FCC Part 15.247

TEST REPORT

For

Pycom Ltd

Surrey Technology Park 2 Huxley Road, Guildford Surrey GU2 7RE, United Kingdom

FCC ID: 2AJMTPYGATE

Report Type:	**Product Type:**
Original Report	gateway

Report Producer : Coco Lin Coco Lin

Report Number : RXZ211104002RF01

Report Date : 2022-01-06

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Revision History

Revision	No.	Report Number	Issue Date	Description	Author/ Revised by
0.0	RXZ211104002	RXZ211104002RF01	2022-01-06	Original Report	Coco Lin

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1 General Information

1.1 Product Description for Equipment under Test (EUT)

Applicant	Pycom Ltd
	Surrey Technology Park 2 Huxley Road, Guildford Surrey GU2 7RE, United Kingdom
Manufacturer	Pycom Ltd
	Surrey Technology Park 2 Huxley Road, Guildford Surrey GU2 7RE, United Kingdom
Brand(Trade) Name	N/A
Product (Equipment)	gateway
Main Model Name	Pygate
Series Model Name	N/A
Model Discrepancy	N/A
Frequency Range	903 ~ 927.5 MHz
Transmit Power (Average)	23.45 dBm
Modulation Technique	LoRa (500KHz)
Power Operation (Voltage Range)	DC 5V from USB Port, DC 3.6V-4.2V from Li-Po Battery and DC 48V from PoE via the optional adapter board (PyEthernet)
Received Date	Nov. 04, 2021
Date of Test	Nov. 12, 2021 ~ Dec. 24, 2021

*All measurement and test data in this report was gathered from production sample serial number: RXZ211104002-01 (Assigned by BACL, New Taipei Laboratory).

1.2 Objective

This report is prepared on behalf of *Pycom Ltd* in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communication Commission's rules.

The objective is to determine compliance with FCC Part 15.247 rules for Output Power, Antenna Requirements, 6 dB Bandwidth, Power Spectral Density, 100 kHz Bandwidth of Band Edges Measurement, Conducted and Radiated Spurious Emissions.

1.3 Related Submittal(s)/Grant(s)

FCC Part 15.247 DSS Submittal with FCC ID: 2AJMTPYGATE

1.4 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.

KDB 558074 D01 15.247 Meas Guidance v05r02

1.5 Statement of Compliance

Decision Rule: No, (The test results do not include MU judgment)

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.

The determination of the test results does not require consideration of the uncertainty of the measurement, unless the assessment is required by customer agreement, regulation or standard document specification.

Bay Area Compliance Laboratories Corp. (New Taipei Laboratory) is not responsible for the authenticity of the information provided by the applicant that affects the test results.

1.6 Measurement Uncertainty

Parameter		Uncertainty
AC Mains		+/- 2.36 dB
RF output power, conducted		+/- 0.93 dB
Power Spectral Density, conducted		+/- 0.93 dBm
Occupied Bandwidth		+/- 0.35 MHz
Unwanted Emissions, conducted		+/- 1.69 dBm
Emissions, radiated	30 MHz~1GHz	+/- 5.22 dB
	1 GHz~18 GHz	+/- 6.12 dB
	18 GHz~40 GHz	+/- 4.99 dB
Temperature		+/- 1.27 °C
Humidity		+/- 3 %

1.7 Environmental Conditions

Test Site	Test Data	Temperature (℃)	Relative Humidity (%)	ATM Pressure (hPa)	Test Engineer
AC Line Conducted Emissions	2021/12/01-12/13	21.6	67	1010	Ken Yu
Radiation Spurious Emissions	2021/11/12-12/24	22.9-23.6	56-74	1010	David Lee
Conducted Spurious Emissions	2021/11/29	24.5	52	1010	Howard Ho
6 dB Emission Bandwidth	2021/11/16	24.6	53	1010	Howard Ho
Maximum Output Power	2021/11/16	24.6	53	1010	Howard Ho
100 kHz Bandwidth of Frequency Band Edge	2021/11/23	24.5	53	1010	Howard Ho
Power Spectral Density	2021/11/16	24.6	53	1010	Howard Ho

1.8 Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (New Taipei Laboratory) to collect test data is located on

☒70, Lane 169, Sec. 2, Datong Road, Xizhi Dist., New Taipei City 22183, Taiwan, R.O.C.

Bay Area Compliance Laboratories Corp. (New Taipei Laboratory) is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 3732) and the FCC designation No.TW3732 under the Mutual Recognition Agreement (MRA) in FCC Test.

2 System Test Configuration

2.1 Description of Test Configuration

For LoRa mode, 16 channels are provided to testing:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	903.0	9	923.3
2	904.6	10	923.9
3	906.2	11	924.5
4	907.8	12	925.1
5	909.4	13	925.7
6	911.0	14	926.3
7	912.6	15	926.9
8	914.2	16	927.5

Were tested with channel 1, 8 and 16.

The system was configured for testing in engineering mode, which was provided by manufacturer.

2.2 Equipment Modifications

No modification was made to the EUT.

2.3 EUT Exercise Software

The test software was used “ATOM, LoRa-net picoGW_hal”

Test Frequency		Low	Middle	High
Power Level Setting	LoRa	13	13	14

2.4 Support Equipment List and Details

Description	Manufacturer	Model	Maximum Antenna Gain
NB	DELL	E6410	N/A
Fixture Board	Uses Technology	B+	N/A
AC Adapter	SOS	SOS-PS-25A	N/A
Gateway module (Development Board)	Pycom Ltd	Wipy3, Lopy4, GPy	N/A
Antenna-0: Internal WiFi/BT/BLE SMD Antenna	Johanson Technology	2450AT43B100	-0.5 dBi (WiPy3) 1.3 dBi (LoPy4/GPy)
Antenna-1: External WiFi/BT/BLE Monopole Antenna	Pycom Ltd	External WiFi Antenna	2.0 dBi (WiPy3)
Antenn-A: LTE External PCB Antenna with Plastic Case	Pycom Ltd	NEW External LTE-M Antenna Kit	2.0 dBi (GPy)
Antenn-B: LTE External PCB Antenna	Pycom Ltd	External LTE-M Antenna Kit	2.2 dBi (GPy)
Raspberry pi 3	Rasbperry Pi	B+	N/A

2.5 External Cable List and Details

Cable Description	Length (m)	From	To
USB type-C Cable	1.5	EUT	NB

2.6 Test Mode

Pre-scan

Radiated Spurious Emissions:

Model 1: Pygate, DC 5V from USB Port

Model 2: Pygate, DC 3.6V from Li-Po Battery

Model 3: Pygate, DC 48V from PoE

AC Line Conducted Emissions:

Model 1: Pygate, DC 5V from USB Port

Model 3: Pygate, DC 48V from PoE

Worst case is the Pygate, DC 5V from USB Port.

Full System (model: Pygate, DC 5V from USB Port) for all test item.

Transmitting simultaneously test

AC Line Conducted Emissions and Radiated Spurious Emissions

	Combination	Transmitting simultaneously Mode	Antenna Use
Model 1	Pygate, DC 5V from USB Port + Wipy3.0 (FCC ID: 2AJMTWIPY3R)	LoRa + WIFI 2.4G/BLE/BT	Wi-Fi Antenna-0/1 LoRa Antenna
Model 2	Pygate, DC 5V from USB Port + LoPy4 1.0 (FCC ID: 2AJMTLOPY4R)	LoRa + WIFI 2.4G/BLE/BT	Wi-Fi Antenna-0 LoRa Antenna
Model 3	Pygate, DC 5V from USB Port + GPy 1.0 (FCC ID: 2AJMTGPY01R)	LoRa + WIFI 2.4G/BLE/BT/LTE	LTE Antenna-A/B Wi-Fi Antenna-0 LoRa Antenna

Note: All the antenna combination had been evaluated, The worst case had been recorded in the report.

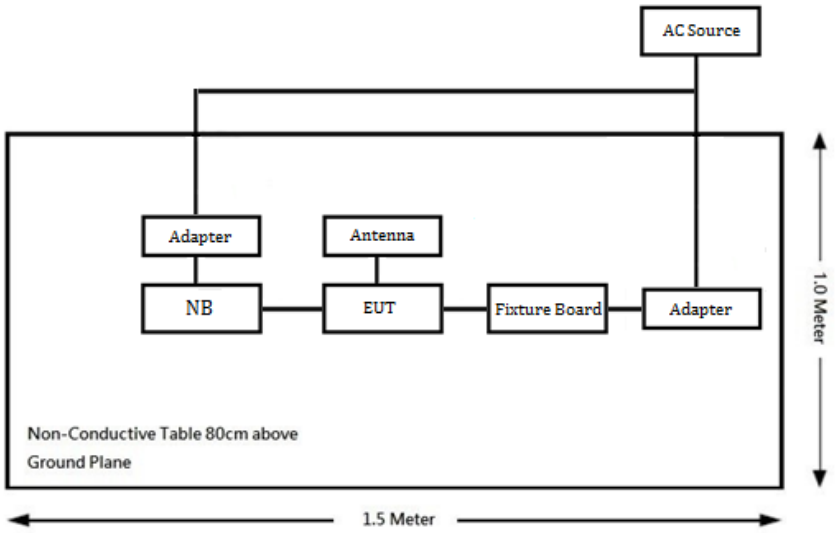
2.7 Block Diagram of Test Setup

See test photographs attached in setup photos for the actual connections between EUT and support equipment.

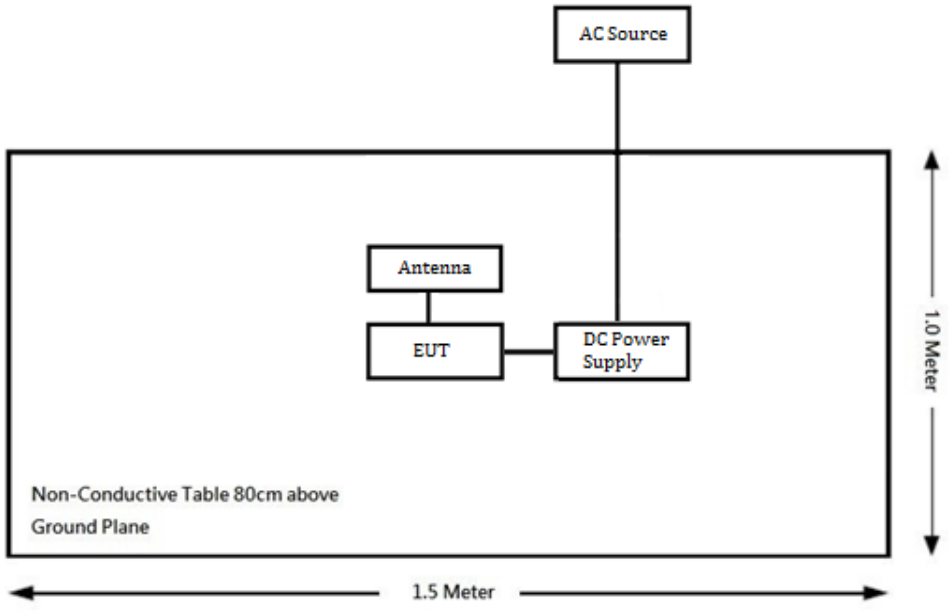
Radiation

Below 1GHz:

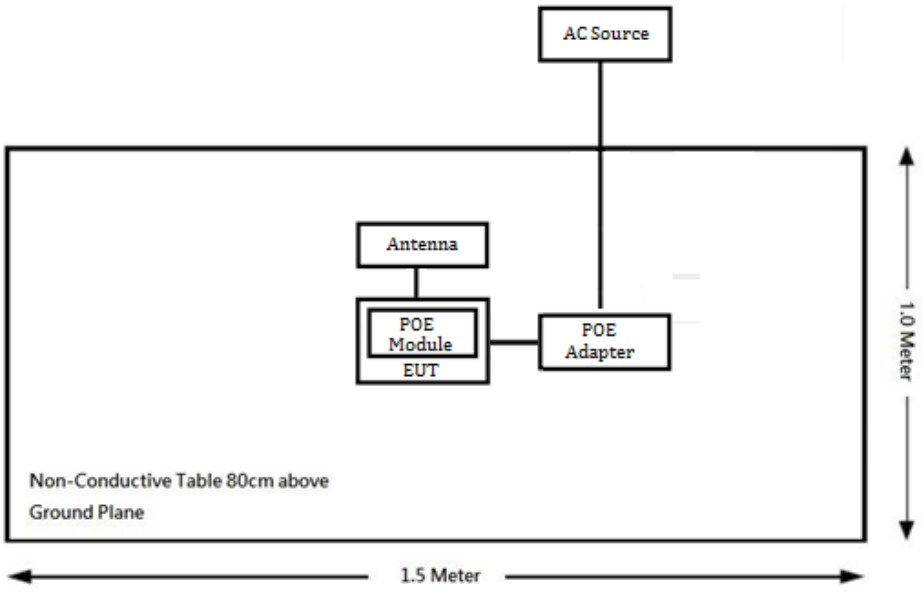
Pygate, DC 5V from USB Port



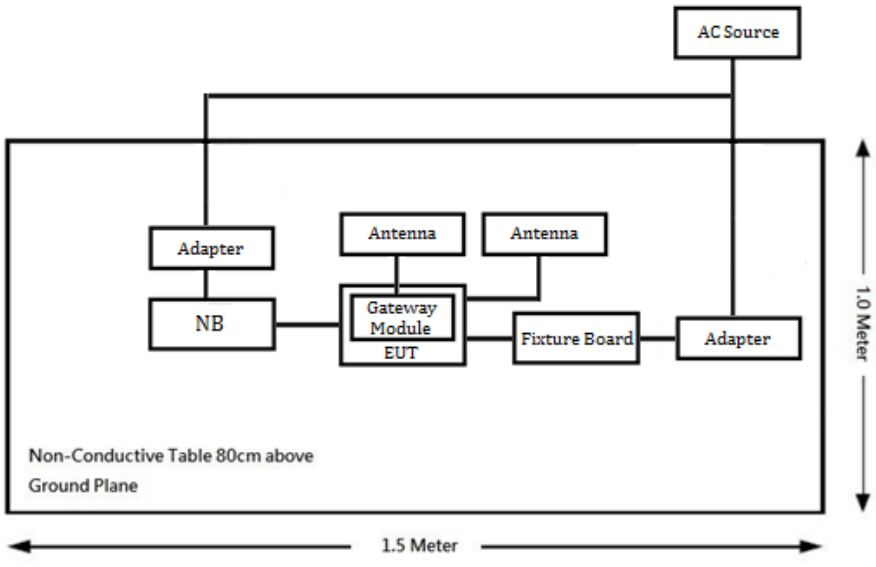
Pygate, DC 3.6V from Li-Po Battery



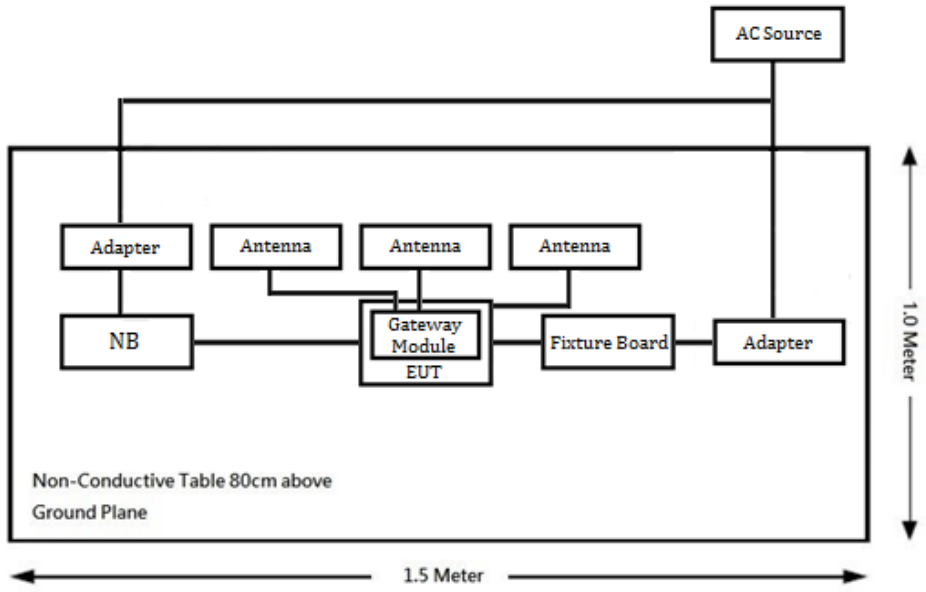
Pygate, DC 48V from PoE



Pygate, DC 5V from USB Port + Gateway Module (Wipy3.0 / LoPy4 1.0)

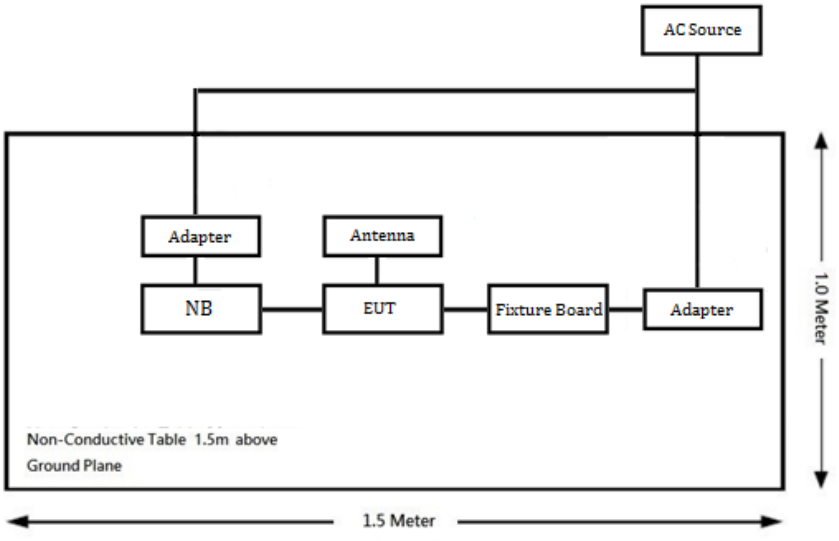


Pygate, DC 5V from USB Port + Gateway Module (GPy 1.0)

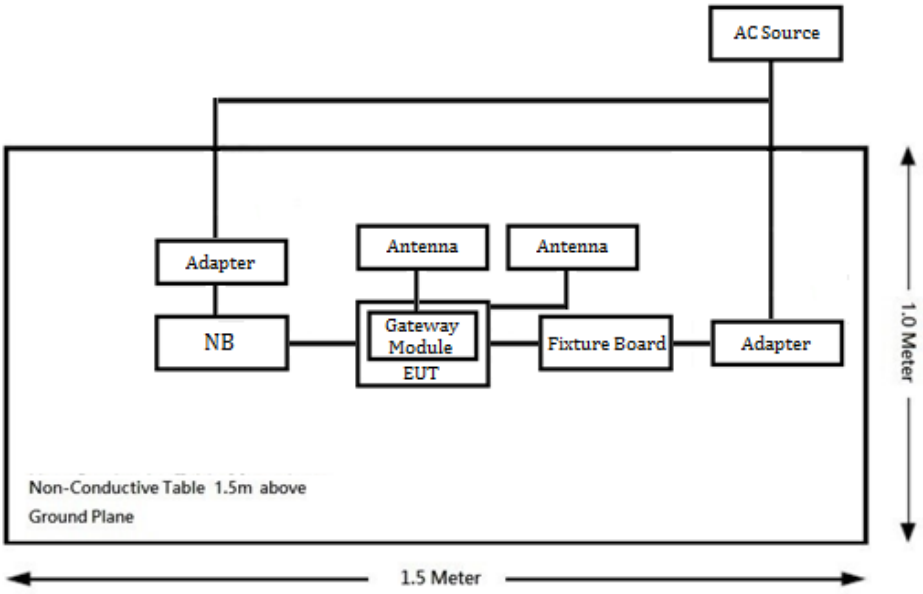


Above 1GHz:

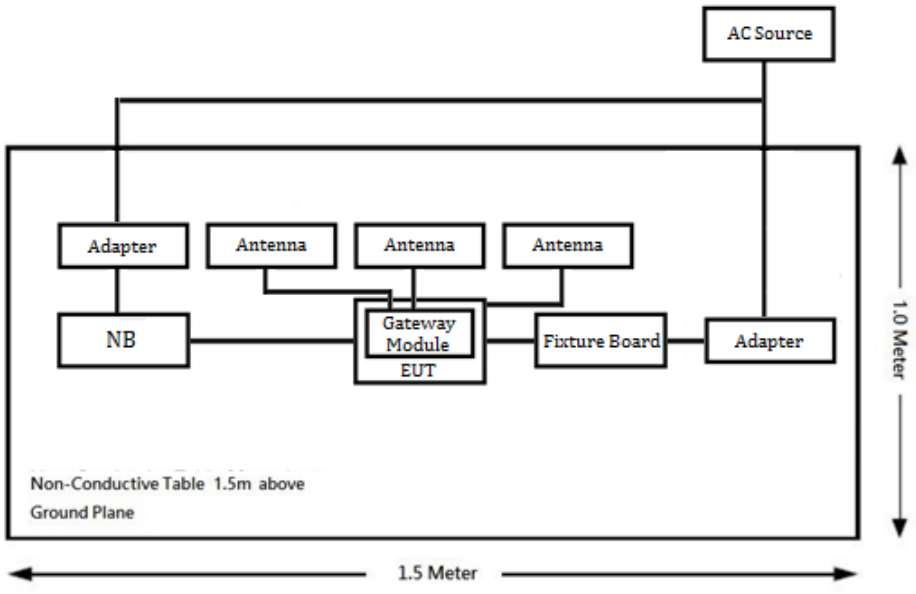
Pygate, DC 5V from USB Port



Pygate, DC 5V from USB Port + Gateway Module (Wipy3.0 / LoPy4 1.0)

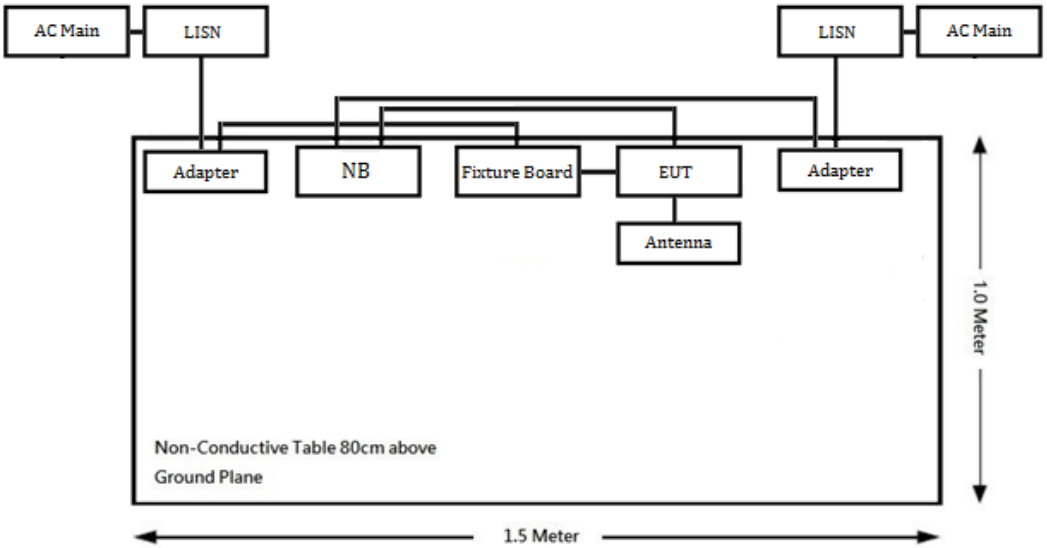


Pygate, DC 5V from USB Port + Gateway Module (GPy 1.0)

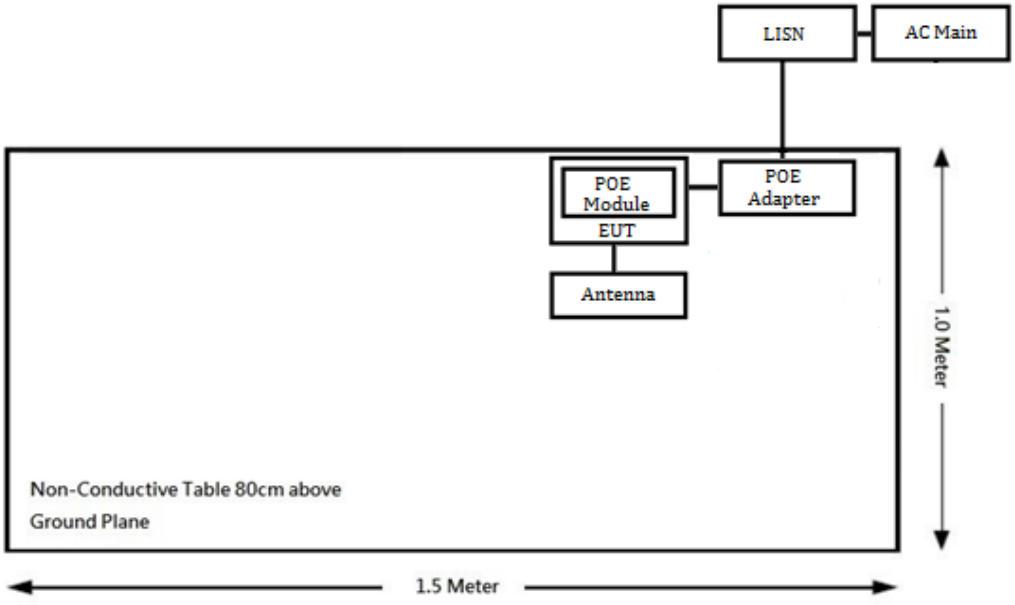


Conduction:

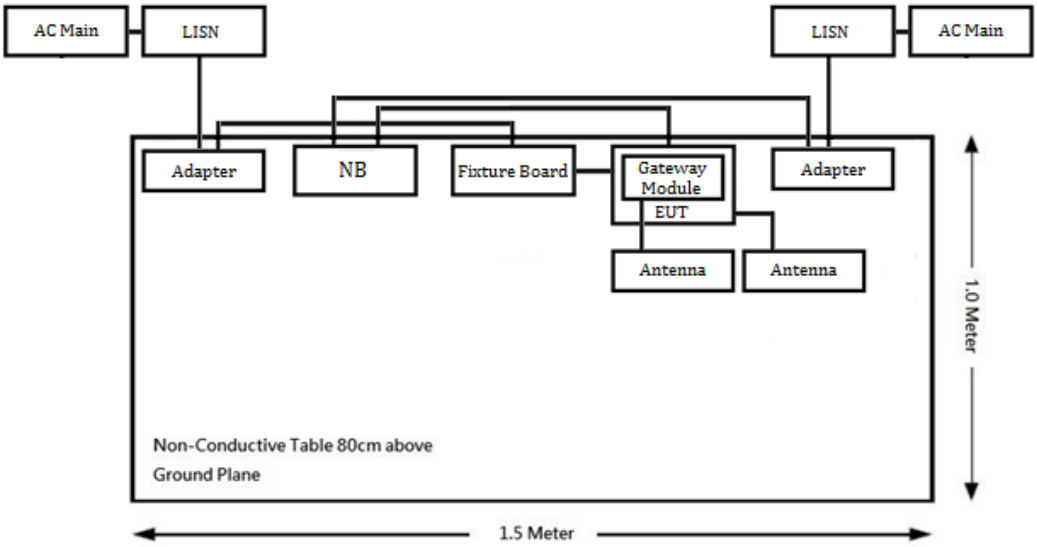
Pygate, DC 5V from USB Port



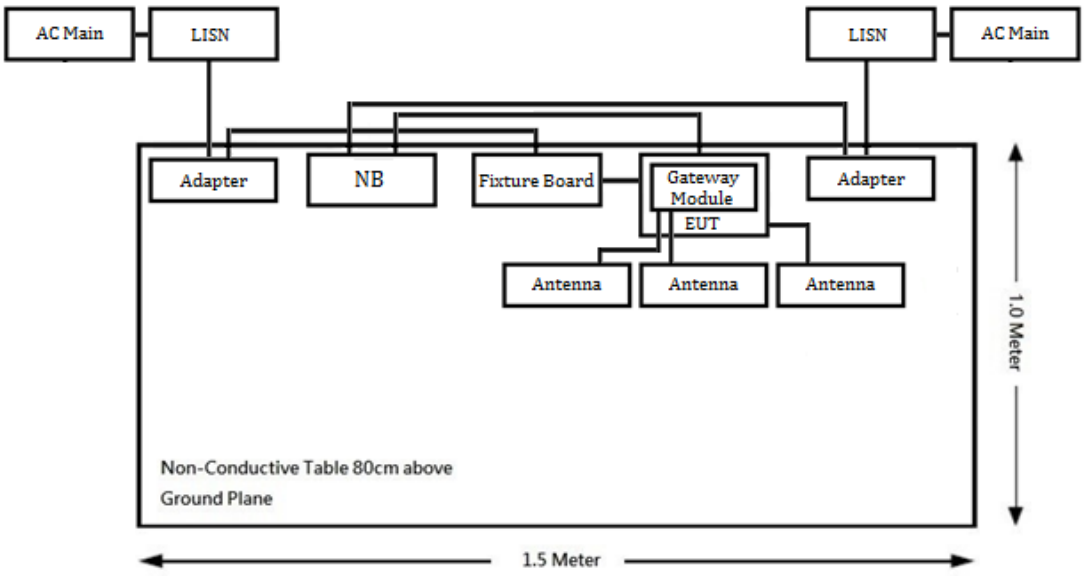
Pygate, DC 48V from PoE



Pygate, DC 5V from USB Port + Gateway Module (Wipy3.0 / LoPy4)



Pygate, DC 5V from USB Port + Gateway Module (GPy)



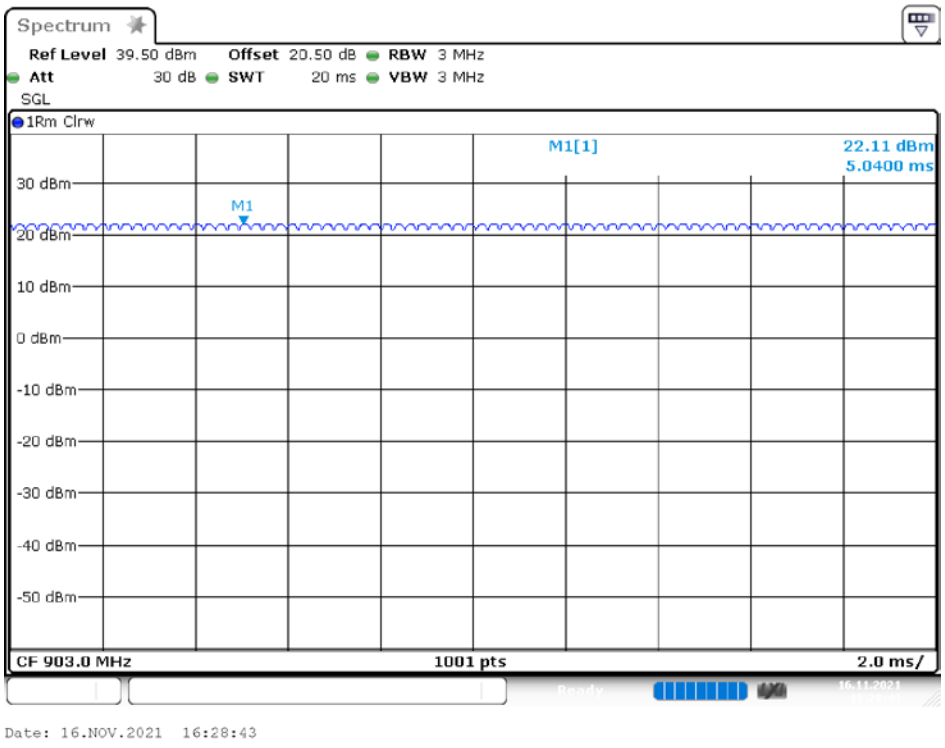
2.8 Duty Cycle

The duty cycle as below:

Radio Mode	On Time (ms)	Off Time (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
LoRa	/	/	100	0

Note: Duty Cycle Correction Factor = 10*log(1/duty cycle)

Please refer to the following plots.



3 Summary of Test Results

FCC Rules	Description of Test	Results
§15.247(i), §1.1310, §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 Average Output Power	Compliance
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliance
§15.247(e)	Power Spectral Density	Compliance

4 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due Date
AC Line Conduction Room (CON-A)					
LISN	Rohde & Schwarz	ENV216	101612	2020/12/30	2021/12/29
LISN	Rohde & Schwarz	ENV216	101248	2021/06/08	2022/06/07
EMI Test Receiver	Rohde & Schwarz	ESR3	102099	2021/6/9	2022/6/8
Pulse Limiter	Rohde & Schwarz	ESH3Z2	TXZEM104	2021/7/29	2022/7/29
RF Cable	EMEC	EM-CB5D	001	2021/6/11	2022/6/11
Software	AUDIX	E3	V9.150826k	N.C.R	N.C.R
Radiated Room (966-A)					
Bilog Antenna with 6 dB Attenuator	SUNOL SCIENCES & MINI-CIRCUITS	JB6/UNAT-6+	A050115/15542_01	2021/01/19	2022/01/18
Horn Antenna	EMCO	SAS-571	1020	2021/4/23	2022/4/22
Preamplifier	Sonoma	310N	130602	2021/06/08	2022/06/07
Preamplifier	A.H. system Inc.	PAM-0118P	470	2021/03/15	2022/03/14
EMI Test Receiver	Rohde & Schwarz	ESR7	101419	2021/11/09	2022/11/08
Spectrum Analyzer	Rohde & Schwarz	FSV40	101435	2021/01/07	2022/01/06
Micro flex Cable	UTIFLEX	UFB197C-1-2362-70U-70U	225757-001	2021/2/1	2022/1/31
Coaxial Cable	COMMATE	PEWC	8Dr	2020/12/25	2021/12/24
Coaxial Cable	UTIFLEX	UFB311A-Q-1440-300300	220490-006	2021/2/1	2022/1/31
Coaxial Cable	JUNFLON	J12J102248-00-B-5	AUG-07-15-044	2020/12/25	2021/12/24
Cable	EMC	EMC105-SM-SM-10000	201003	2021/2/3	2022/2/2
Software	Farad	EZ_EMC	BACL-03A1	N.C.R	N.C.R
Conducted Room					
Spectrum Analyzer	Rohde & Schwarz	FSV40	101140	2021/01/07	2022/01/06
Cable	UTIFLEX	UFA210A	9435	2021/10/05	2022/10/04
Attenuator	MCL	BW-S10W5+	1419	2021/01/28	2022/01/27

Power Sensor	KEYSIGHT	U2021XA	MY54080018	2021/01/28	2022/01/27

***Statement of Traceability:** BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to the SI System of Units via the R.O.C. Center for Measurement Standards of the Electronics Testing Center, Taiwan (ETC) or to another internationally recognized National Metrology Institute (NMI), and were compliant with the current Taiwan Accreditation Foundation (TAF) requirements

5 FCC §15.247(i), §1.1310, § 2.1091 - Maximum Permissible Exposure (MPE)

5.1 Applicable Standard

According to subpart 15.247(i)and subpart §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) 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;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:

Predication of MPE limit at a given distance

$S = PG/4\pi R^2$ = power density (in appropriate units, e.g. mW/cm^2);

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:

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

5.2 RF Exposure Evaluation Result

Calculated Data (worst case):

Model 1

Mode	Frequency Range (MHz)	Antenna Gain		Target Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
LoRa (125kHz)	902.3-927.7	0.87	1.222	24	251.189	20	0.0611	0.602
LoRa (250kHz)	902.3-927.5	0.87	1.222	24	251.189	20	0.0611	0.602
LoRa (500kHz)	903-927.5	0.87	1.222	23.5	223.87	20	0.0544	0.602
WIFI (Internal Antenna)	2412-2462	-0.5	0.891	18	63.096	20	0.0112	1
BLE (Internal Antenna)	2402-2480	-0.5	0.891	3.5	2.239	20	0.0004	1
BT2.1+EDR (Internal Antenna)	2402-2480	-0.5	0.891	5.5	3.548	20	0.0006	1
WIFI (External Antenna)	2412-2462	2	1.585	18	63.096	20	0.0199	1
BLE (External Antenna)	2402-2480	2	1.585	3.5	2.239	20	0.0007	1
BT2.1+EDR (External Antenna)	2402-2480	2	1.585	5.5	3.548	20	0.0011	1

Note: WIFI 2.4G/BLE/BT (FCC ID: 2AJMTWIPY3R) and LoRa can transmit simultaneously; the worst condition as below:

$$\sum_i \frac{S_i}{S_{Limit,i}}$$ = 0.0611/0.602+0.0199/1.00= 0.1213 < 1.0

Model 2

Mode	Frequency Range (MHz)	Antenna Gain		Target Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
LoRa (125kHz)	902.3-927.7	0.87	1.222	24	251.189	20	0.0611	0.602
LoRa (250kHz)	902.3-927.5	0.87	1.222	24	251.189	20	0.0611	0.602
LoRa (500kHz)	903-927.5	0.87	1.222	23.5	223.87	20	0.0544	0.602
WIFI	2412-2462	1.3	1.349	23	199.526	20	0.0535	1
BLE	2402-2480	1.3	1.349	3	1.995	20	0.0005	1
BT3.0	2402-2480	1.3	1.349	6	3.981	20	0.0011	1
Sigfox	902-928	0.87	1.222	20	100.000	20	0.0243	0.601

Note: WIFI 2.4G/BLE/BT (FCC ID: 2AJMTLOPY4R) and LoRa can transmit simultaneously; the worst condition as below:

$$\sum_i \frac{S_i}{S_{Limit,i}}$$ = 0.0611/0.602+0.0535/1.00= 0.1549 < 1.0

Model 3

Mode	Frequency Range (MHz)	Antenna Gain		Target Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
LoRa (125kHz)	902.3-927.7	0.87	1.222	24	251.189	20	0.0611	0.602
LoRa (250kHz)	902.3-927.5	0.87	1.222	24	251.189	20	0.0611	0.602
LoRa (500kHz)	903-927.5	0.87	1.222	23.5	223.87	20	0.0544	0.602
WIFI	2412-2462	1.3	1.35	23	199.526	20	0.0535	1
BLE	2402-2480	1.3	1.35	5	3.16	20	0.0008	1
BT3.0	2402-2480	1.3	1.35	6.5	4.47	20	0.0012	1
FDD Band4	1710-1755	7	5.012	23	199.53	20	0.1989	1
FDD Band12	699-716	9.4	8.710	23.5	223.87	20	0.3879	0.466
FDD Band13	777-787	10.4	10.965	23	199.53	20	0.4352	0.518

Note: WIFI 2.4G/BLE/BT, LTE (FCC ID: 2AJMTGPY01R) and LoRa can transmit simultaneously; the worst condition as below:

$\sum_i \frac{S_i}{S_{Limit,i}}$ =0.0611/0.602+0.0535/1.00+0.4352/0.518= 0.995 < 1.0

Result: MPE evaluation of single and simultaneous transmission meet **20cm** the requirement of standard.

6 FCC §15.203 – Antenna Requirements

6.1 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.

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.

6.2 Antenna Information

Function	Manufacturer	Type	Model	Antenna Gain
LoRa External	Pycom Ltd	Monopole	LoRa (865MHz/915MHz) & Sigfox Antenna Kit	0.87 dBi (Pygate)

Result: Compliance

7 FCC §15.207(a) – AC Line Conducted Emissions

7.1 Applicable Standard

According to §15.207

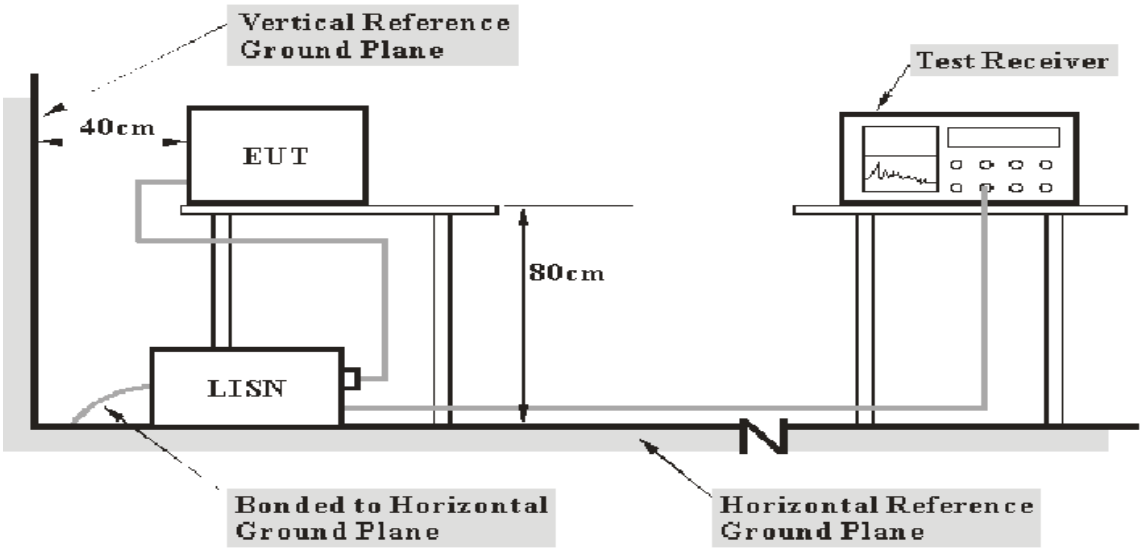
For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured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

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 Note 1	56 to 46 Note 1
0.5-5	56	46
5-30	60	50

Note 1: Decreases with the logarithm of the frequency.

7.2 EUT Setup

The setup of EUT is



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.

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

7.3 EMI Test Receiver Setup

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

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

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

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

7.5 Corrected Factor & Margin Calculation

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

Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation

The “Over Limit” column of the following data tables indicates the degree of compliance with the applicable limit. For example, an over limit of -7 dB means the emission is 7 dB below the limit. The equation for Over Limit calculation is as follows:

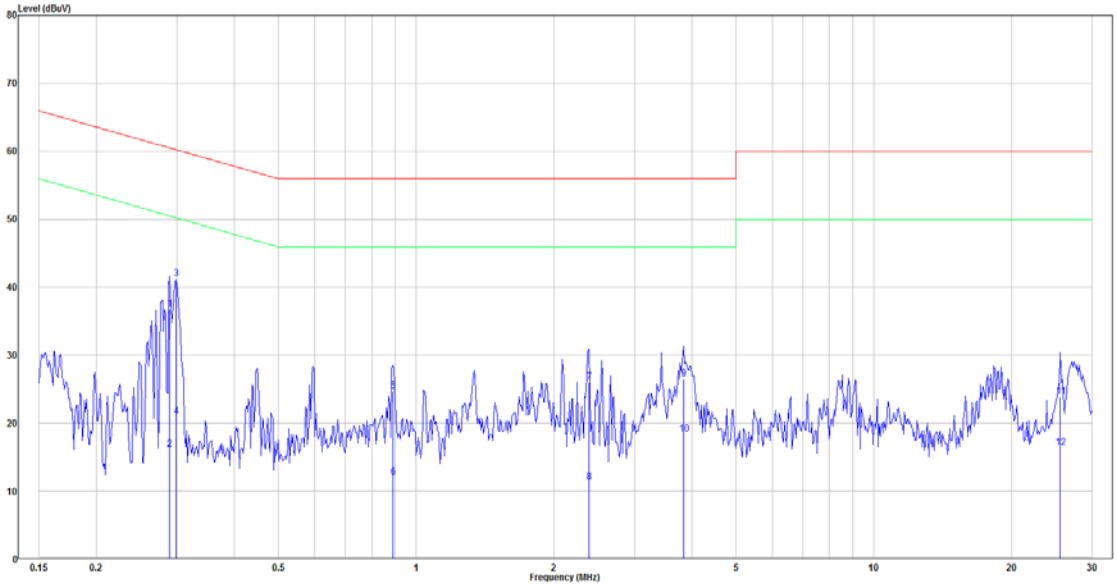
Over Limit = Level – Limit Line

7.6 Test Results

Test Mode: Transmitting

Pygate, DC 5V from USB Port

Main: AC120 V, 60 Hz, Line



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBµV)	Factor(dB)	(dBµV)	(dBµV)	(dB)	
1	0.289	17.13	19.58	36.71	60.54	-23.83	QP
2	0.289	-3.41	19.58	16.17	50.54	-34.37	Average
3	0.299	21.65	19.58	41.23	60.28	-19.05	QP
4	0.299	1.44	19.58	21.02	50.28	-29.26	Average
5	0.890	5.11	19.61	24.72	56.00	-31.28	QP
6	0.890	-7.63	19.61	11.98	46.00	-34.02	Average
7	2.384	6.43	19.65	26.08	56.00	-29.92	QP
8	2.384	-8.31	19.65	11.34	46.00	-34.66	Average
9	3.840	6.86	19.69	26.55	56.00	-29.45	QP
10	3.840	-1.28	19.69	18.41	46.00	-27.59	Average
11	25.591	4.04	19.94	23.98	60.00	-36.02	QP
12	25.591	-3.54	19.94	16.40	50.00	-33.60	Average

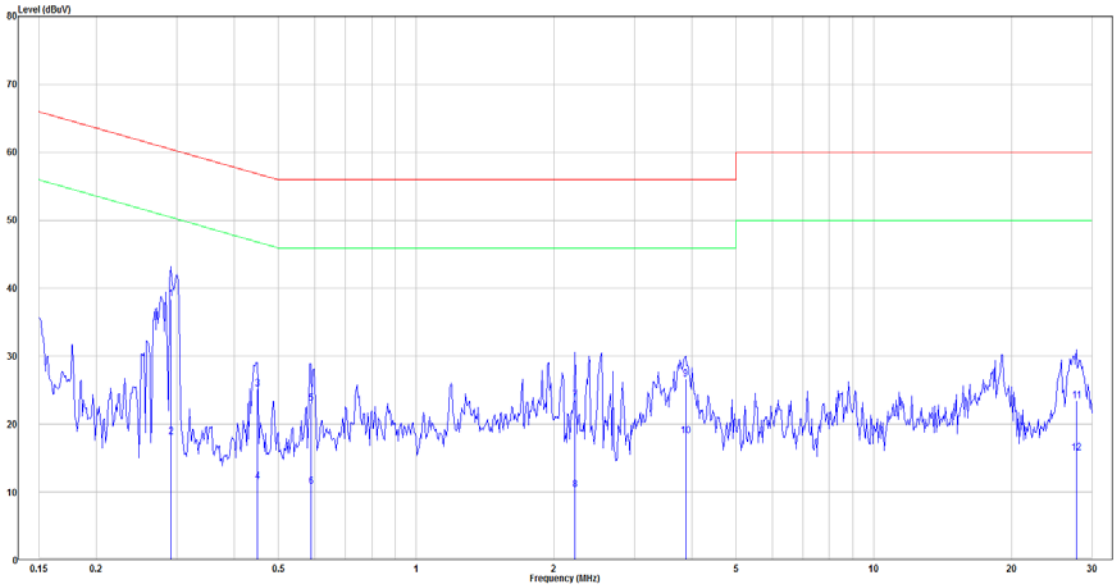
Note:

Level = Read Level + Factor

Over Limit = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

Main: AC120 V, 60 Hz, Neutral



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBµV)	Factor(dB)	(dBµV)	(dBµV)	(dB)	
1	0.291	18.87	19.58	38.45	60.50	-22.05	QP
2	0.291	-1.45	19.58	18.13	50.50	-32.37	Average
3	0.449	5.59	19.59	25.18	56.89	-31.71	QP
4	0.449	-8.08	19.59	11.51	46.89	-35.38	Average
5	0.589	3.46	19.59	23.05	56.00	-32.95	QP
6	0.589	-8.78	19.59	10.81	46.00	-35.19	Average
7	2.225	3.92	19.65	23.57	56.00	-32.43	QP
8	2.225	-9.29	19.65	10.36	46.00	-35.64	Average
9	3.881	6.89	19.69	26.58	56.00	-29.42	QP
10	3.881	-1.46	19.69	18.23	46.00	-27.77	Average
11	27.708	3.46	19.98	23.44	60.00	-36.56	QP
12	27.708	-4.16	19.98	15.82	50.00	-34.18	Average

Note:

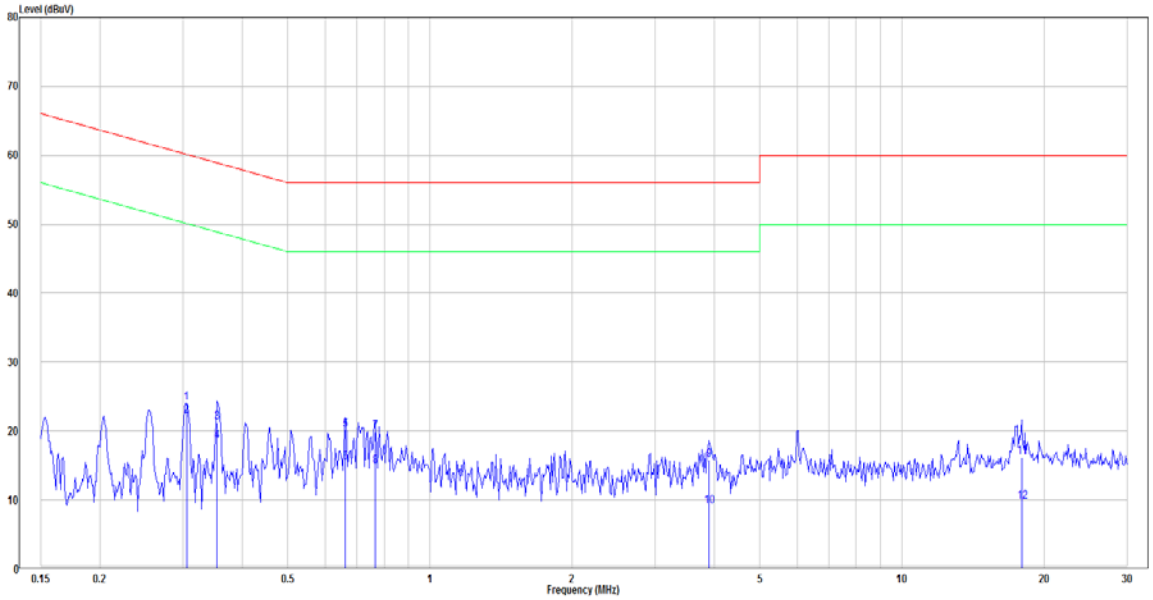
Level = Read Level + Factor

Over Limit = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

Pygate, DC 48V from PoE

Main: AC120 V, 60 Hz, Line



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBµV)	Factor(dB)	(dBµV)	(dBµV)	(dB)	
1	0.305	4.46	19.58	24.04	60.10	-36.06	QP
2	0.305	2.61	19.58	22.19	50.10	-27.91	Average
3	0.354	1.62	19.58	21.20	58.87	-37.67	QP
4	0.354	-1.05	19.58	18.53	48.87	-30.34	Average
5	0.661	0.59	19.60	20.19	56.00	-35.81	QP
6	0.661	-4.18	19.60	15.42	46.00	-30.58	Average
7	0.767	0.27	19.60	19.87	56.00	-36.13	QP
8	0.767	-4.65	19.60	14.95	46.00	-31.05	Average
9	3.901	-3.88	19.69	15.81	56.00	-40.19	QP
10	3.901	-10.59	19.69	9.10	46.00	-36.90	Average
11	17.944	-3.63	19.87	16.24	60.00	-43.76	QP
12	17.944	-10.14	19.87	9.73	50.00	-40.27	Average

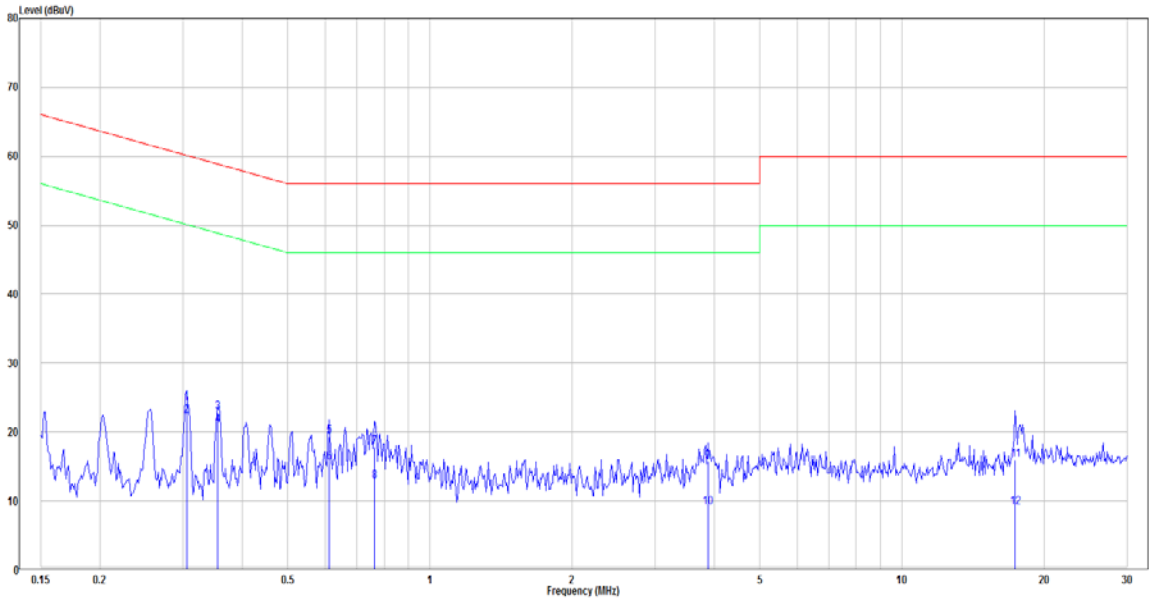
Note:

Level = Read Level + Factor

Over Limit = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

Main: AC120 V, 60 Hz, Neutral



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBµV)	Factor(dB)	(dBµV)	(dBµV)	(dB)	
1	0.305	4.65	19.58	24.23	60.10	-35.87	QP
2	0.305	2.80	19.58	22.38	50.10	-27.72	Average
3	0.356	3.31	19.58	22.89	58.83	-35.94	QP
4	0.356	1.36	19.58	20.94	48.83	-27.89	Average
5	0.611	-0.21	19.59	19.38	56.00	-36.62	QP
6	0.611	-4.07	19.59	15.52	46.00	-30.48	Average
7	0.763	-1.69	19.60	17.91	56.00	-38.09	QP
8	0.763	-6.77	19.60	12.83	46.00	-33.17	Average
9	3.881	-3.93	19.69	15.76	56.00	-40.24	QP
10	3.881	-10.63	19.69	9.06	46.00	-36.94	Average
11	17.383	-3.94	19.89	15.95	60.00	-44.05	QP
12	17.383	-10.80	19.89	9.09	50.00	-40.91	Average

Note:

Level = Read Level + Factor

Over Limit = Level – Limit Line

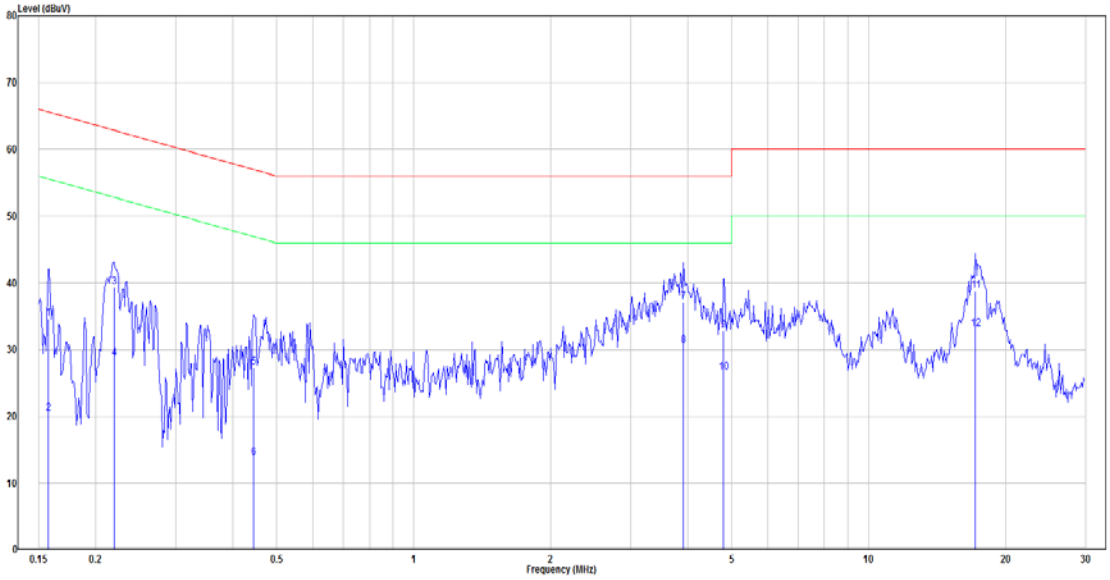
Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

Transmitting simultaneously test:

Model 1

The worst case of LoRa and WIFI mode transmitting simultaneously was recorded

Main: AC120 V, 60 Hz, Line



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBµV)	Factor(dB)	(dBµV)	(dBµV)	(dB)	
1	0.157	15.08	19.59	34.67	65.60	-30.93	QP
2	0.157	0.81	19.59	20.40	55.60	-35.20	Average
3	0.220	19.72	19.58	39.30	62.83	-23.53	QP
4	0.220	9.11	19.58	28.69	52.83	-24.14	Average
5	0.444	7.76	19.59	27.35	56.98	-29.63	QP
6	0.444	-5.74	19.59	13.85	46.98	-33.13	Average
7	3.922	17.42	19.69	37.11	56.00	-18.89	QP
8	3.922	10.94	19.69	30.63	46.00	-15.37	Average
9	4.797	13.11	19.71	32.82	56.00	-23.18	QP
10	4.797	6.81	19.71	26.52	46.00	-19.48	Average
11	17.199	18.90	19.86	38.76	60.00	-21.24	QP
12	17.199	13.25	19.86	33.11	50.00	-16.89	Average

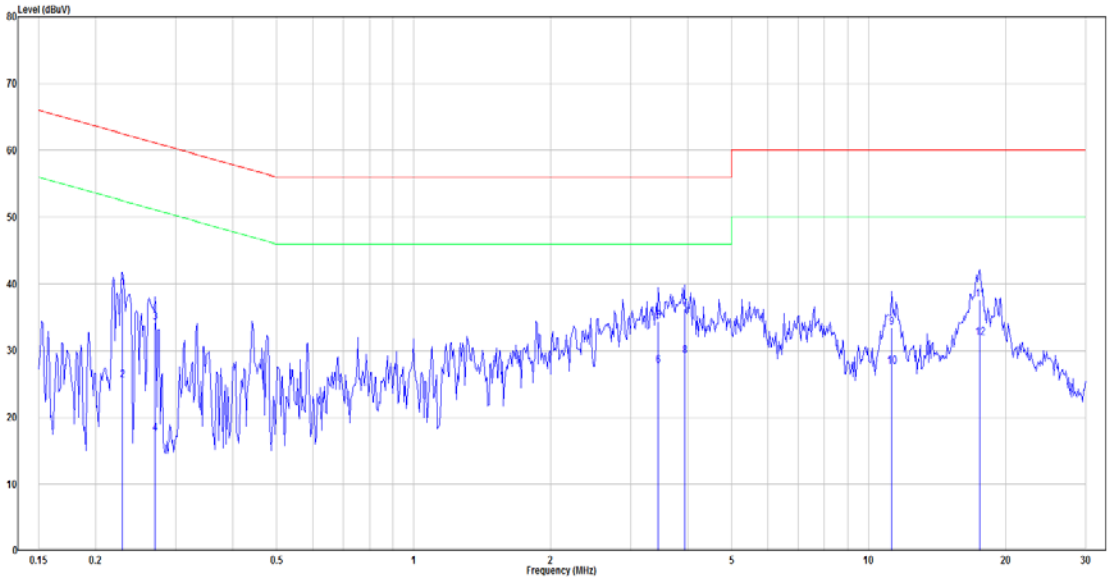
Note:

Level = Read Level + Factor

Over Limit = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

Main: AC120 V, 60 Hz, Neutral



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBµV)	Factor(dB)	(dBµV)	(dBµV)	(dB)	
1	0.229	19.76	19.58	39.34	62.48	-23.14	QP
2	0.229	5.99	19.58	25.57	52.48	-26.91	Average
3	0.270	14.73	19.58	34.31	61.12	-26.81	QP
4	0.270	-2.03	19.58	17.55	51.12	-33.57	Average
5	3.454	14.73	19.68	34.41	56.00	-21.59	QP
6	3.454	8.13	19.68	27.81	46.00	-18.19	Average
7	3.943	16.48	19.69	36.17	56.00	-19.83	QP
8	3.943	9.53	19.69	29.22	46.00	-16.78	Average
9	11.257	13.60	19.82	33.42	60.00	-26.58	QP
10	11.257	7.76	19.82	27.58	50.00	-22.42	Average
11	17.568	17.77	19.89	37.66	60.00	-22.34	QP
12	17.568	11.99	19.89	31.88	50.00	-18.12	Average

Note:

Level = Read Level + Factor

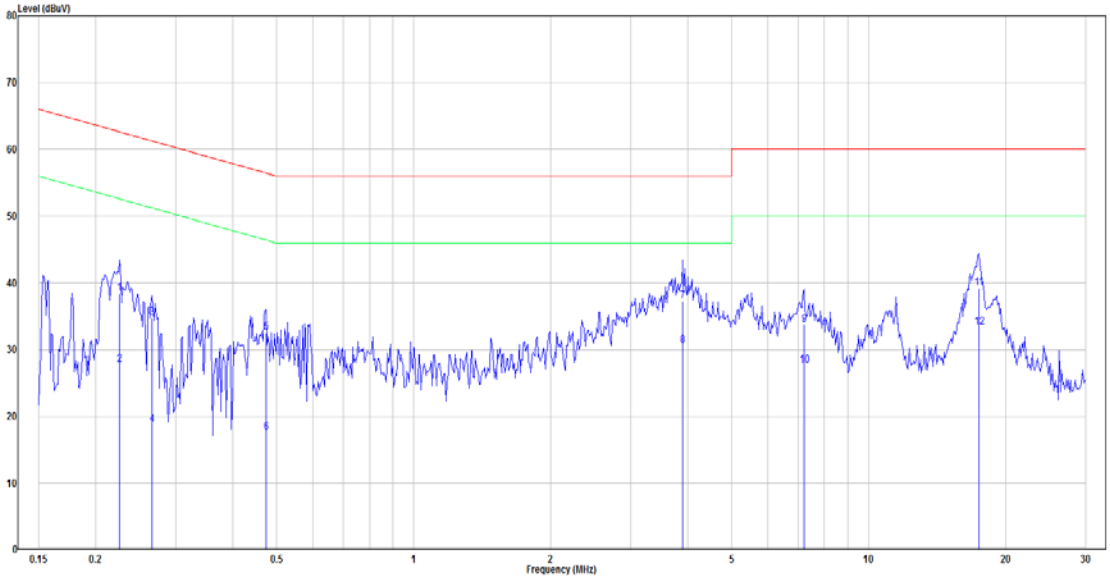
Over Limit = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

Model 2

The worst case of LoRa and WIFI mode transmitting simultaneously was recorded

Main: AC120 V, 60 Hz, Line



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBµV)	Factor(dB)	(dBµV)	(dBµV)	(dB)	
1	0.226	18.80	19.58	38.38	62.61	-24.23	QP
2	0.226	8.18	19.58	27.76	52.61	-24.85	Average
3	0.266	15.15	19.58	34.73	61.25	-26.52	QP
4	0.266	-0.84	19.58	18.74	51.25	-32.51	Average
5	0.474	13.03	19.59	32.62	56.45	-23.83	QP
6	0.474	-1.97	19.59	17.62	46.45	-28.83	Average
7	3.901	17.62	19.69	37.31	56.00	-18.69	QP
8	3.901	10.91	19.69	30.60	46.00	-15.40	Average
9	7.213	14.04	19.76	33.80	60.00	-26.20	QP
10	7.213	7.86	19.76	27.62	50.00	-22.38	Average
11	17.475	19.30	19.86	39.16	60.00	-20.84	QP
12	17.475	13.45	19.86	33.31	50.00	-16.69	Average

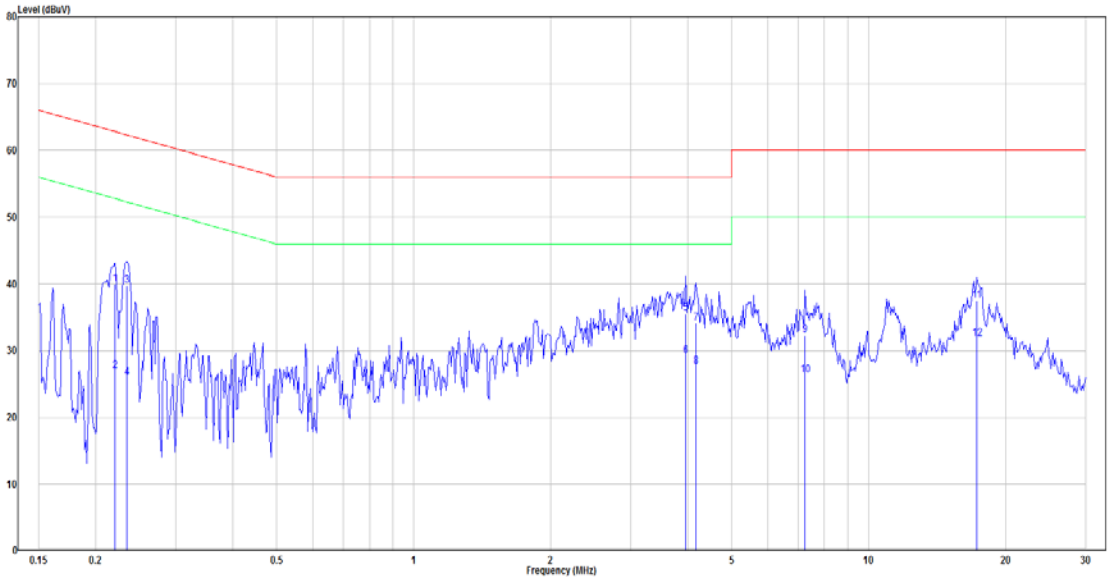
Note:

Level = Read Level + Factor

Over Limit = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

Main: AC120 V, 60 Hz, Neutral



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBµV)	Factor(dB)	(dBµV)	(dBµV)	(dB)	
1	0.221	20.47	19.58	40.05	62.79	-22.74	QP
2	0.221	7.45	19.58	27.03	52.79	-25.76	Average
3	0.234	20.20	19.58	39.78	62.30	-22.52	QP
4	0.234	6.36	19.58	25.94	52.30	-26.36	Average
5	3.964	15.83	19.69	35.52	56.00	-20.48	QP
6	3.964	9.53	19.69	29.22	46.00	-16.78	Average
7	4.180	14.39	19.70	34.09	56.00	-21.91	QP
8	4.180	7.96	19.70	27.66	46.00	-18.34	Average
9	7.252	12.54	19.76	32.30	60.00	-27.70	QP
10	7.252	6.62	19.76	26.38	50.00	-23.62	Average
11	17.291	17.60	19.89	37.49	60.00	-22.51	QP
12	17.291	11.92	19.89	31.81	50.00	-18.19	Average

Note:

Level = Read Level + Factor

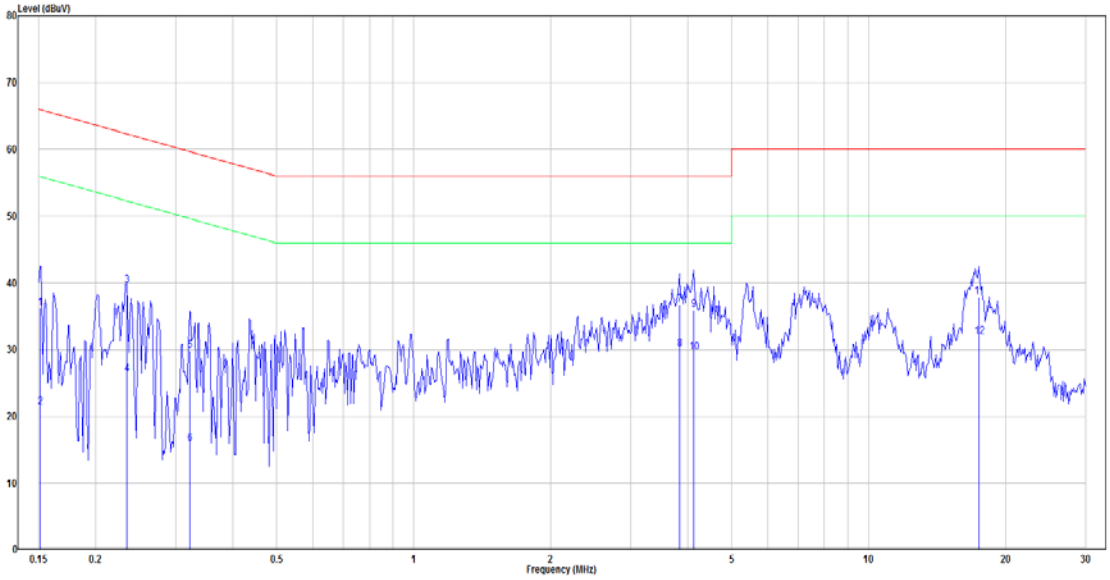
Over Limit = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

Model 3

The worst case of LoRa and WIFI, LTE mode transmitting simultaneously was recorded

Main: AC120 V, 60 Hz, Line



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBµV)	Factor(dB)	(dBµV)	(dBµV)	(dB)	
1	0.151	16.60	19.59	36.19	65.96	-29.77	QP
2	0.151	1.71	19.59	21.30	55.96	-34.66	Average
3	0.234	20.09	19.58	39.67	62.30	-22.63	QP
4	0.234	6.68	19.58	26.26	52.30	-26.04	Average
5	0.322	10.21	19.58	29.79	59.66	-29.87	QP
6	0.322	-3.67	19.58	15.91	49.66	-33.75	Average
7	3.840	17.07	19.69	36.76	56.00	-19.24	QP
8	3.840	10.39	19.69	30.08	46.00	-15.92	Average
9	4.136	16.24	19.69	35.93	56.00	-20.07	QP
10	4.136	9.92	19.69	29.61	46.00	-16.39	Average
11	17.475	18.02	19.86	37.88	60.00	-22.12	QP
12	17.475	12.07	19.86	31.93	50.00	-18.07	Average

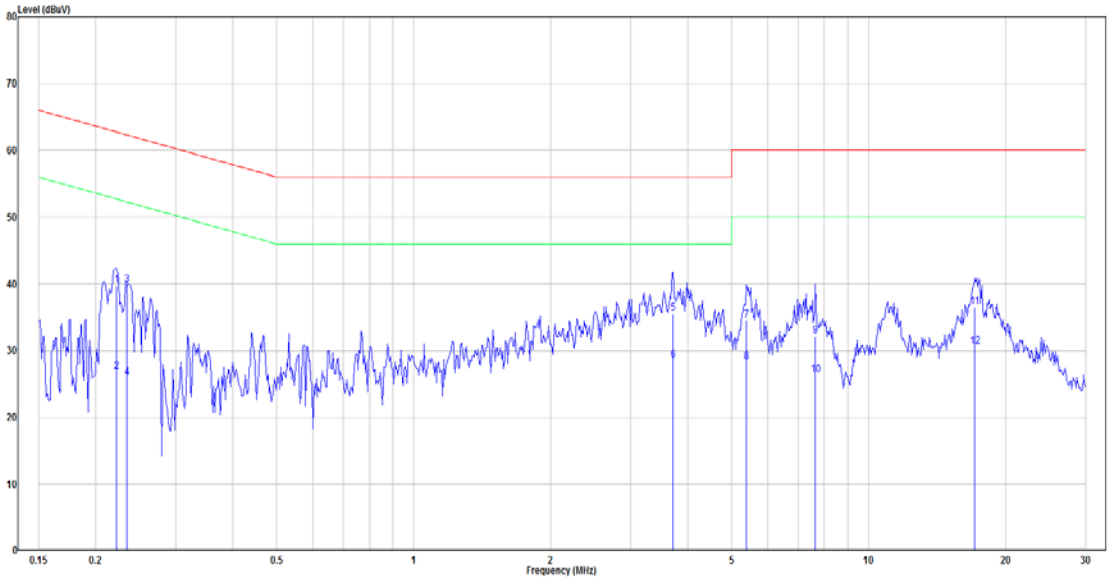
Note:

Level = Read Level + Factor

Over Limit = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

Main: AC120 V, 60 Hz, Neutral



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBµV)	Factor(dB)	(dBµV)	(dBµV)	(dB)	
1	0.222	20.16	19.58	39.74	62.74	-23.00	QP
2	0.222	7.28	19.58	26.86	52.74	-25.88	Average
3	0.234	20.32	19.58	39.90	62.30	-22.40	QP
4	0.234	6.30	19.58	25.88	52.30	-26.42	Average
5	3.720	15.83	19.68	35.51	56.00	-20.49	QP
6	3.720	8.79	19.68	28.47	46.00	-17.53	Average
7	5.390	14.78	19.73	34.51	60.00	-25.49	QP
8	5.390	8.51	19.73	28.24	50.00	-21.76	Average
9	7.646	12.41	19.76	32.17	60.00	-27.83	QP
10	7.646	6.59	19.76	26.35	50.00	-23.65	Average
11	17.109	16.62	19.86	36.48	60.00	-23.52	QP
12	17.109	10.82	19.86	30.68	50.00	-19.32	Average

Note:

Level = Read Level + Factor

Over Limit = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

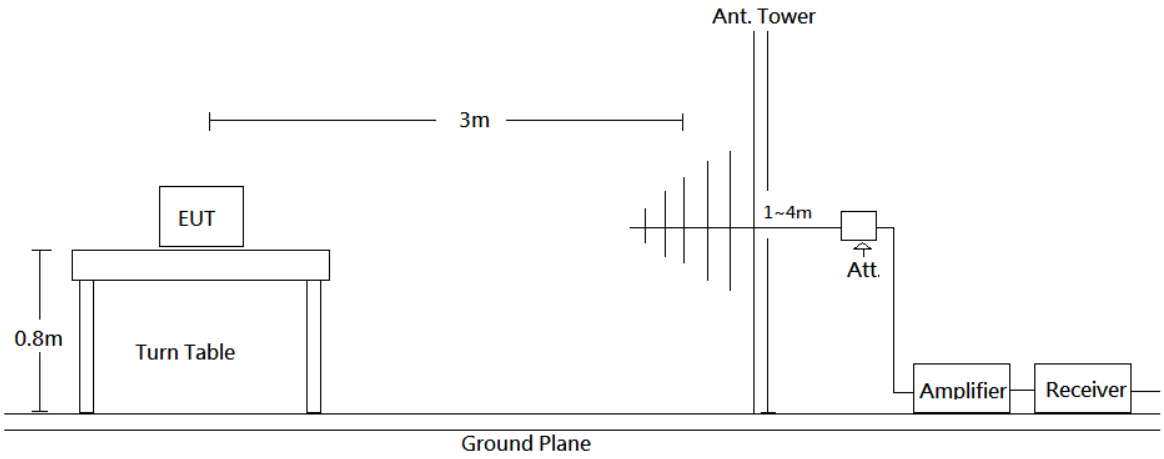
8 FCC §15.209, §15.205 , §15.247(d) – Spurious Emissions

8.1 Applicable Standard

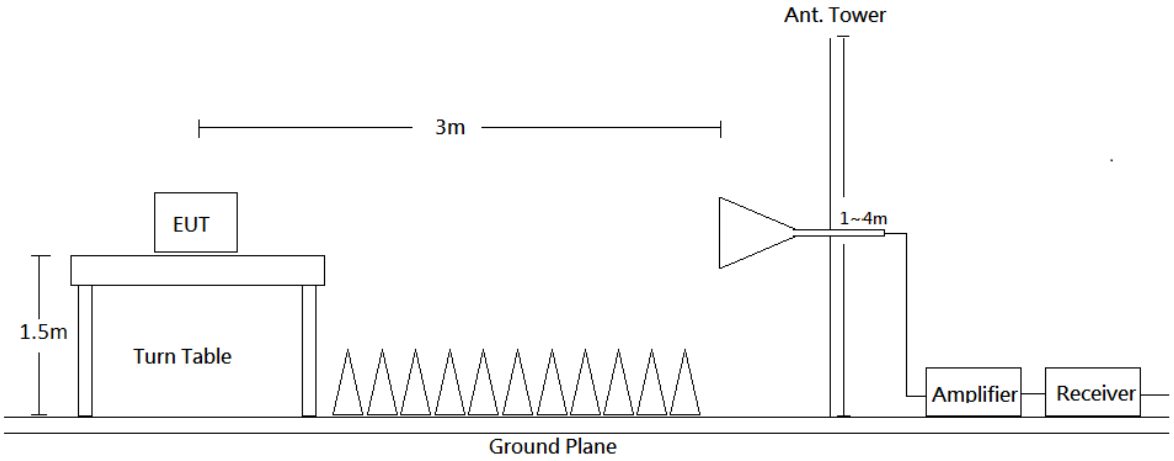
FCC §15.205; §15.209; §15.247(d)

8.2 EUT Setup

Below 1 GHz:



Above 1 GHz:



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

8.3 EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 10 GHz. During the radiated emission test, the EMI test receiver was set with the following configurations measurement method 6.3 in ANSI C63.10.

Frequency Range	RBW	VBW	Duty cycle	Measurement method
30-1000 MHz	120 kHz	300 kHz	/	QP
Above 1 GHz	1 MHz	3 MHz	/	PK
	1 MHz	10Hz	>98%	Ave
	1 MHz	1/T	<98%	Ave

8.4 Test Procedure

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

All data was recorded in the Quasi-peak detector mode from 30 MHz to 1 GHz and PK and average detector modes for frequencies above 1 GHz.

8.5 Corrected Factor & Margin Calculation

The Correct Factor 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:

Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain

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:

Margin = Result – Limit

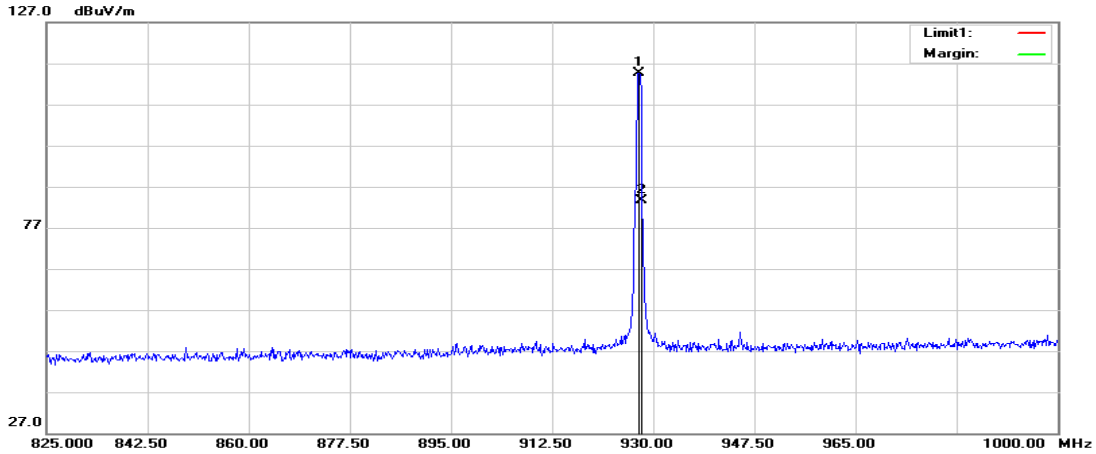
8.6 Test Results

Test Mode: Transmitting (Pre-scan with three orthogonal axis, and worse case as Y axis.)

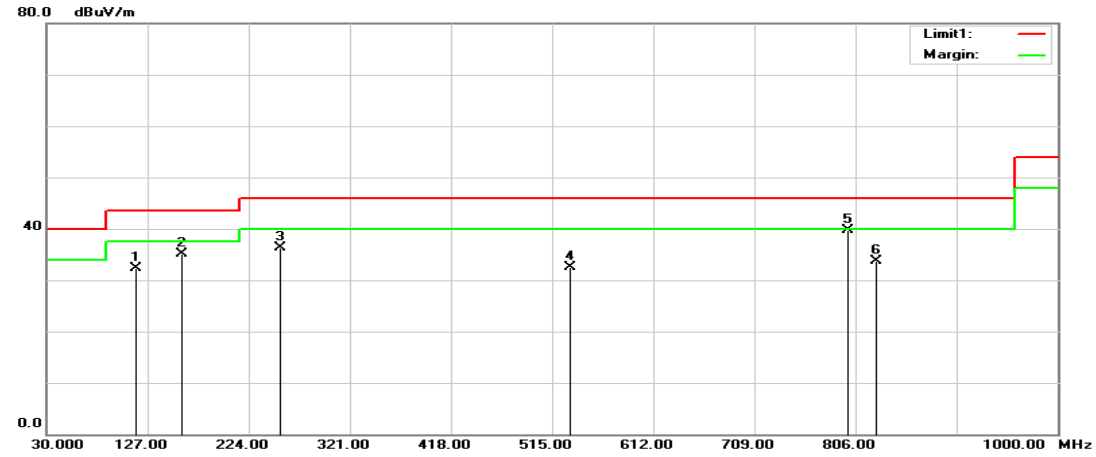
Pygate, DC 5V from USB Port

Horizontal (worst case is high channel)

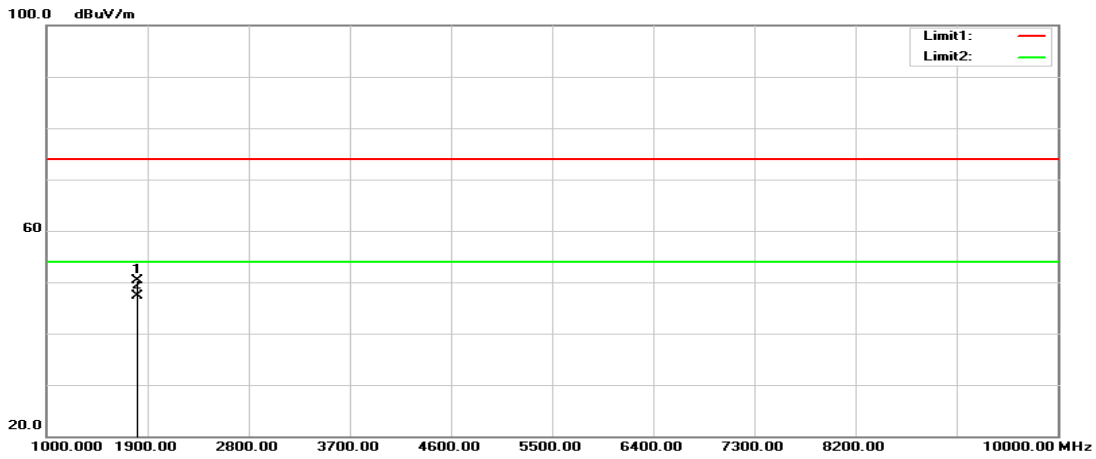
Fundamental:



30MHz-1GHz:

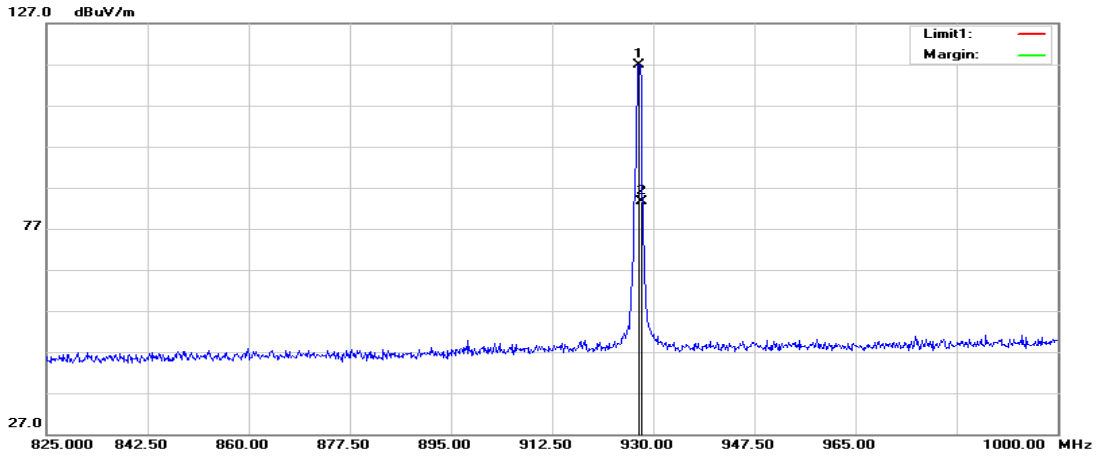


1GHz-10GHz:

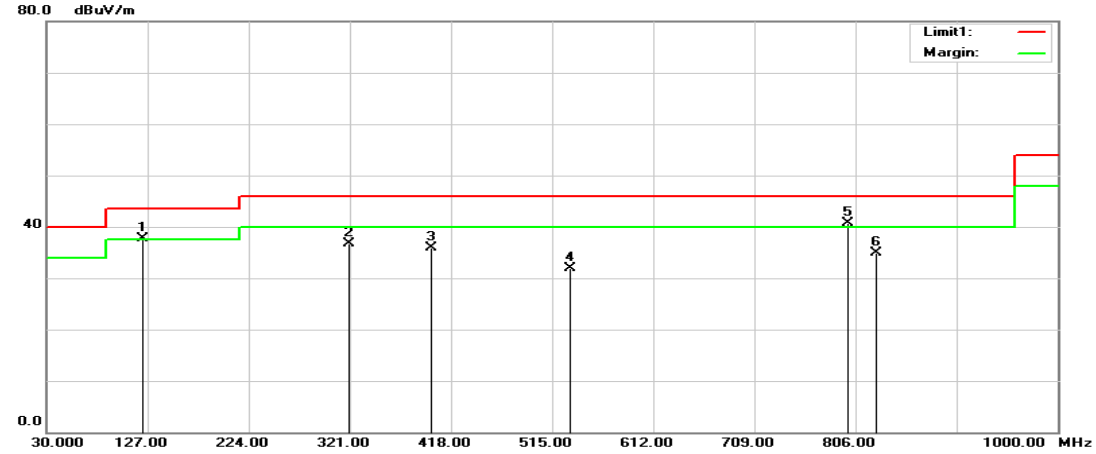


Vertical (worst case is high channel)

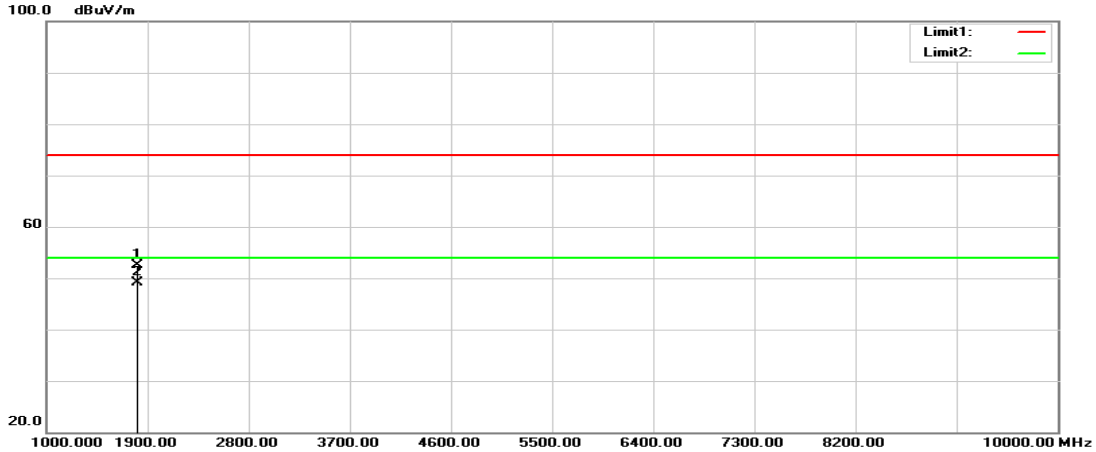
Fundamental:



30MHz-1GHz:



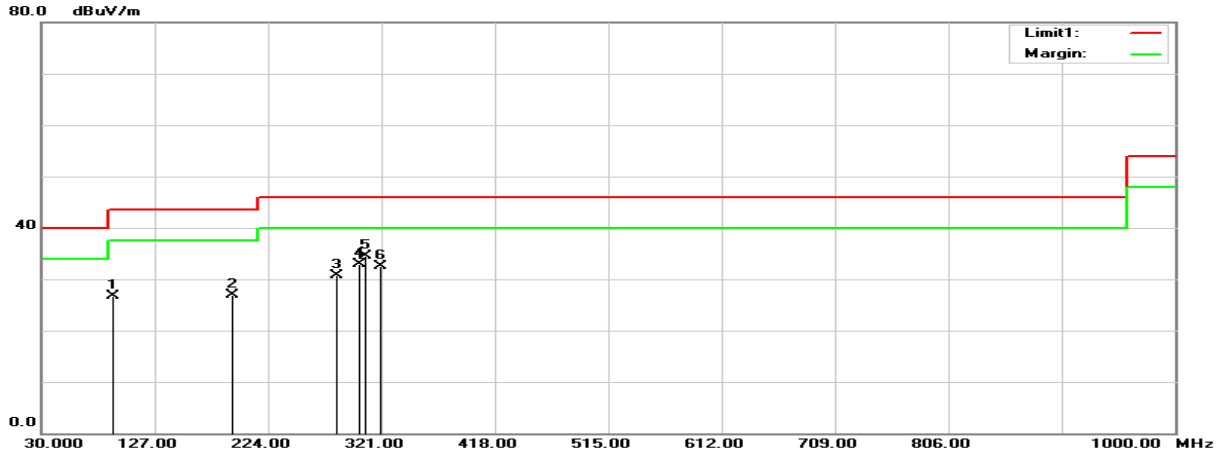
1GHz-10GHz:



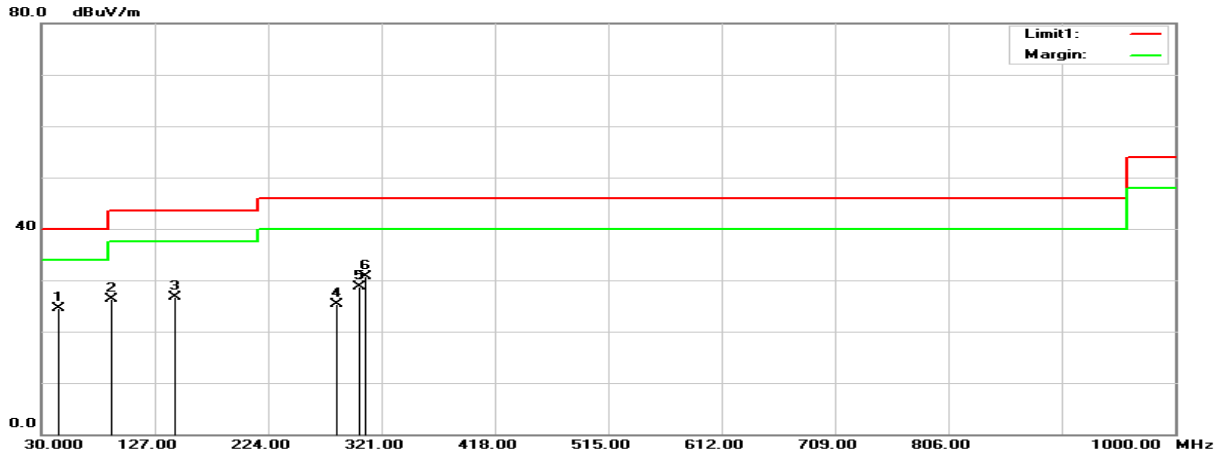
Pygate, DC 3.6V from Li-Po Battery

30MHz-1GHz:

Horizontal



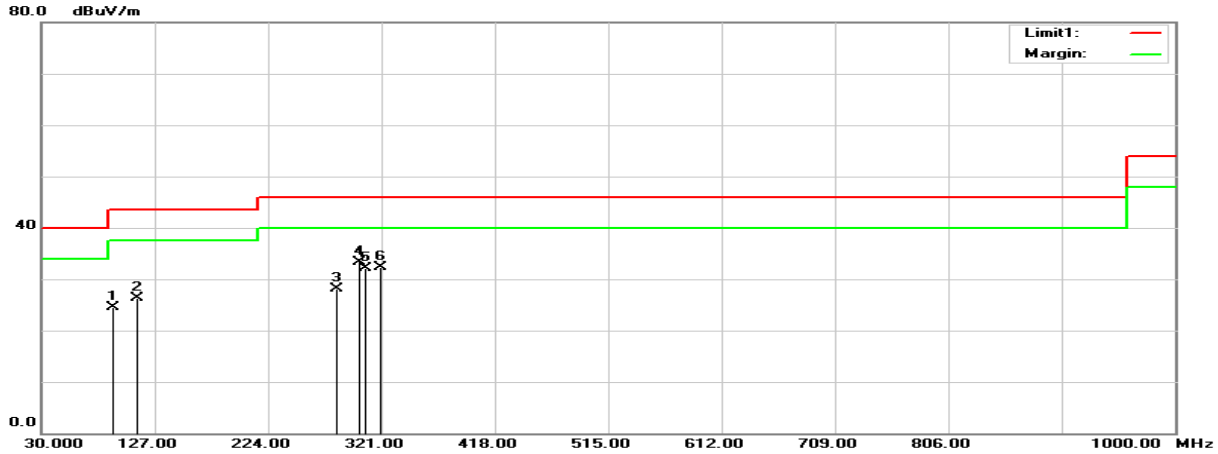
Vertical



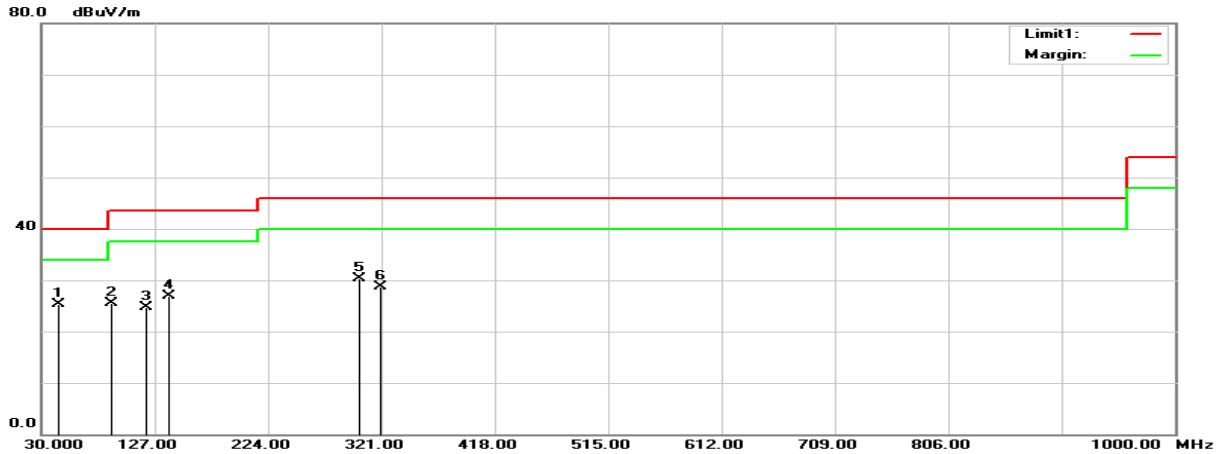
Pygate, DC 48V from PoE

30MHz-1GHz:

Horizontal



Vertical



Pygate, DC 5V from USB Port

30MHz-10GHz

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
Low channel , 903.0MHz								
902.0000	65.69	1.01	66.70	83.89	-17.19	109	241	QP
903.0000	112.84	1.05	113.89	N/A	N/A	109	241	QP
1806.000	62.89	-12.55	50.34	74.00	-23.66	131	158	peak
1806.000	59.94	-12.55	47.39	54.00	-6.61	131	158	AVG
Middle channel, 914.2MHz								
914.2000	112.14	1.54	113.68	N/A	N/A	119	247	QP
1828.400	62.63	-12.34	50.29	74.00	-23.71	137	166	peak
1828.400	59.63	-12.34	47.29	54.00	-6.71	137	166	AVG
High channel, 927.5MHz								
116.3300	43.25	-10.92	32.33	43.50	-11.17	100	81	peak
159.9800	46.30	-11.14	35.16	43.50	-8.34	100	147	peak
254.0700	48.52	-12.24	36.28	46.00	-9.72	100	132	peak
532.4600	38.15	-5.64	32.51	46.00	-13.49	100	254	peak
798.2400	40.78	-1.04	39.74	46.00	-6.26	100	138	peak
826.3700	34.23	-0.50	33.73	46.00	-12.27	100	264	peak
927.5000	112.86	1.78	114.64	N/A	N/A	111	266	QP
928.0000	81.77	1.79	83.56	84.64	-1.08	111	266	QP
1855.000	63.03	-12.11	50.92	74.00	-23.08	118	173	peak
1855.000	60.58	-12.11	48.47	54.00	-5.53	118	173	AVG

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Vertical

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
Low channel , 903.0MHz								
902.0000	73.76	1.01	74.77	86.39	-11.62	134	222	QP
903.0000	115.34	1.05	116.39	N/A	N/A	134	222	QP
1806.000	64.98	-12.55	52.43	74.00	-21.57	108	79	peak
1806.000	61.73	-12.55	49.18	54.00	-4.82	108	79	AVG
Middle channel, 914.2MHz								
914.2000	115.16	1.54	116.70	N/A	N/A	111	330	QP
1828.400	66.27	-12.34	53.93	74.00	-20.07	147	68	peak
1828.400	63.23	-12.34	50.89	54.00	-3.11	147	68	AVG
High channel, 927.5MHz								
122.1500	48.44	-10.72	37.72	43.50	-5.78	100	299	peak
320.0300	46.33	-9.63	36.70	46.00	-9.30	100	145	peak
398.6000	43.85	-7.88	35.97	46.00	-10.03	100	342	peak
532.4600	37.46	-5.64	31.82	46.00	-14.18	100	341	peak
798.2400	41.74	-1.04	40.70	46.00	-5.30	100	58	peak
826.3700	35.44	-0.50	34.94	46.00	-11.06	100	181	peak
927.5000	115.17	1.78	116.95	N/A	N/A	139	285	QP
928.0000	81.73	1.79	83.52	86.95	-3.43	139	285	QP
1855.000	64.39	-12.11	52.28	74.00	-21.72	123	284	peak
1855.000	62.23	-12.11	50.12	54.00	-3.88	123	284	AVG

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Pygate, DC 3.6V from Li-Po Battery

30MHz-1GHz

Horizontal

Frequency	Reading	Correct	Result	Limit	Margin	Height	Degree	Remark
(MHz)	(dBµV)	Factor(dB/m)	(dBµV/m)	(dBµV/m)	(dB)	(cm)	(°)	
91.1100	43.27	-16.49	26.78	43.50	-16.72	100	226	peak
192.9600	39.25	-12.29	26.96	43.50	-16.54	100	147	peak
283.1700	40.83	-10.22	30.61	46.00	-15.39	100	225	peak
301.6000	43.03	-10.06	32.97	46.00	-13.03	100	314	peak
307.4200	44.42	-9.93	34.49	46.00	-11.51	100	229	peak
320.0300	42.07	-9.63	32.44	46.00	-13.56	100	107	peak

Vertical

Frequency	Reading	Correct	Result	Limit	Margin	Height	Degree	Remark
(MHz)	(dBµV)	Factor(dB/m)	(dBµV/m)	(dBµV/m)	(dB)	(cm)	(°)	
44.5500	38.08	-13.59	24.49	40.00	-15.51	100	348	peak
90.1400	42.80	-16.53	26.27	43.50	-17.23	100	332	peak
144.4600	37.63	-10.89	26.74	43.50	-16.76	100	139	peak
283.1700	35.47	-10.22	25.25	46.00	-20.75	100	231	peak
301.6000	38.69	-10.06	28.63	46.00	-17.37	100	253	peak
307.4200	40.54	-9.93	30.61	46.00	-15.39	100	100	peak

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Pygate, DC 48V from PoE

30MHz-1GHz

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
91.1100	40.96	-16.49	24.47	43.50	-19.03	100	258	peak
111.4800	37.77	-11.55	26.22	43.50	-17.28	100	249	peak
283.1700	38.41	-10.22	28.19	46.00	-17.81	100	132	peak
301.6000	43.42	-10.06	33.36	46.00	-12.64	100	118	peak
307.4200	42.03	-9.93	32.10	46.00	-13.90	100	240	peak
320.0300	41.98	-9.63	32.35	46.00	-13.65	100	97	peak

Vertical

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
44.5500	38.82	-13.59	25.23	40.00	-14.77	100	195	peak
90.1400	42.02	-16.53	25.49	43.50	-18.01	100	71	peak
120.2100	35.02	-10.27	24.75	43.50	-18.75	100	68	peak
138.6400	37.55	-10.69	26.86	43.50	-16.64	100	142	peak
301.6000	40.31	-10.06	30.25	46.00	-15.75	100	229	peak
320.0300	38.30	-9.63	28.67	46.00	-17.33	100	302	peak

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

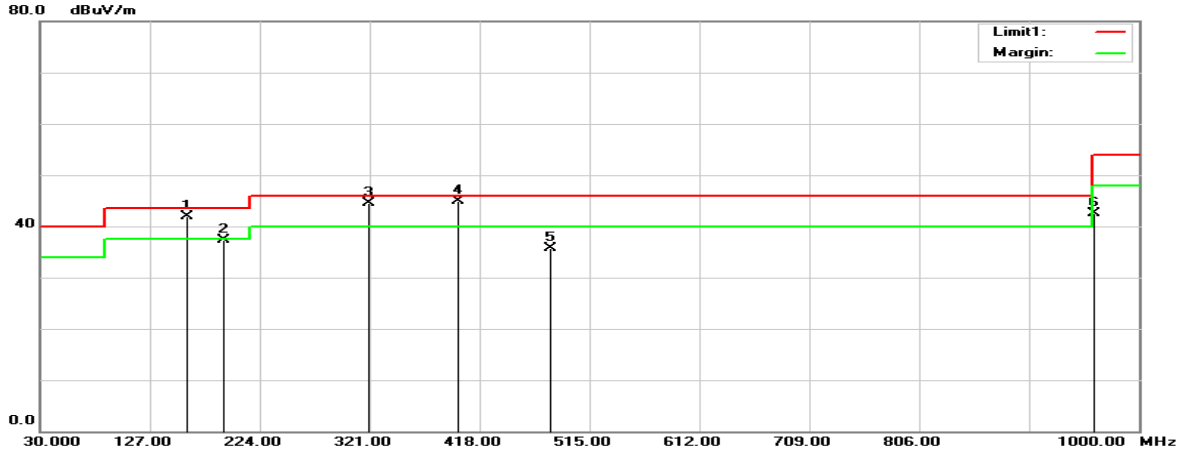
Transmitting simultaneously test:

Model 1

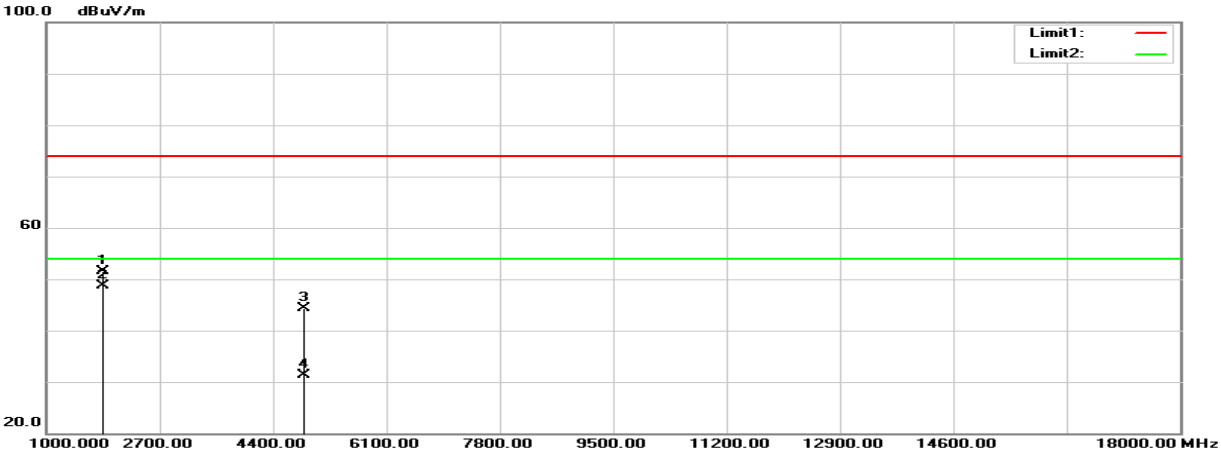
The worst case of LoRa and WIFI mode transmitting simultaneously was recorded

Horizontal

30MHz-1GHz

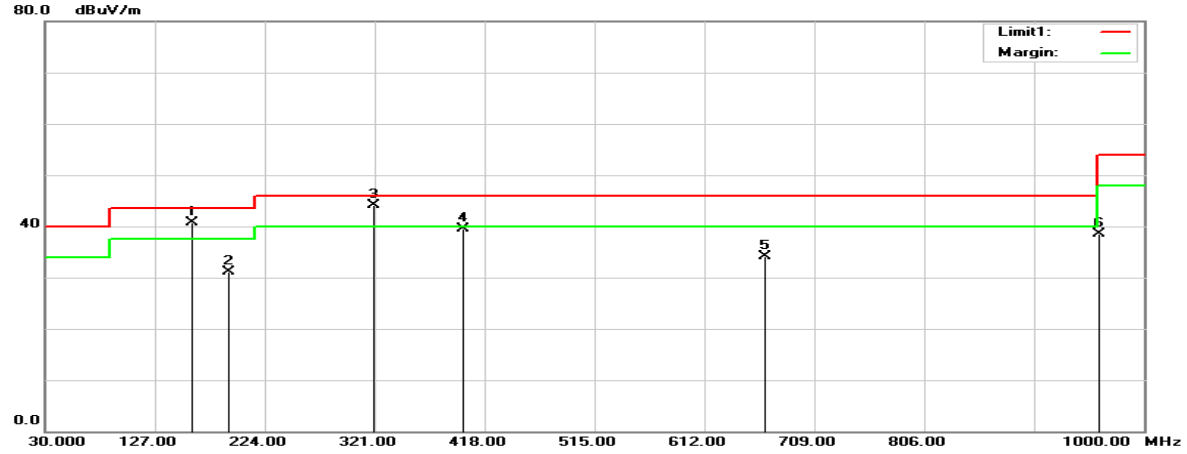


1GHz-18GHz

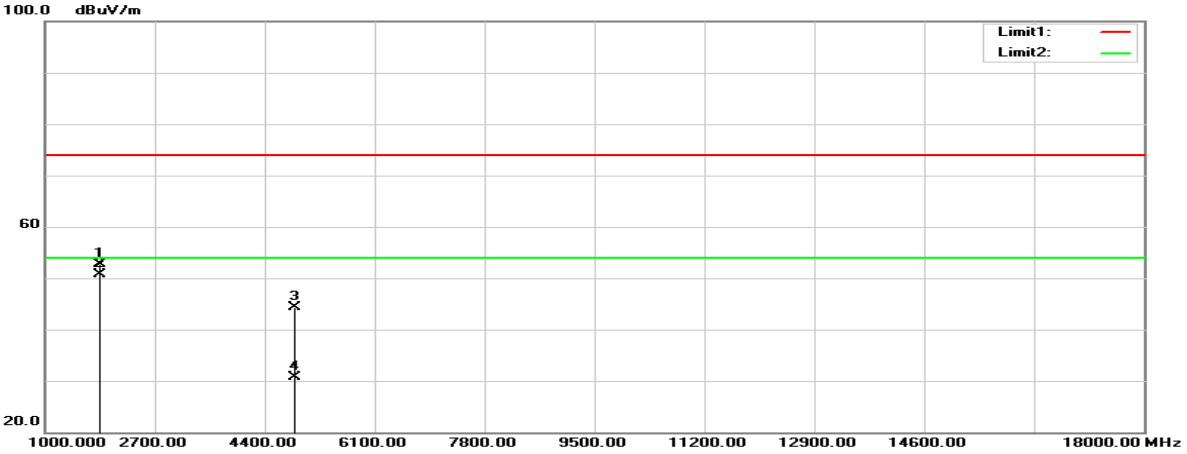


Vertical

30MHz-1GHz



1GHz-18GHz



Below 1GHz

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
159.9800	53.04	-11.14	41.90	43.50	-1.60	100	21	peak
191.9900	49.73	-12.48	37.25	43.50	-6.25	100	96	peak
320.0300	54.12	-9.63	44.49	46.00	-1.51	100	44	QP
398.6000	52.78	-7.88	44.90	46.00	-1.10	100	62	peak
480.0800	41.76	-6.00	35.76	46.00	-10.24	100	214	peak
960.2300	40.11	2.35	42.46	54.00	-11.54	100	125	peak

Vertical

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
159.9800	51.85	-11.14	40.71	43.50	-2.79	100	65	peak
191.9900	43.65	-12.48	31.17	43.50	-12.33	100	185	peak
320.0300	53.80	-9.63	44.17	46.00	-1.83	100	125	peak
398.6000	47.30	-7.88	39.42	46.00	-6.58	100	62	peak
665.3500	37.51	-3.40	34.11	46.00	-11.89	100	99	peak
960.2300	36.06	2.35	38.41	54.00	-15.59	100	152	peak

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Above 1GHz

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
1855.000	63.68	-12.11	51.57	74.00	-22.43	121	168	peak
1855.000	60.87	-12.11	48.76	54.00	-5.24	121	168	AVG
4874.000	46.20	-1.92	44.28	74.00	-29.72	162	239	peak
4874.000	33.19	-1.92	31.27	54.00	-22.73	162	239	AVG

Vertical

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
1855.000	64.77	-12.11	52.66	74.00	-21.34	122	275	peak
1855.000	62.82	-12.11	50.71	54.00	-3.29	122	275	AVG
4874.000	46.22	-1.92	44.30	74.00	-29.70	166	238	peak
4874.000	32.57	-1.92	30.65	54.00	-23.35	166	238	AVG

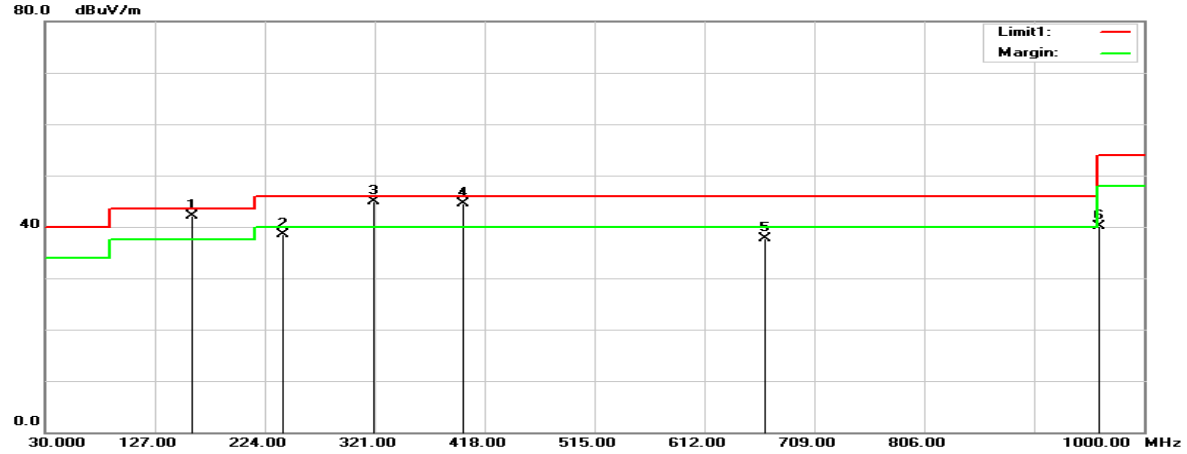
Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Model 2

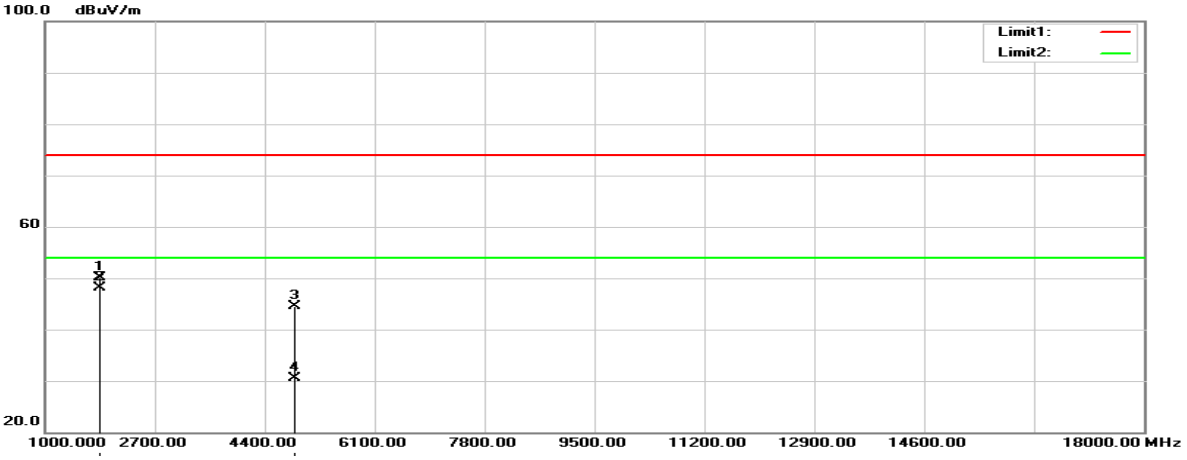
The worst case of LoRa and WIFI mode transmitting simultaneously was recorded

Horizontal

30MHz-1GHz

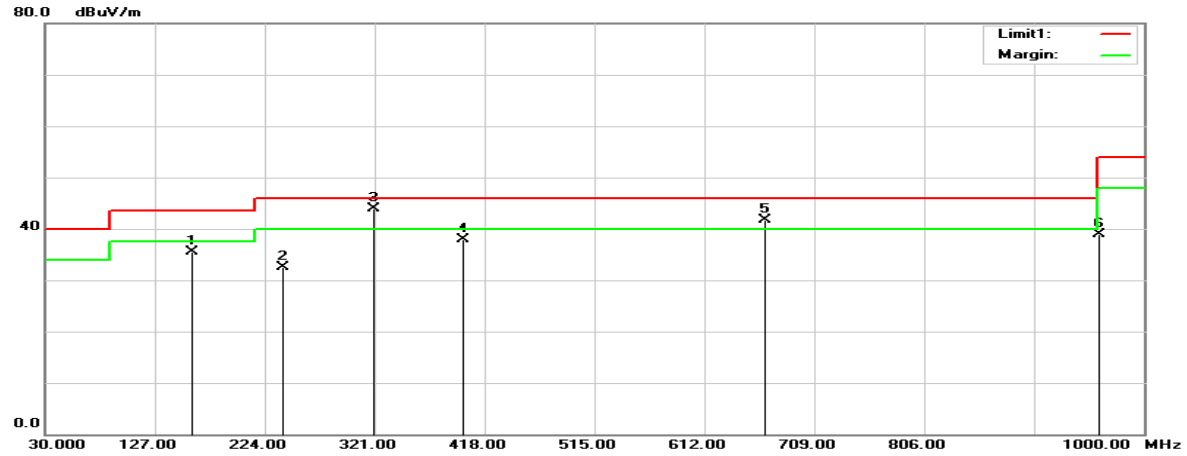


1GHz-18GHz

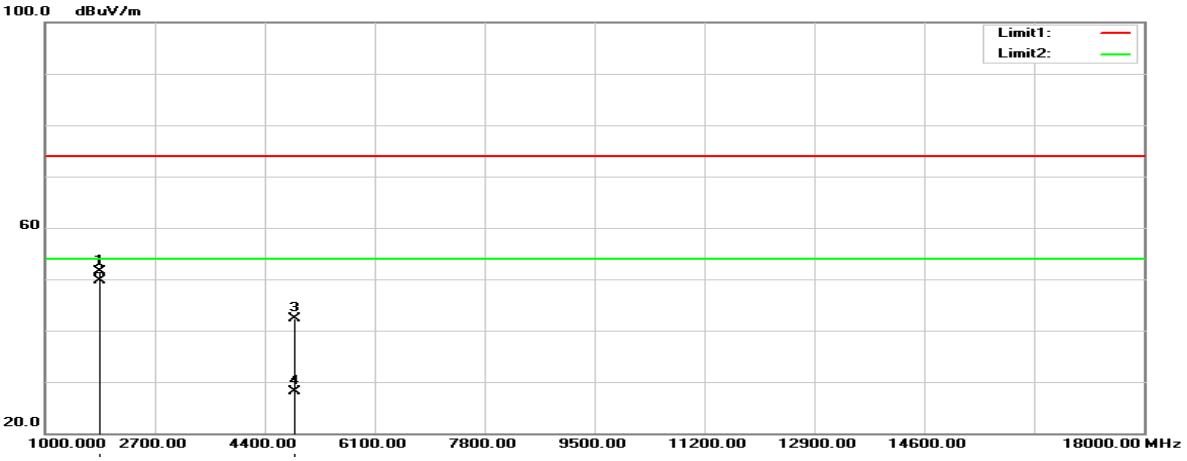


Vertical

30MHz-1GHz



1GHz-18GHz



Below 1GHz

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
159.9800	53.25	-11.14	42.11	43.50	-1.39	100	52	peak
239.5200	50.69	-12.25	38.44	46.00	-7.56	100	96	peak
320.0300	54.55	-9.63	44.92	46.00	-1.08	100	116	QP
398.6000	52.44	-7.88	44.56	46.00	-1.44	100	85	peak
665.3500	41.12	-3.40	37.72	46.00	-8.28	100	135	peak
960.2300	37.83	2.35	40.18	54.00	-13.82	100	108	peak

Vertical

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
159.9800	46.59	-11.14	35.45	43.50	-8.05	100	28	peak
239.5200	44.70	-12.25	32.45	46.00	-13.55	100	96	peak
320.0300	53.53	-9.63	43.90	46.00	-2.10	100	221	QP
398.6000	45.78	-7.88	37.90	46.00	-8.10	100	154	peak
665.3500	45.14	-3.40	41.74	46.00	-4.26	100	125	peak
960.2300	36.49	2.35	38.84	54.00	-15.16	100	63	peak

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Above 1GHz

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
1855.000	62.13	-12.11	50.02	74.00	-23.98	110	178	peak
1855.000	60.28	-12.11	48.17	54.00	-5.83	110	178	AVG
4874.000	46.39	-1.92	44.47	74.00	-29.53	150	233	peak
4874.000	32.48	-1.92	30.56	54.00	-23.44	150	233	AVG

Vertical

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
1855.000	63.68	-12.11	51.57	74.00	-22.43	120	275	peak
1855.000	61.74	-12.11	49.63	54.00	-4.37	120	275	AVG
4874.000	44.29	-1.92	42.37	74.00	-31.63	144	180	peak
4874.000	30.04	-1.92	28.12	54.00	-25.88	144	180	AVG

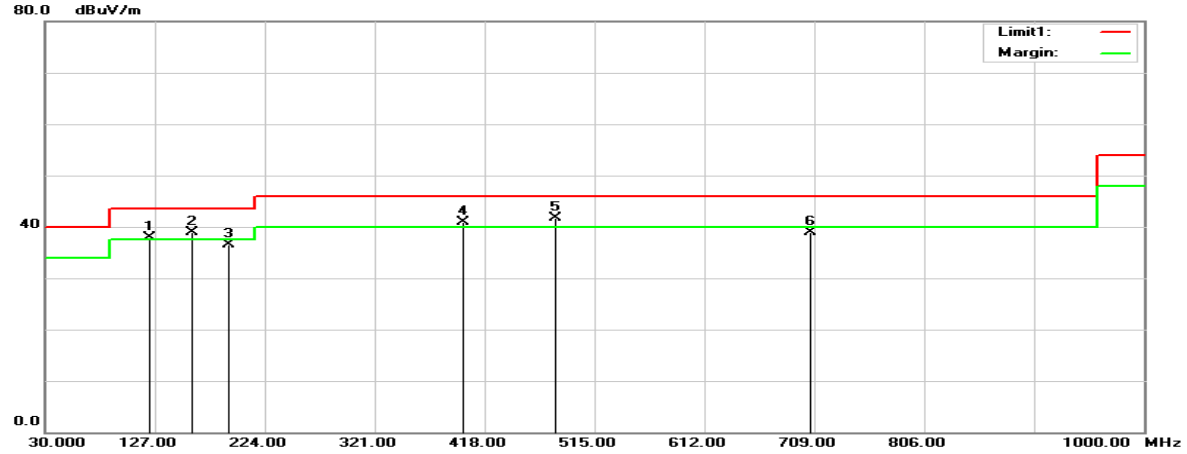
Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Model 3

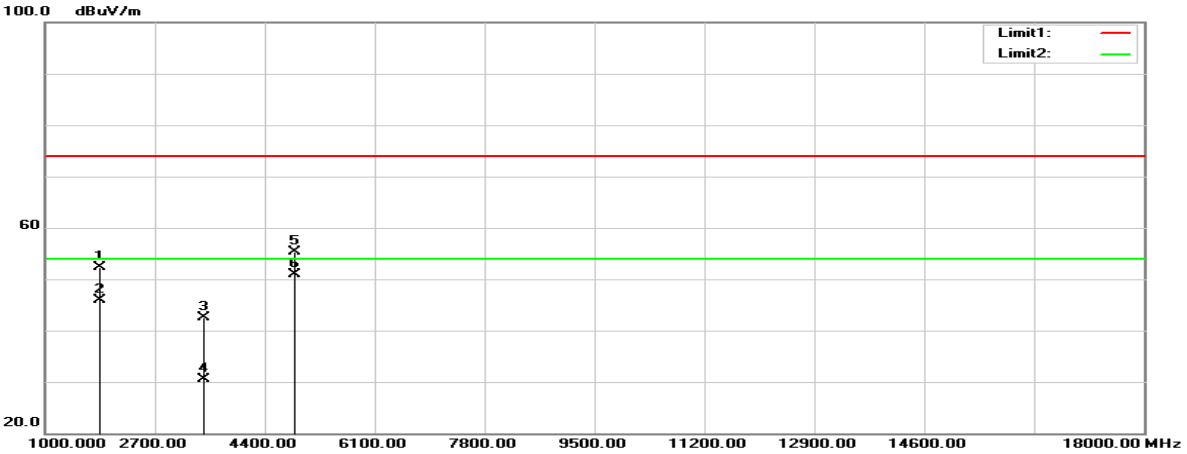
The worst case of LoRa and WIFI, LTE mode transmitting simultaneously was recorded

Horizontal

30MHz-1GHz

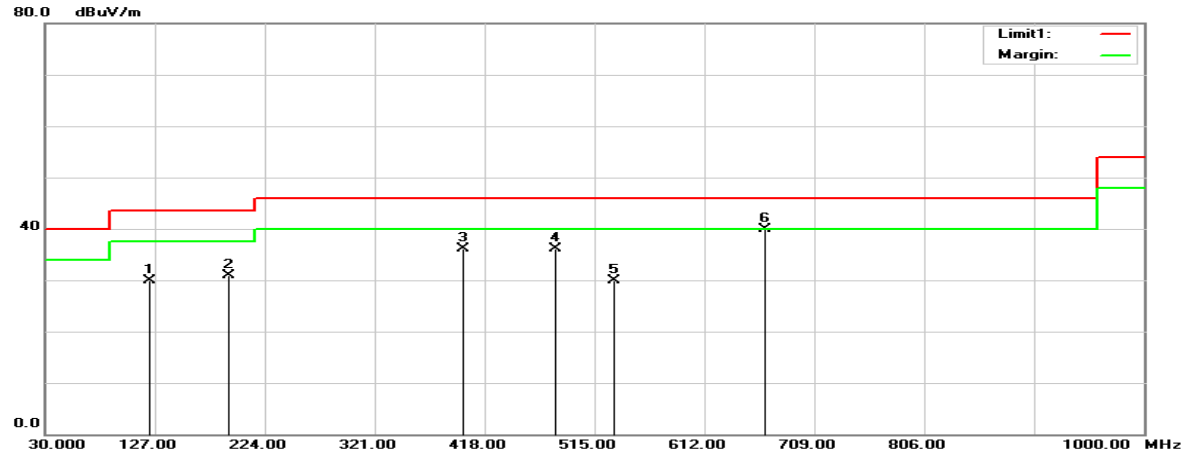


1GHz-18GHz

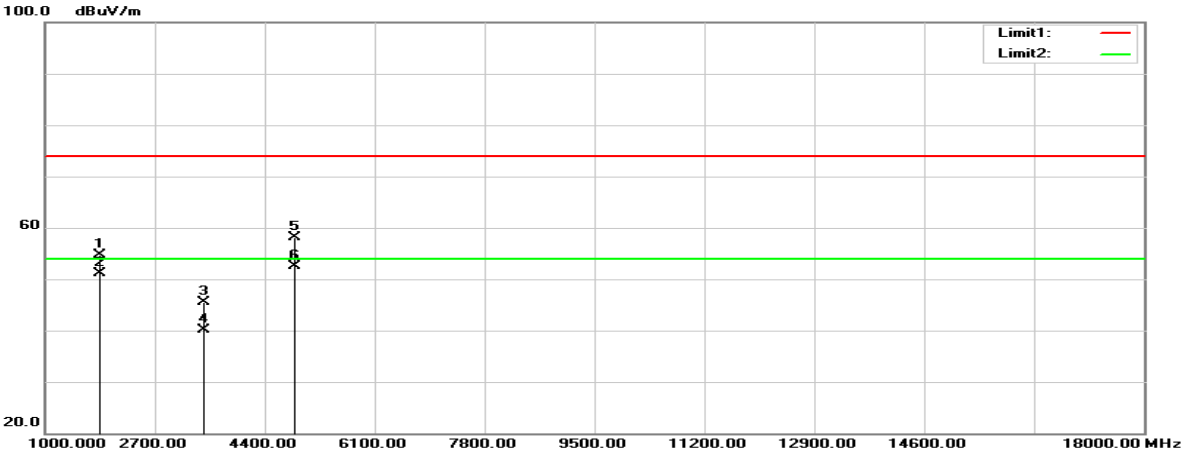


Vertical

30MHz-1GHz



1GHz-18GHz



Below 1GHz

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
122.1500	48.64	-10.72	37.92	43.50	-5.58	100	52	peak
159.9800	50.01	-11.14	38.87	43.50	-4.63	100	258	peak
191.9900	49.04	-12.48	36.56	43.50	-6.94	100	96	peak
398.6000	48.83	-7.88	40.95	46.00	-5.05	100	154	peak
480.0800	47.65	-6.00	41.65	46.00	-4.35	100	62	peak
705.1200	41.79	-2.88	38.91	46.00	-7.09	100	37	peak

Vertical

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
122.1500	40.70	-10.72	29.98	43.50	-13.52	100	96	peak
191.9900	43.32	-12.48	30.84	43.50	-12.66	100	62	peak
398.6000	44.00	-7.88	36.12	46.00	-9.88	100	123	peak
480.0800	42.12	-6.00	36.12	46.00	-9.88	100	64	peak
532.4600	35.59	-5.64	29.95	46.00	-16.05	100	111	peak
665.3500	43.40	-3.40	40.00	46.00	-6.00	100	125	peak

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Above 1GHz

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
1855.000	64.33	-12.11	52.22	74.00	-21.78	154	22	peak
1855.000	57.98	-12.11	45.87	54.00	-8.13	154	22	AVG
3465.000	48.33	-5.81	42.52	74.00	-31.48	148	287	peak
3465.000	36.24	-5.81	30.43	54.00	-23.57	148	287	AVG
4874.000	57.21	-1.92	55.29	74.00	-18.71	121	136	peak
4874.000	52.88	-1.92	50.96	54.00	-3.04	121	136	AVG

Vertical

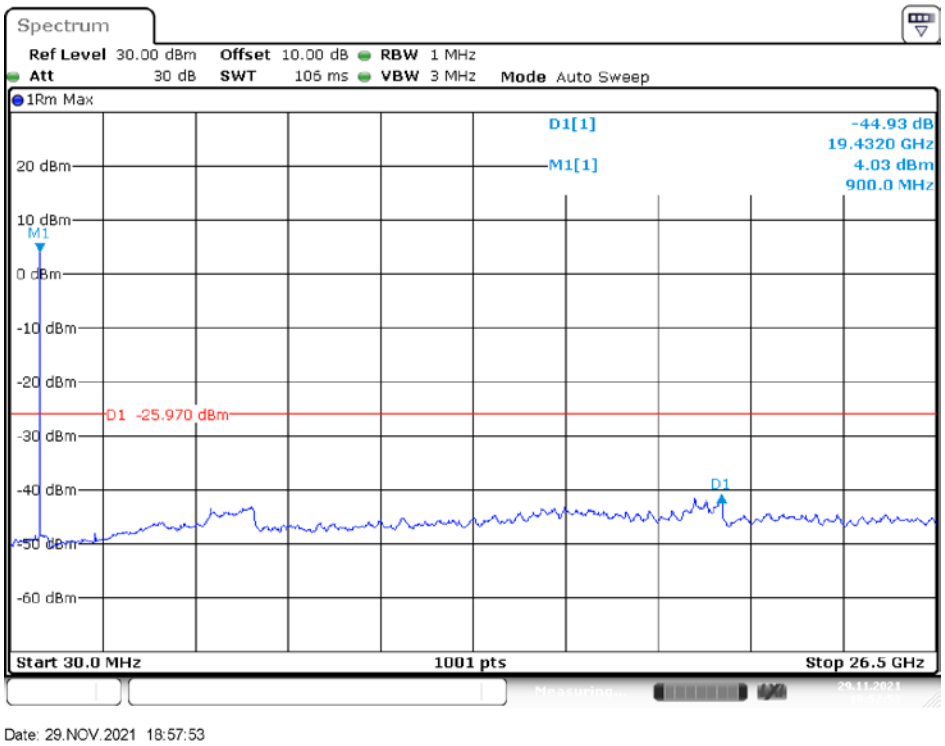
Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
1855.000	66.88	-12.11	54.77	74.00	-19.23	152	22	peak
1855.000	63.21	-12.11	51.10	54.00	-2.90	152	22	AVG
3465.000	51.22	-5.81	45.41	74.00	-28.59	161	136	peak
3465.000	45.98	-5.81	40.17	54.00	-13.83	161	136	AVG
4874.000	60.12	-1.92	58.20	74.00	-15.80	124	187	peak
4874.000	54.33	-1.92	52.41	54.00	-1.59	124	187	AVG

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Conducted Spurious Emissions:

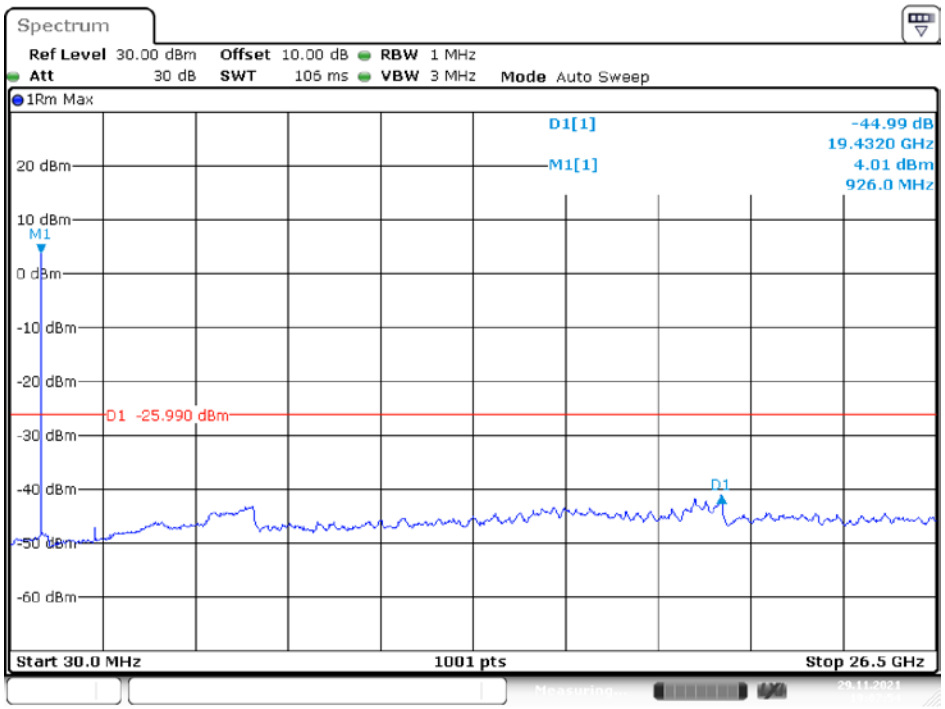
Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
Low	903.0	44.93	≥ 30	PASS
Mid	914.2	44.99	≥ 30	PASS
High	927.5	45.00	≥ 30	PASS

Low Channel



Date: 29.NOV.2021 18:57:53

Middle Channel



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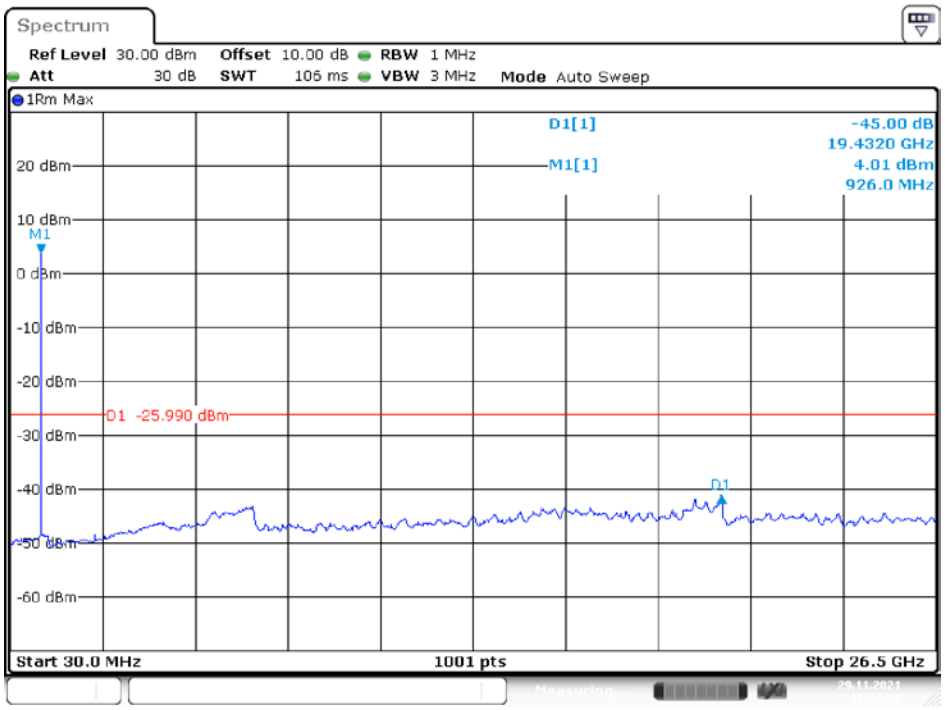
High Channel



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9 FCC §15.247(a)(2) – 6 dB Emission Bandwidth

9.1 Applicable Standard

According to FCC §15.247(a)(2).

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.

9.2 Test Procedure

The steps for the first option are as follows:

a) Set RBW = 100 kHz.

b) Set the VBW ≥ [3 × RBW].

c) Detector = peak.

d) Trace mode = max hold.

e) Sweep = auto couple.

f) Allow the trace to stabilize.

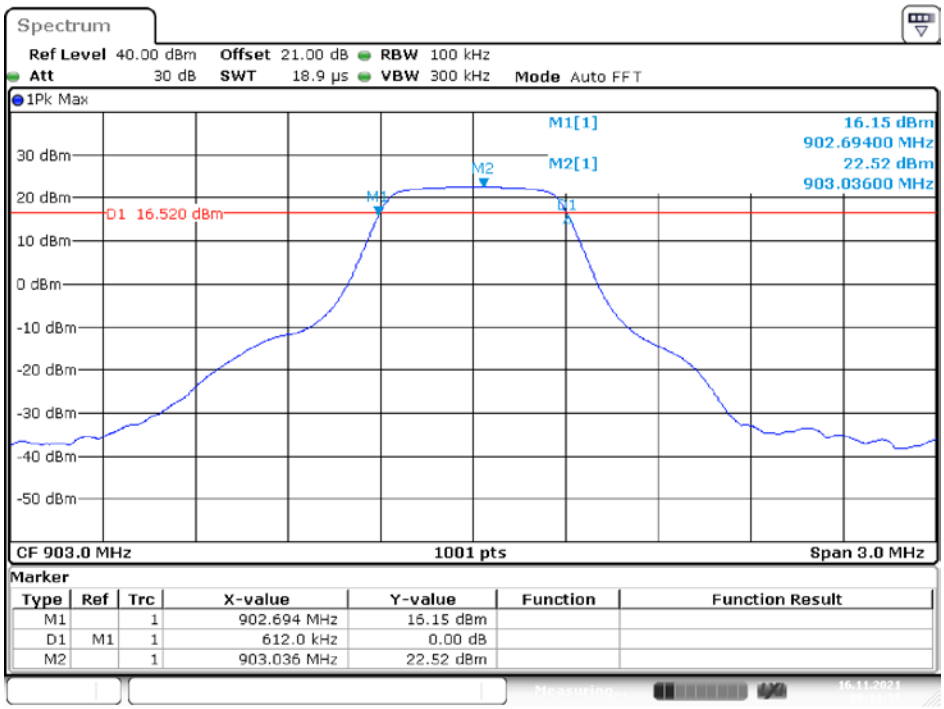
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

9.3 Test Results

Channel	Frequency (MHz)	6 dB Emission Bandwidth (kHz)	Limit (kHz)	Result
Low	903.0	612	> 500	Compliance
Middle	914.2	606	> 500	Compliance
High	927.5	606	> 500	Compliance

Please refer to the following plots

Low Channel



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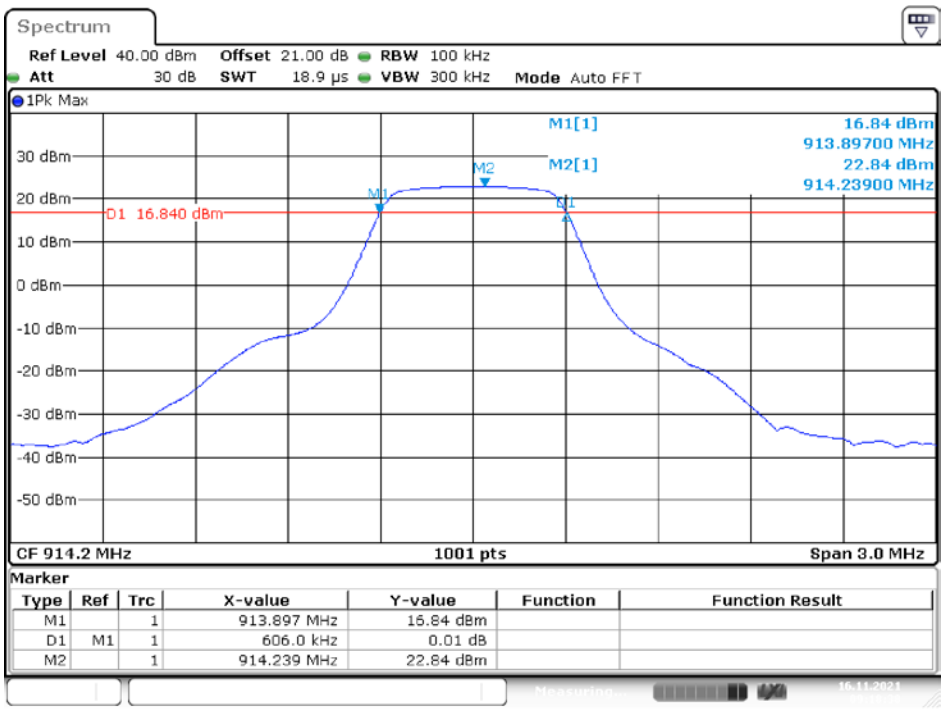
Middle Channel



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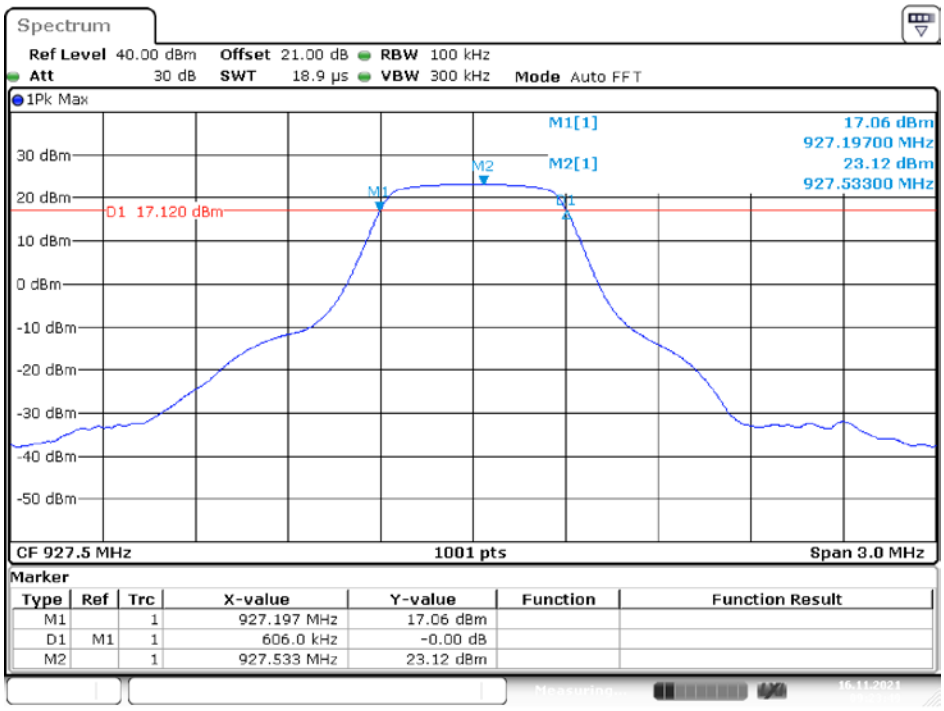
High Channel



10 FCC §15.247(b)(3) – Maximum Average Output Power

10.1 Applicable Standard

According to FCC §15.247(b) (3).

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.

10.2 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 measuring equipment.

10.3 Test Results

Conducted Average Output Power

Channel	Frequency (MHz)	Power (dBm)	Limit (W)	Result
Low	903.0	22.87	30	PASS
Middle	914.2	23.16	30	PASS
High	927.5	23.45	30	PASS

11 FCC§15.247(d) – 100 kHz Bandwidth of Frequency Band Edge

11.1 Applicable Standard

According to FCC §15.247(d).

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)).

11.2 Test Procedure

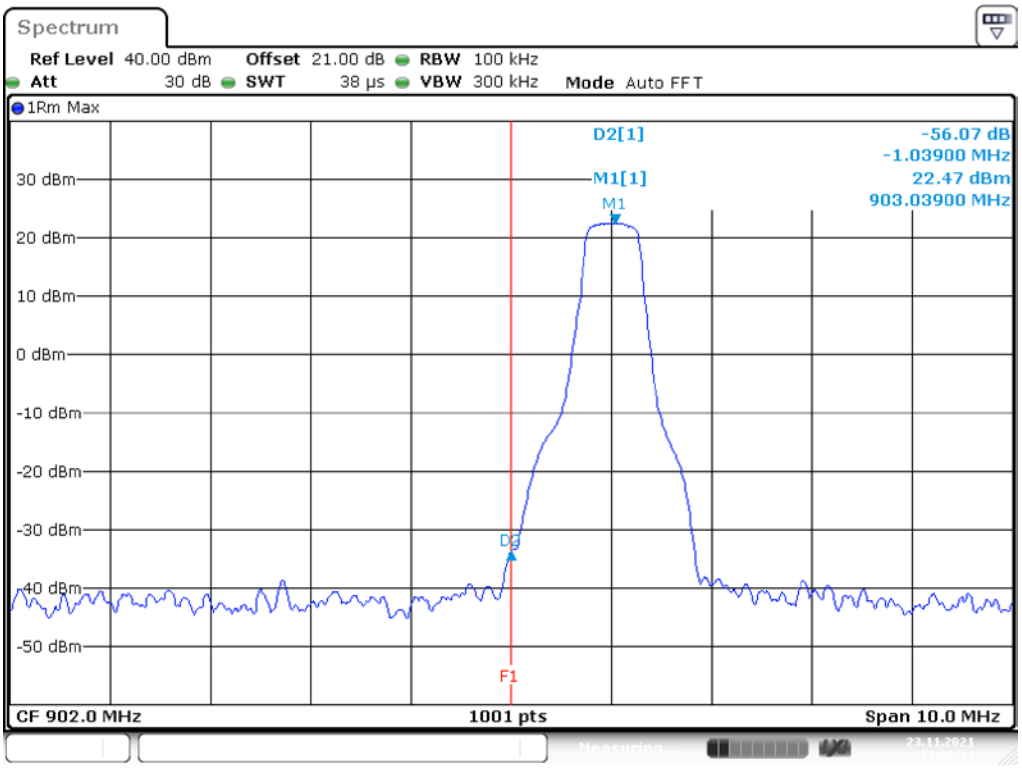
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then 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.

11.3 Test Results

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
Low	903.0	56.07	≥ 30	PASS
High	927.5	33.85	≥ 30	PASS

Please refer to the following plots

Band Edge, Left Side



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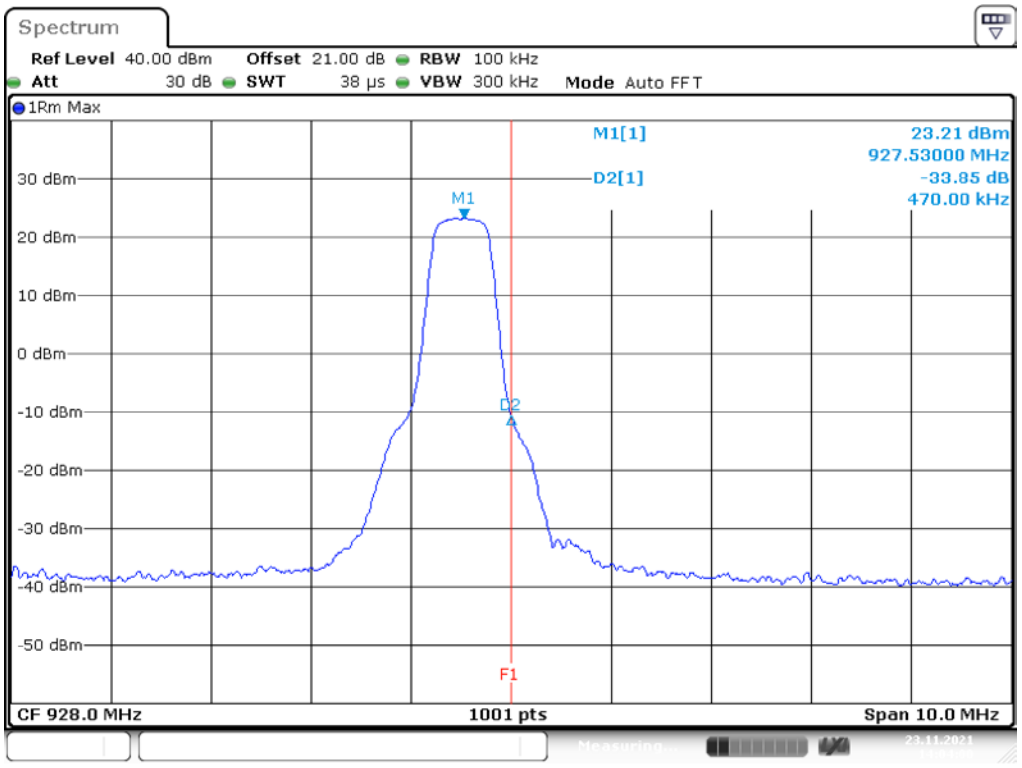
Band Edge, Right Side



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12 FCC §15.247(e) – Power Spectral Density

12.1 Applicable Standard

According to FCC §15.247(e).

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.

12.2 Test Procedure

a) Set analyzer center frequency to DTS channel center frequency.

b) Set the span to 1.5 times the DTS bandwidth.

c) Set the RBW to 3 kHz ≤ RBW ≤ 100 kHz.

d) Set the VBW ≥ [3 × RBW].

e) Detector = power averaging (rms).

f) Sweep time = auto couple.

g) Trace mode = max hold.

h) Allow trace to fully stabilize.

i) Use the peak marker function to determine the maximum amplitude level within the RBW.

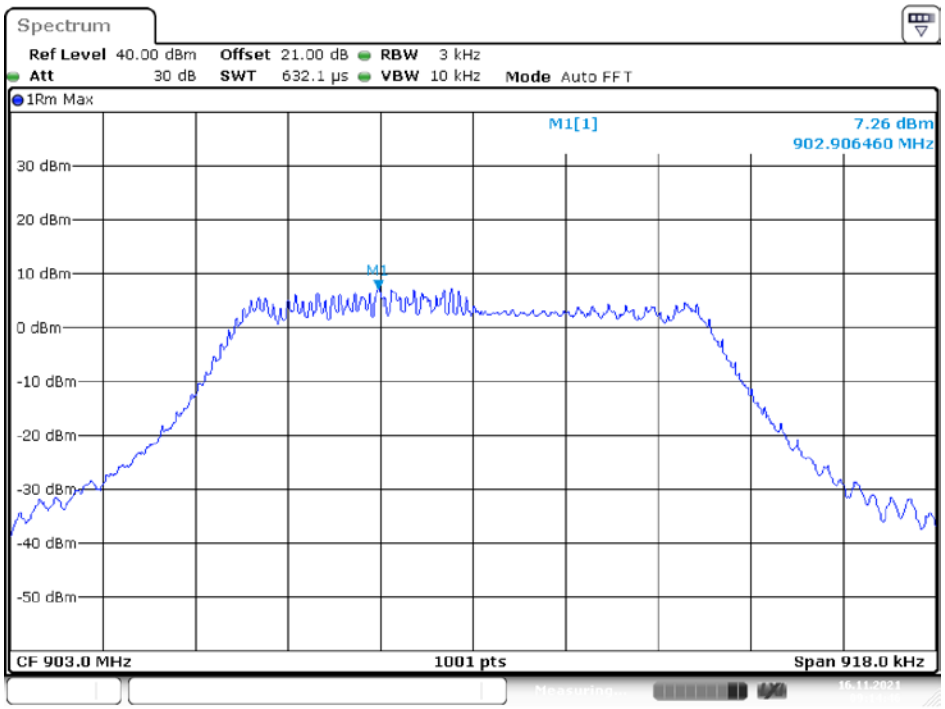
j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat

12.3 Test Results

Channel	Frequency (MHz)	Power Spectral Density (dBm/3 kHz)	Limit (dBm/3 kHz)	Result
Low	903.0	7.26	8	Compliance
Middle	914.2	7.16	8	Compliance
High	927.5	4.08	8	Compliance

Please refer to the following plots

Low Channel



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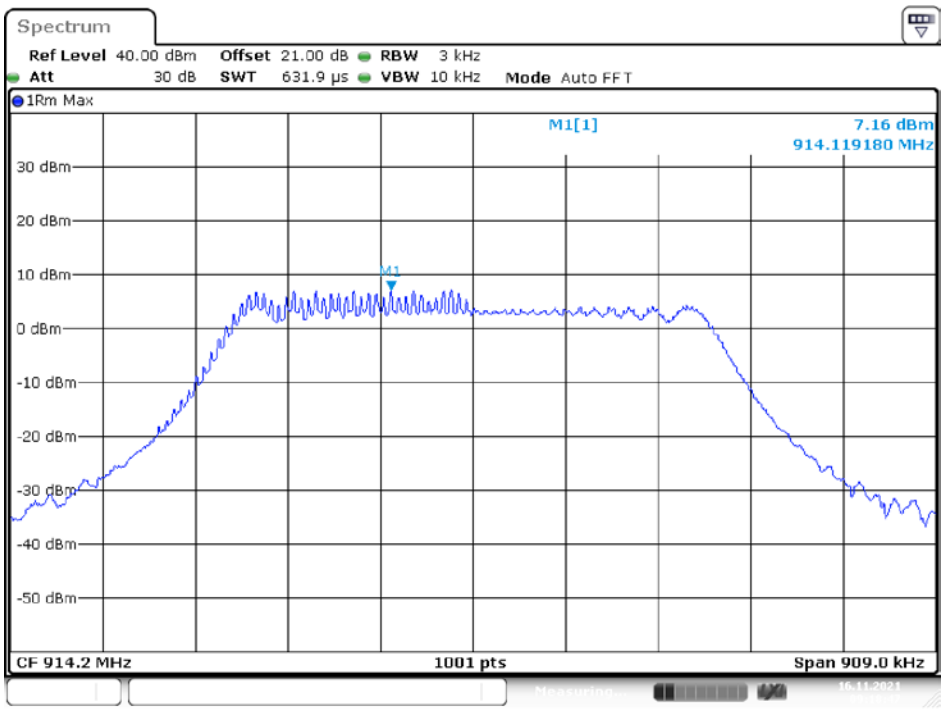
Middle Channel



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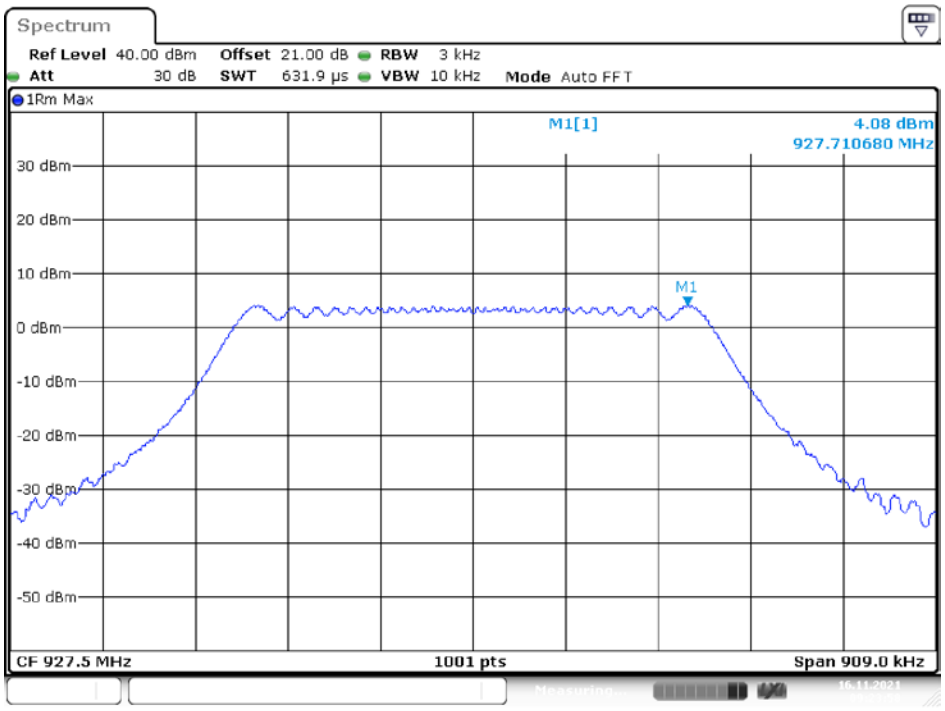
High Channel



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