

# ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT



**FCC Applicant:** Device Solutions Inc.  
3211 Moorefields Road, Hillsborough North Carolina 27278

**Product Name:** Gateway

**Brand Name:** Cellio

**Model No.:** DS0052V-G

**Model Difference:** N/A

**Report Number:** ER/2021/40081

**FCC ID** OXW-AS0133

**IC:** 10572A-AS0133

**Issue Date:** Jun.08,2021

**Date of Test:** Apr. 23,2021~May 19,2021

**Date of EUT Received:** Apr. 23,2021

Approved By JJ Chen  
JJ Chen

## We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Central RF Lab The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT comply with FCC rule part §15.247, ISED RSS-247.

The results of this report relate only to the sample identified in this report.

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## Revision History

Report Number	Revision	Description	Issue Date	Revised By
ER/2021/40081	Rev.00	Original.	Jun.08,2021	Viola Su

**Note:**

- 1、Antenna information is provided by the applicant, test results of this report are applicable to the sample EUT received.

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# 1 GENERAL INFORMATION

## 1.1 Product Description

Product Name:	Gateway
Brand Name:	Cellio
Model No.:	DS0052V-G
Model Difference:	N/A
Hardware Version:	B
Firmware Version:	N/A
EUT Series No.:	BTGB03
Power Supply:	3.7Vdc from Rechargeable Li-polymer Battery 5.9Vdc from AC/DC adapter

## 1.2 RF Specification

Radio Technology:	LoRa
Frequency Range:	907 – 923MHz
Channel number:	3 channels
Modulation type:	Chirp Spread Spectrum (CSS)
Transmit Power:	15.72 dBm

## 1.3 Antenna Designation

Antenna Type	Supplier	Antenna Part No.	Freq. (MHz)	Peak Antenna Gain (dBi)
Chip Antenna	johansontechnology	0915AT43A0026	902-928	-1

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### 1.4 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247  
 FCC KDB 558074 D01 15.247 Meas Guidance v05r02  
 RSS-247 issue 2 Feb. 2017  
 RSS-Gen Issue 5, Amendment 2, February 2021  
 ANSI C63.10:2013

Note: All test items have been performed and record as per the above standards.

### 1.5 Test Facility

Laboratory	Test Site Address	Test Site Name	FCC Designation number	IC CAB identifier
SGS Taiwan Ltd. Central RF Lab. (TAF code 3702)	No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan.	SAC 1	TW0027	TW3702
		SAC 3		
		Conduction 1		
		Conducted 1		
		Conducted 2		
		Conducted 3		
		Conducted 4		
		Conducted 5		
		Conducted 6		
	No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333	Conduction A	TW0028	
		SAC C		
		SAC D		
		SAC G		
		Conducted A		
		Conducted B		
		Conducted C		
		Conducted D		
		Conducted E		
		Conducted F		
Conducted G				

**Note:** Test site name is remarked on the equipment list in each section of this report as an indication where measurements occurred in specific test site and address.

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## 1.6 Special Accessories

There are no special accessories used while test was conducted.

## 1.7 Equipment Modifications

There was no modification incorporated into the EUT.

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## 2 SYSTEM TEST CONFIGURATION

### 2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

### 2.2 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

### 2.3 Test Procedure

#### 2.3.1 Conducted Emissions

The EUT is placed on a table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz. The CISPR Quasi-Peak and Average detector mode is employed. The two LISNs provide 50uH/50 ohm of coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

#### 2.3.2 Conducted Test (RF)

The active antenna port of the unlicensed wireless device is connected to the spectrum analyzer with attenuator to protect the instrumentation. If a second antenna port is available, it is tested at one operating frequency, with other port(s) appropriately terminated, to verify it has similar output characteristics as the fully tested port.

#### 2.3.3 Radiated Emissions

The EUT is placed on a turn table. For emissions testing at or below 1 GHz, the table height shall be 0.8 m above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.

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## 2.4 Measurement Results Explanation Example

### 2.4.1 Radiated Emission Test Sites For Measurements From 9 kHz To 30 MHz

Radiated emission below 30MHz is measured in a 9m\*9m\*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

### 2.4.2 For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

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## 2.5 Configuration of Tested System

Fig. 2-1 Conducted Setup

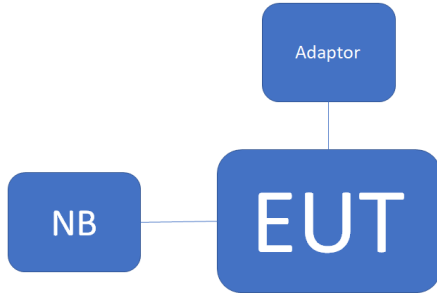


Fig 2-2 Radiated Setup & Conduction Setup



Table 2-1 Equipment Used in Tested System

Item	Equipment	MRF/BRAND	Model/Type No.	Series No.	Version
1	Tera term	N/A	N/A	N/A	4.102
2	Notebook	Lenovo	X250	PC-06A4E7	N/A
3	Notebook	Lenovo	L480	PF-1S9NT5	N/A
4	Adapter	Triad	WSU020-1250	WS2U059-1250	N/A

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### 3 SUMMARY OF TEST RESULTS

FCC Rules	ISED Rules	Description Of Test	Result
§15.207(a)	RSS-Gen §8.8	AC Power Line Conducted Emission	Compliant
§15.247(b) (3)	RSS-247 §5.4 d	Peak Output Power	Compliant
§15.247(a)(2)	RSS-247 §5.2 a RSS-Gen §6.7	Emission Bandwidth	Compliant
§15.205 §15.209 §15.247(d)	RSS-247 §5.5	Conducted Band Edge and Spurious Emission	Compliant
§15.205 §15.209 §15.247(d)	RSS-247 §5.5	Radiated Band Edge and Spurious Emission	Compliant
§15.247(e)	RSS-247 §5.2 b	Peak Power Density	Compliant
§15.203 §15.247(b)	N/A	Antenna Requirement	Compliant

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## 4 DESCRIPTION OF TEST MODES

### 4.1 Operating frequency

3 channels are provided for Lora

CHANNEL	FREQUENCY
Low	907 MHz
Mid	913 MHz
High	923 MHz

### 4.2 The Worst Test Modes and Channel Details

1. The EUT has been tested under operating condition.
2. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.
3. Investigation has been done on all the possible configurations for searching the worst case.

RADIATED EMISSION TEST (BELOW 1 GHz)				
MODE	AVAILABLE FREQUENCY (Mhz)	TESTED FREQUENCY (MHz)	MODULATION	DATA RATE (kbps)
Lora	907 to 923	907	Chirp Spread Spectrum (CSS)	0.3
RADIATED EMISSION TEST (ABOVE 1 GHz)				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)
Lora	907 to 923	907,913,923	Chirp Spread Spectrum (CSS)	0.3

**Note:** The field strength of radiation emission was measured as EUT three orthogonal plans, E1 / E2 / H, are positioned to pre-scan the emission generating the highest one. The worst E1 position is tested, and recorded.

CONDUCTED TEST				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)
Lora	907 to 923	907,913,923	Chirp Spread Spectrum (CSS)	0.3

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## 5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 2.34 dB
Peak Output Power	+/- 1 dB
6dB Bandwidth & 99% Bandwidth	+/- 1.53 Hz
100 KHz Bandwidth Of Frequency Band Edges	+/- 1.69 dB
Peak Power Density	+/- 1.53 dB
Temperature	+/- 0.4 °C
Humidity	+/- 3.5 %
DC / AC Power Source	+/- 1 %

Radiated Spurious Emission Measurement Uncertainty		
Polarization: Vertical	+/- 2.64 dB	9kHz~30MHz
	+/- 4.93 dB	30MHz - 1000MHz
	+/- 4.81 dB	1GHz - 18GHz
	+/- 4.52 dB	18GHz - 40GHz
Polarization: Horizontal	+/- 2.64 dB	9kHz~30MHz
	+/- 4.45 dB	30MHz - 1000MHz
	+/- 4.81 dB	1GHz - 18GHz
	+/- 4.52 dB	18GHz - 40GHz

### Note:

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

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## 6 CONDUCTED EMISSION TEST

### 6.1 Standard Applicable:

Frequency range within 150kHz to 30MHz shall not exceed the Limit table as below.

Frequency range MHz	Limits dB( $\mu$ V)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

Note

- 1.The lower limit shall apply at the transition frequencies
- 2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

### 6.2 Measurement Equipment Used:

Radiated Emission Test Site: Conduction 1					
EQUIPMENT TYPE	MFR/BRAND	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EMI Test Receiver	R&S	ESCI 7	100759	07/13/2020	07/12/2021
LISN	SCHWARZBECK	NSLK 8127	8127-465	04/09/2021	04/08/2022
Coaxial Cables	N/A	Coaxial Cable	161207	12/07/2020	12/06/2021
Test Software	audix	e3	Ver. 6.11-20180413	N.C.R	N.C.R

### 6.3 EUT Setup:

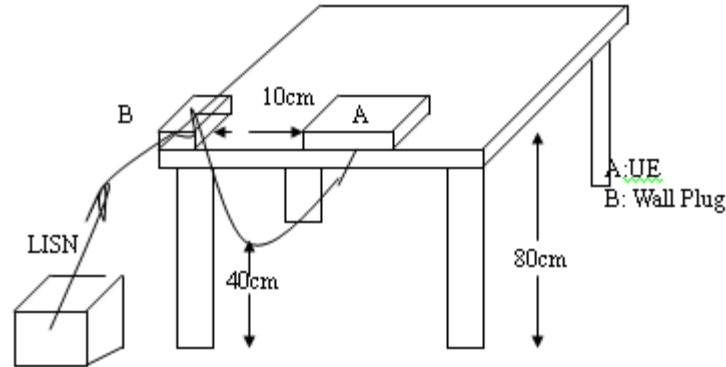
1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.10:2013.
2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

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## 6.4 Test SET-UP (Block Diagram of Configuration)



## 6.5 Measurement Procedure:

1. The EUT was placed on a table which is 0.8m above ground plan.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all phases of power being supplied by given UE are completed

## 6.6 Measurement Result:

Note: Refer to next page for measurement data and plots.

Note2: The \* reveals the worst-case results that closet to the limit.

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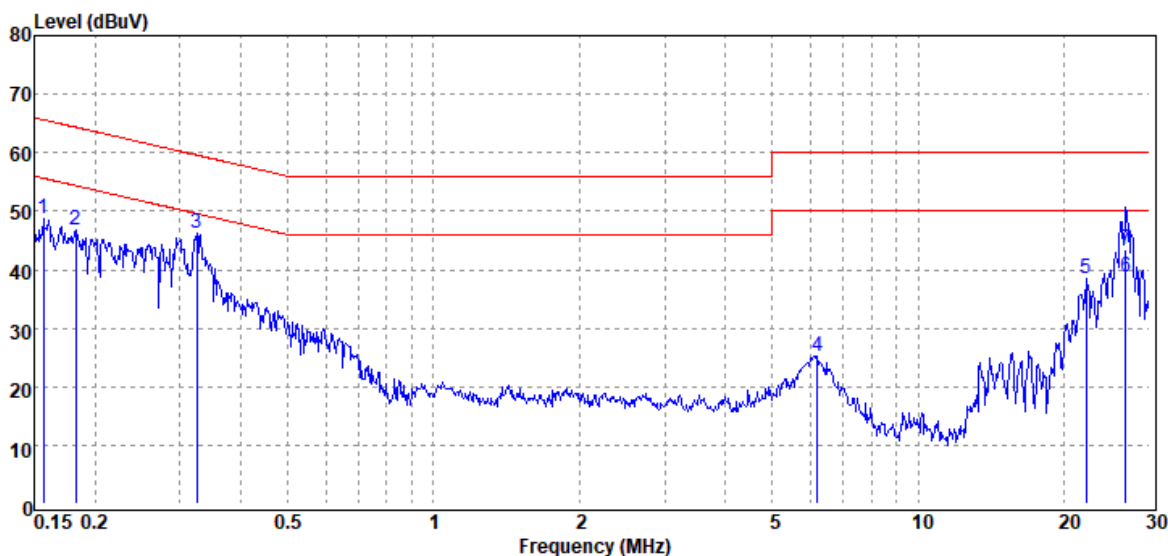
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### AC POWER LINE CONDUCTED EMISSION TEST DATA

Report Number :ER-2021-40081  
 Test Mode :LoRa  
 Power :AC 120V/60Hz  
 Probe :L  
 Note: :

Test Site :Conduction 6F  
 Test Date :2021-05-03  
 Temp./Humi. :24.5/63  
 Engineer :GN Lin



Freq. MHz	Detector Mode	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV	Limit dBμV	Margin dB
0.16	Peak	48.69	0.04	48.73	65.65	-16.92
0.18	Peak	46.86	0.04	46.90	64.37	-17.47
0.33	Peak	46.12	0.07	46.19	59.57	-13.38
6.19	Peak	24.69	0.63	25.32	60.00	-34.68
22.18	Peak	37.08	1.27	38.35	60.00	-21.65
26.84	Average	37.34	1.45	38.79	50.00	-11.21
26.84	QP	42.15	1.45	43.60	60.00	-16.40

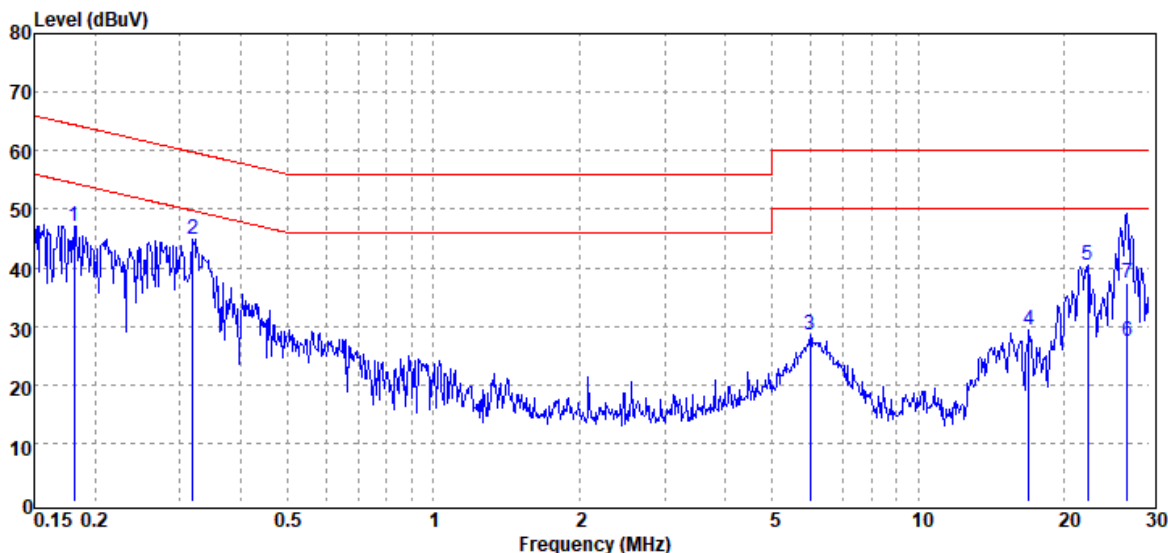
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Report Number :ER-2021-40081  
 Test Mode :LoRa  
 Power :AC 120V/60Hz  
 Probe :N  
 Note: :

Test Site :Conduction 6F  
 Test Date :2021-05-03  
 Temp./Humi. :24.5/63  
 Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV	Limit dBμV	Margin dB
0.18	Peak	46.96	0.11	47.07	64.42	-17.35
0.32	Peak	44.78	0.12	44.90	59.75	-14.85
5.99	Peak	27.97	0.53	28.50	60.00	-31.50
16.93	Peak	28.37	1.06	29.43	60.00	-30.57
22.42	Peak	39.05	1.23	40.28	60.00	-19.72
26.98	Average	26.07	1.33	27.40	50.00	-22.60
26.98	QP	35.98	1.33	37.31	60.00	-22.69

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## 7 PEAK OUTPUT POWER MEASUREMENT

### 7.1 Standard Applicable:

For systems using digital modulation in the 2400-2483.5 MHz bands, the limit for peak output power is 1Watt and the e.i.r.p. shall not exceed 4 W.

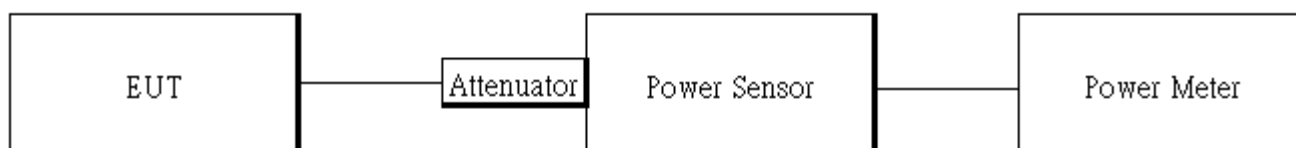
If the transmitting antenna of directional gain greater than 6dBi are used the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the Antenna exceeds 6dBi.

In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of Antenna exceeds 6dBi.

### 7.2 Measurement Equipment Used:

Conducted Emission Test Site: Conducted 2					
EQUIPMENT TYPE	MFR/BRAND	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Power Meter	Anritsu	ML2496A	1804001	03/02/2021	03/01/2022
Power Sensor	Anritsu	MA2411B	1726104	03/02/2021	03/01/2022
Power Sensor	Anritsu	MA2411B	1726107	03/02/2021	03/01/2022
Attenuator	Mini-Circuit	BW-S10W2+	4	12/16/2020	12/15/2021

### 7.3 Test Set-up:



### 7.4 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.
4. Record the max. Reading as observed from Power Meter.
5. Repeat above procedures until all test default channel measured was complete.

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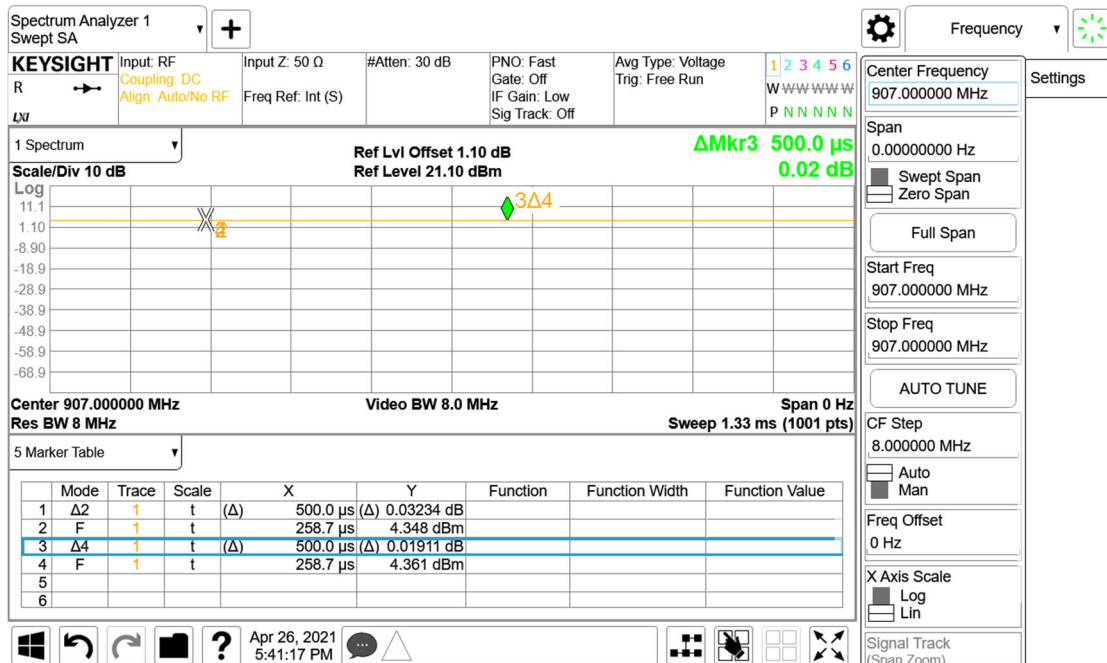
### 7.5 Duty Factor:

#### Duty Cycle

	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log ( 1/Duty Cycle )	1/T (kHz)	VBW setting (kHz)
Lora	100.00	0.00	2.00	0.01

Duty Cycle Factor:  $10 \cdot \log(1/(100/100))=0$

Duty Cycle\_Low-907MHz



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## 7.6 Output Power:

### 7.6.1 Peak & Avg

Lora:

CH	Frequency (MHz)	Power set	Peak Power Output (dBm)	Required Limit
Low	907	Max-3 step	15.72	1 Watt = 30 dBm
Mid	913	Max-3 step	15.64	1 Watt = 30 dBm
High	923	Max-3 step	15.47	1 Watt = 30 dBm
CH	Frequency (MHz)	Power set	Max. Avg. Output include tune up tolerance Power (dBm)	Required Limit
Low	907	Max-3 step	15.68	1 Watt = 30 dBm
Mid	913	Max-3 step	15.60	1 Watt = 30 dBm
High	923	Max-3 step	15.43	1 Watt = 30 dBm

**\*Note:** Measured by power meter, cable loss 11.1 dB + Duty cycle factor has been offsetted to the power meter for Avg. power and cable loss has been offsetted for Peak power measurement.

### 7.6.2 EIRP

EIRP Lora

CH	Frequency (MHz)	Power set	Max. Avg. Output include tune up tolerance Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit
Low	907	Max-3 step	15.68	-1.00	14.68	4W= 36 dBm
Mid	913	Max-3 step	15.60	-1.00	14.60	4W= 36 dBm
High	923	Max-3 step	15.43	-1.00	14.43	4W= 36 dBm

**\* Note:** EIRP = Average Power + Gain

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## 8 EMISSION BANDWIDTH MEASUREMENT

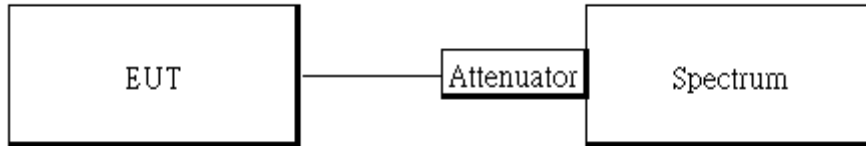
### 8.1 Standard Applicable

The minimum 6 dB bandwidth shall be at least 500 kHz .

### 8.2 Measurement Equipment Used

Conducted Emission Test Site: Conducted 2					
EQUIPMENT TYPE	MFR/BRAND	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EXA Spectrum Analyzer	KEYSIGHT	N9010B	MY60240503	12/11/2020	12/10/2021
Attenuator	Mini-Circuit	BW-S10W2+	4	12/16/2020	12/15/2021
DC Block	Mini-Circuits	BLK-18-S+	1	12/16/2020	12/15/2021

### 8.3 Test Set-up:



### 8.4 Measurement Procedure:

- Place the EUT on the table and set it in transmitting mode.
- The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
- Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
- Set the spectrum analyzer as  
 RBW= 1 % to 5% of OBW ,  
 VBW = 3 X RBW,  
 Span= 2 to 5 times of the OBW,  
 Sweep=auto,  
 Detector = Peak, and Max hold for 20dB Bandwidth test.
- Mark the peak frequency and -20dB (upper and lower) frequency
- Set the spectrum analyzer as  
 RBW= 1 % to 5% of 99% Bandwidth ,  
 VBW ≥ 3 X RBW,  
 Span= large enough to capture all products of the modulation process,  
 Sweep=auto,  
 Detector = Peak, and Max hold for 99% Bandwidth test.
- Mark the peak frequency and 99%dB (upper and lower) frequency.
- Repeat above procedures until all test default channel is completed

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8.5 Measurement Result:

Lora

Frequency (MHz)	6dB BW (MHz)	Required BW (MHz)	Result
907	0.719	$\geq 0.5$	PASS
913	0.7686	$\geq 0.5$	PASS
923	0.7438	$\geq 0.5$	PASS

Lora

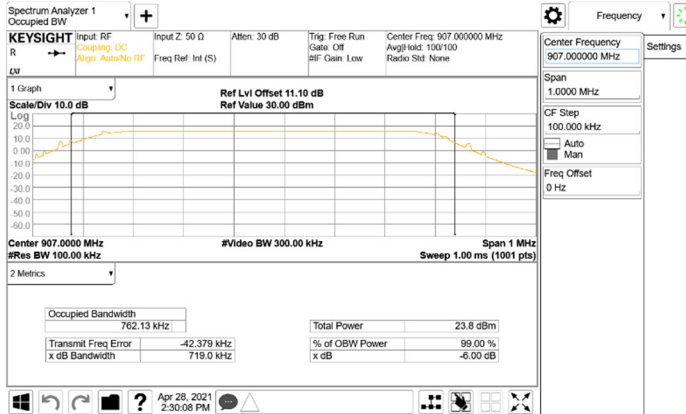
Frequency (MHz)	99%Bandwidth (MHz)
907	0.57278
913	0.59507
923	0.6156

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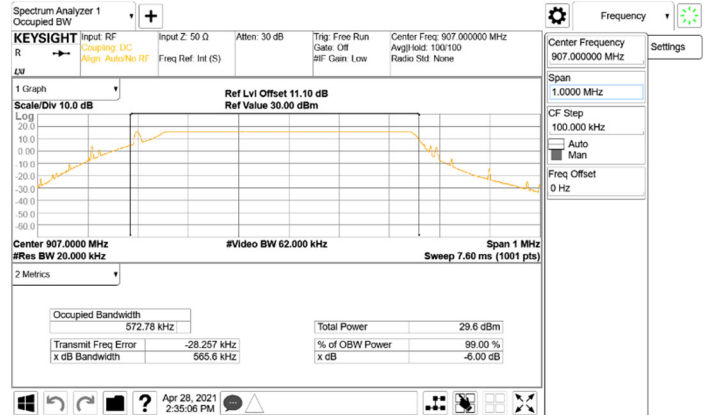
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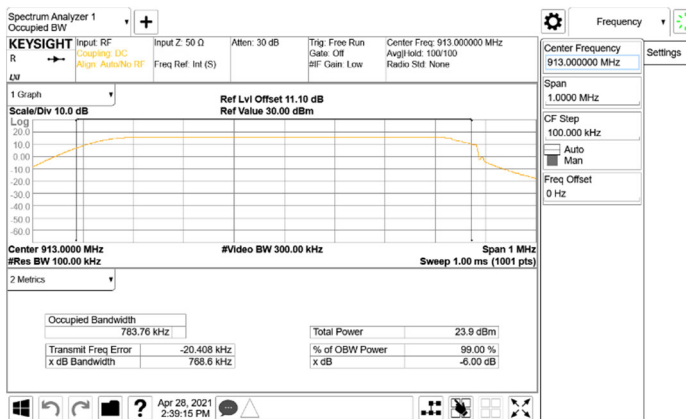
### OBW 6dB\_Low-907



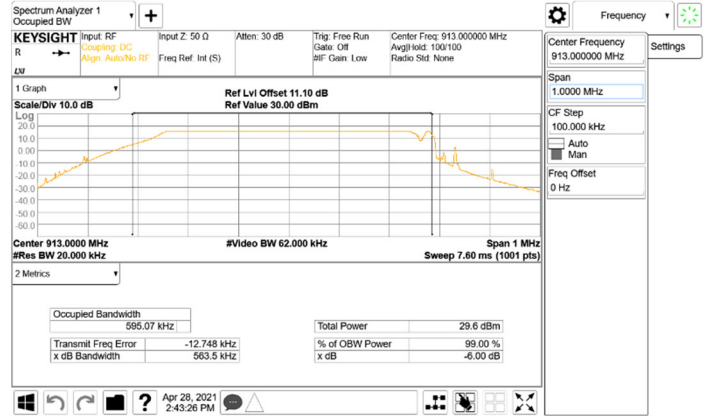
### IC OBW 99%\_Low-907



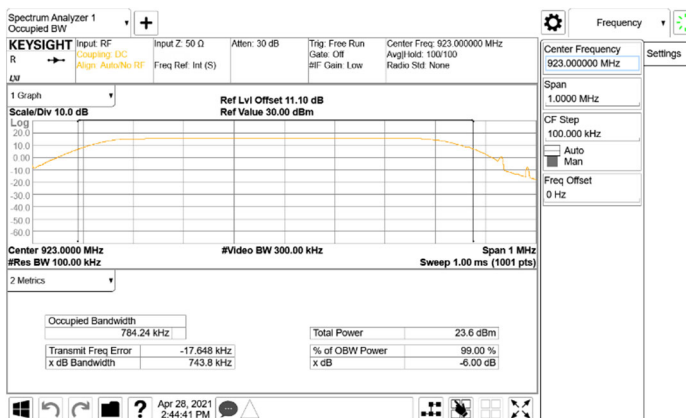
### OBW 6dB\_Mid-913



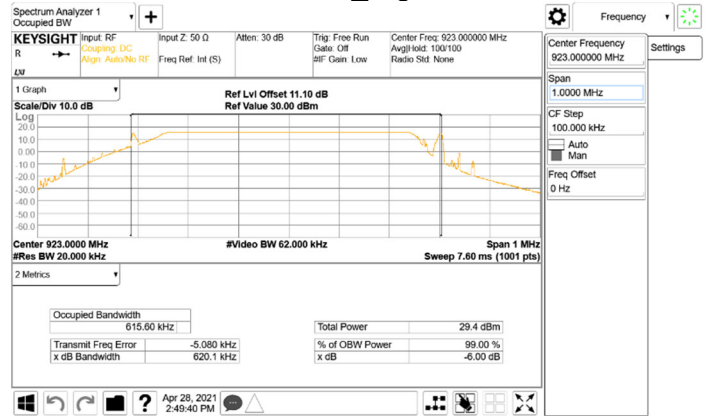
### IC OBW 99%\_Mid-913



### OBW 6dB\_High-923



### IC OBW 99%\_High-923



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## 9 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

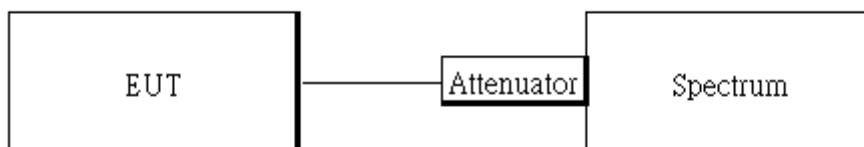
### 9.1 Standard Applicable

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. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a) & RSS-Gen §8.10, must also comply with the radiated emission limits specified in §15.209(a) & RSS-Gen §8.9.

### 9.2 Measurement Equipment Used:

Conducted Emission Test Site: Conducted 2					
EQUIPMENT TYPE	MFR/BRAND	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EXA Spectrum Analyzer	KEYSIGHT	N9010B	MY60240503	12/11/2020	12/10/2021
Attenuator	Mini-Circuit	BW-S10W2+	4	12/16/2020	12/15/2021
DC Block	Mini-Circuits	BLK-18-S+	1	12/16/2020	12/15/2021

### 9.3 Test SET-UP:



### 9.4 Measurement Procedure

#### 9.4.1 Reference Level of Emission Limit:

1. Set analyzer center frequency to DTS channel center frequency.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Set the span to 1.5 times the DTS channel bandwidth.
4. Set the RBW = 100kHz & VBW = 300 kHz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.

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8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level.

#### 9.4.2 Conducted Band Edge:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set start to edge frequency, and stop frequency of spectrum analyzer so as to encompass the spectrum to be examined.
5. Set the spectrum analyzer as RBW=100 kHz, VBW=300 kHz, Detector = Peak, Sweep = auto
6. Set DL as the limit = reading on marker of reference level measurement – 20dBm
7. Mark the highest readings of the emissions outside of 2400MHz~2483.5MHz.
8. Repeat above procedures until all default test channel (low, middle, and high) was complete.

#### 9.4.3 Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Set RBW = 100 kHz & VBW=300 kHz, Detector =Peak, Sweep = Auto
4. Allow trace to fully stabilize.
5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
6. Repeat above procedures until all default test channel measured were complete.

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## 9.5 Measurement Result

### Reference Level of Limit

Frequency (MHz)	RF Power Density (dBm)	Reference Level of Limit = PSD - 20dB (dBm)
907	15.68	-4.32
913	15.60	-4.40
923	15.43	-4.57

**NOTE: cable loss as 11.1dB that offsets in the spectrum**

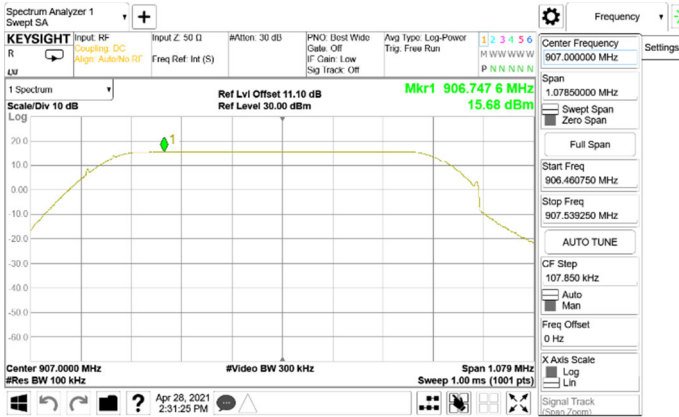
**NOTE: Refer to next page for plots.**

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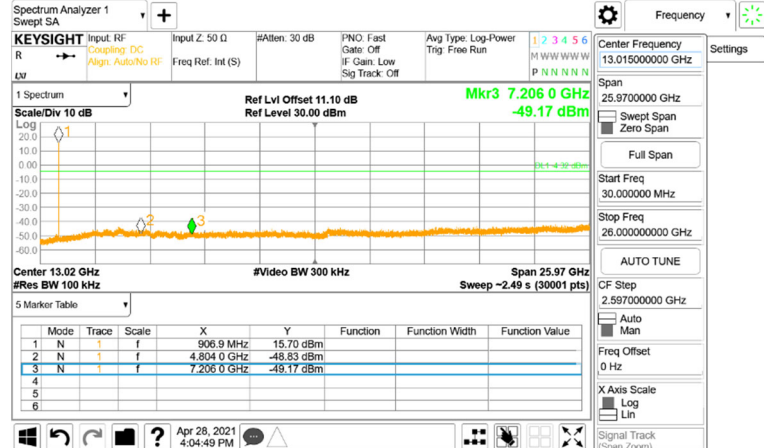
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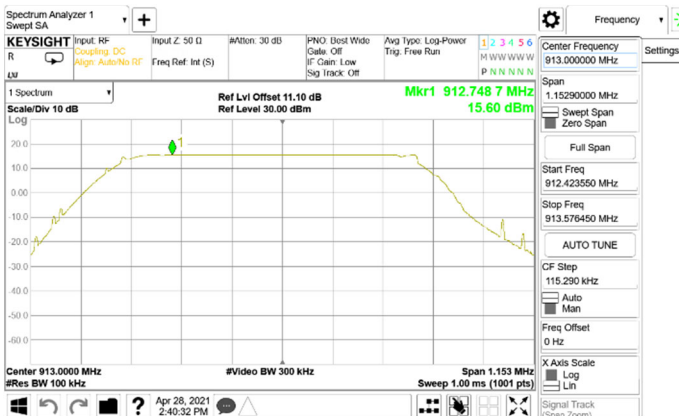
### Reference Level\_Low-907



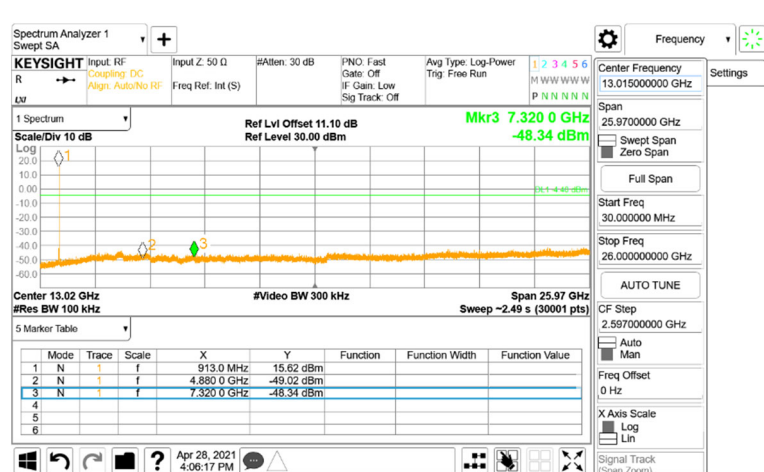
### Spurious Emission\_Low-907



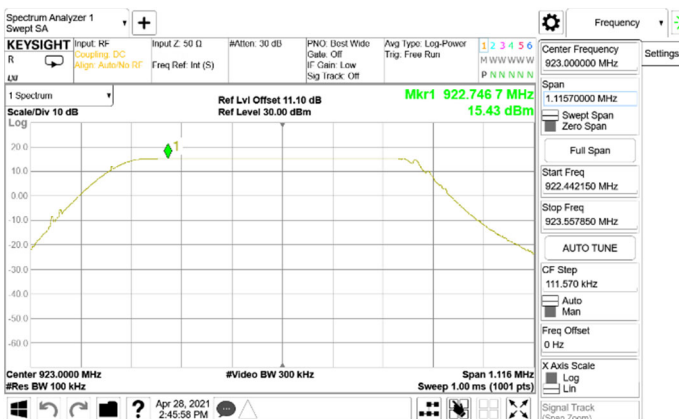
### Reference Level\_Mid-913



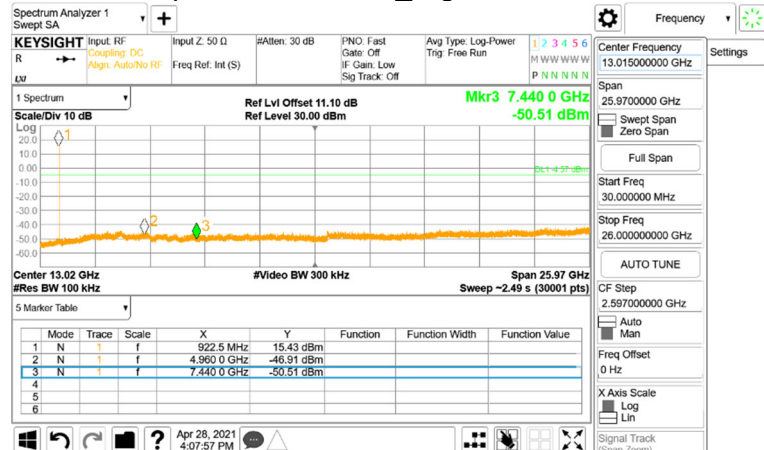
### Spurious Emission\_Mid-913



### Reference Level\_High-923



### Spurious Emission\_High-923



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## 10 RADIATED BANDEDGE AND SPURIOUS EMISSION MEASUREMENT

### 10.1 Standard Applicable

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. In addition, radiated emissions which fall in the restricted bands must also comply with the §15.209 and RSS-Gen §8.9 Table 5 and 6 limit as below.

And according to §15.33(a) (1) & RSS-Gen §6.13.2.a for an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

Frequency (MHz)	Field strength (microvolts/meter)	Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

**Note:**

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBµV/m) = 20 log Emission level (µV/m)

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## 10.2 Measurement Equipment Used

Radiated Emission Test Site: SAC 1					
EQUIPMENT TYPE	MFR/BRAND	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Site Cal	SGS	SAC I chamber	N/A	01/01/2021	12/31/2021
Horn Antenna	Schwarzbeck	BBHA9120D	D803	12/17/2020	12/16/2021
Bi-log Antenna	TESEO	CBL 6112D	35242 & AT-N0555	01/13/2021	01/12/2022
Loop Antenna	ETS.LINDGR EN	6502	148045	10/19/2020	10/18/2021
Spectrum Analyzer	Agilent	E4446A	MY51100003	10/29/2020	10/28/2021
Test Software	audix	e3	Ver. 6.11-20180413	01/01/2021	12/31/2021
EMI Test Receiver	R&S	ESCI 7	100759	07/13/2020	07/12/2021
Pre-Amplifier	HP	8449B	3008A01973	12/16/2020	12/15/2021
Pre-Amplifier	HP	8447D	2944A09469	12/16/2020	12/15/2021
Bandreject Filter 800-1000	Micro-Tronics	EWT	M1	12/16/2020	12/15/2021
1.3G-15GHz High Pass Filter	WI	WHKX10-1066-80SS	19	04/20/2021	12/15/2021
Coaxial Cable	Huber Suhner	succoflex 102	MY2622/2	12/16/2020	12/15/2021
Coaxial Cable	Huber Suhner	succoflex 104A	800086/4a	12/16/2020	12/15/2021
Coaxial Cable	Huber Suhner	EMC 104-SM-SM-2000	160123	12/16/2020	12/15/2021

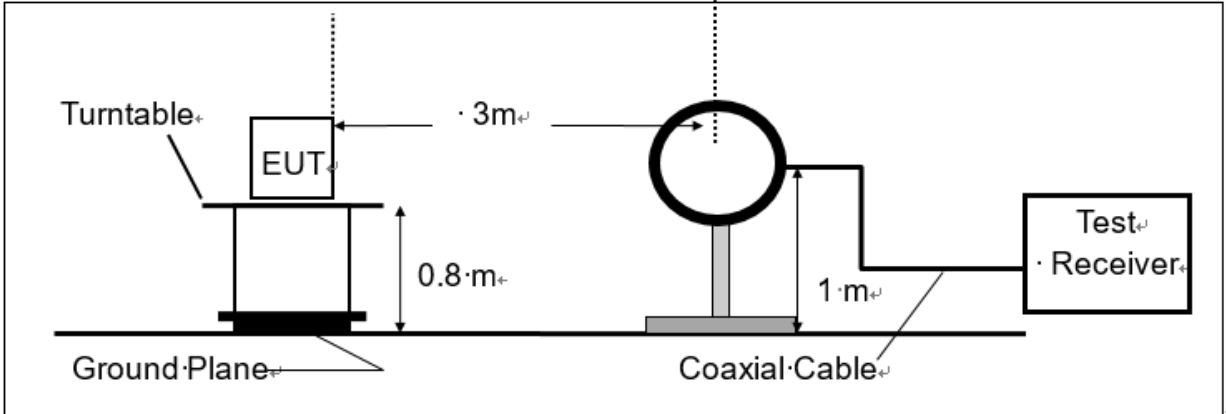
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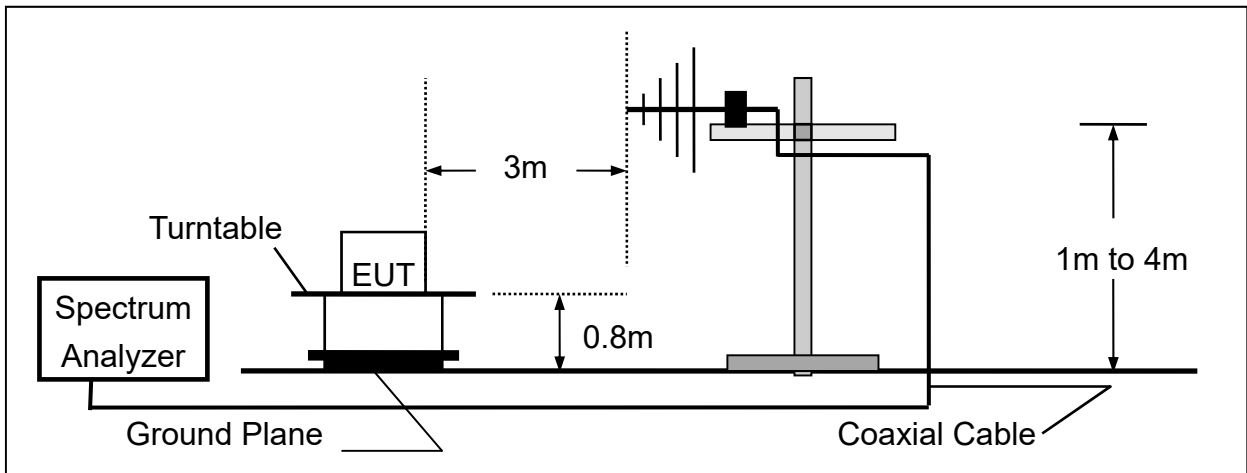
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### 10.3 Test SET-UP

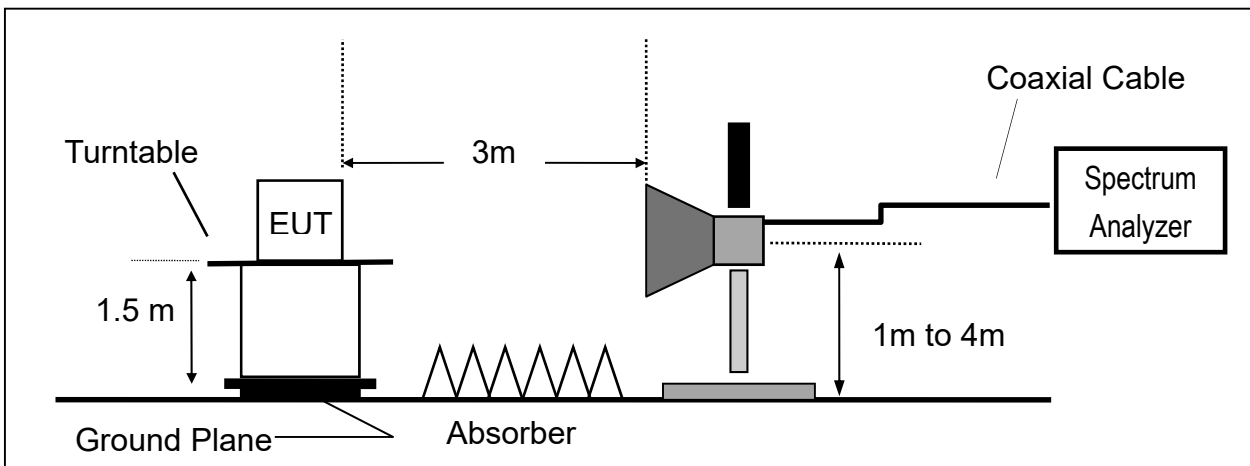
(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



(B) Radiated Emission Test Set-UP, Frequency form 30MHz to 1000MHz



(C) Radiated Emission Test Set-UP Frequency Over 1 GHz



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## 10.4 Measurement Procedure

1. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
2. The EUT was placed on a turn table with 0.8m for frequency < 1GHz and 1.5m for frequency > 1GHz above ground plan.
3. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
4. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
5. Set the spectrum analyzer as RBW=120 kHz and VBW=300 kHz for Peak Detector (PK) and Quasi-peak (QP) at frequency below 1 GHz.
6. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz for Peak Detector at frequency above 1 GHz.
7. Set the spectrum analyzer as RBW=1 MHz, VBW=10 Hz (Duty cycle > 98%) or VBW ≥ 1/T (Duty cycle < 98%) for Average Detector at frequency above 1 GHz.
8. When measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” is still within the 3dB illumination BW of the measurement antenna.
9. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
10. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. On spectrum, change spectrum mode in linear display mode, and reduce VBW = 10Hz if average reading is measured.
11. Repeat above procedures until all default test channel measured were complete.

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### 10.5 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

**Where** *FS = Field Strength* *CL = Cable Attenuation Factor (Cable Loss)*  
*RA = Reading Amplitude* *AG = Amplifier Gain*  
*AF = Antenna Factor*

*The limit of the emission level is expressed in dBuV/m, which converts 20\*log(uV/m)*

*Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)*

*Factor(dB) = Antenna Factor(dBμV/m) + Cable Loss(dB) – Pre\_Amplifier Gain(dB)*

### 10.6 Test Results of Radiated Spurious Emissions form 9 kHz to 30 MHz

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit per 15.31(o) was not reported.

### 10.7 Measurement Result:

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

#### 10.7.1 Radiated Band Edge Measurement Result

N/A

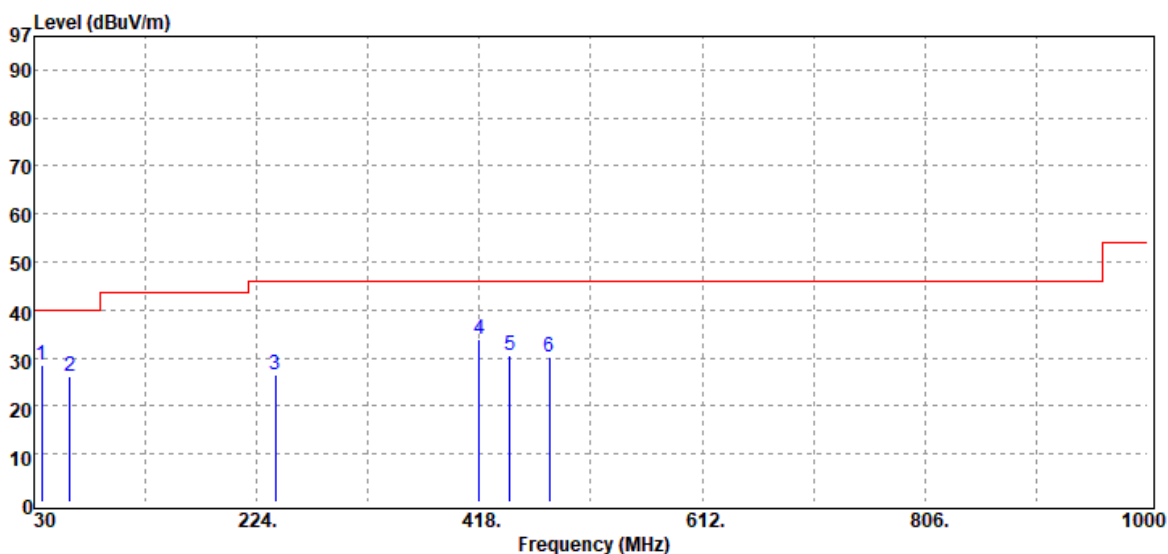
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### 10.7.2 Radiated Spurious Emission from 30MHz to 1000MHz

Report Number	:ER/2021/40081	Test Site	:SAC I Chamber
Operation Mode	:LoRa	Test Date	:2021-05-03
Test Frequency	:907 MHz	Temp./Humi.	:24.3/65
Test Mode	:Tx CH Low	Antenna Pol.	:VERTICAL
EUT Pol	:E1 Plane	Engineer	:GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
36.79	Peak	36.82	-8.36	28.46	40.00	-11.54
61.04	Peak	44.26	-17.95	26.31	40.00	-13.69
240.49	Peak	37.51	-10.98	26.53	46.00	-19.47
418.00	Peak	40.38	-6.64	33.74	46.00	-12.26
444.19	Peak	36.42	-5.97	30.45	46.00	-15.55
479.11	Peak	36.23	-5.88	30.35	46.00	-15.65

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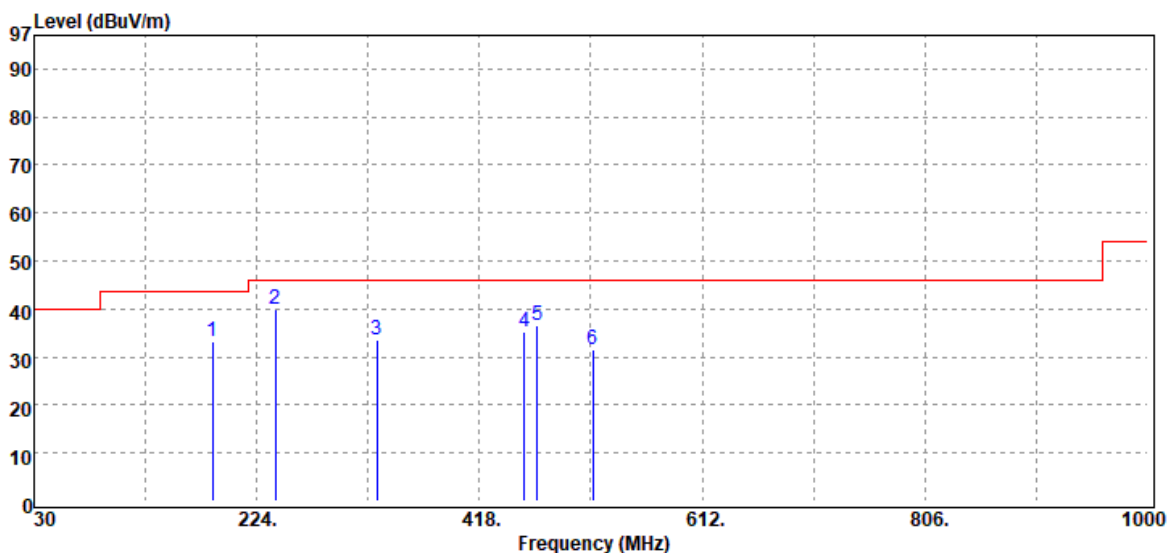
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Report Number :ER/2021/40081  
 Operation Mode :LoRa  
 Test Frequency :907 MHz  
 Test Mode :Tx CH Low  
 EUT Pol :E1 Plane

Test Site :SAC I Chamber  
 Test Date :2021-05-03  
 Temp./Humi. :24.3/65  
 Antenna Pol. :HORIZONTAL  
 Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
185.20	Peak	47.55	-14.26	33.29	43.50	-10.21
240.49	Peak	50.90	-10.98	39.92	46.00	-6.08
328.76	Peak	41.94	-8.49	33.45	46.00	-12.55
456.80	Peak	40.95	-5.76	35.19	46.00	-10.81
468.44	Peak	42.32	-5.88	36.44	46.00	-9.56
516.94	Peak	36.87	-5.45	31.42	46.00	-14.58

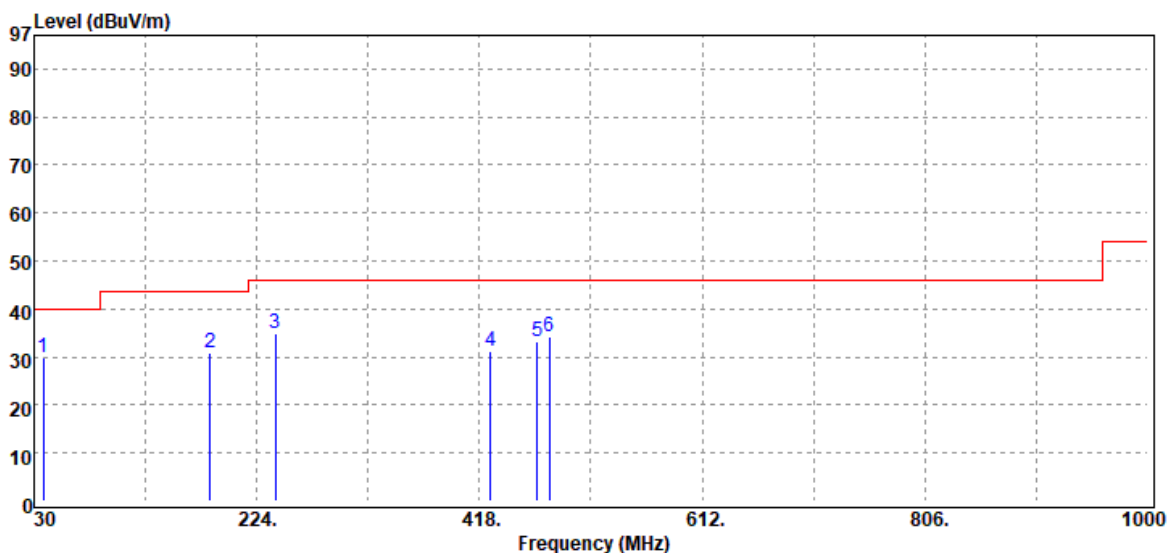
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Report Number :ER/2021/40081  
 Operation Mode :LoRa  
 Test Frequency :913 MHz  
 Test Mode :Tx CH Mid  
 EUT Pol :E1 Plane

Test Site :SAC I Chamber  
 Test Date :2021-05-03  
 Temp./Humi. :24.3/65  
 Antenna Pol. :VERTICAL  
 Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB $\mu$ V	Factor dB	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
37.76	Peak	38.85	-8.95	29.90	40.00	-10.10
183.26	Peak	45.28	-14.32	30.96	43.50	-12.54
240.49	Peak	45.73	-10.98	34.75	46.00	-11.25
427.70	Peak	38.13	-6.78	31.35	46.00	-14.65
468.44	Peak	39.26	-5.88	33.38	46.00	-12.62
479.11	Peak	39.99	-5.88	34.11	46.00	-11.89

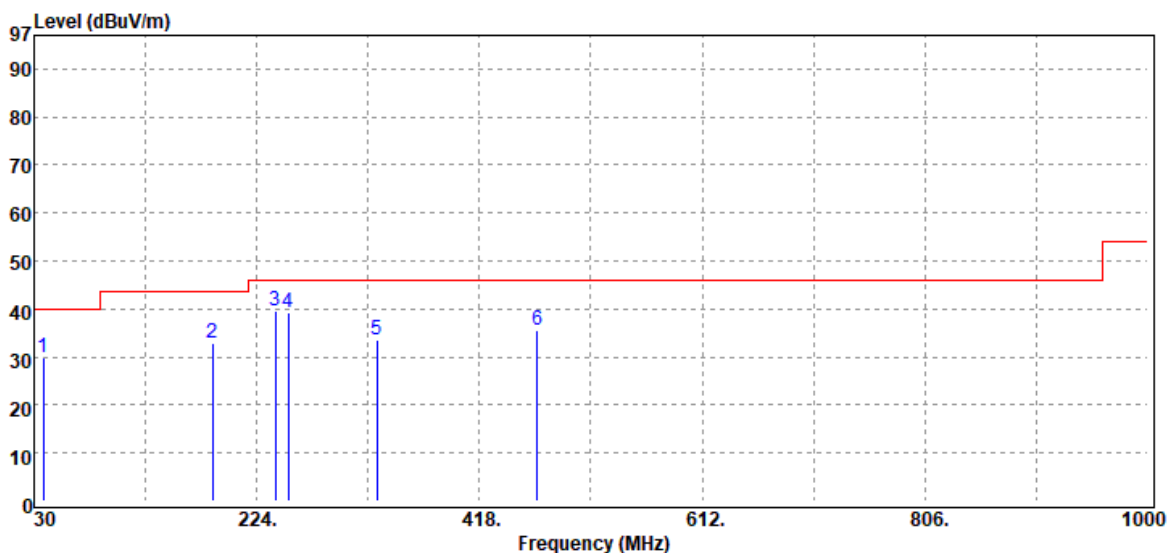
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Report Number :ER/2021/40081  
 Operation Mode :LoRa  
 Test Frequency :913 MHz  
 Test Mode :Tx CH Mid  
 EUT Pol :E1 Plane

Test Site :SAC I Chamber  
 Test Date :2021-05-03  
 Temp./Humi. :24.3/65  
 Antenna Pol. :HORIZONTAL  
 Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
37.76	Peak	38.94	-8.95	29.99	40.00	-10.01
185.20	Peak	47.14	-14.26	32.88	43.50	-10.62
240.49	Peak	50.72	-10.98	39.74	46.00	-6.26
251.16	Peak	48.91	-9.72	39.19	46.00	-6.81
328.76	Peak	42.19	-8.49	33.70	46.00	-12.30
468.44	Peak	41.42	-5.88	35.54	46.00	-10.46

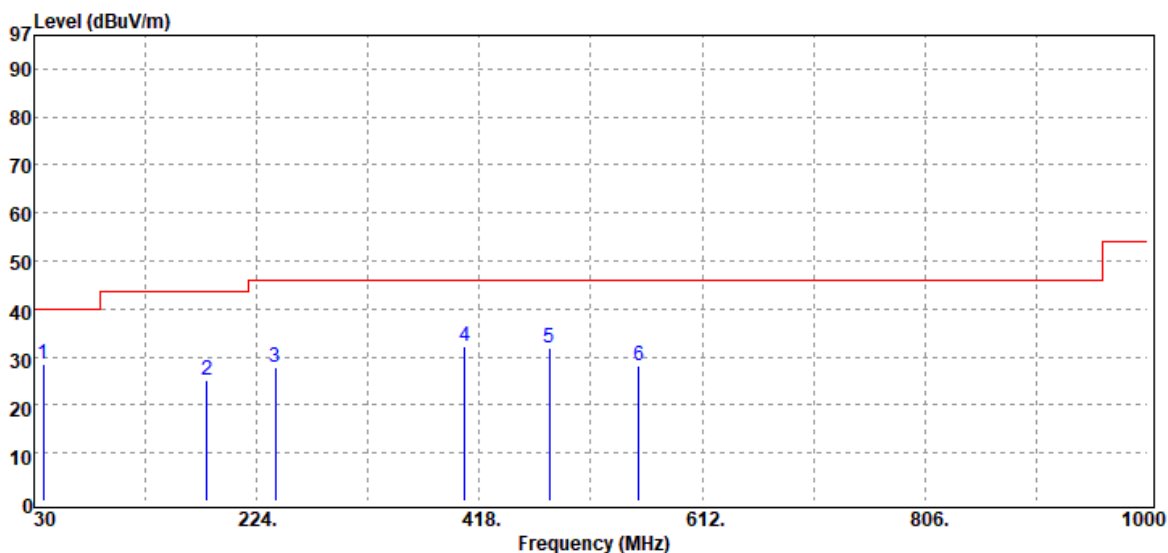
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Report Number :ER/2021/40081  
 Operation Mode :LoRa  
 Test Frequency :923 MHz  
 Test Mode :Tx CH High  
 EUT Pol :E1 Plane

Test Site :SAC I Chamber  
 Test Date :2021-05-03  
 Temp./Humi. :24.3/65  
 Antenna Pol. :VERTICAL  
 Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB $\mu$ V	Factor dB	Actual FS dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB
37.76	Peak	37.38	-8.95	28.43	40.00	-11.57
180.35	Peak	39.34	-14.25	25.09	43.50	-18.41
240.49	Peak	38.85	-10.98	27.87	46.00	-18.13
405.39	Peak	38.57	-6.32	32.25	46.00	-13.75
479.11	Peak	37.87	-5.88	31.99	46.00	-14.01
556.71	Peak	31.78	-3.48	28.30	46.00	-17.70

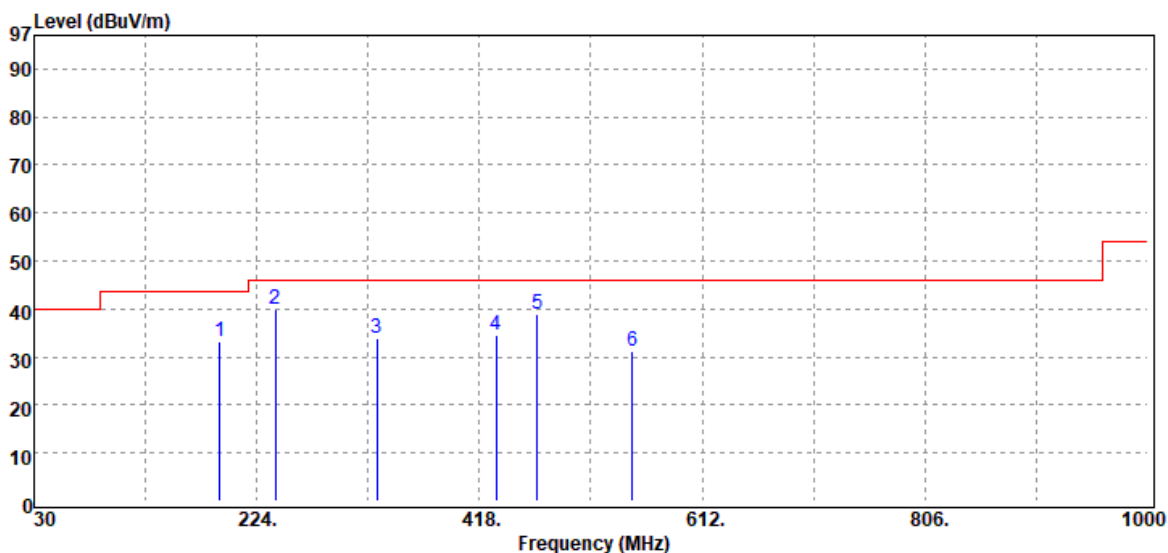
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Report Number :ER/2021/40081  
 Operation Mode :LoRa  
 Test Frequency :923 MHz  
 Test Mode :Tx CH High  
 EUT Pol :E1 Plane

Test Site :SAC I Chamber  
 Test Date :2021-05-03  
 Temp./Humi. :24.3/65  
 Antenna Pol. :HORIZONTAL  
 Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
191.99	Peak	47.39	-14.06	33.33	43.50	-10.17
240.49	Peak	50.87	-10.98	39.89	46.00	-6.11
328.76	Peak	42.45	-8.49	33.96	46.00	-12.04
432.55	Peak	41.31	-6.72	34.59	46.00	-11.41
468.44	Peak	44.88	-5.88	39.00	46.00	-7.00
550.89	Peak	34.53	-3.21	31.32	46.00	-14.68

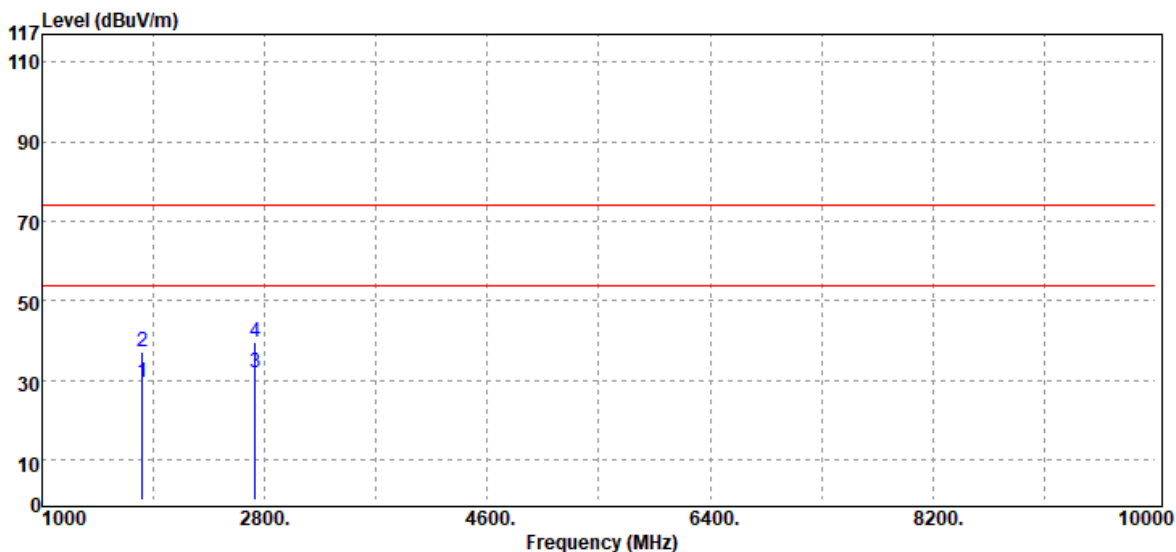
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### 10.7.1 Radiated Spurious Emission above 1GHz

Report Number	:ER/2021/40081	Test Site	:SAC I Chamber
Operation Mode	:LoRa	Test Date	:2021-05-03
Test Frequency	:907 MHz	Temp./Humi.	:24.3/65
Test Mode	:Tx CH Low	Antenna Pol.	:VERTICAL
EUT Pol	:E1 Plane	Engineer	:GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
1814.00	Average	32.57	-3.06	29.51	54.00	-24.49
1814.00	Peak	40.32	-3.06	37.26	74.00	-36.74
2721.00	Average	30.55	1.52	32.07	54.00	-21.93
2721.00	Peak	38.13	1.52	39.65	74.00	-34.35

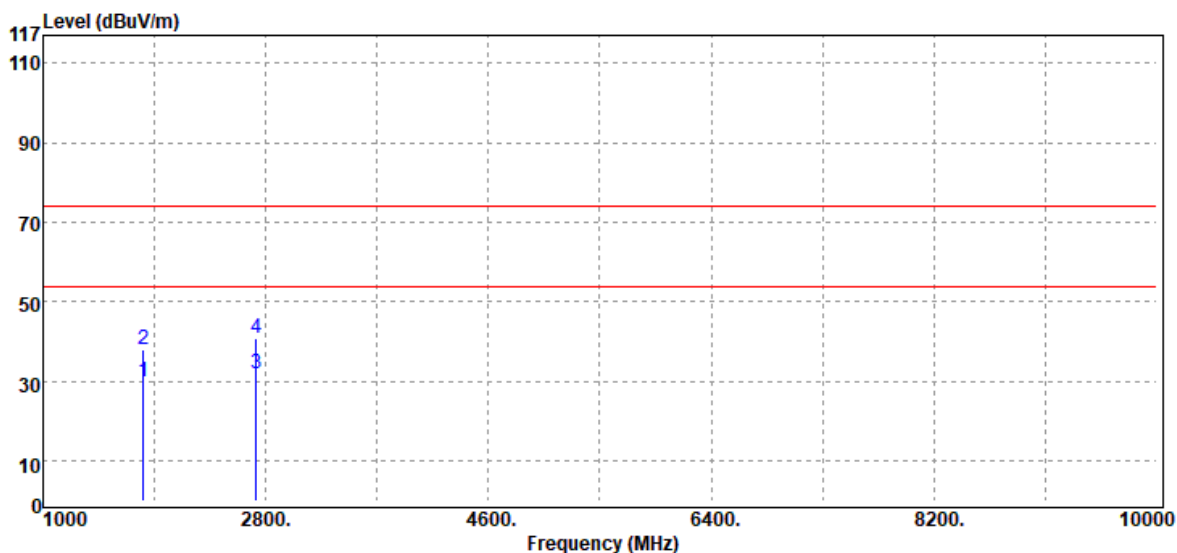
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Report Number :ER/2021/40081  
 Operation Mode :LoRa  
 Test Frequency :907 MHz  
 Test Mode :Tx CH Low  
 EUT Pol :E1 Plane

Test Site :SAC I Chamber  
 Test Date :2021-05-03  
 Temp./Humi. :24.3/65  
 Antenna Pol. :HORIZONTAL  
 Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
1814.00	Average	33.03	-3.06	29.97	54.00	-24.03
1814.00	Peak	41.21	-3.06	38.15	74.00	-35.85
2721.00	Average	30.33	1.52	31.85	54.00	-22.15
2721.00	Peak	39.19	1.52	40.71	74.00	-33.29

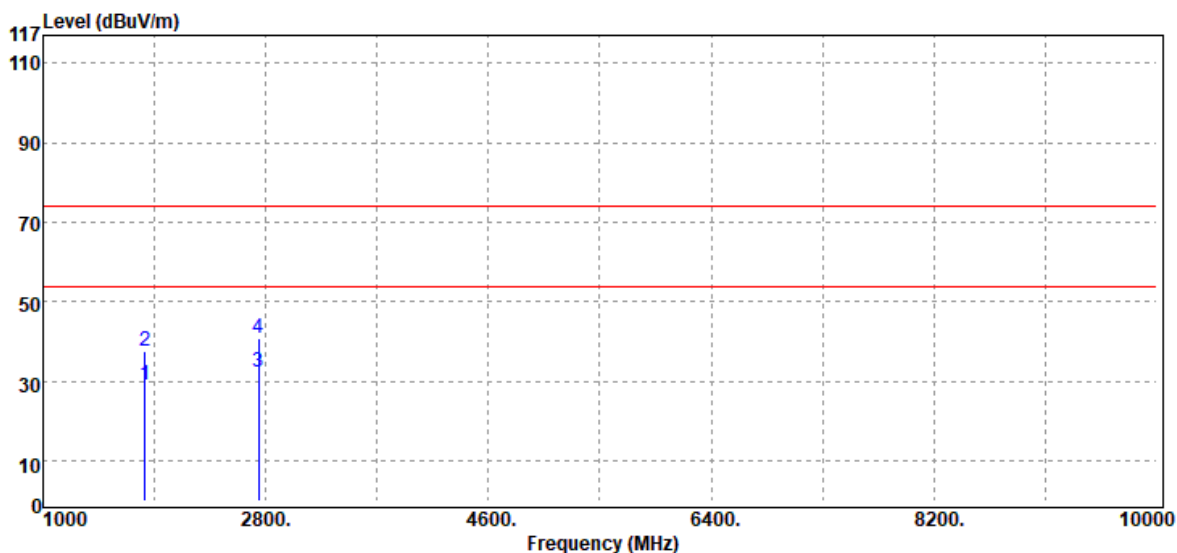
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Report Number :ER/2021/40081  
 Operation Mode :LoRa  
 Test Frequency :913 MHz  
 Test Mode :Tx CH Mid  
 EUT Pol :E1 Plane

Test Site :SAC I Chamber  
 Test Date :2021-05-03  
 Temp./Humi. :24.3/65  
 Antenna Pol. :VERTICAL  
 Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
1826.00	Average	32.13	-3.02	29.11	54.00	-24.89
1826.00	Peak	40.58	-3.02	37.56	74.00	-36.44
2739.00	Average	30.65	1.78	32.43	54.00	-21.57
2739.00	Peak	39.12	1.78	40.90	74.00	-33.10

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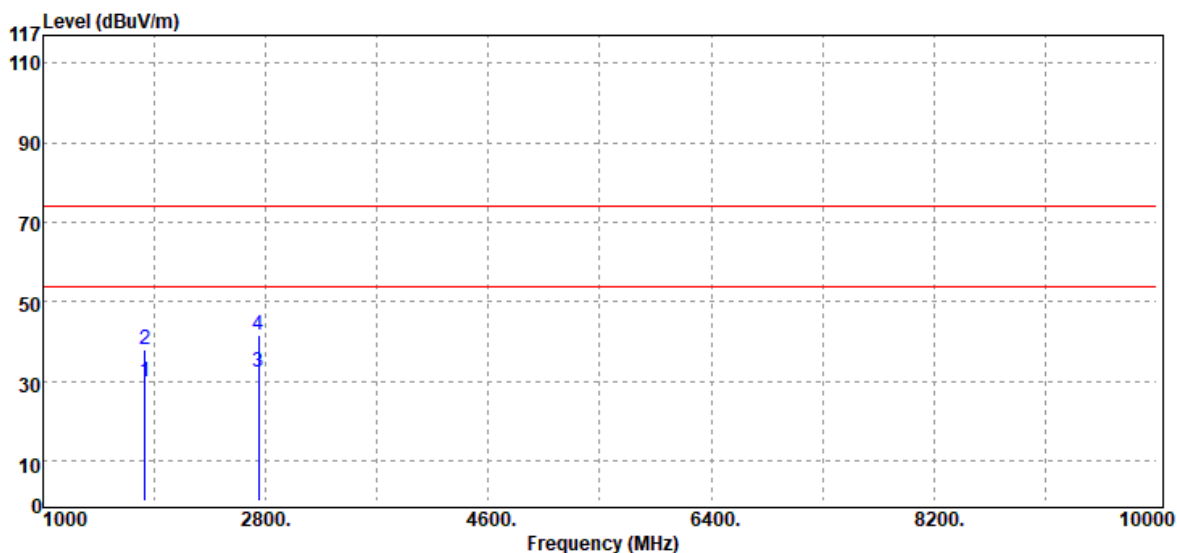
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Report Number :ER/2021/40081  
 Operation Mode :LoRa  
 Test Frequency :913 MHz  
 Test Mode :Tx CH Mid  
 EUT Pol :E1 Plane

Test Site :SAC I Chamber  
 Test Date :2021-05-03  
 Temp./Humi. :24.3/65  
 Antenna Pol. :HORIZONTAL  
 Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
1826.00	Average	33.02	-3.02	30.00	54.00	-24.00
1826.00	Peak	41.17	-3.02	38.15	74.00	-35.85
2739.00	Average	30.62	1.78	32.40	54.00	-21.60
2739.00	Peak	40.04	1.78	41.82	74.00	-32.18

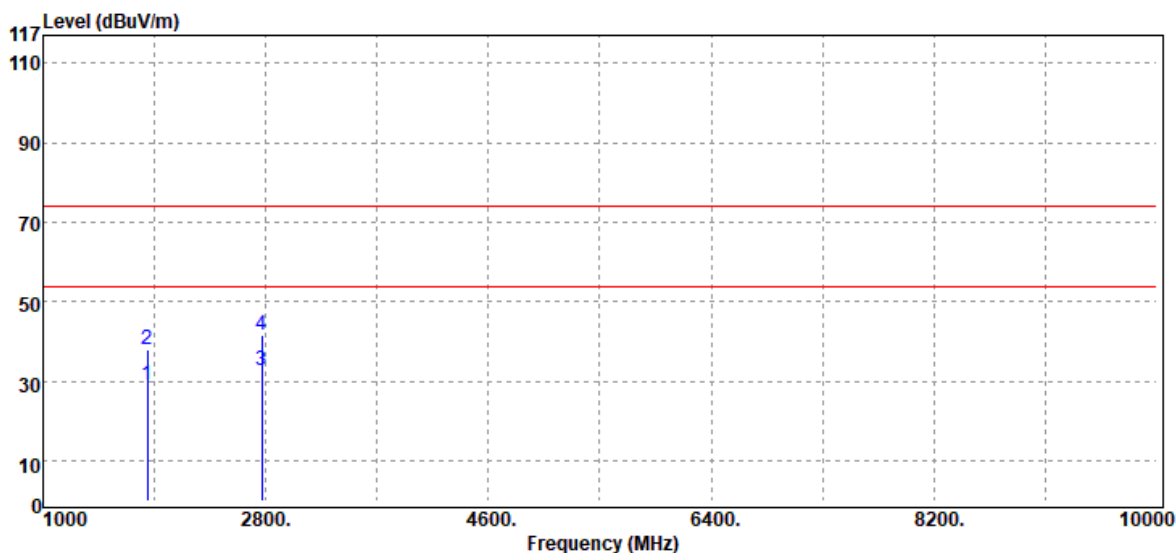
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Report Number :ER/2021/40081  
 Operation Mode :LoRa  
 Test Frequency :923 MHz  
 Test Mode :Tx CH High  
 EUT Pol :E1 Plane

Test Site :SAC I Chamber  
 Test Date :2021-05-03  
 Temp./Humi. :24.3/65  
 Antenna Pol. :VERTICAL  
 Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
1846.00	Average	32.21	-2.94	29.27	54.00	-24.73
1846.00	Peak	40.83	-2.94	37.89	74.00	-36.11
2769.00	Average	30.67	2.22	32.89	54.00	-21.11
2769.00	Peak	39.28	2.22	41.50	74.00	-32.50

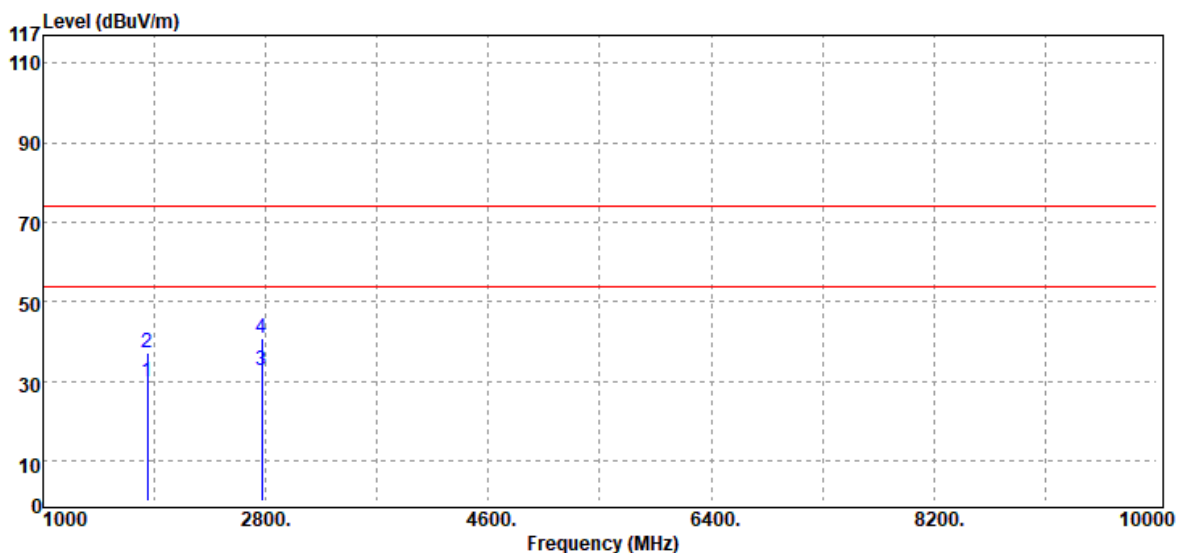
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Report Number :ER/2021/40081  
 Operation Mode :LoRa  
 Test Frequency :923 MHz  
 Test Mode :Tx CH High  
 EUT Pol :E1 Plane

Test Site :SAC I Chamber  
 Test Date :2021-05-03  
 Temp./Humi. :24.3/65  
 Antenna Pol. :HORIZONTAL  
 Engineer :GN Lin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBuV	Factor dB	Actual FS dBuV/m	Limit @3m dBuV/m	Margin dB
1846.00	Average	32.81	-2.94	29.87	54.00	-24.13
1846.00	Peak	40.02	-2.94	37.08	74.00	-36.92
2769.00	Average	30.73	2.22	32.95	54.00	-21.05
2769.00	Peak	38.75	2.22	40.97	74.00	-33.03

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## 11 POWER SPECTRAL DENSITY

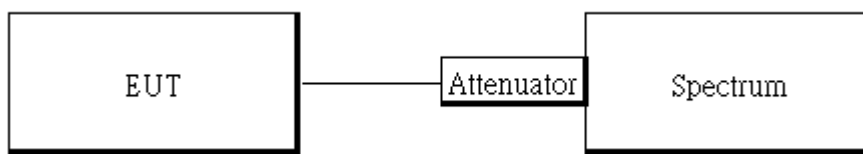
### 11.1 Standard Applicable:

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

### 11.2 Measurement Equipment Used:

Conducted Emission Test Site: Conducted 2					
EQUIPMENT TYPE	MFR/BRAND	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
EXA Spectrum Analyzer	KEYSIGHT	N9010B	MY60240503	12/11/2020	12/10/2021
Attenuator	Mini-Circuit	BW-S10W2+	4	12/16/2020	12/15/2021
DC Block	Mini-Circuits	BLK-18-S+	1	12/16/2020	12/15/2021

### 11.3 Test Set-up:



### 11.4 Measurement Procedure:

1. Set analyzer center frequency to DTS channel center frequency.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Set the span to 1.5 times the DTS channel bandwidth.
4. Set the RBW = 3 kHz. & the VBW = 10 kHz
5. For defining Restricted Band Edge Limit:  
Set the RBW = 100kHz & VBW = 300 kHz.
6. Detector = peak.
7. Sweep time = auto couple.
8. Trace mode = max hold.
9. Allow trace to fully stabilize.
10. Use the peak marker function to determine the maximum amplitude level.

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### 11.5 Measurement Result:

#### Lora

Frequency (MHz)	RF Power Density (dBm/3kHz)	Maximum Limit (dBm/3kHz)	Result
907	6.930	8	PASS
913	6.940	8	PASS
923	7.190	8	PASS

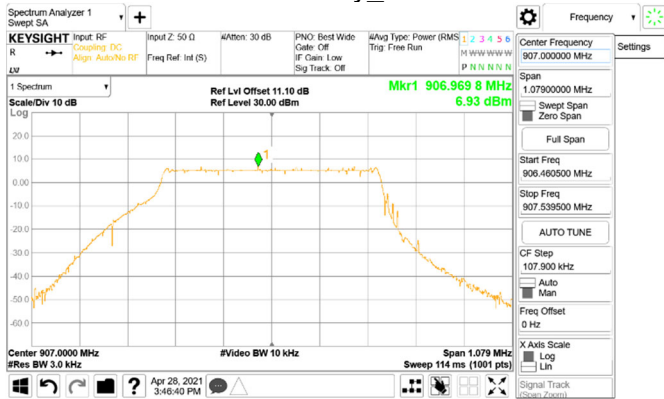
**NOTE: cable loss as 11.1dB that offsets in the spectrum**

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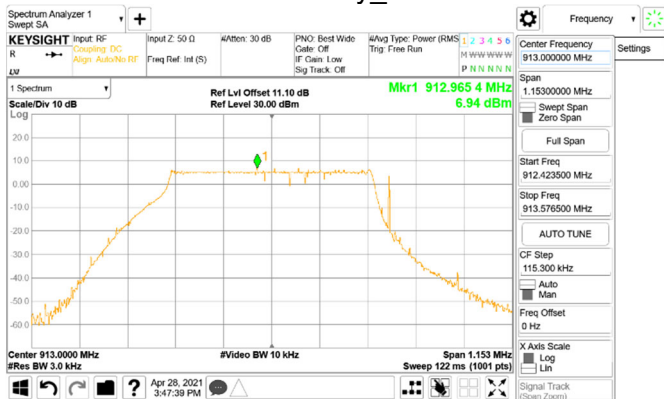
Power Density\_Low-907



Power Density\_High-923



Power Density\_Mid-913



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## 12 ANTENNA REQUIREMENT

### 12.1 Standard Applicable:

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device.

If the transmitting antenna is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi.

In case of point-to-point operation, the power shall be reduced by the one dB for every 3 dB that the directional gain of antenna exceeds 6dBi.

### 12.2 Antenna Connected Construction:

The antenna is designed as permanently attached and no consideration of replacement. Please see EUT photo for details.

*~ End of Report ~*

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