9.000	N	19.8	15.2	49.3
0.834000	24.8	9.000	N	19.8	21.2	46.0
0.974000	27.4	9.000	N	19.8	18.6	46.0
1.046000	29.0	9.000	N	19.8	17.0	46.0
1.126000	29.8	9.000	N	19.8	16.2	46.0

LoRa Mode (Internal Transmit Antenna):**Powered by adapter:****AC 120V/60 Hz, Line****Final Result 1**

Frequency (MHz)	QuasiPeak (dB μV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μV)
0.286500	47.2	9.000	L1	19.7	13.4	60.6
0.305470	49.0	9.000	L1	19.7	11.1	60.1
0.313230	48.3	9.000	L1	19.8	11.6	59.9
3.923890	39.1	9.000	L1	19.9	16.9	56.0
4.081610	40.1	9.000	L1	19.9	15.9	56.0
4.518470	38.7	9.000	L1	19.9	17.3	56.0

Final Result 2

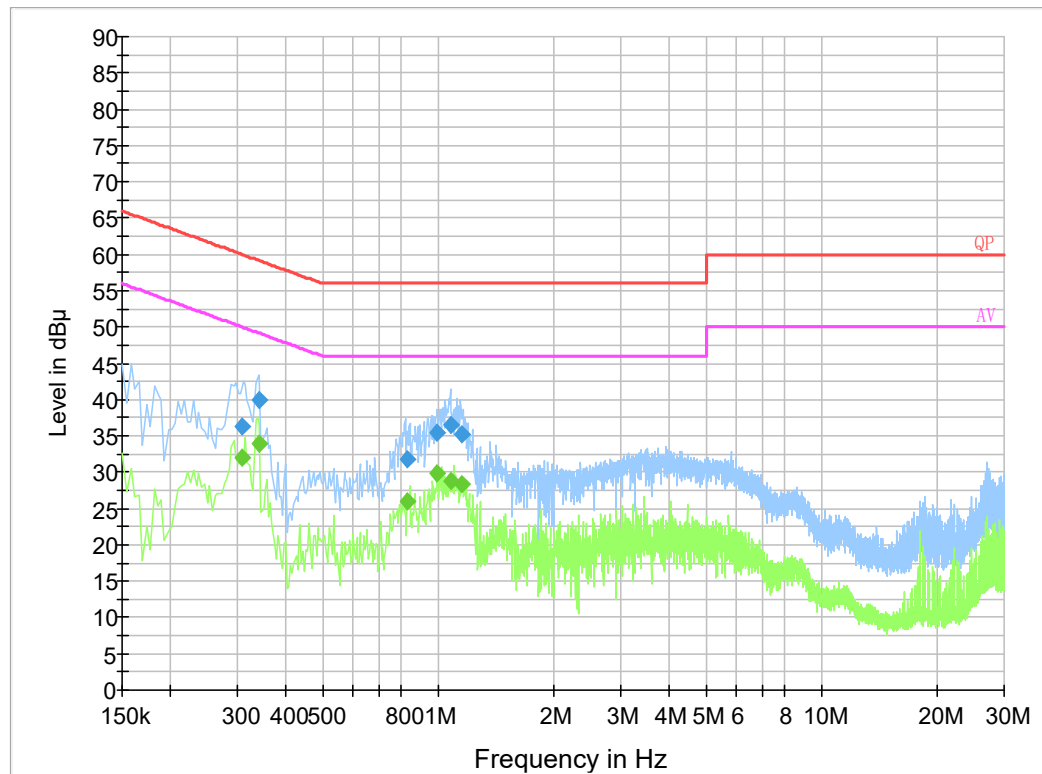
Frequency (MHz)	Average (dB μV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μV)
0.286500	38.2	9.000	L1	19.7	12.4	50.6
0.305470	40.9	9.000	L1	19.7	9.2	50.1
0.313230	37.7	9.000	L1	19.8	12.2	49.9
3.923890	29.6	9.000	L1	19.9	16.4	46.0
4.081610	31.9	9.000	L1	19.9	14.1	46.0
4.518470	30.6	9.000	L1	19.9	15.4	46.0

AC 120V/60 Hz, Neutral**Final Result 1**

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.302500	49.2	9.000	N	19.7	11.0	60.2
1.148750	39.5	9.000	N	19.8	16.5	56.0
3.332650	37.3	9.000	N	19.9	18.7	56.0
4.014210	41.6	9.000	N	19.9	14.4	56.0
4.297510	42.0	9.000	N	19.9	14.0	56.0
4.430950	39.7	9.000	N	19.9	16.3	56.0

Final Result 2

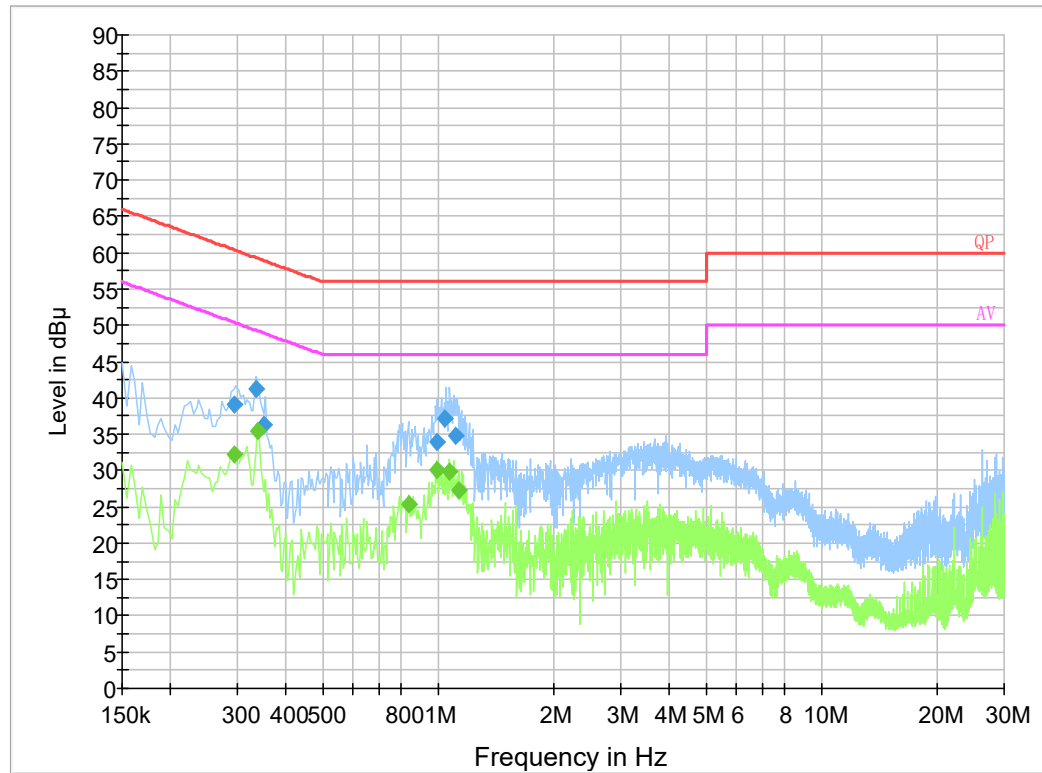
Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.306000	42.3	9.000	N	19.7	7.8	50.1
0.318000	40.2	9.000	N	19.7	9.6	49.8
1.146000	32.3	9.000	N	19.8	13.7	46.0
3.574000	31.8	9.000	N	19.9	14.2	46.0
3.790000	32.9	9.000	N	19.9	13.1	46.0
4.094000	33.6	9.000	N	19.9	12.4	46.0

Powered by POE:**AC 120V/60 Hz, Line****Final Result 1**

Frequency (MHz)	QuasiPeak (dB μV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μV)
0.309350	36.3	9.000	L1	19.7	23.7	60.0
0.340870	39.9	9.000	L1	19.9	19.3	59.2
0.829670	31.8	9.000	L1	19.8	24.2	56.0
0.995030	35.5	9.000	L1	19.9	20.5	56.0
1.085830	36.4	9.000	L1	19.9	19.6	56.0
1.152810	35.3	9.000	L1	19.8	20.7	56.0

Final Result 2

Frequency (MHz)	Average (dB μV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μV)
0.309350	32.0	9.000	L1	19.7	18.0	50.0
0.340870	34.0	9.000	L1	19.9	15.2	49.2
0.829670	25.9	9.000	L1	19.8	20.1	46.0
0.995030	29.9	9.000	L1	19.9	16.2	46.0
1.085830	28.9	9.000	L1	19.9	17.1	46.0
1.152810	28.3	9.000	L1	19.8	17.7	46.0

AC 120V/60 Hz, Neutral**Final Result 1**

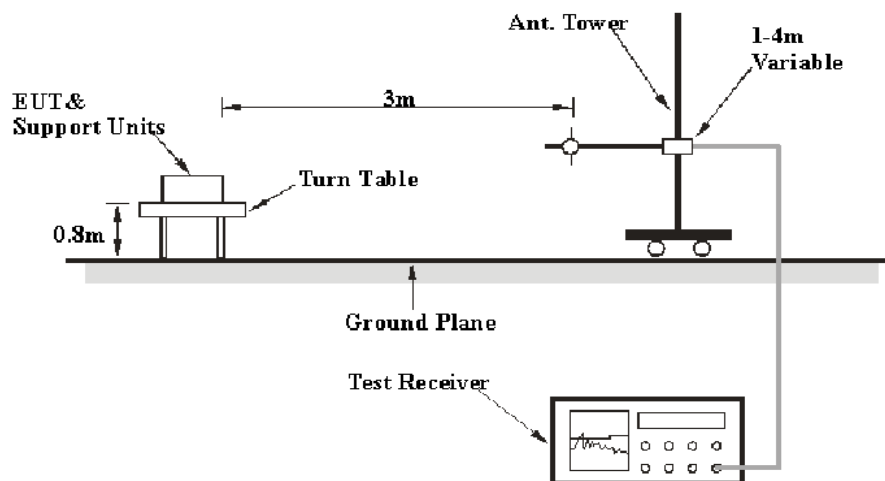
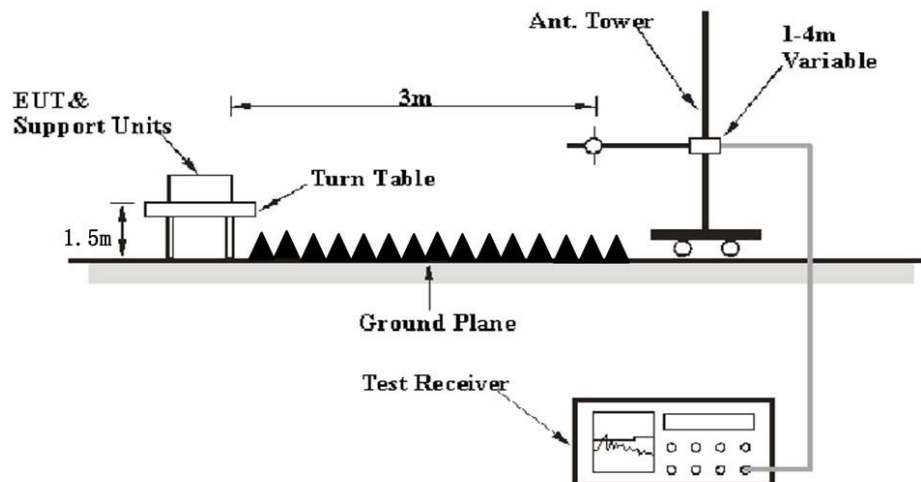
Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.293500	39.1	9.000	N	19.7	21.3	60.4
0.336990	41.3	9.000	N	19.8	18.0	59.3
0.352690	36.3	9.000	N	19.9	22.6	58.9
0.991030	34.0	9.000	N	19.8	22.0	56.0
1.046250	37.2	9.000	N	19.8	18.8	56.0
1.113110	34.8	9.000	N	19.8	21.2	56.0

Final Result 2

Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.294000	32.2	9.000	N	19.7	18.2	50.4
0.338000	35.4	9.000	N	19.8	13.9	49.3
0.842000	25.3	9.000	N	19.8	20.7	46.0
0.998000	30.1	9.000	N	19.8	15.9	46.0
1.074000	29.8	9.000	N	19.8	16.2	46.0
1.138000	27.2	9.000	N	19.8	18.8	46.0

FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS**Applicable Standard**

FCC §15.247 (d); §15.209; §15.205;

EUT Setup**Below 1 GHz:****Above 1GHz:**

The radiated emission tests were performed in the 3 meters test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 limits.

EMI Test Receiver & Spectrum Analyzer Setup

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1MHz	3 MHz	/	PK
	1MHz	10 Hz ^{Note 1}	/	Average
	1MHz	> 1/T ^{Note 2}	/	Average

Note 1: when duty cycle is no less than 98%

Note 2: when duty cycle is less than 98%

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

Data was recorded in Quasi-peak detection mode for frequency range of 30 MHz-1 GHz, peak and Average detection modes for frequencies above 1 GHz.

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

Test Data

Environmental Conditions

Temperature:	27.3~30.4 °C
Relative Humidity:	42~56 %
ATM Pressure:	100.9~101.1 kPa

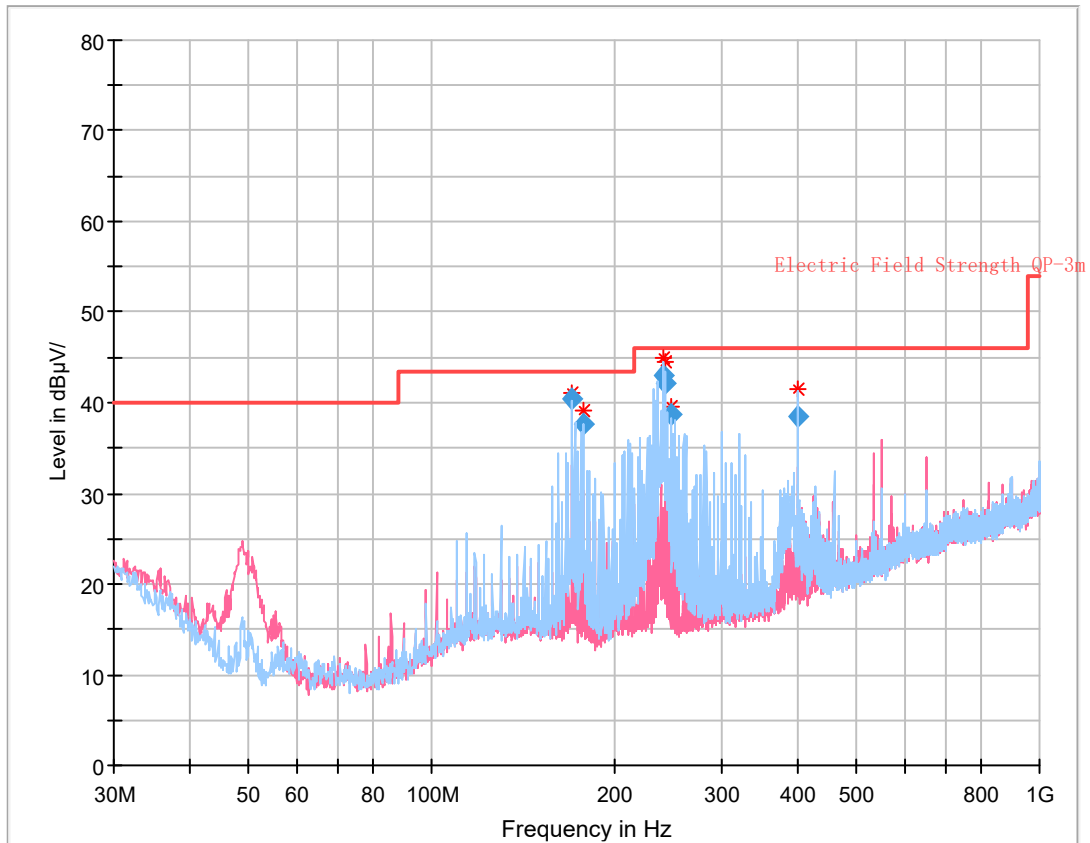
The testing was performed by Charlie Cha and Holland Yang from 2020-11-12 to 2020-11-13 for below 1GHz, Leven Gan on 2020-10-22 for above 1GHz.

EUT operation mode: Transmitting

Wi-Fi Mode: (Worst case at 802.11b mode, middle channel)

Powered by adapter

30 MHz~1 GHz:

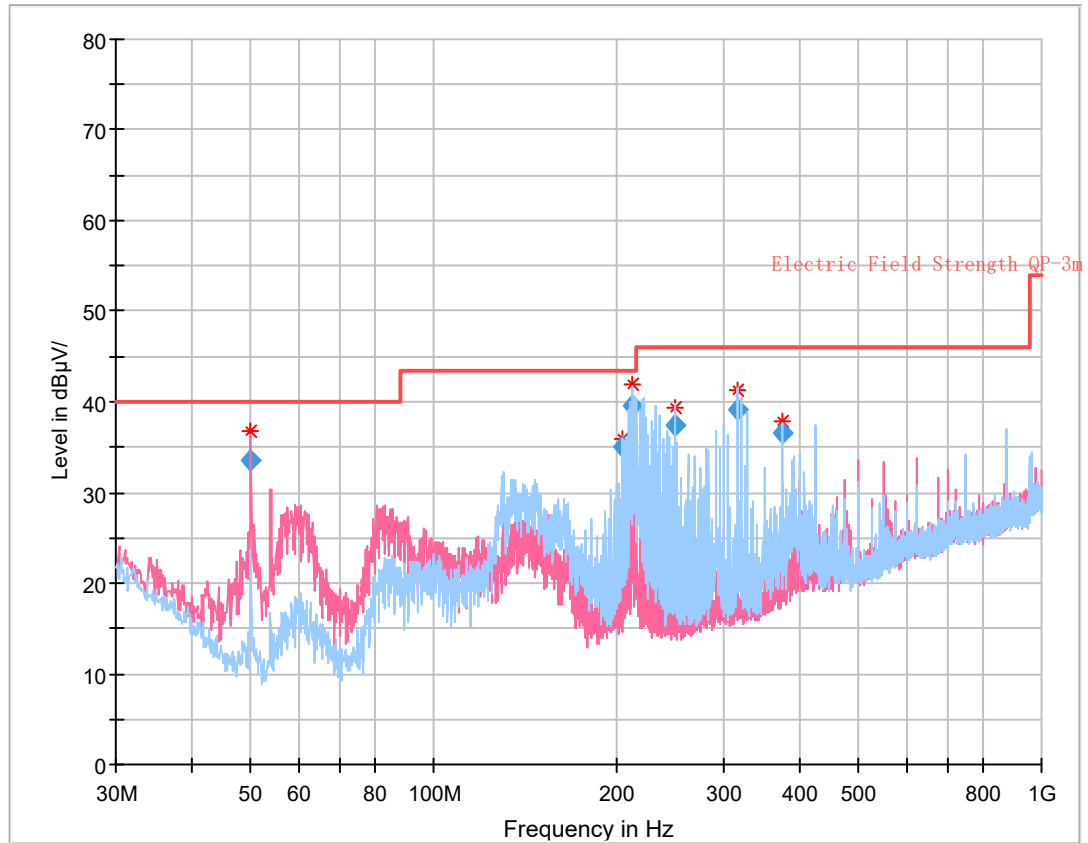


Final_Result

Frequency (MHz)	QuasiPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
169.983625	40.33	43.50	3.17	142.0	H	104.0	-11.7
178.012500	37.70	43.50	5.80	138.0	H	99.0	-11.9
240.014625	42.96	46.00	3.06	130.0	H	87.0	-10.8
241.998625	42.24	46.00	3.76	130.0	H	80.0	-10.8
248.012000	38.65	46.00	7.35	114.0	H	71.0	-10.8
399.947500	38.42	46.00	7.58	102.0	H	90.0	-7.5

Powered by POE:

30 MHz~1 GHz:



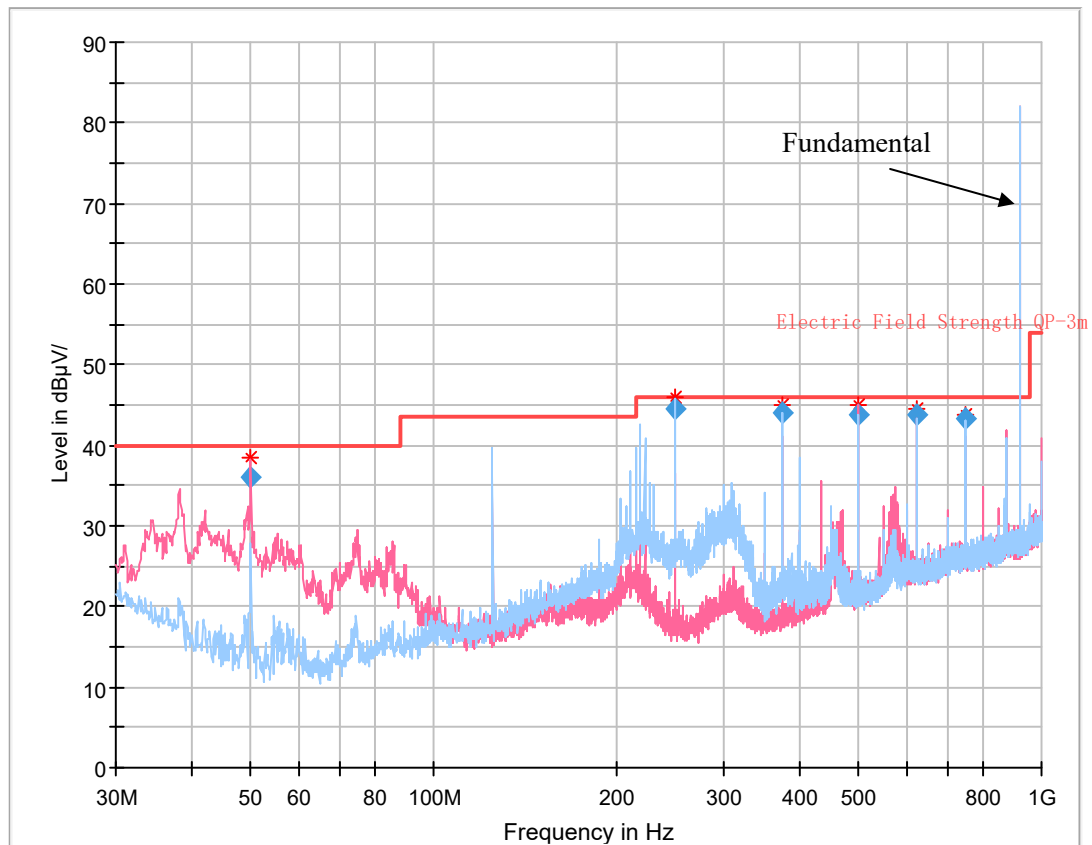
Final Result

Frequency (MHz)	QuasiPeak (dB µ V/m)	Limit (dB µ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
49.993500	33.65	40.00	6.35	106.0	V	13.0	-16.5
203.993000	34.95	43.50	8.55	172.0	H	90.0	-10.7
211.998000	39.50	43.50	4.00	153.0	H	89.0	-10.7
250.013000	37.52	46.00	8.48	114.0	H	92.0	-10.8
315.986000	39.18	46.00	6.82	110.0	H	80.0	-8.9
374.997125	36.58	46.00	9.42	103.0	H	80.0	-7.9

LoRa Mode: (Worst case at external transmit antenna, low channel)

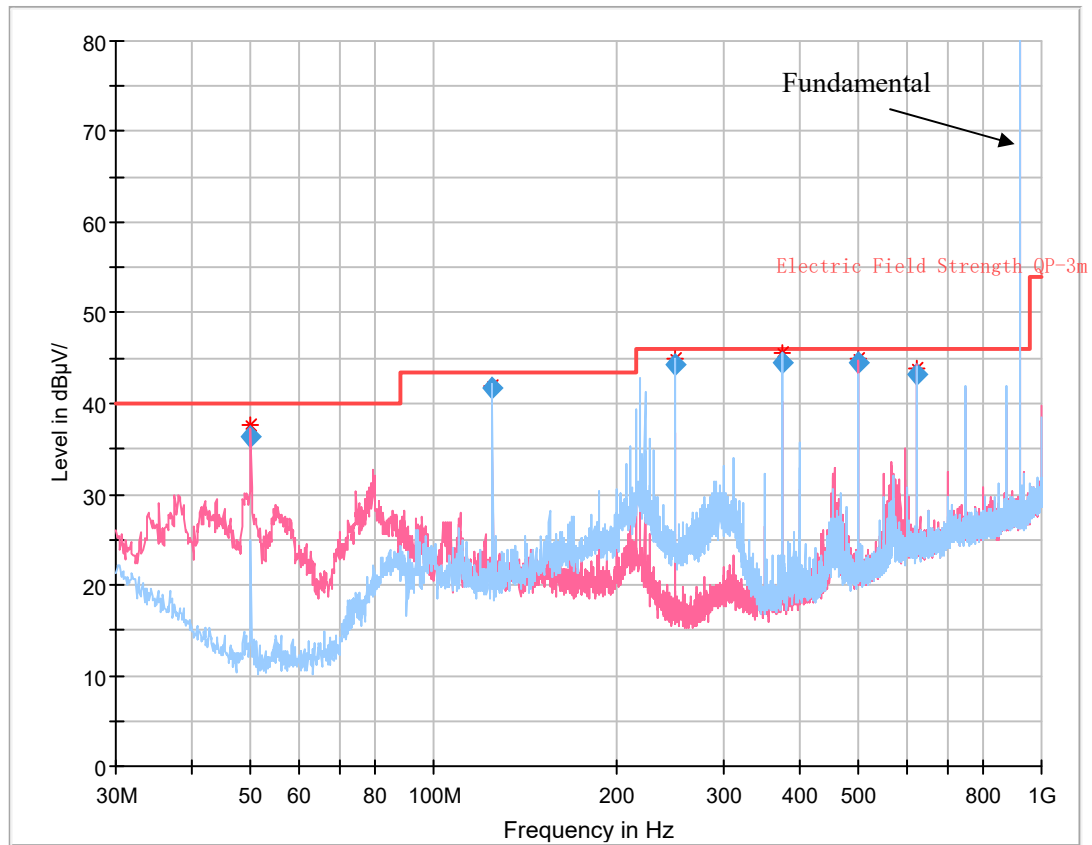
Powered by adapter

30 MHz~1 GHz:



Final_Result

Frequency (MHz)	QuasiPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
49.992250	36.10	40.00	3.90	133.0	V	90.0	-16.5
250.006625	44.41	46.00	1.59	111.0	H	94.0	-10.8
375.004000	44.02	46.00	1.98	110.0	H	91.0	-7.9
499.996000	43.79	46.00	2.27	176.0	V	0.0	-4.9
625.001500	43.75	46.00	2.25	153.0	V	114.0	-2.1
750.023750	43.25	46.00	2.75	104.0	H	140.0	-0.1

Powered by POE:**30 MHz~1 GHz:****Final_Result**

Frequency (MHz)	QuasiPeak (dB µ V/m)	Limit (dB µ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
50.003750	36.26	40.00	3.74	109.0	V	44.0	-16.5
125.005000	41.62	43.50	1.88	292.0	H	270.0	-10.8
250.001625	44.40	46.00	1.60	111.0	H	105.0	-10.8
374.994875	44.58	46.00	1.42	109.0	H	84.0	-7.9
500.012375	44.54	46.00	1.46	180.0	V	0.0	-4.8
625.002250	43.23	46.00	2.77	122.0	H	123.0	-2.1

1 GHz-25 GHz (Wi-Fi):**802.11b Mode:**

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2412 MHz)									
2388.41	28.34	PK	324	1.1	H	31.87	60.21	74	13.79
2388.41	14.12	Ave.	324	1.1	H	31.87	45.99	54	8.01
2483.65	28.53	PK	210	2.3	H	32.13	60.66	74	13.34
2483.65	13.98	Ave.	210	2.3	H	32.13	46.11	54	7.89
4824.00	45.38	PK	267	1.7	H	6.28	51.66	74	22.34
4824.00	31.45	Ave.	267	1.7	H	6.28	37.73	54	16.27
Middle Channel (2437MHz)									
4874.00	45.89	PK	70	1.8	H	6.76	52.65	74	21.35
4874.00	32.71	Ave.	70	1.8	H	6.76	39.47	54	14.53
High Channel (2462 MHz)									
2387.94	28.36	PK	265	2.3	H	31.87	60.23	74	13.77
2387.94	14.09	Ave.	265	2.3	H	31.87	45.96	54	8.04
2483.85	29.21	PK	152	2.4	H	32.13	61.34	74	12.66
2483.85	14.26	Ave.	152	2.4	H	32.13	46.39	54	7.61
4924.00	45.97	PK	264	1.6	H	6.76	52.73	74	21.27
4924.00	33.57	Ave.	264	1.6	H	6.76	40.33	54	13.67

802.11g Mode:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2412 MHz)									
2388.82	28.81	PK	241	1.6	H	31.87	60.68	74	13.32
2388.82	14.23	Ave.	241	1.6	H	31.87	46.10	54	7.90
2484.53	28.71	PK	84	1.5	H	32.13	60.84	74	13.16
2484.53	14.25	Ave.	84	1.5	H	32.13	46.38	54	7.62
4824.00	45.36	PK	46	1.8	H	6.28	51.64	74	22.36
4824.00	30.12	Ave.	46	1.8	H	6.28	36.40	54	17.60
Middle Channel (2437MHz)									
4874.00	45.79	PK	337	1.2	H	6.76	52.55	74	21.45
4874.00	30.96	Ave.	337	1.2	H	6.76	37.72	54	16.28
High Channel (2462 MHz)									
2388.82	28.67	PK	48	1.3	H	31.87	60.54	74	13.46
2388.82	14.21	Ave.	48	1.3	H	31.87	46.08	54	7.92
2483.96	29.11	PK	121	2.4	H	32.13	61.24	74	12.76
2483.96	14.30	Ave.	121	2.4	H	32.13	46.43	54	7.57
4924.00	46.14	PK	14	2.2	H	6.76	52.90	74	21.10
4924.00	31.52	Ave.	14	2.2	H	6.76	38.28	54	15.72

802.11n-HT20 Mode:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2412 MHz)									
2388.74	28.61	PK	321	1.5	H	31.87	60.48	74	13.52
2388.74	14.77	Ave.	321	1.5	H	31.87	46.64	54	7.36
2484.87	28.51	PK	134	1.9	H	32.13	60.64	74	13.36
2484.87	14.64	Ave.	134	1.9	H	32.13	46.77	54	7.23
4824.00	45.27	PK	71	2.0	H	6.28	51.55	74	22.45
4824.00	30.18	Ave.	71	2.0	H	6.28	36.46	54	17.54
Middle Channel (2437MHz)									
4874.00	45.88	PK	161	1.5	H	6.76	52.64	74	21.36
4874.00	30.74	Ave.	161	1.5	H	6.76	37.50	54	16.50
High Channel (2462 MHz)									
2387.81	28.43	PK	296	1.5	H	31.87	60.30	74	13.70
2387.81	14.72	Ave.	296	1.5	H	31.87	46.59	54	7.41
2483.78	28.91	PK	68	1.9	H	32.13	61.04	74	12.96
2483.78	14.81	Ave.	68	1.9	H	32.13	46.94	54	7.06
4924.00	45.81	PK	300	2.2	H	6.76	52.57	74	21.43
4924.00	31.35	Ave.	300	2.2	H	6.76	38.11	54	15.89

802.11n-HT40 Mode:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2422 MHz)									
2388.42	29.67	PK	71	1.8	H	31.87	61.54	74	12.46
2388.42	15.75	Ave.	71	1.8	H	31.87	47.62	54	6.38
2484.56	28.63	PK	242	1.4	H	32.13	60.76	74	13.24
2484.56	14.88	Ave.	242	1.4	H	32.13	47.01	54	6.99
4844.00	44.91	PK	171	2.5	H	6.28	51.19	74	22.81
4844.00	29.84	Ave.	171	2.5	H	6.28	36.12	54	17.88
Middle Channel (2437MHz)									
4874.00	45.08	PK	271	2.3	H	6.76	51.84	74	22.16
4874.00	29.93	Ave.	271	2.3	H	6.76	36.69	54	17.31
High Channel (2452 MHz)									
2387.92	28.81	PK	340	2.1	H	31.87	60.68	74	13.32
2387.92	14.91	Ave.	340	2.1	H	31.87	46.78	54	7.22
2484.56	30.24	PK	87	2.2	H	32.13	62.37	74	11.63
2484.56	15.59	Ave.	87	2.2	H	32.13	47.72	54	6.28
4904.00	45.33	PK	231	1.5	H	6.76	52.09	74	21.91
4904.00	30.10	Ave.	231	1.5	H	6.76	36.86	54	17.14

1 GHz-10 GHz (LoRa-Internal transmit antenna)

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel(923.3MHz)									
1846.60	43.87	PK	144	1.9	H	-1.55	42.32	74	31.68
1846.60	28.69	Ave.	144	1.9	H	-1.55	27.14	54	26.86
High Channel(927.5MHz)									
1855.00	44.83	PK	280	2.3	H	-1.16	43.67	74	30.33
1855.00	29.33	Ave.	280	2.3	H	-1.16	28.17	54	25.82

1 GHz-10 GHz (LoRa- External antenna)

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel(923.3MHz)									
1846.60	43.32	PK	274	2.1	H	-1.55	41.77	74	32.23
1846.60	28.91	Ave.	274	2.1	H	-1.55	27.36	54	26.64
High Channel(927.5MHz)									
1855.00	44.28	PK	53	1.8	H	-1.16	43.12	74	30.88
1855.00	29.15	Ave.	53	1.8	H	-1.16	27.99	54	26.01

Note:

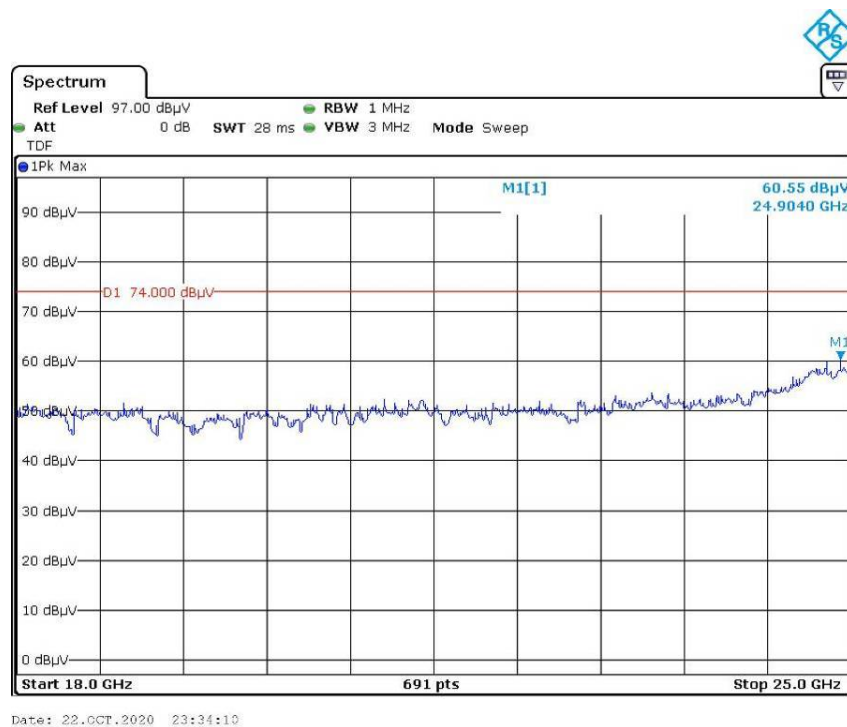
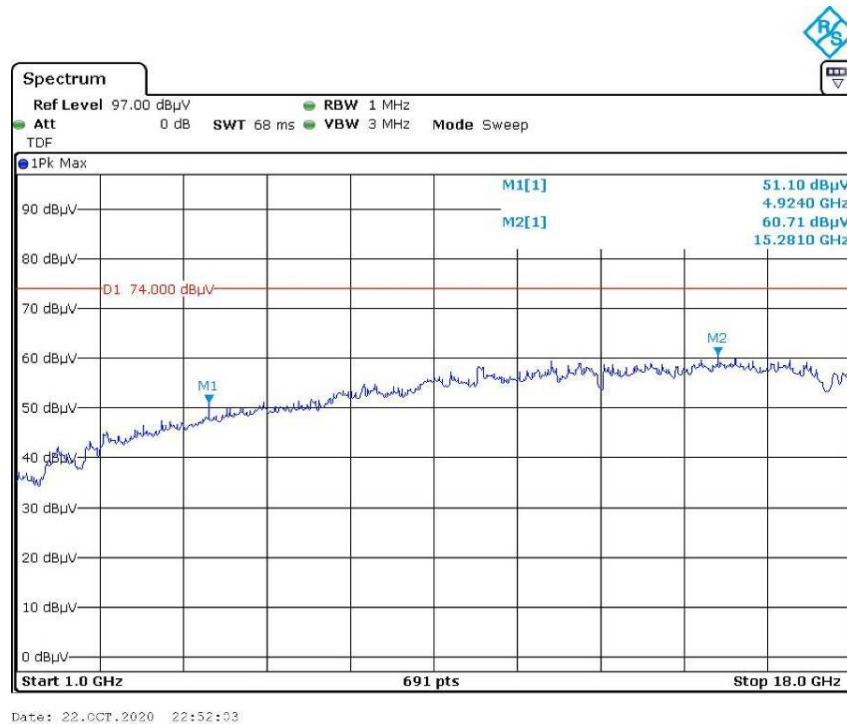
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Corrected Amplitude = Corrected Factor + Reading

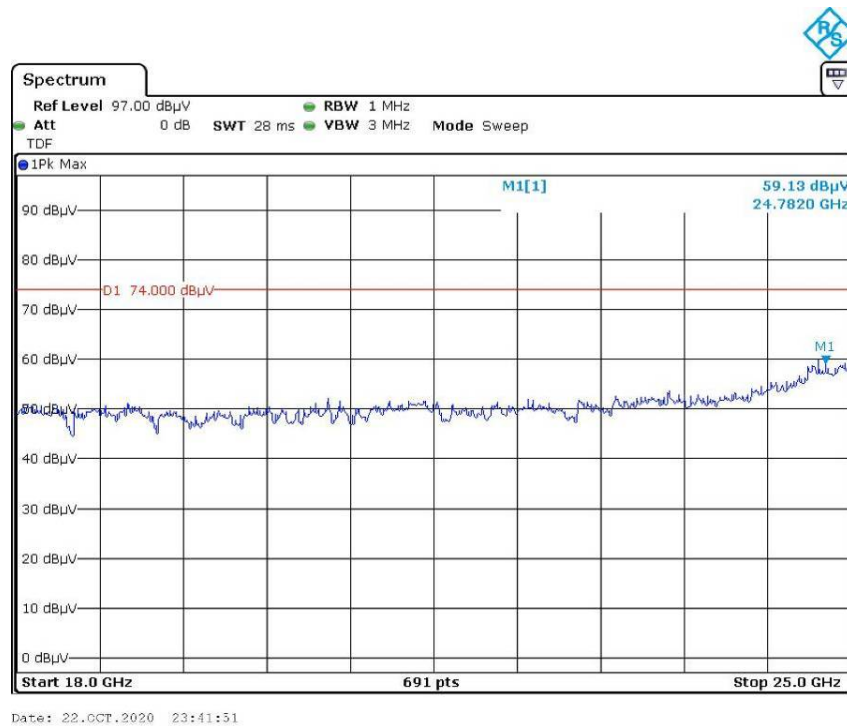
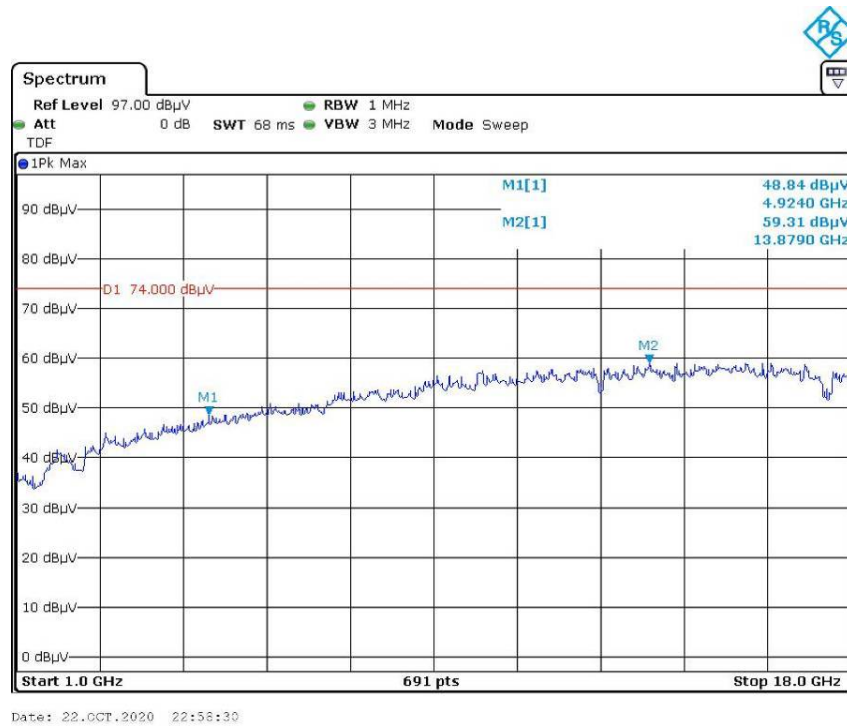
Margin = Limit - Corrected. Amplitude

The other spurious emission which is 20dB to the limit was not recorded.

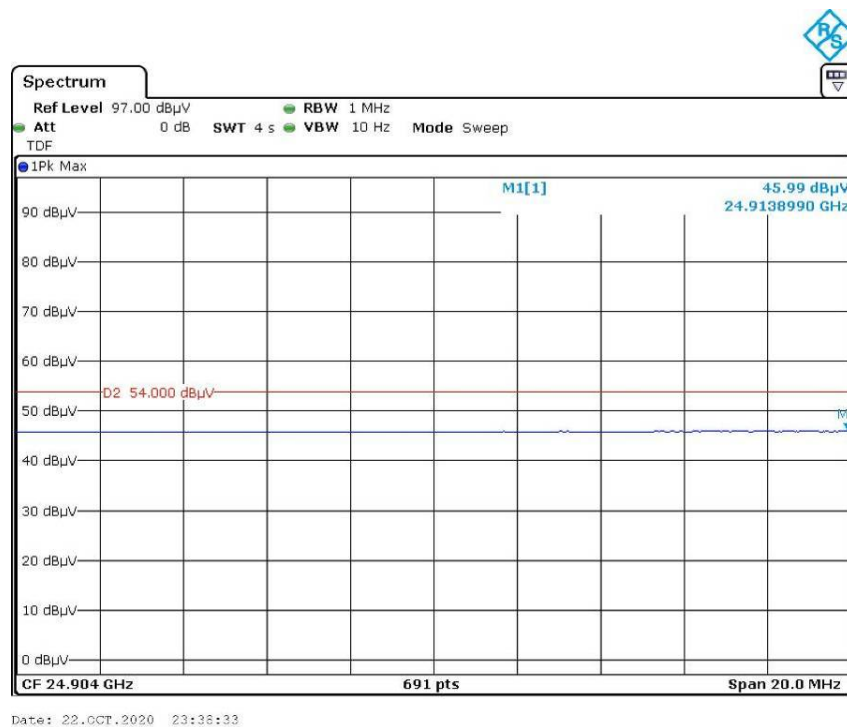
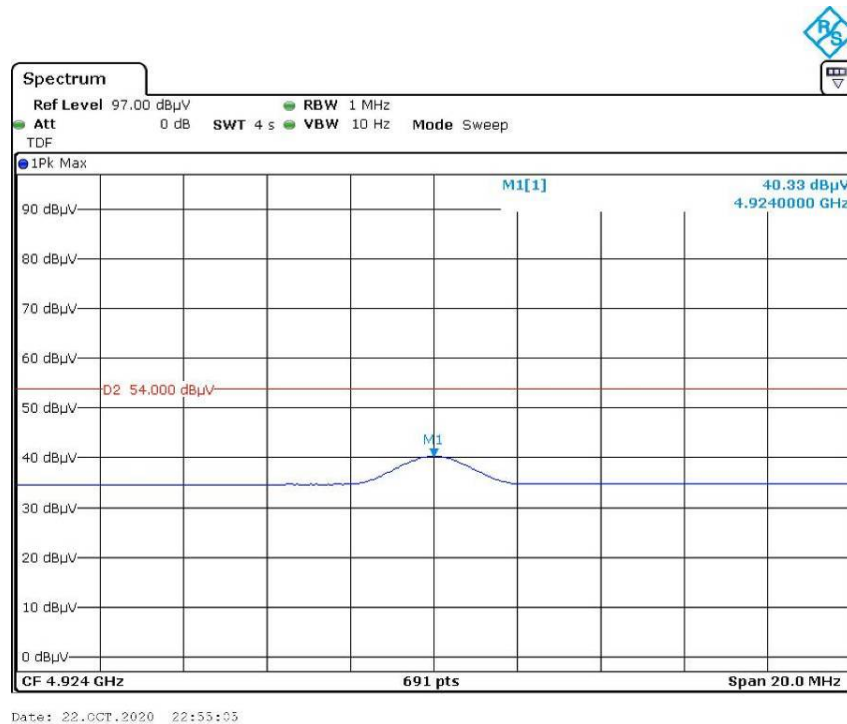
Pre-scan with Wi-Fi, high channel in 802.11b mode Horizontal



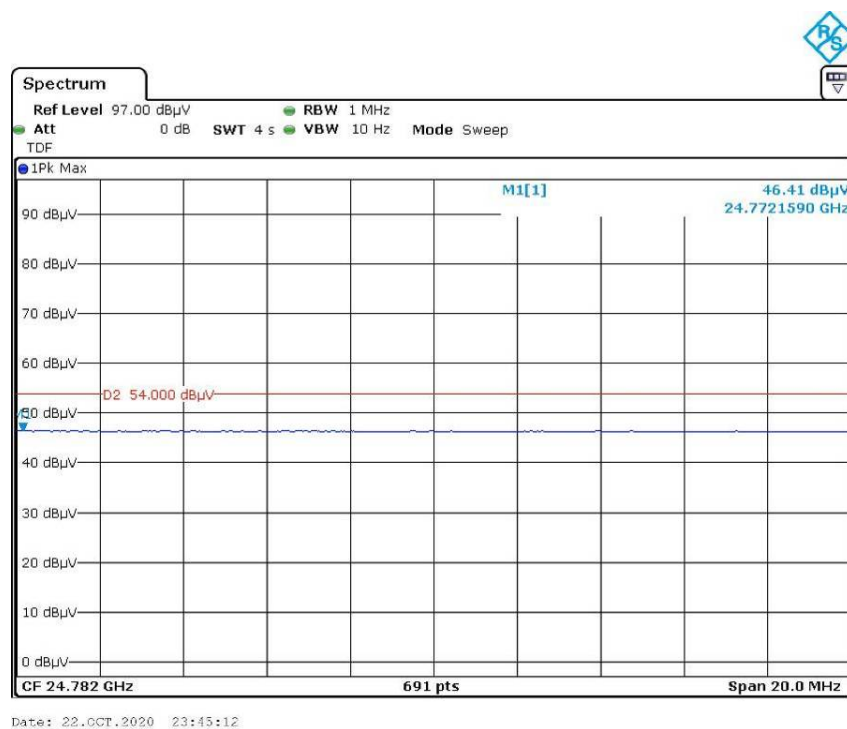
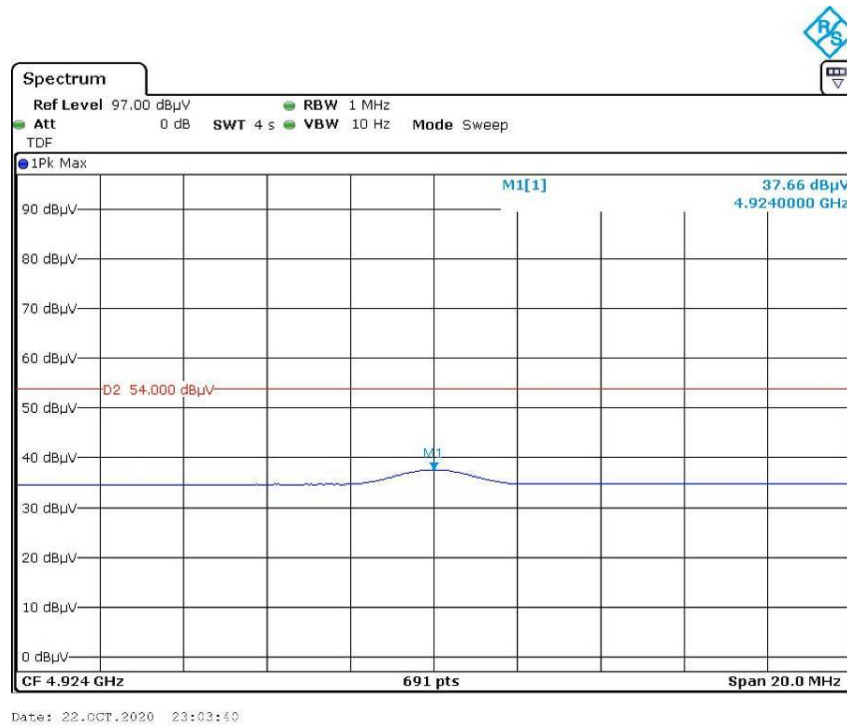
Vertical



Pre-scan for Average Horizontal



Vertical



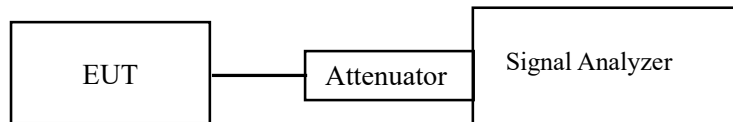
FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH

Applicable Standard

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.

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 6 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.



Test Data

Environmental Conditions

Temperature:	24~25 °C
Relative Humidity:	50~55 %
ATM Pressure:	101.0 kPa

The testing was performed by Coco Liu from 2020-10-13 to 2021-02-03.

Test Result: Pass.

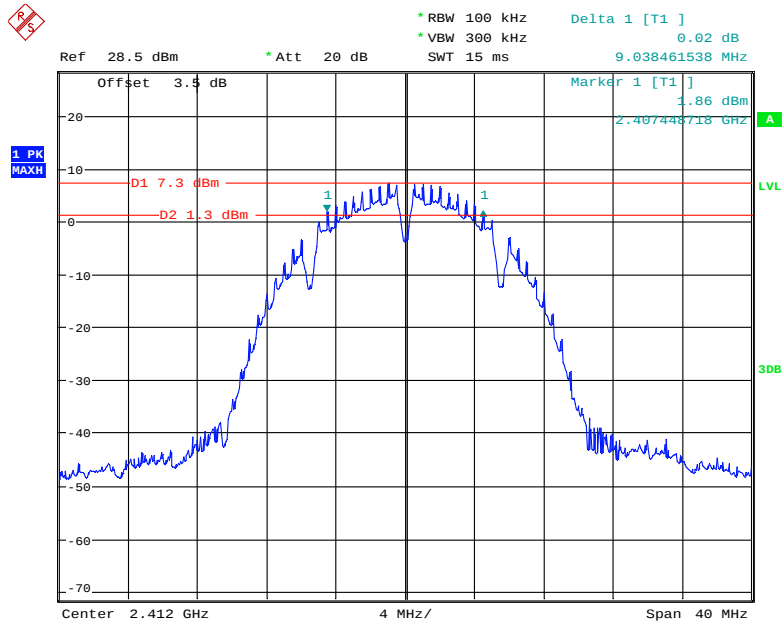
Please refer to the following table and plots.

EUT operation mode: Transmitting

Channel	Frequency (MHz)	6dB bandwidth (MHz)	99% OBW (MHz)	Limit (kHz)
802.11b mode				
Low	2412	9.038	13.462	≥500
Middle	2437	8.974	13.526	≥500
High	2462	9.487	13.590	≥500
802.11g mode				
Low	2412	16.410	17.500	≥500
Middle	2437	16.346	17.564	≥500
High	2462	16.474	17.500	≥500
802.11n-HT20 mode				
Low	2412	17.628	18.397	≥500
Middle	2437	17.564	18.333	≥500
High	2462	17.615	18.397	≥500
802.11n-HT40 mode				
Low	2422	35.128	36.410	≥500
Middle	2437	35.256	36.282	≥500
High	2452	35.128	36.282	≥500

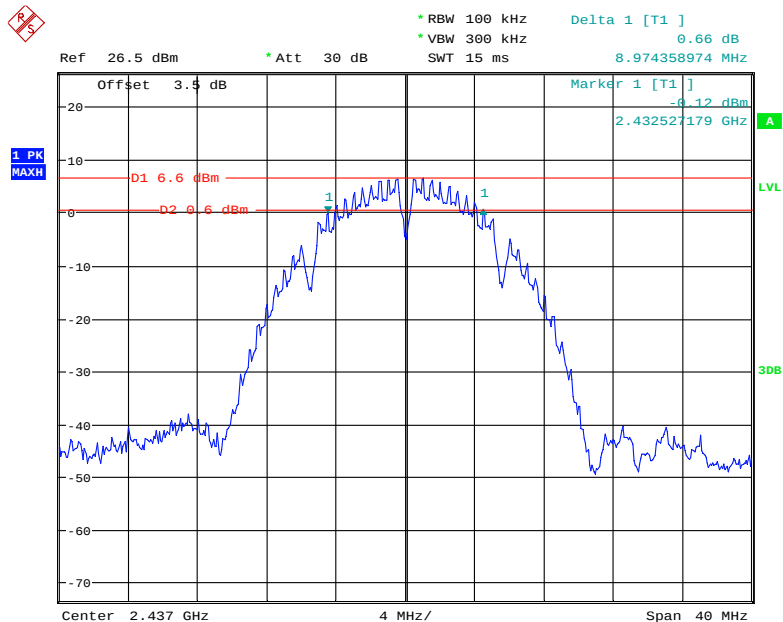
Channel	Frequency (MHz)	6 dB Emission Bandwidth(MHz)	99% OBW (MHz)	Limit (kHz)
LoRa mode-Internal transmit antenna				
Low	923.3	0.638	0.504	≥500
High	927.5	0.640	0.506	≥500
LoRa mode- External transmit antenna				
Low	923.3	0.638	0.504	≥500
High	927.5	0.636	0.504	≥500

6dB Bandwidth, 802.11b Low Channel



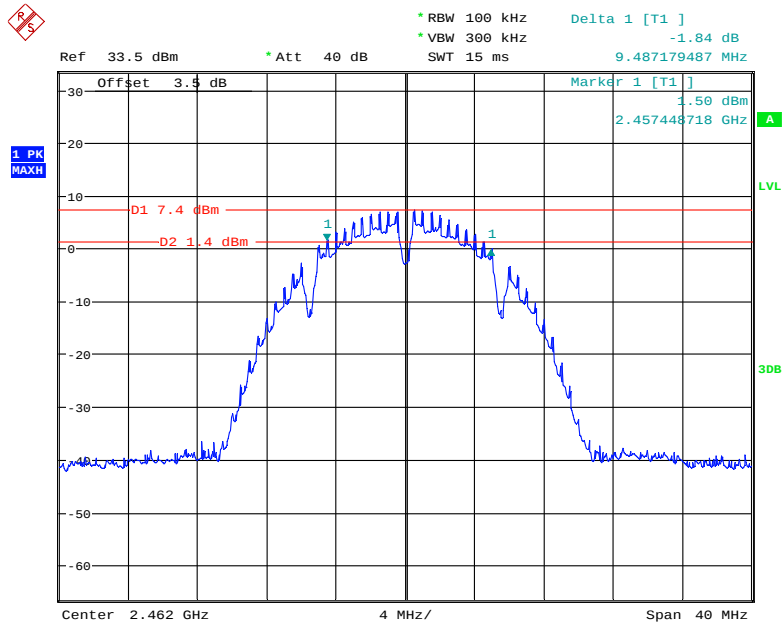
Date: 13.OCT.2020 14:44:28

6dB Bandwidth, 802.11b Middle Channel



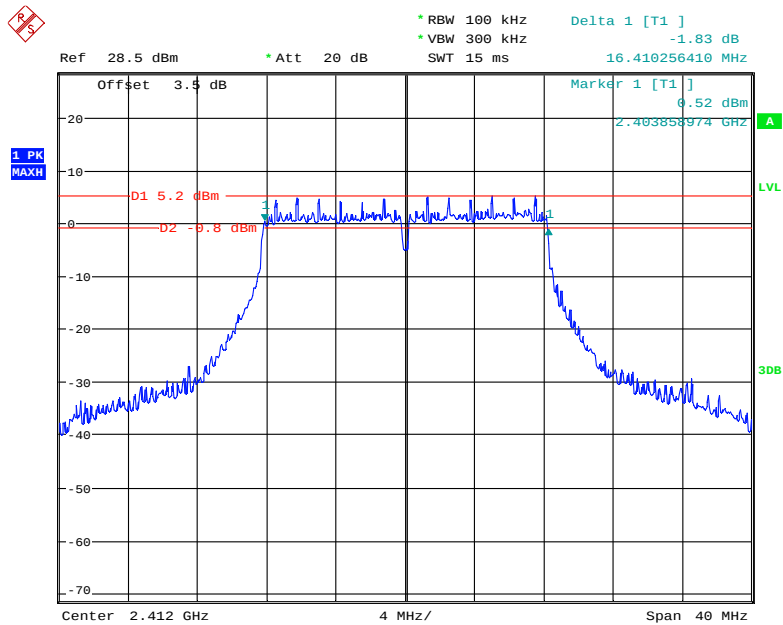
Date: 3.FEB.2021 17:48:18

6dB Bandwidth, 802.11b High Channel



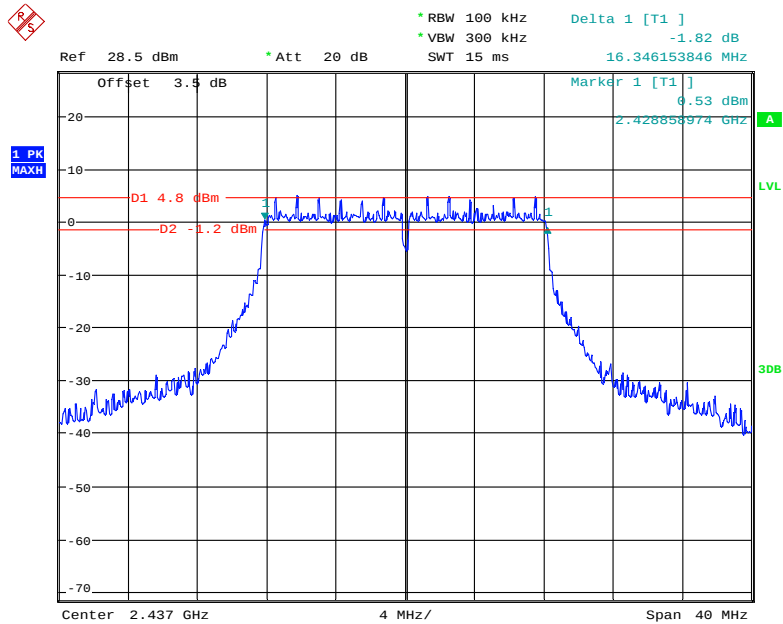
Date: 13.OCT.2020 15:13:00

6dB Bandwidth, 802.11g Low Channel



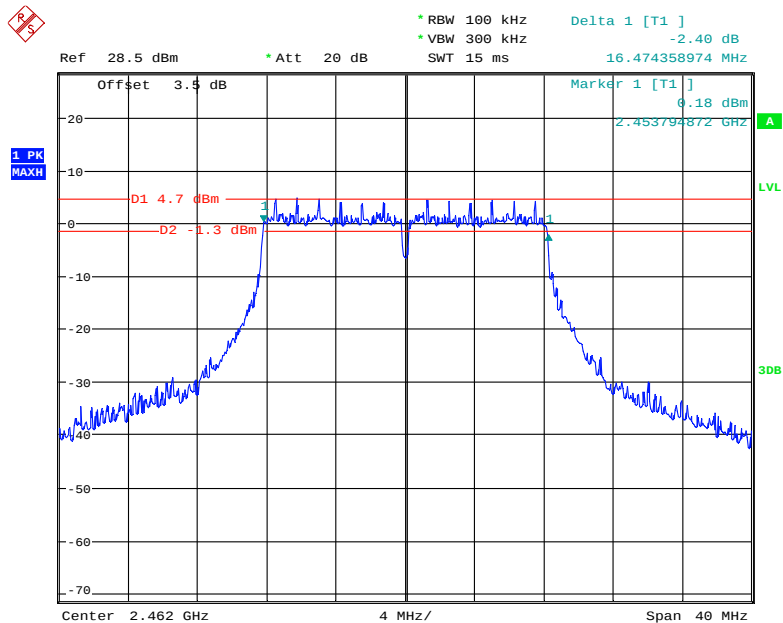
Date: 13.OCT.2020 14:46:00

6dB Bandwidth, 802.11g Middle Channel



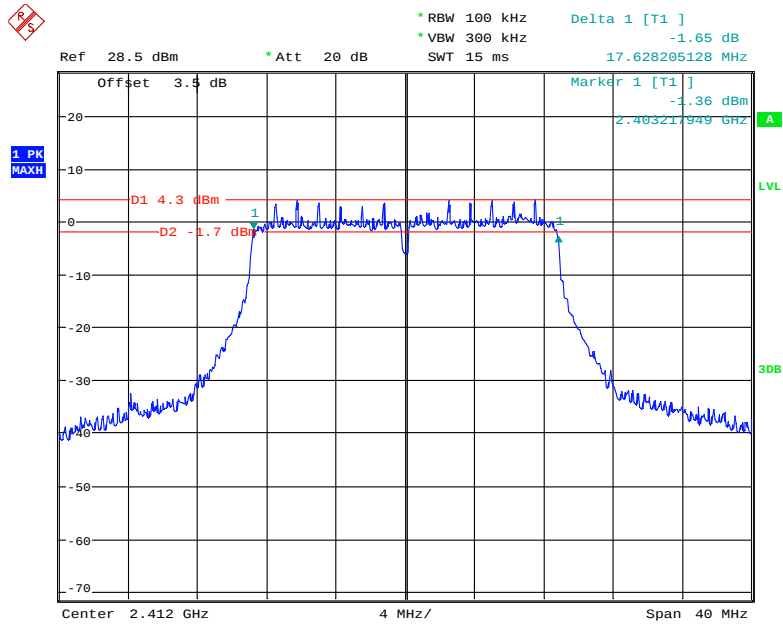
Date: 13.OCT.2020 14:49:05

6dB Bandwidth, 802.11g High Channel



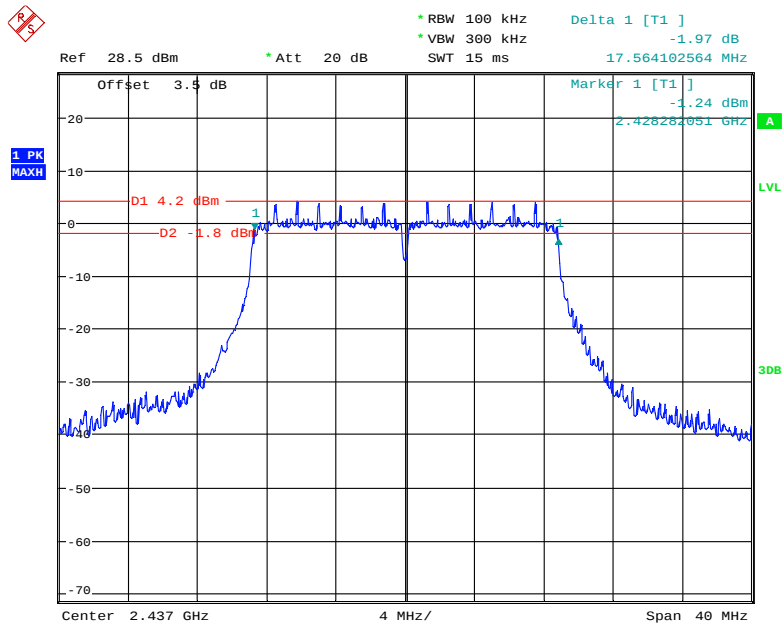
Date: 13.OCT.2020 14:51:42

6dB Bandwidth, 802.11n-HT20 Low Channel



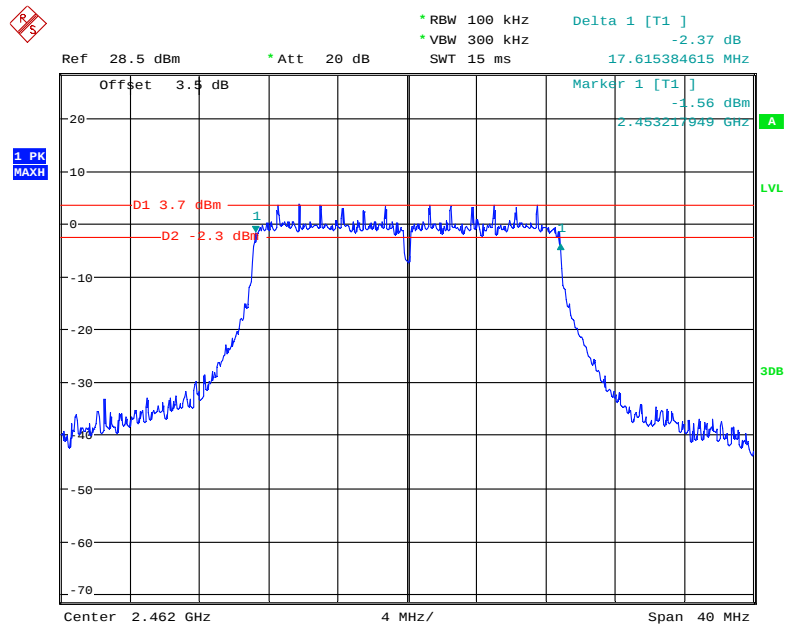
Date: 13.OCT.2020 14:46:54

6dB Bandwidth, 802.11n-HT20 Middle Channel



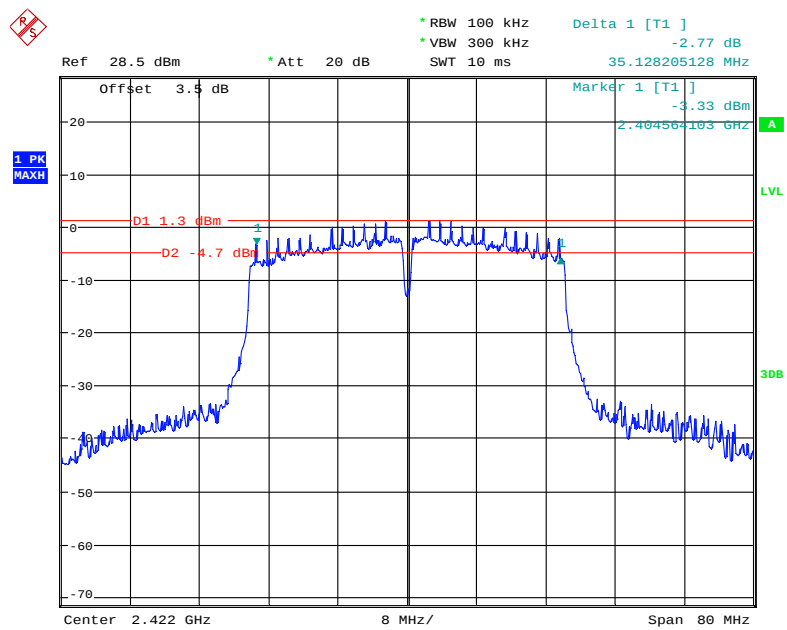
Date: 13.OCT.2020 14:48:16

6dB Bandwidth, 802.11n-HT20 High Channel



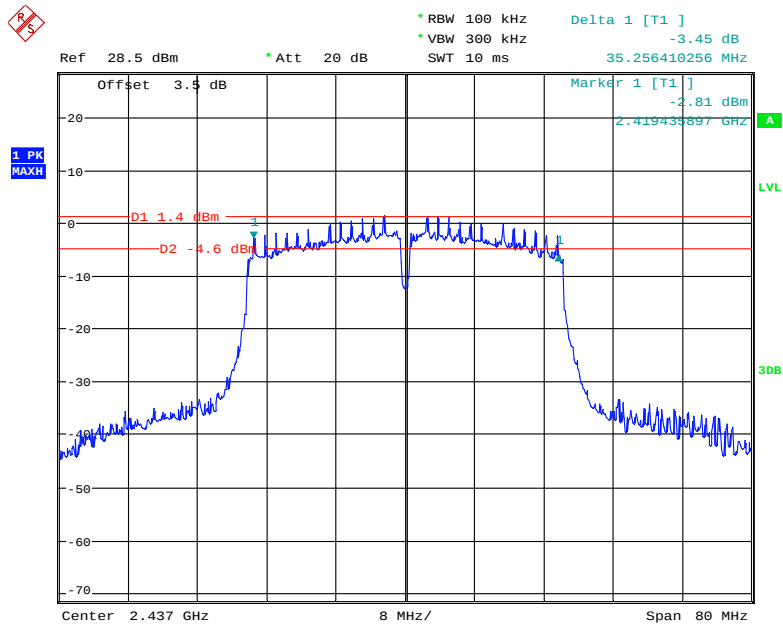
Date: 13.OCT.2020 14:52:41

6dB Bandwidth, 802.11n-HT40 Low Channel



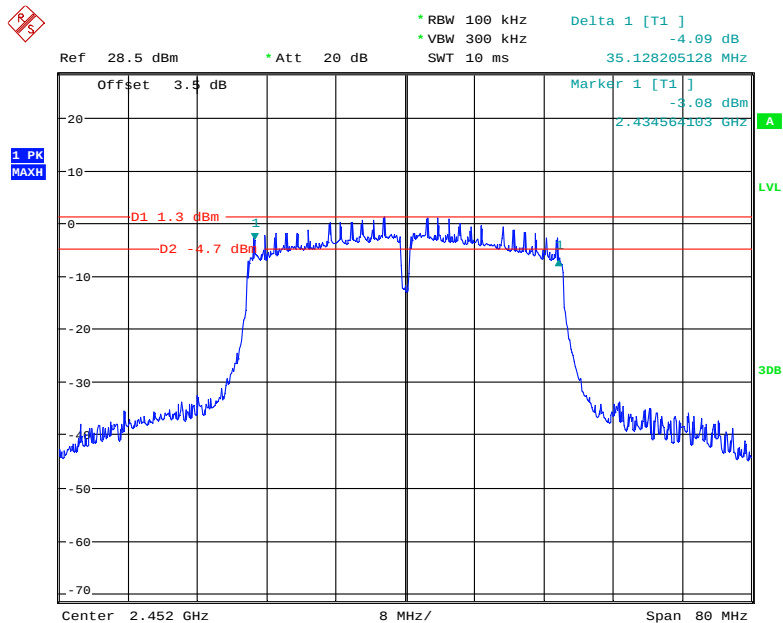
Date: 29.JAN.2021 16:11:55

6dB Bandwidth, 802.11n-HT40 Middle Channel



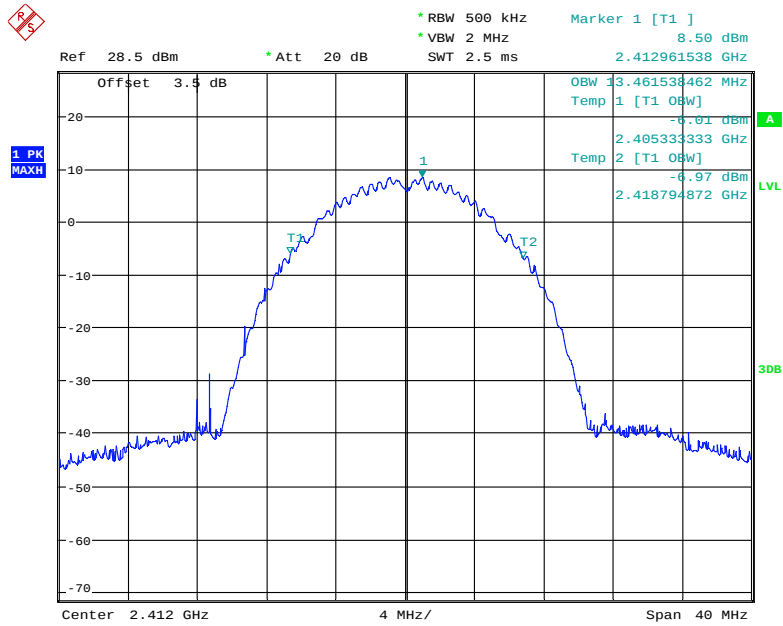
Date: 29.JAN.2021 16:11:07

6dB Bandwidth, 802.11n-HT40 High Channel



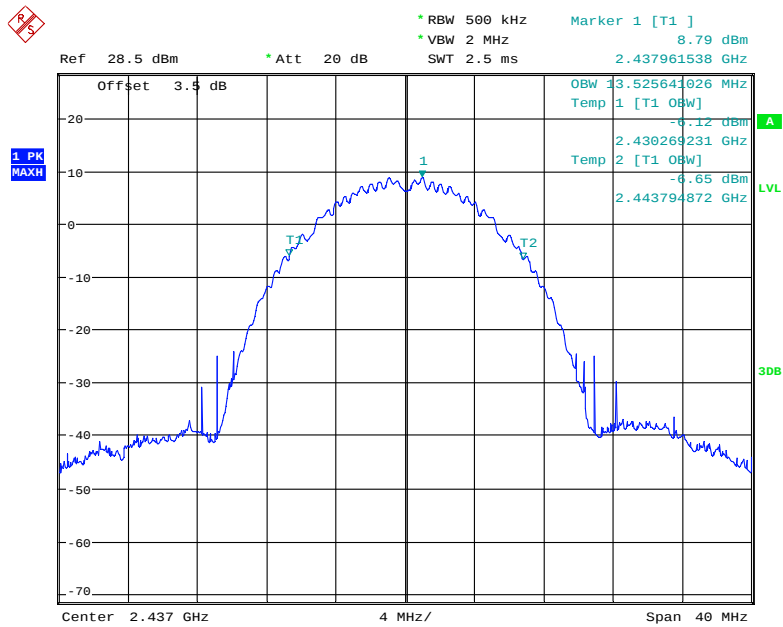
Date: 29.JAN.2021 16:12:43

99% Occupied Bandwidth, 802.11b Low Channel



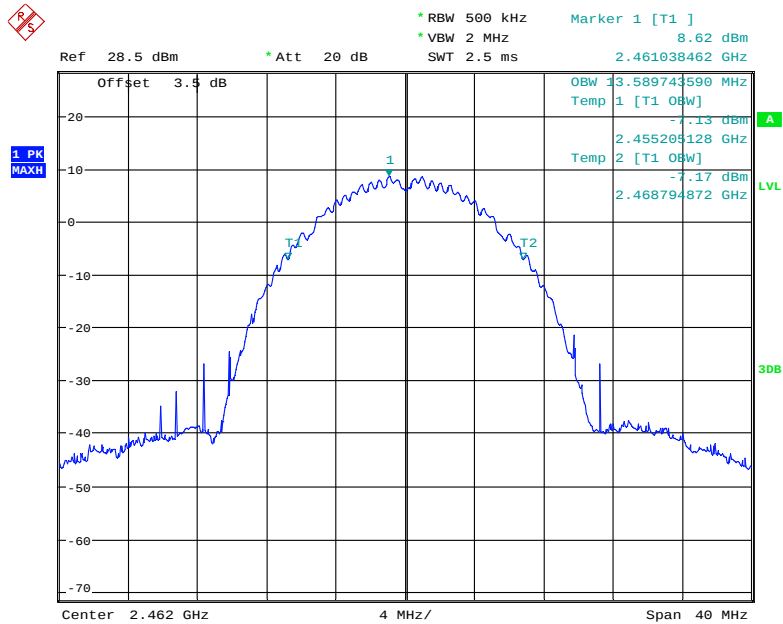
Date: 13.OCT.2020 14:58:31

99% Occupied Bandwidth, 802.11b Middle Channel



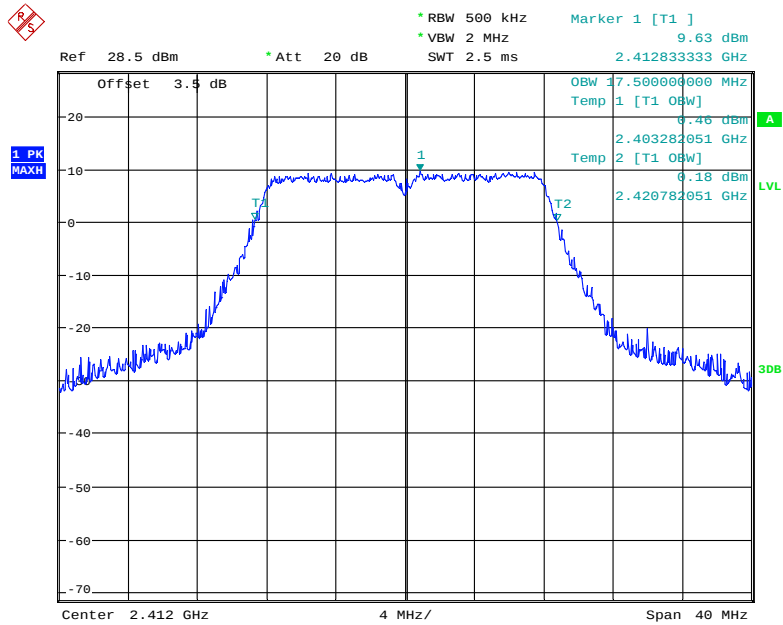
Date: 13.OCT.2020 14:56:19

99% Occupied Bandwidth, 802.11b High Channel



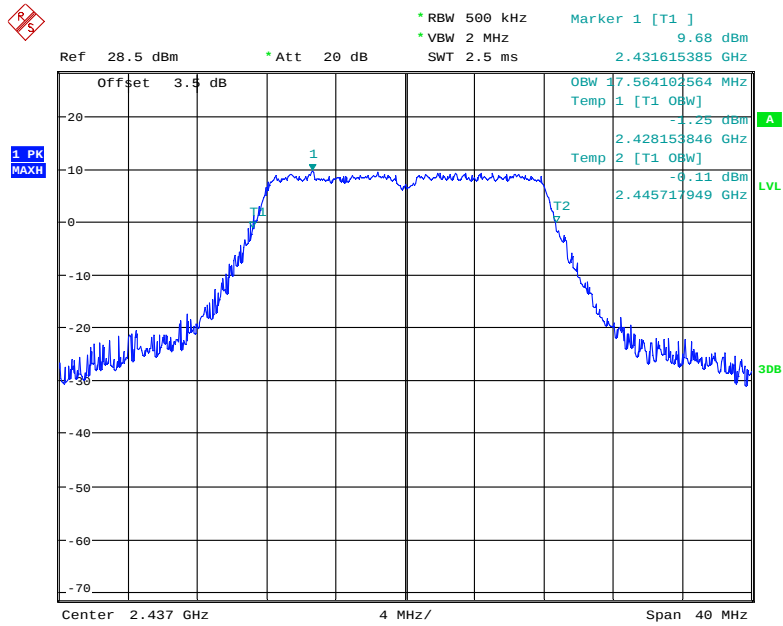
Date: 13.OCT.2020 14:55:30

99% Occupied Bandwidth, 802.11g Low Channel



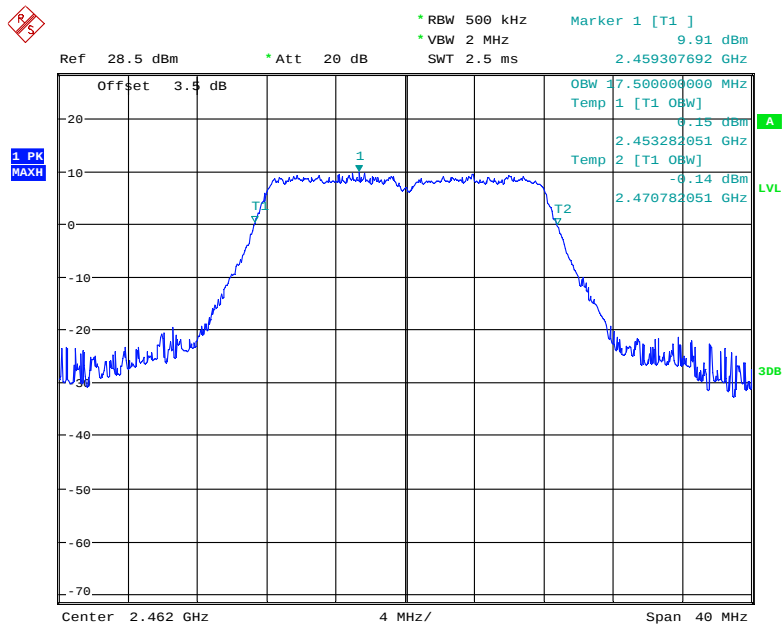
Date: 13.OCT.2020 14:58:11

99% Occupied Bandwidth, 802.11g Middle Channel



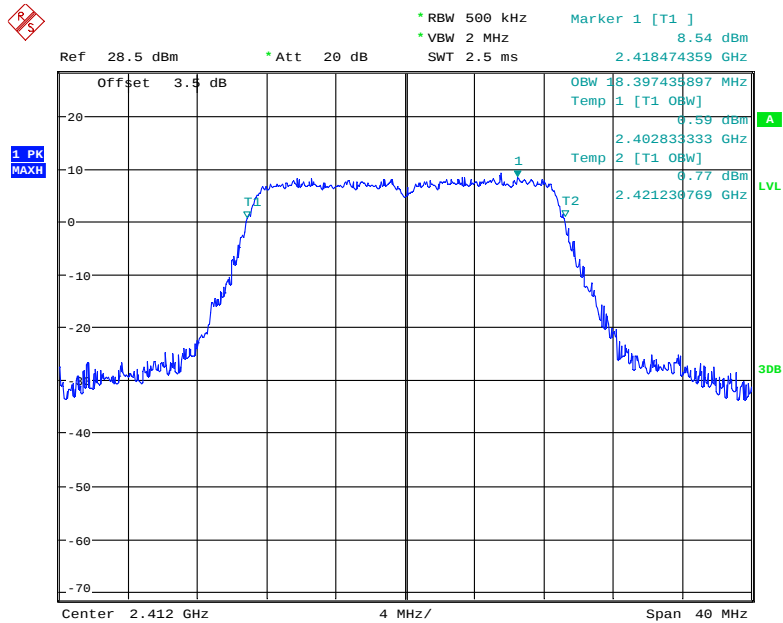
Date: 13.OCT.2020 14:56:40

99% Occupied Bandwidth, 802.11g High Channel



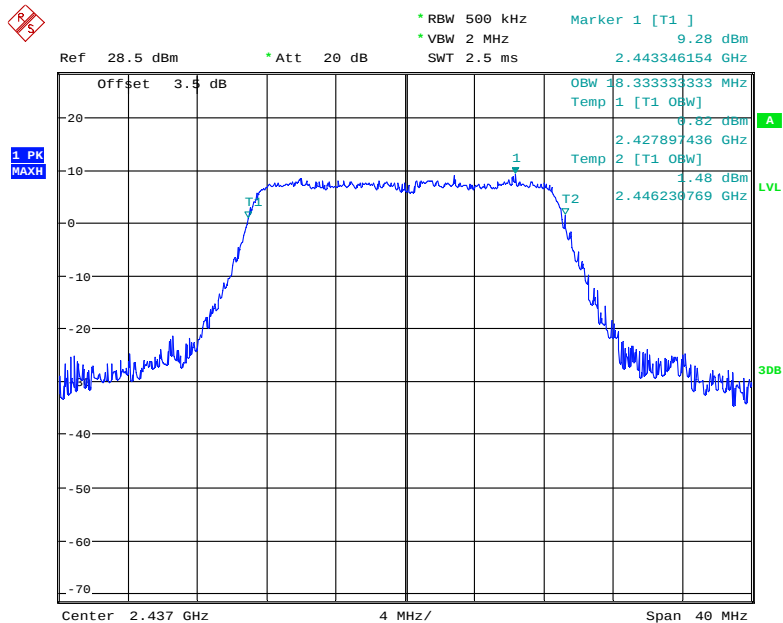
Date: 13.OCT.2020 14:55:02

99% Occupied Bandwidth, 802.11n-HT20 Low Channel



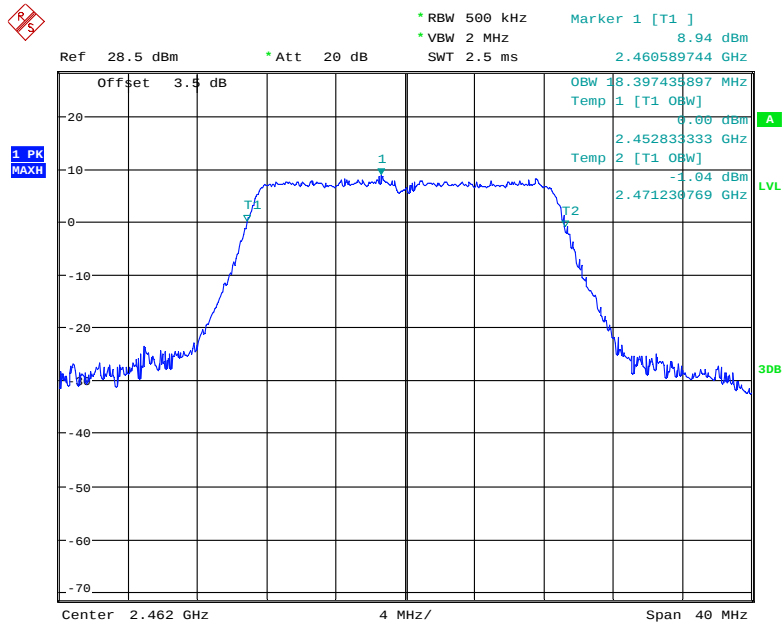
Date: 13.OCT.2020 14:57:48

99% Occupied Bandwidth, 802.11n-HT20 Middle Channel



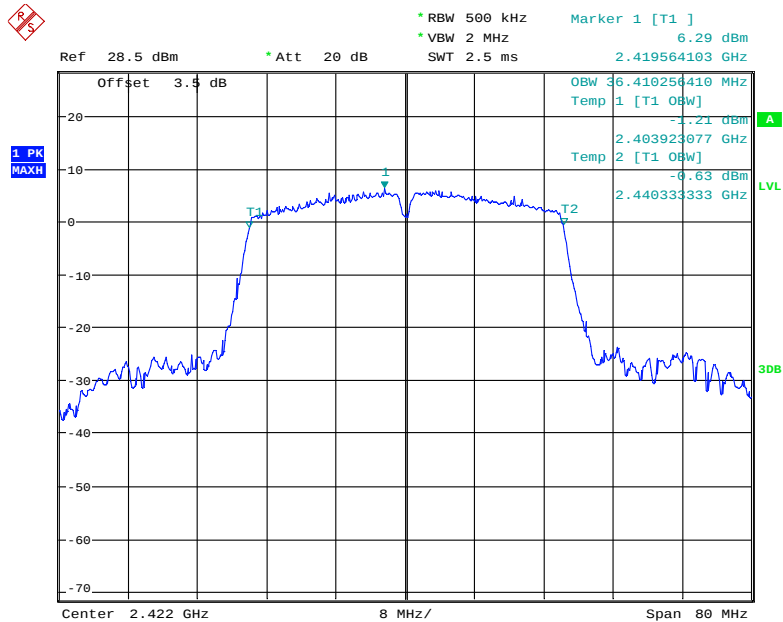
Date: 13.OCT.2020 14:57:10

99% Occupied Bandwidth, 802.11n-HT20 High Channel



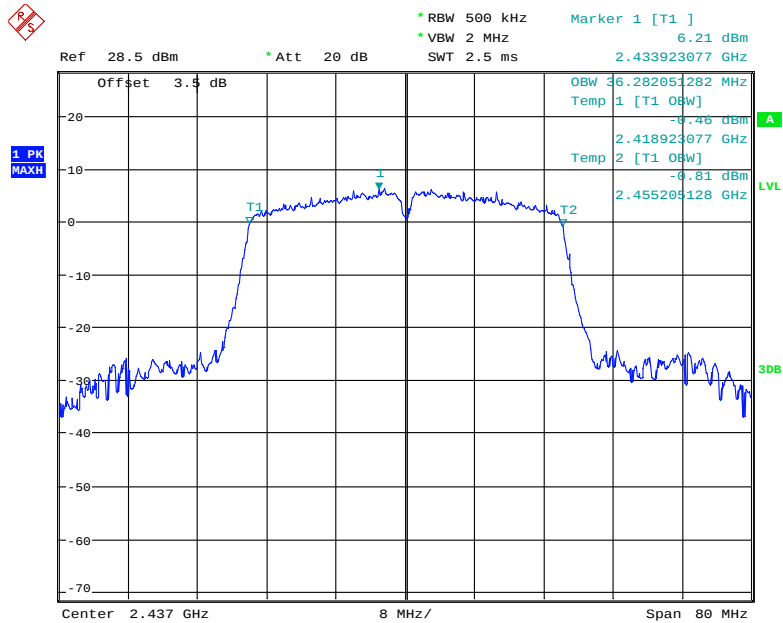
Date: 13.OCT.2020 14:54:22

99% Occupied Bandwidth, 802.11n-HT40 Low Channel



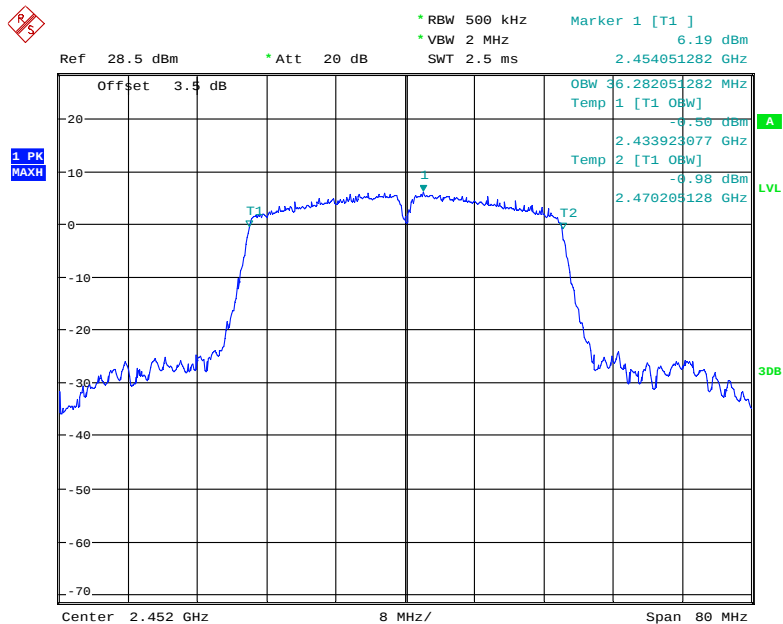
Date: 29.JAN.2021 16:15:03

99% Occupied Bandwidth, 802.11n-HT40 Middle Channel



Date: 29.JAN.2021 16:14:40

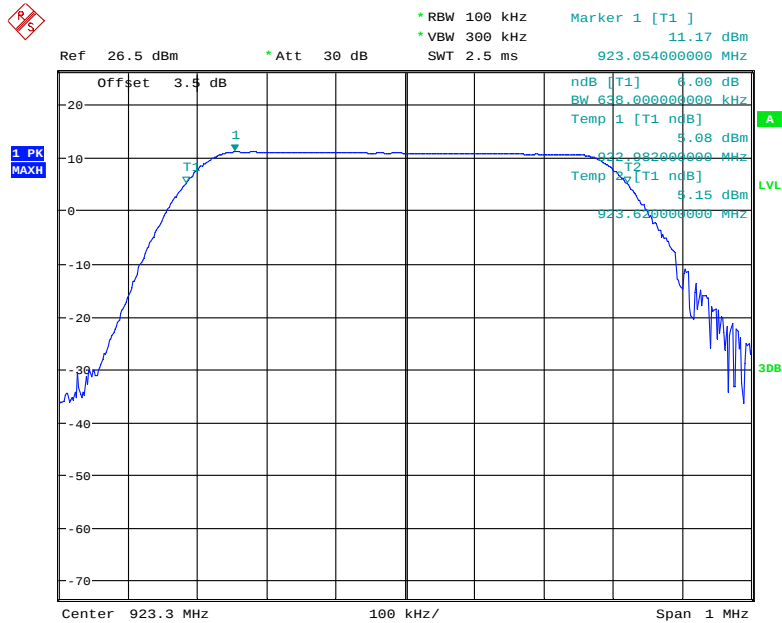
99% Occupied Bandwidth, 802.11n-HT40 High Channel



Date: 29.JAN.2021 16:13:44

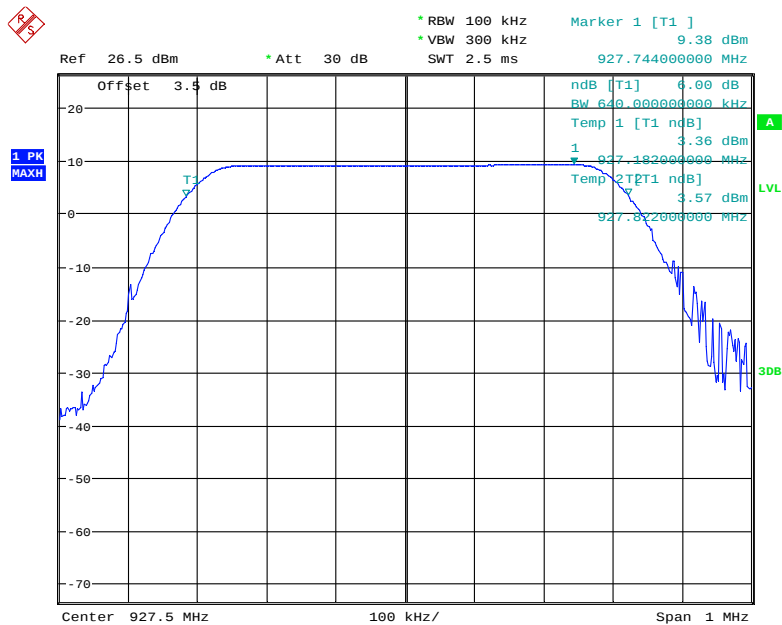
LoRa mode-Internal transmit antenna

6dB Bandwidth, Low Channel



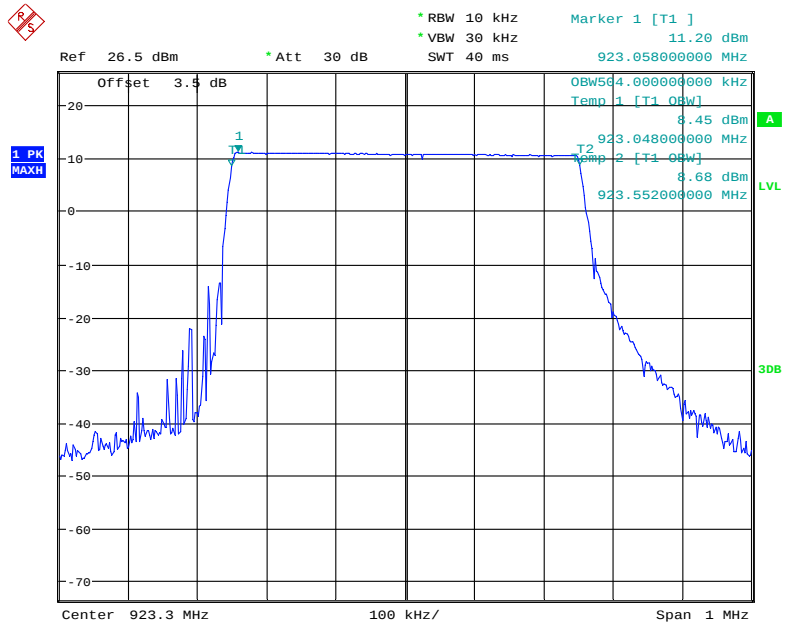
Date: 3.FEB.2021 16:06:47

6dB Bandwidth, High Channel



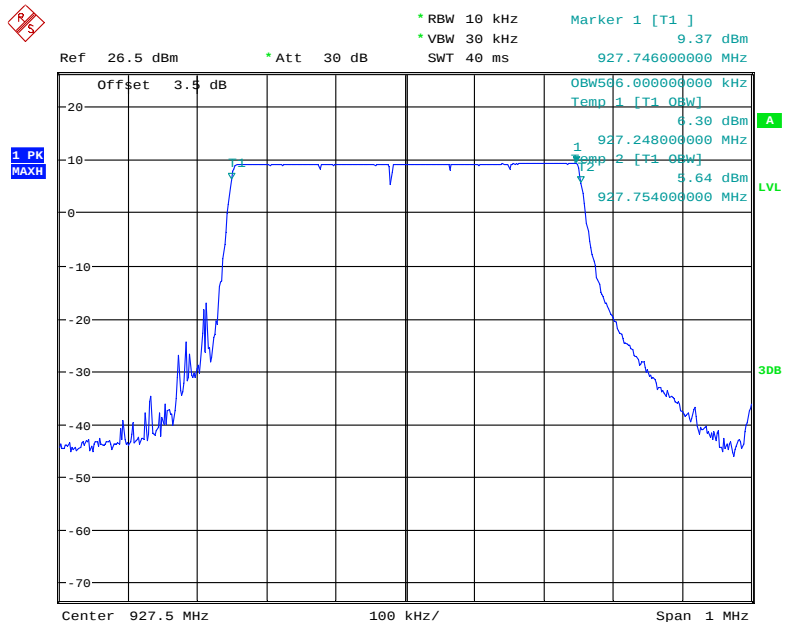
Date: 3.FEB.2021 16:08:31

99% Occupied Bandwidth Low Channel



Date: 3.FEB.2021 17:29:38

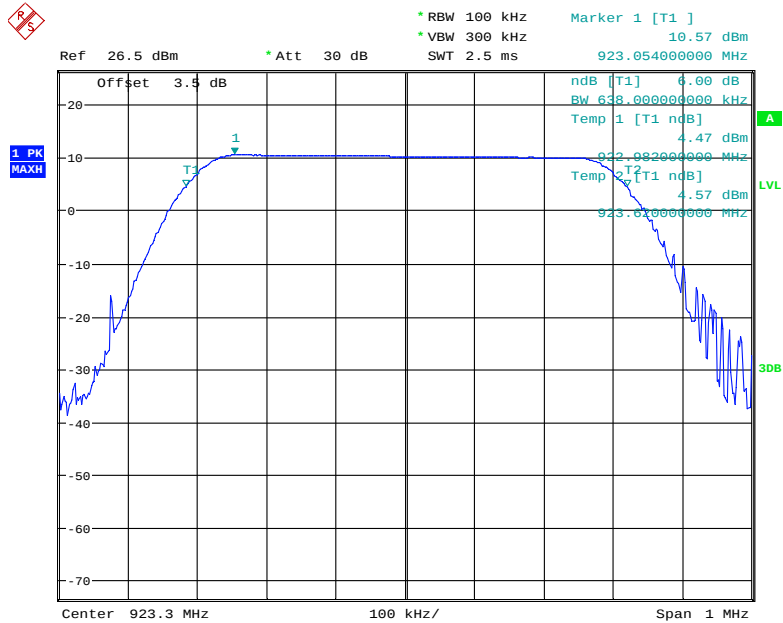
99% Occupied Bandwidth High Channel



Date: 3.FEB.2021 17:27:30

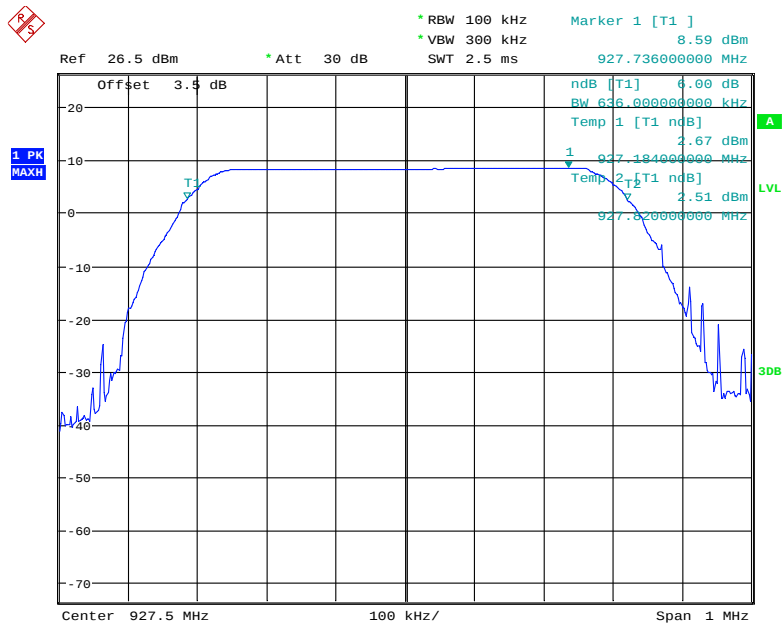
LoRa mode- External transmit antenna

6dB Bandwidth, Low Channel



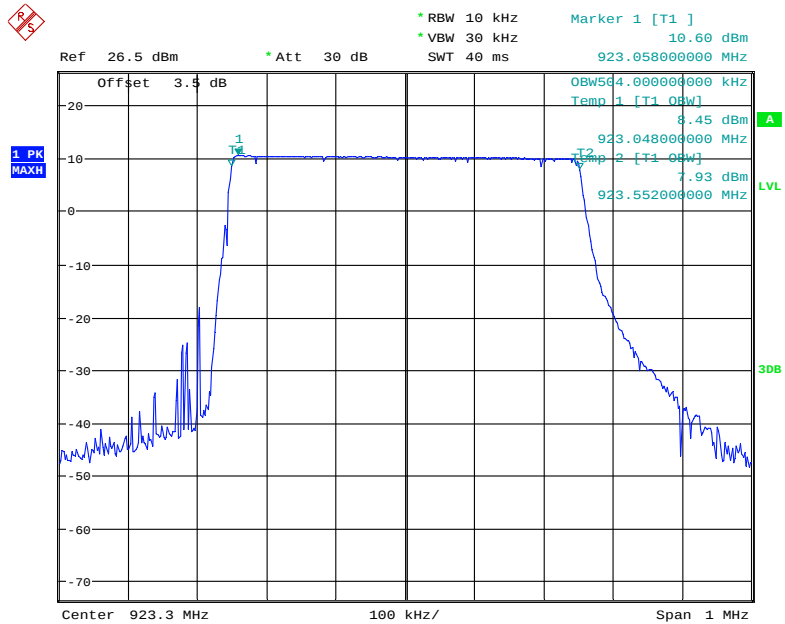
Date: 3.FEB.2021 16:39:49

6dB Bandwidth, High Channel



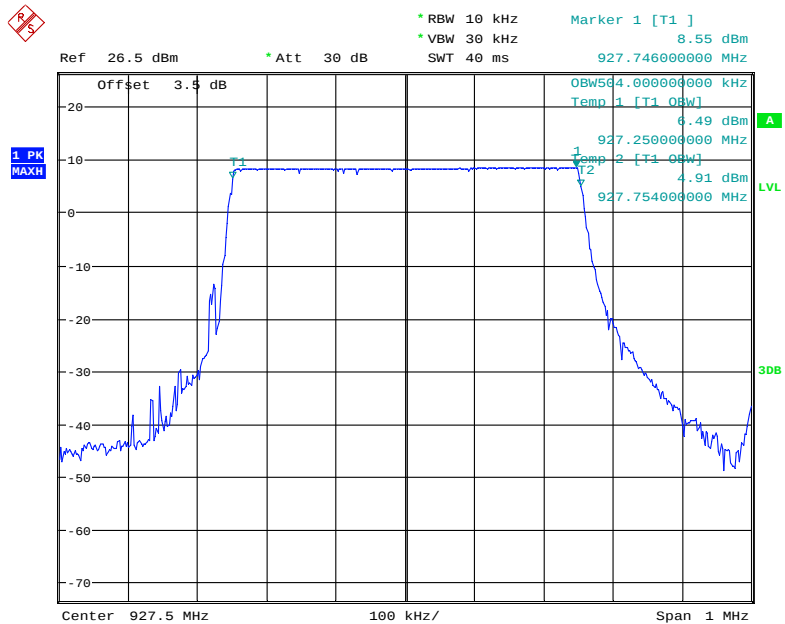
Date: 3.FEB.2021 16:38:37

99% Occupied Bandwidth Low Channel



Date: 3.FEB.2021 17:23:45

99% Occupied Bandwidth High Channel



Date: 3.FEB.2021 17:25:41

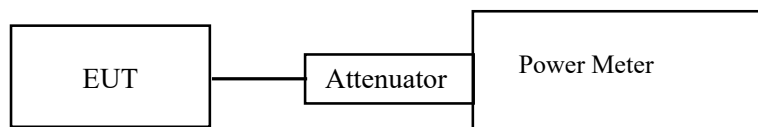
FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

Applicable Standard

According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. 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.

Test Procedure

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.



Test Data

Environmental Conditions

Temperature:	24~25 °C
Relative Humidity:	50~55 %
ATM Pressure:	101.0 kPa

The testing was performed by Coco Liu from 2020-10-13 to 2021-02-03.

EUT operation mode: Transmitting

Wi-Fi mode

Channel	Frequency (MHz)	Max Conducted Peak Output Power (dBm)	Max Conducted Average Output Power (dBm)	Limit (dBm)
802.11b				
Low	2412	17.55	14.55	30
Middle	2437	17.80	14.81	30
High	2462	17.65	14.79	30
802.11g				
Low	2412	16.34	9.78	30
Middle	2437	16.64	9.99	30
High	2462	16.69	9.94	30
802.11n HT20				
Low	2412	16.81	9.63	30
Middle	2437	16.81	10.00	30
High	2462	16.67	9.90	30
802.11n HT40				
Low	2422	16.65	9.68	30
Middle	2437	16.88	10.20	30
High	2452	16.90	10.14	30

LoRa mode-Internal transmit antenna

Channel	Frequency (MHz)	Max Average Output Power (dBm)	Limit (dBm)	Result
Low	923.3	11.47	30	Pass
High	927.5	9.51	30	Pass

LoRa mode- External transmit antenna

Channel	Frequency (MHz)	Max Average Output Power (dBm)	Limit (dBm)	Result
Low	923.3	10.81	30	Pass
High	927.5	8.74	30	Pass

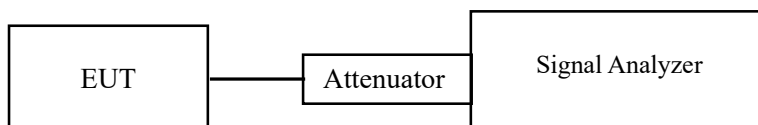
FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

Applicable Standard

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)).

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.



Test Data

Environmental Conditions

Temperature:	24~25 °C
Relative Humidity:	50~55 %
ATM Pressure:	101.0 kPa

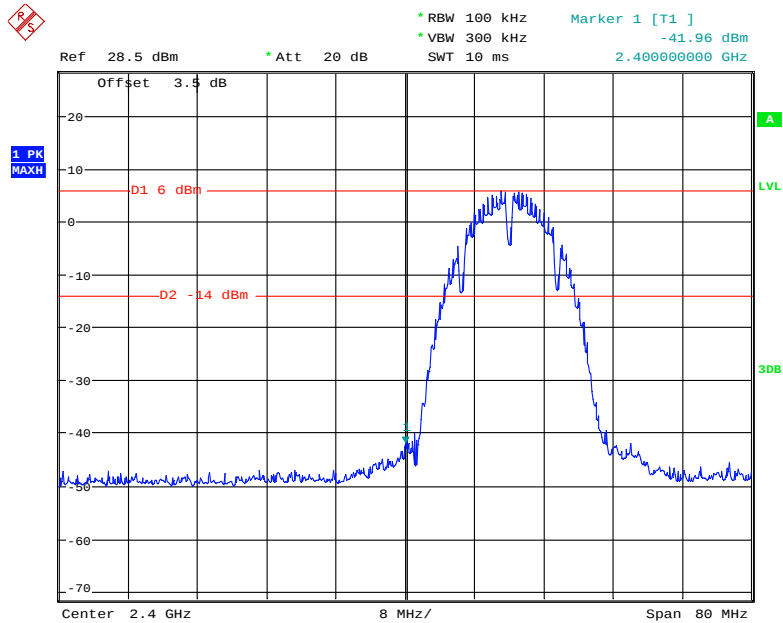
The testing was performed by Coco Liu from 2020-10-13 to 2021-02-03.

EUT operation mode: Transmitting

Test Result: Compliance

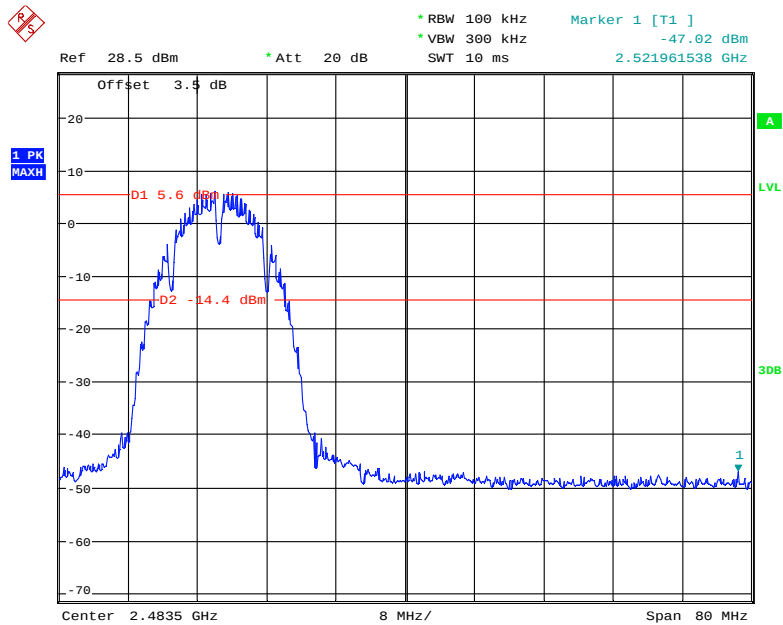
Please refer to the following plots.

802.11b: Band Edge, Left Side



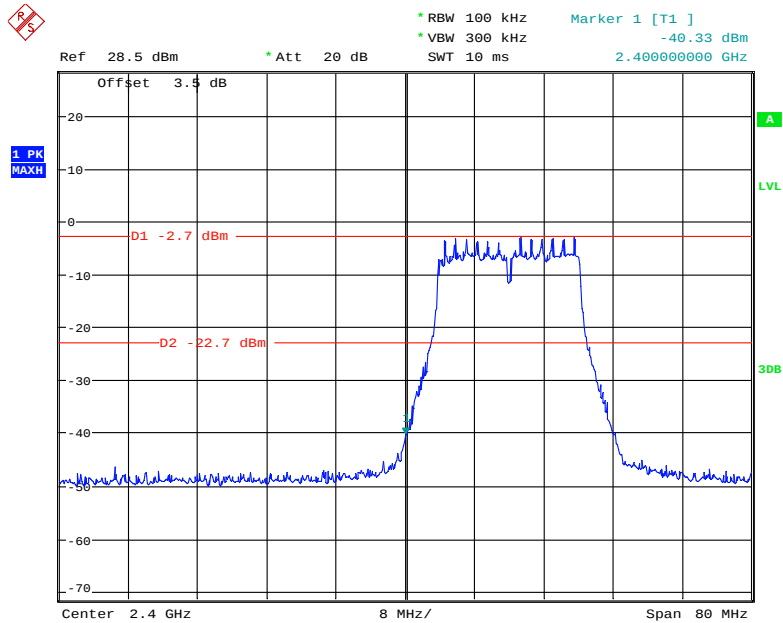
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802.11b: Band Edge, Right Side



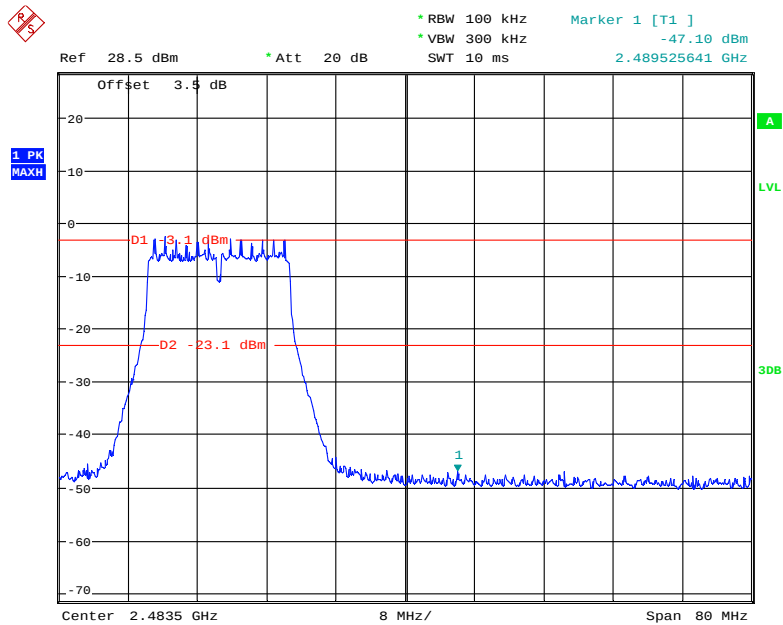
Date: 13.OCT.2020 14:30:33

802.11g: Band Edge, Left Side



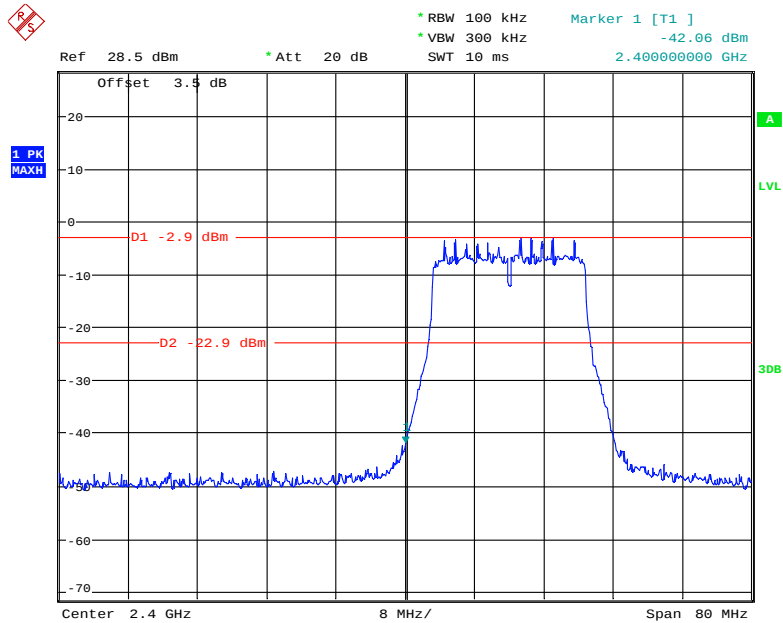
Date: 13.OCT.2020 14:24:30

802.11g: Band Edge, Right Side



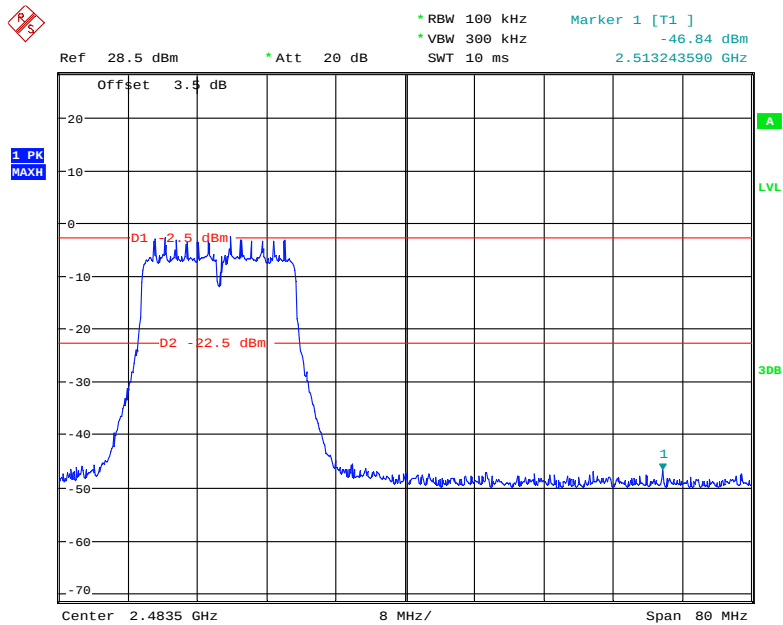
Date: 13.OCT.2020 14:29:38

802.11n-HT20: Band Edge, Left Side



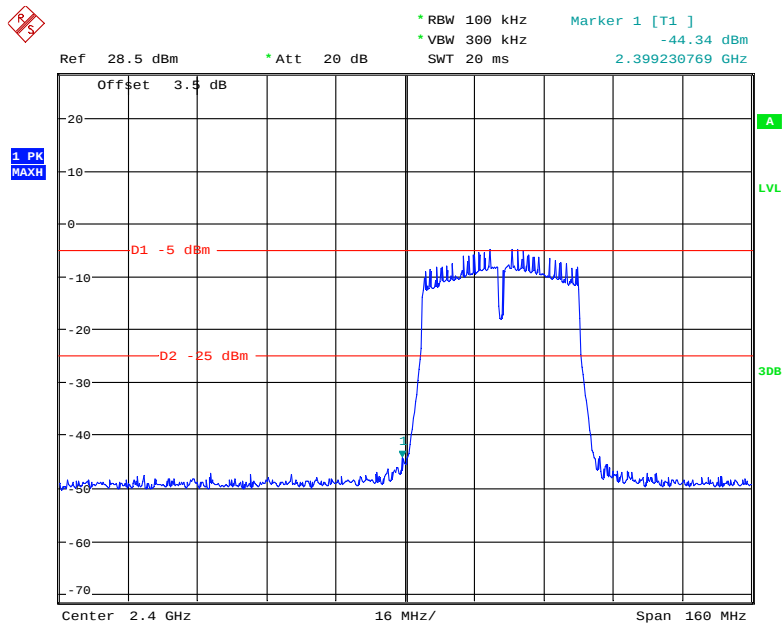
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802.11n-HT20: Band Edge, Right Side



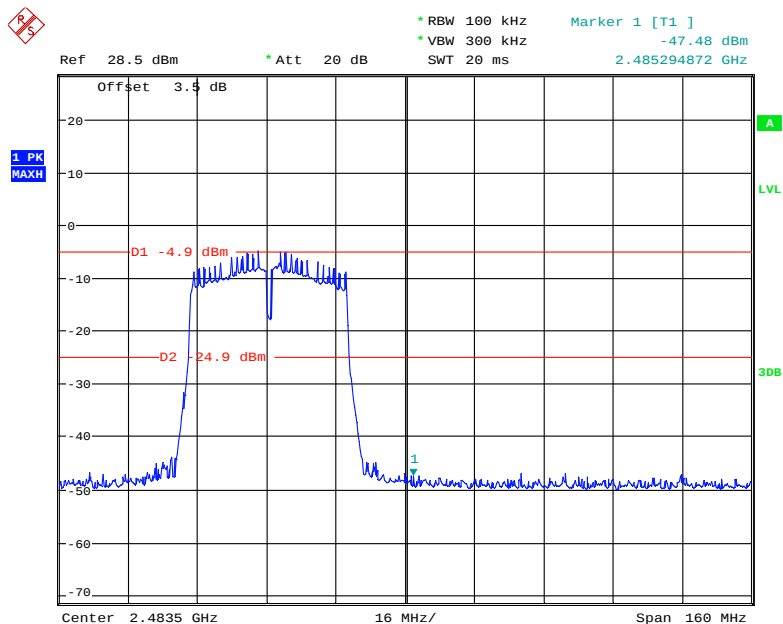
Date: 13.OCT.2020 14:28:44

802.11n-HT40: Band Edge, Left Side

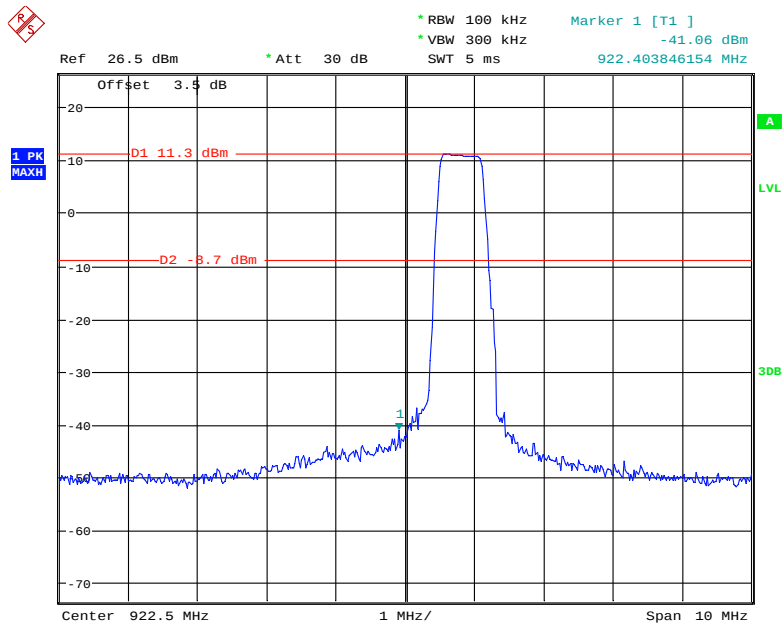


Date: 29.JAN.2021 16:06:36

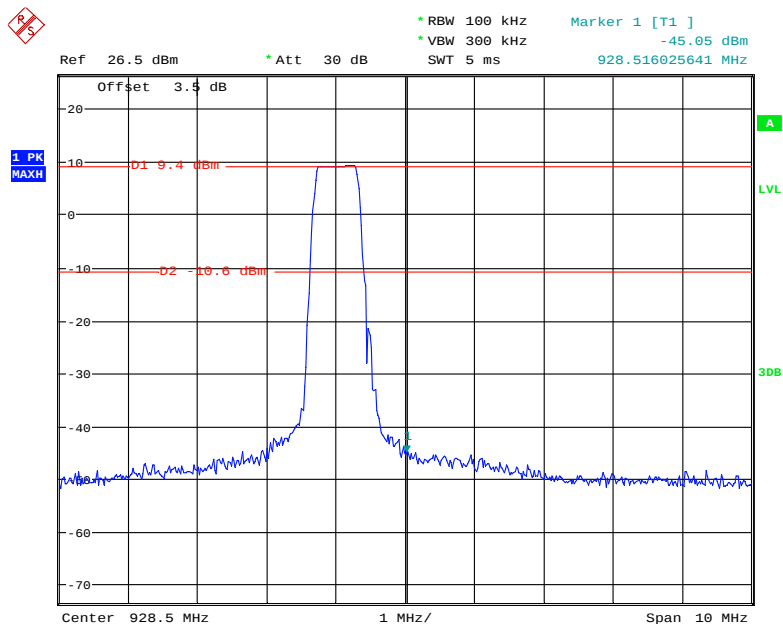
802.11n-HT40: Band Edge, Right Side



Date: 29.JAN.2021 16:05:54

LoRa mode-Internal transmit antenna**Band Edge, Left Side**

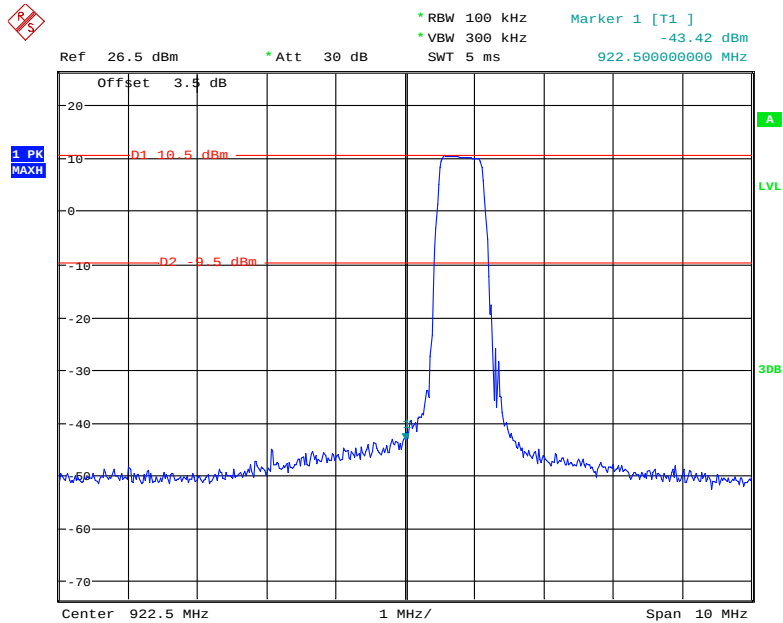
Date: 3.FEB.2021 16:11:16

LoRa: Band Edge, Right Side

Date: 3.FEB.2021 16:10:06

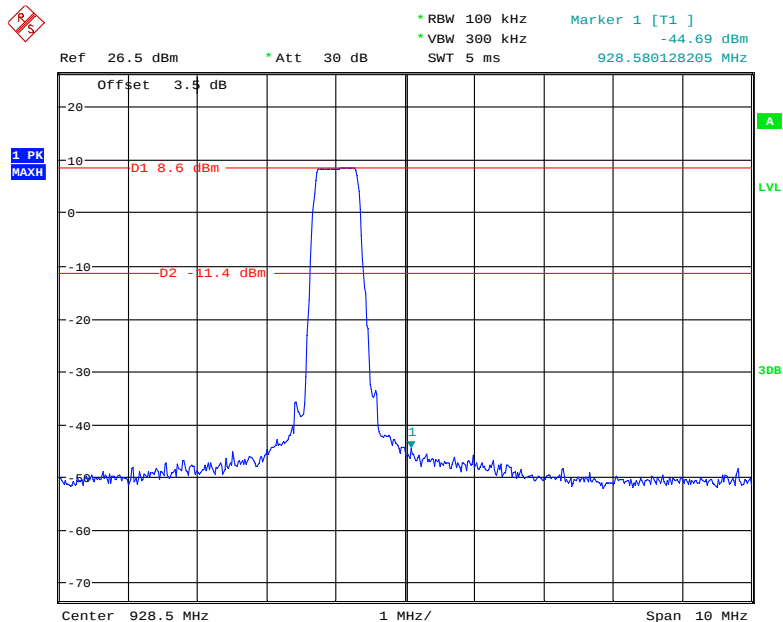
LoRa mode-External transmit antenna

Band Edge, Left Side



Date: 3.FEB.2021 16:40:42

LoRa: Band Edge, Right Side



Date: 3.FEB.2021 16:41:57

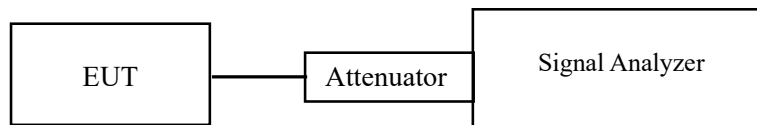
FCC §15.247(e) - POWER SPECTRAL DENSITY

Applicable Standard

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.

Test Procedure

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW to: $3\text{kHz} \leq \text{RBW} \leq 100\text{ kHz}$.
3. Set the VBW $\geq 3 \times \text{RBW}$.
4. Set the span to 1.5 times the DTS bandwidth.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.



Test Data

Environmental Conditions

Temperature:	24~25 °C
Relative Humidity:	50~55 %
ATM Pressure:	101.0 kPa

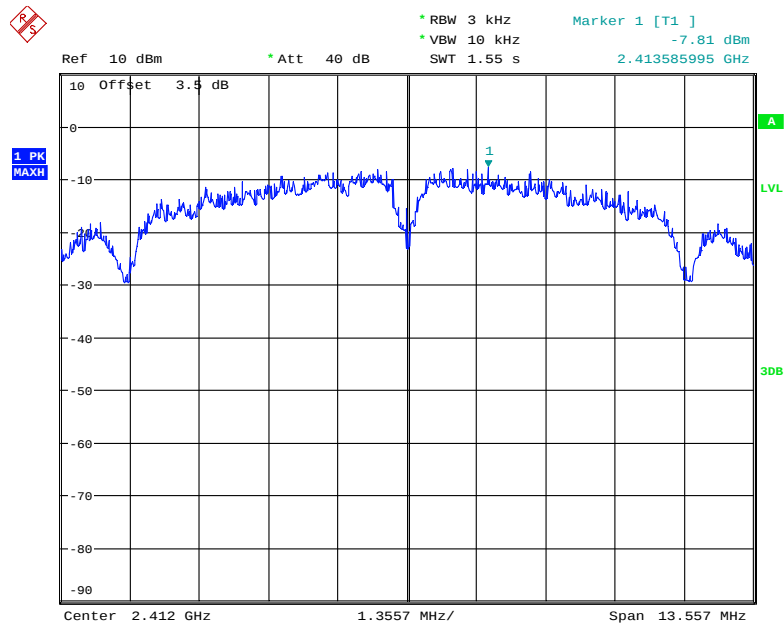
The testing was performed by Coco Liu from 2020-10-13 to 2021-02-03.

EUT operation mode: Transmitting

Test Result: Pass

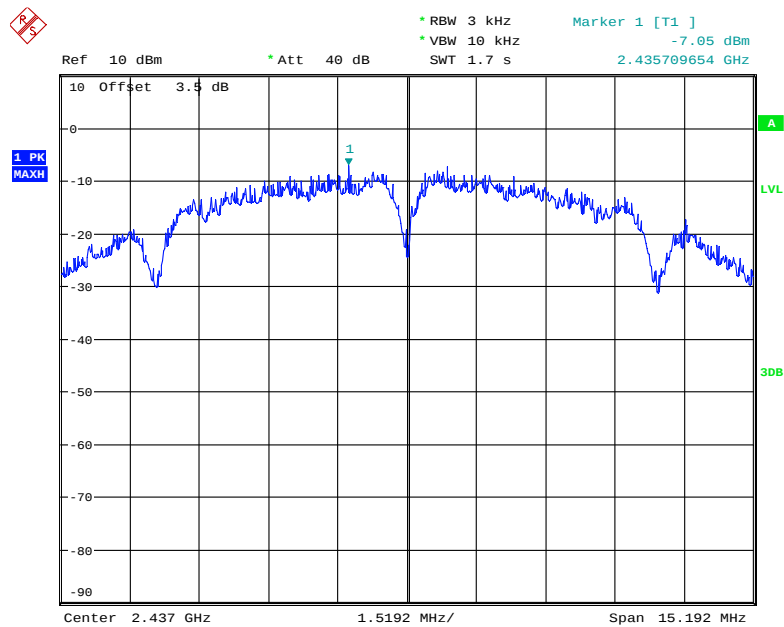
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
802.11b mode			
Low	2412	-7.81	≤ 8
Middle	2437	-7.05	≤ 8
High	2462	-7.29	≤ 8
802.11g mode			
Low	2412	-9.12	≤ 8
Middle	2437	-10.41	≤ 8
High	2462	-8.90	≤ 8
802.11n-HT20 mode			
Low	2412	-9.20	≤ 8
Middle	2437	-11.45	≤ 8
High	2462	-10.52	≤ 8
802.11n-HT40 mode			
Low	2422	-11.69	≤ 8
Middle	2437	-11.33	≤ 8
High	2452	-10.94	≤ 8
LoRa mode-Internal transmit antenna			
Low	923.3	7.88	≤ 8
High	927.5	5.78	≤ 8
LoRa mode-External transmit antenna			
Low	923.3	7.28	≤ 8
High	927.5	6.24	≤ 8

Power Spectral Density, 802.11b Low Channel



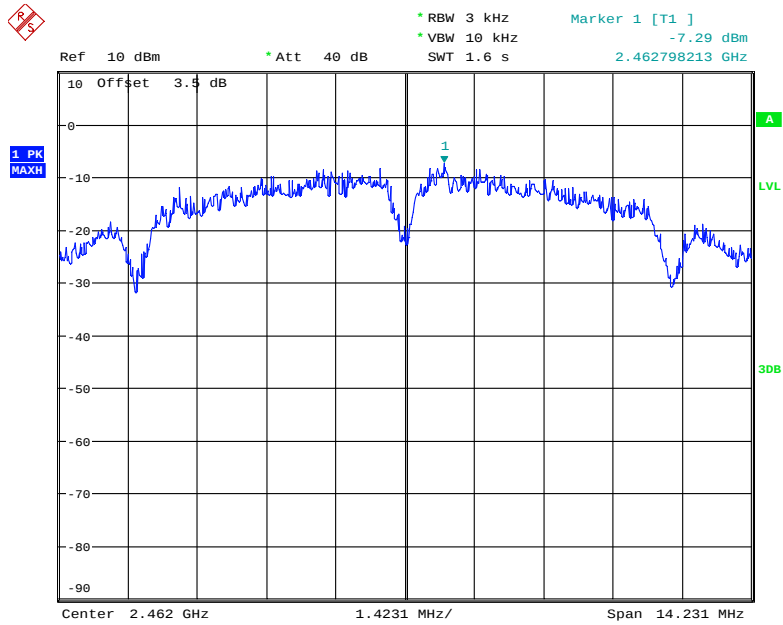
Date: 13.OCT.2020 15:21:48

Power Spectral Density, 802.11b Middle Channel



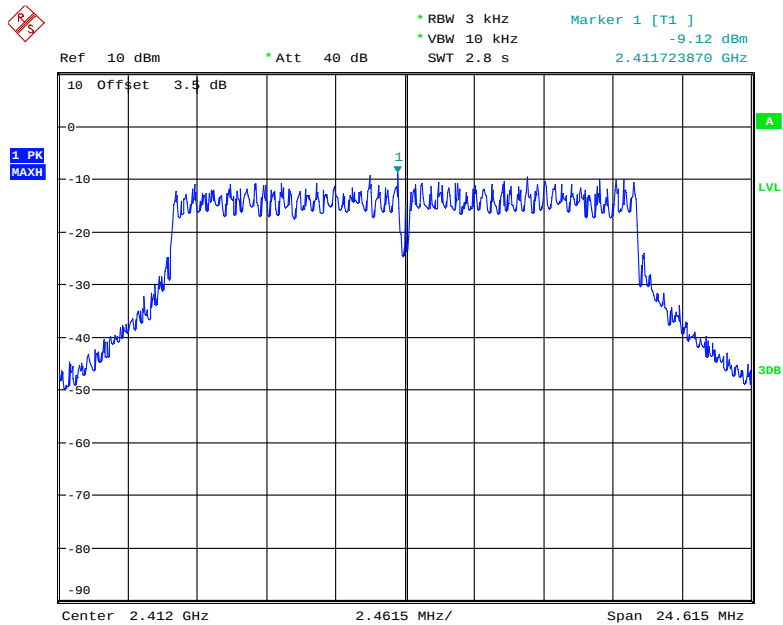
Date: 13.OCT.2020 15:20:40

Power Spectral Density, 802.11b High Channel



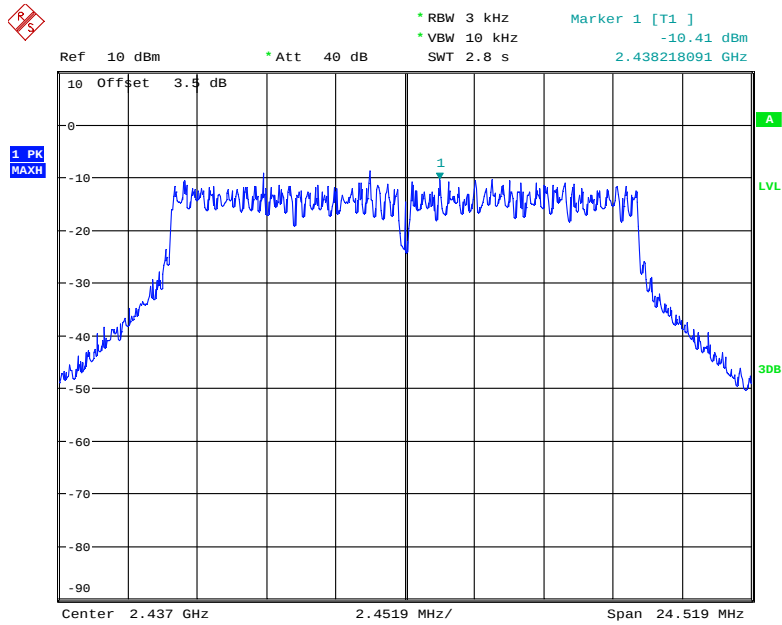
Date: 13.OCT.2020 15:15:07

Power Spectral Density, 802.11g Low Channel



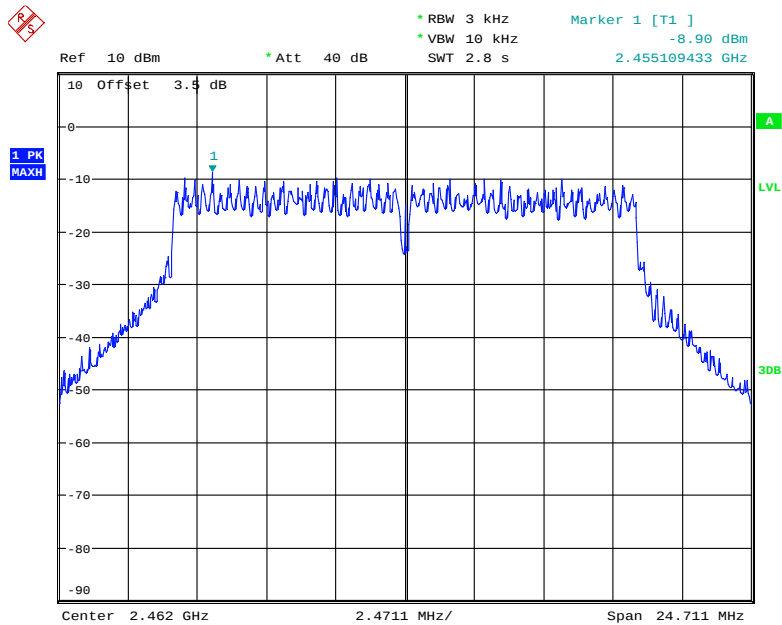
Date: 13.OCT.2020 15:22:32

Power Spectral Density, 802.11g Middle Channel



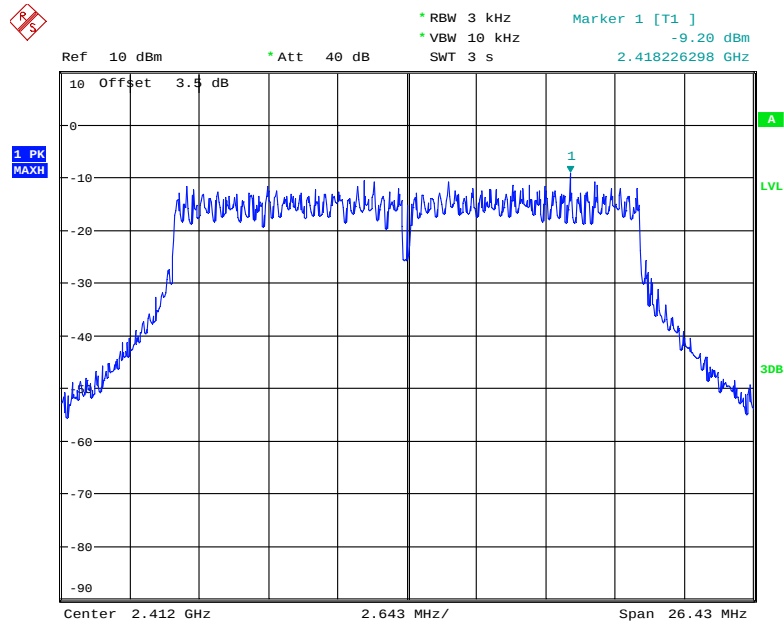
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Power Spectral Density, 802.11g High Channel



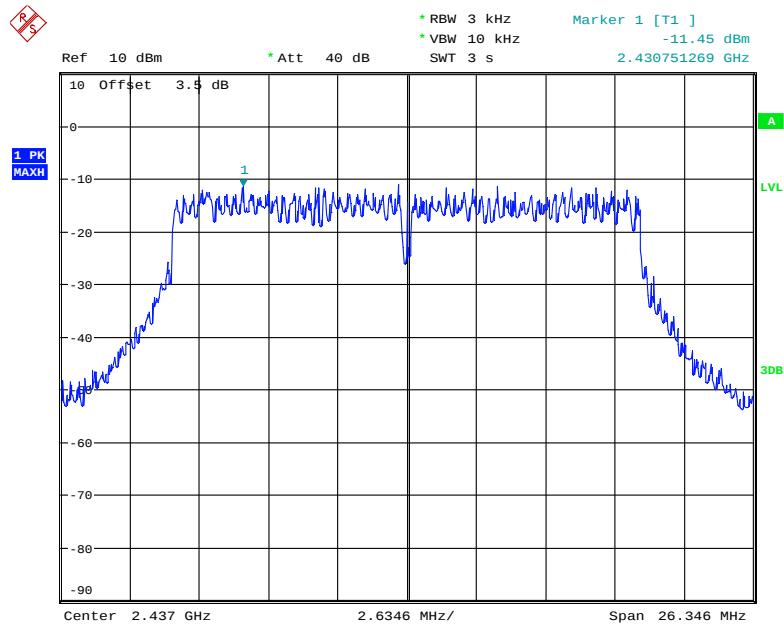
Date: 13.OCT.2020 15:16:59

Power Spectral Density, 802.11n-HT20 Low Channel



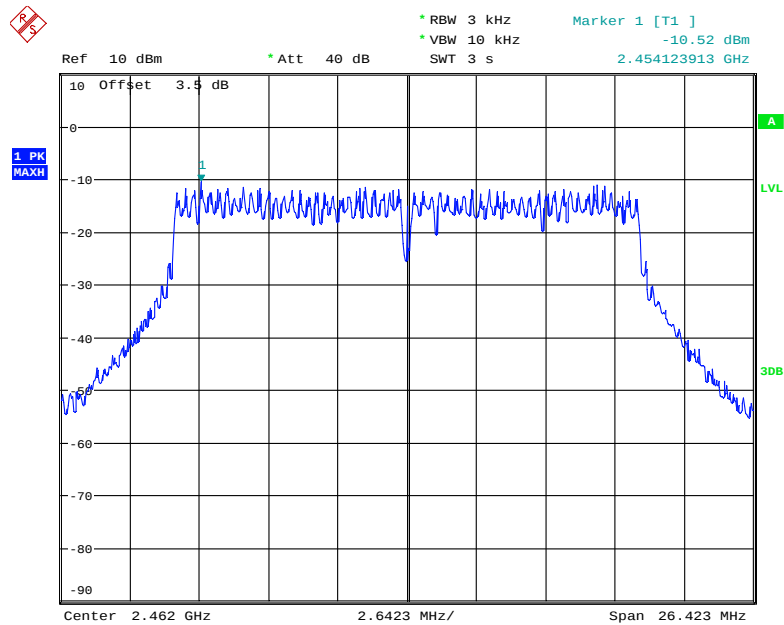
Date: 13.OCT.2020 15:23:24

Power Spectral Density, 802.11n-HT20 Middle Channel



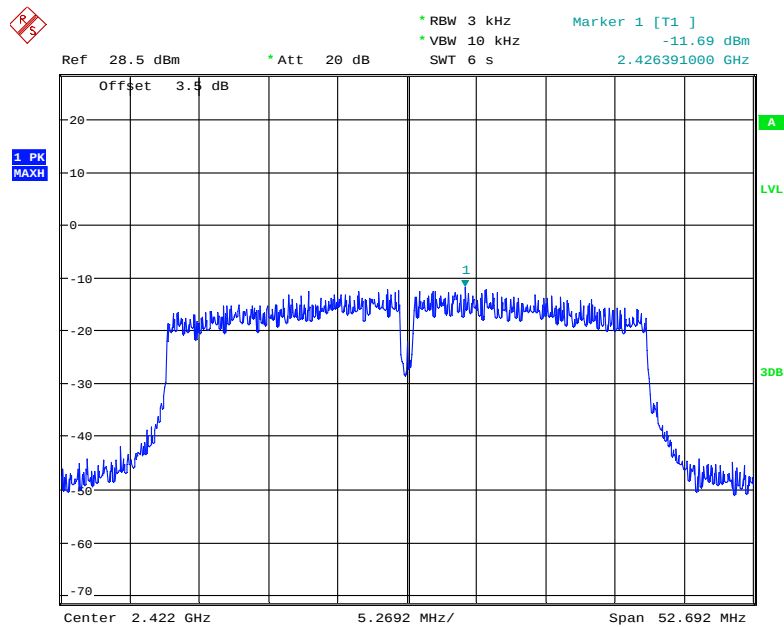
Date: 13.OCT.2020 15:18:59

Power Spectral Density, 802.11n-HT20 High Channel



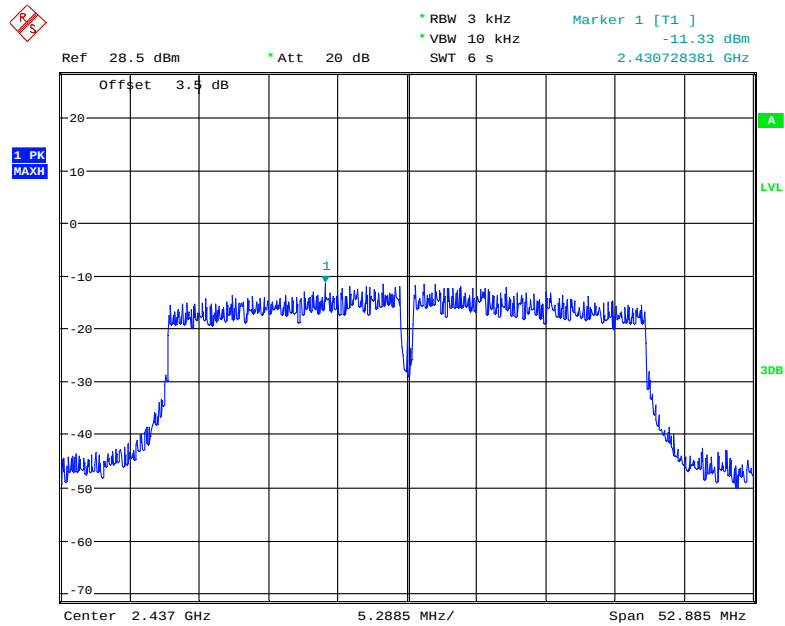
Date: 13.OCT.2020 15:18:04

Power Spectral Density, 802.11n-HT40 Low Channel



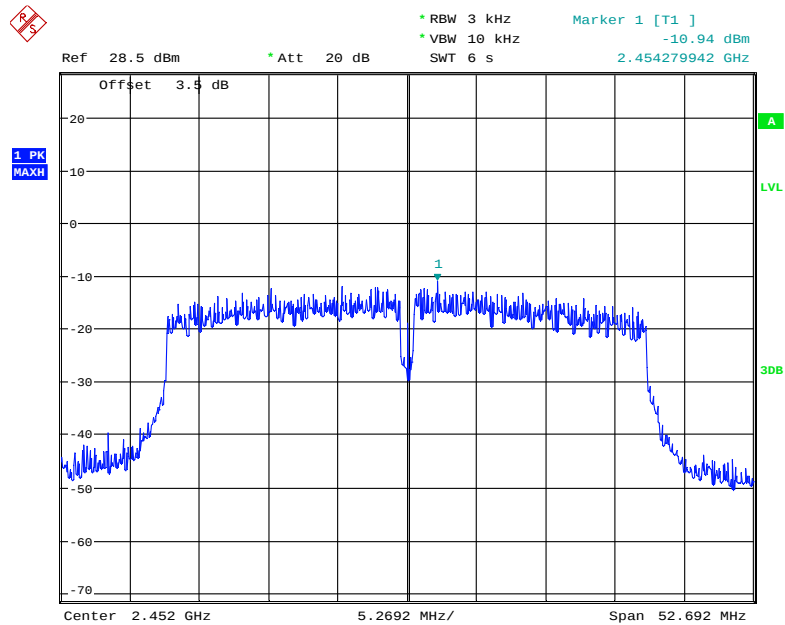
Date: 29.JAN.2021 16:21:14

Power Spectral Density, 802.11n-HT40 Middle Channel



Date: 29.JAN.2021 16:25:03

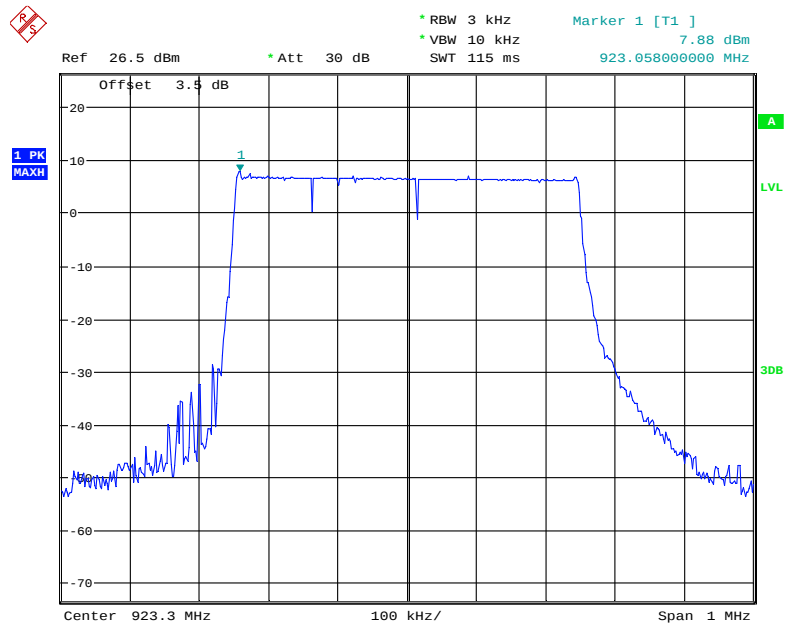
Power Spectral Density, 802.11n-HT40 High Channel



Date: 29.JAN.2021 16:25:59

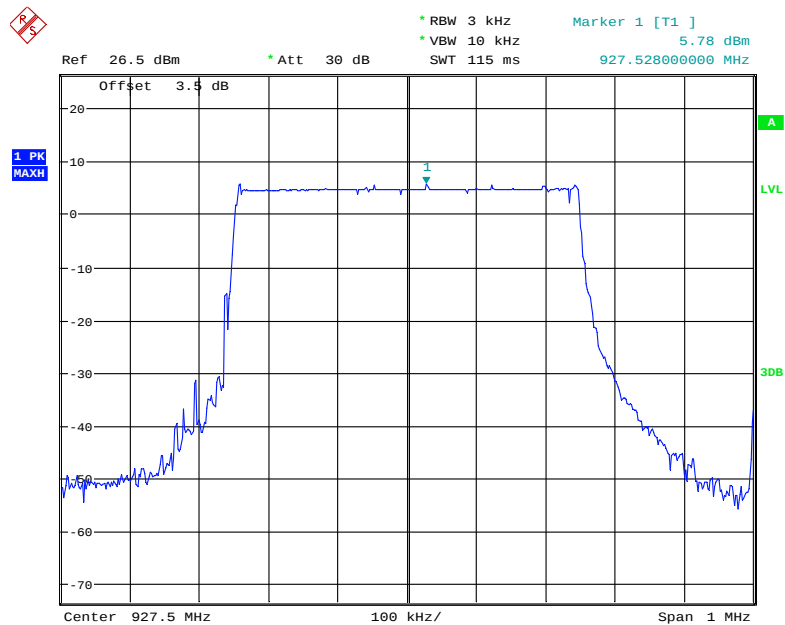
LoRa mode-Internal transmit antenna

Power Spectral Density, Low Channel



Date: 3.FEB.2021 16:00:56

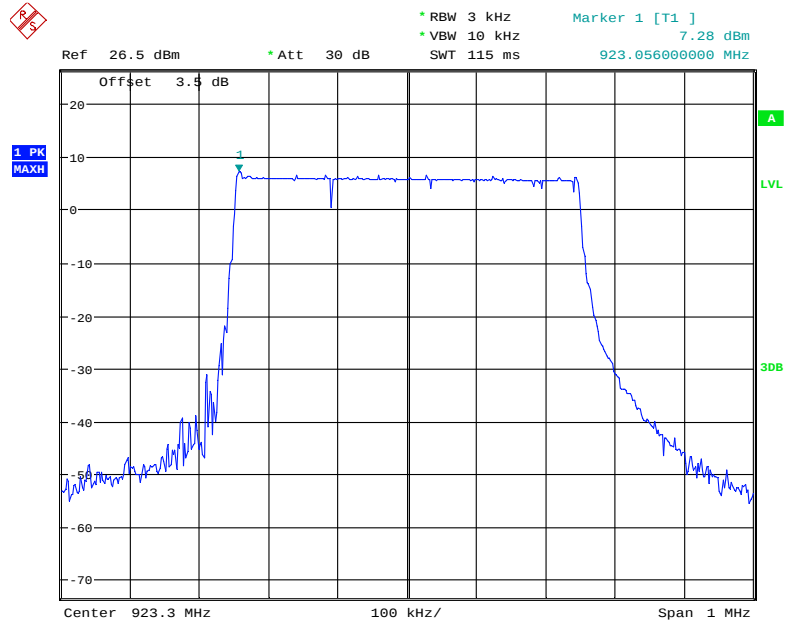
Power Spectral Density, LoRa High Channel



Date: 3.FEB.2021 16:01:48

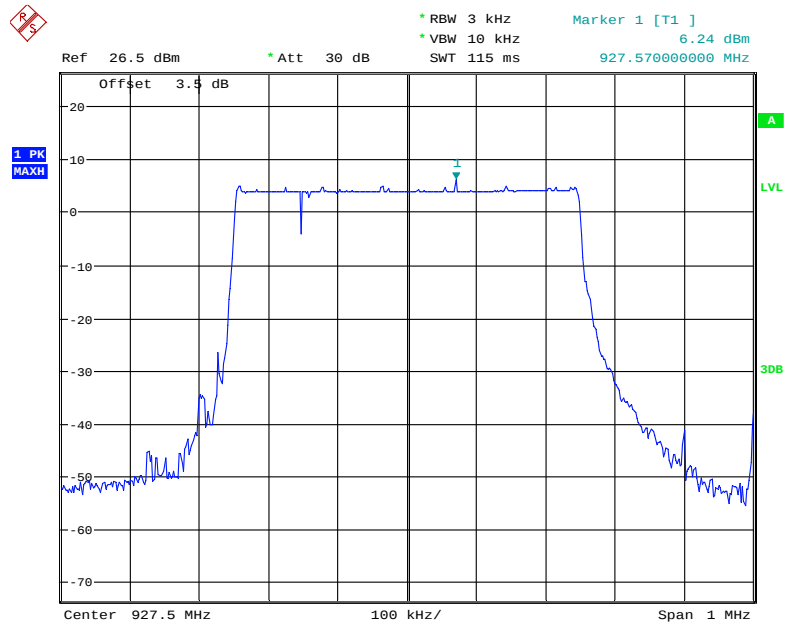
LoRa mode-External transmit antenna

Power Spectral Density, Low Channel



Date: 3.FEB.2021 16:33:24

Power Spectral Density, LoRa High Channel



Date: 3.FEB.2021 16:31:02

***** END OF REPORT *****