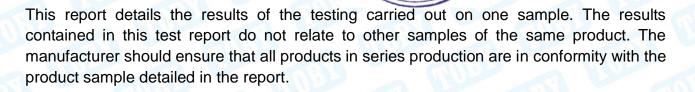




Report No.: TBR-C-202204-0107-13 1 of 61 Page:

## **Radio Test Report** FCC ID: 2A2GJ-M2802

Report No.		TBR-C-202204-0107-13					
Applicant	1	Heltec Automation Technology Co., Ltd					
Equipment Under Test (EUT)							
EUT Name	;	Heltec Indoor Hotspot					
Model No.	-	HT-M2802					
Series Model No.		The second secon					
Brand Name	:						
Sample ID	(9)	RW-C-202204-0107-1-1# & RW-C-202204-0107-1-2#					
Receipt Date	:	2022-04-15					
Test Date	81	2022-04-15 to 2022-04-29					
Issue Date	:	2022-05-10					
Standards	3	FCC Part 15 Subpart C 15.247					
Test Method	÷	ANSI C63.10: 2013					
		KDB 558074 D01 15.247 Meas Guidance v05r02					
Conclusions	:	PASS					
		In the configuration tested, the EUT complied with the standards specified above.					
Witness Engineer		: Jaile W Wade Cor					
Engineer Supervisor	5	: Jule W : INAN SU : fuy ta. Parl at					
Engineer Manager		: fuy toi. Ray Lat					



TB-RF-074-1.0



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### **Revision History**

Report No.	Version	Description	Issued Date
TBR-C-202204-0107-13	Rev.01	Initial issue of report	2022-05-10
Con Con Co	00	TEL DE TEL	CONT.
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### 1. General Information about EUT

#### 1.1 Client Information

Applicant	-	Heltec Automation Technology Co., Ltd				
Address 1st floor, No. 54, 56, 58 zirui North Street, High-tech Zone,		1st floor, No. 54, 56, 58 zirui North Street, High-tech Zone,				
Chengdu city, China		Chengdu city, China				
Manufacturer	: Heltec Automation Technology Co., Ltd					
Address 1st floor, No. 54, 56, 58 zirui North Street, High-tech Zone,		1st floor, No. 54, 56, 58 zirui North Street, High-tech Zone,				
Chengdu city, China		Chengdu city, China				

#### 1.2 General Description of EUT (Equipment Under Test)

EUT Name	:	Heltec Indoor Hotspot		
Models No.		HT-M2802		
Model Different				
Product Description		Operation Frequency:	LoRa(125KHz): 902.3MHz-914.9MHz	
	•	Number of Channel: 64 channels		
		Antenna Gain:	3.0dBi Dipole Antenna	
		Bit Rate of Transmitter:	5.47kbps	
Power Rating	∧	Adapter(DSS12D-0502000-E) Input: 100-240V~50/60Hz 0.5A Output: 5V2A		
Software Version	2	N/A		
Hardware Version	-	N/A		
Remark:		CIND I		

#### Remark:

(1) The antenna gain and adapter provided by the applicant, the verified for the RF conduction test provided by TOBY test lab.

(2) For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual.

(3) Antenna information provided by the applicant. And the type of antenna please see the external photos.

# TOBY

### (4) Channel List:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
01	902.3	23	906.7	45	911.1
02	902.5	24	906.9	46	911.3
03	902.7	25	907.1	47	911.5
04	902.9	26	907.3	48	911.7
05	903.1	27	907.5	49	911.9
06	903.3	28	907.7	50	912.1
07	903.5	29	907.9	51	912.3
08	903.7	30	908.1	52	912.5
09	903.9	31	908.3	53	912.7
10	904.1	32	908.5	54	912.9
11	904.3	33	908.7	55	913.1
12	904.5	34	908.9	56	913.3
13	904.7	35	909.1	57	913.5
14	904.9	36	909.3	58	913.7
15	905.1	37	909.5	59	913.9
16	905.3	38	909.7	60	914.1
17	905.5	39	909.9	61	914.3
18	905.7	40	910.1	62	914.5
19	905.9	41	910.3	63	914.7
20	906.1	42	910.5	64	914.9
21	906.3	43	910.7	SIL SI	6132
22	906.5	44	910.9		



### 1.3 Block Diagram Showing the Configuration of System Tested

#### **Conducted Test**

	EUT ADAPTER	
iated Test		
	EUT ADAPTER	

1.4 Description of Support Units

Equipment Information						
Name	Model	FCC ID/SDOC	Manufacturer	Used "√"		
Adapter	DSS12D-0502000-E		DSS	$\checkmark$		
Cable Information						
Number         Shielded Type         Ferrite Core         Length         Note						
Cable 1	Yes	NO	1.0M	Accessory		

#### 1.5 Description of Test Mode

To investigate the maximum EMI emission characteristics generates from EUT, the test system was pre-scanning tested base on the consideration of following EUT operation mode or test configuration mode which possible have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned follow was evaluated respectively.

Decarintian				
Final Test Mode Description				
TX Mode Channel 01				
For Radiated Test				
Description				
TX Mode Channel 01				
TX Mode Channel 01/32/64				
Mode 3 Hopping Mode				

#### Note:

(1) For all test, we have verified the construction and function in typical operation. And all the test modes were carried out with the EUT in transmitting operation in maximum power with all kinds of data rate.

According to ANSI C63.10 standards, the measurements are performed at the highest, middle, lowest available channels.

- (2) During the testing procedure, the continuously transmitting with the maximum power mode was programmed by the customer.
- (3) The EUT is considered a Mobile unit; in normal use it was positioned on X-plane. The worst case was found positioned on X-plane. Therefore only the test data of this X-plane was used for radiated emission measurement test.

#### 1.6 Description of Test Software Setting

During testing channel& Power controlling software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product power parameters of RF setting.

Test Software Version	anB	SecureCRT.ex	e
Frequency	902.3MHz	908.5MHz	914.9MHz
LoRa	DEF	DEF	DEF

#### 1.7 Measurement Uncertainty

The reported uncertainty of measurement  $y \pm U_3$ , where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95 %.

Test Item	Parameters	Expanded Uncertainty (U <sub>Lab</sub> )
Conducted Emission	Level Accuracy: 9kHz~150kHz 150kHz to 30MHz	±3.50 dB ±3.10 dB
Radiated Emission	Level Accuracy: 9kHz to 30 MHz	±4.60 dB
Radiated Emission	Level Accuracy: 30MHz to 1000 MHz	±4.50 dB
Radiated Emission	Level Accuracy: Above 1000MHz	±4.20 dB



#### 1.8 Test Facility

The testing report were performed by the Shenzhen Toby Technology Co., Ltd., in their facilities located at 1/F.,Building 6, Rundongsheng Industrial Zone, Longzhu, Xixiang, Bao'an District, Shenzhen, Guangdong, China. At the time of testing, the following bodies accredited the Laboratory:

#### CNAS (L5813)

The Laboratory has been accredited by CNAS to ISO/IEC 17025: 2017 General Requirements for the Competence of Testing and Calibration Laboratories for the competence in the field of testing. And the Registration No.: CNAS L5813.

#### A2LA Certificate No.: 4750.01

The laboratory has been accredited by American Association for Laboratory Accreditation(A2LA) to ISO/IEC 17025: 2017 General Requirements for the Competence of Testing and Calibration Laboratories for the technical competence in the field of Electrical Testing. And the A2LA Certificate No.: 4750.01.FCC Accredited Test Site Number: 854351. Designation Number: CN1223.

#### IC Registration No.: (11950A)

The Laboratory has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing. The site registration: Site# 11950A. CAB identifier: CN0056.

### 2. Test Summary

Standard Section	To of House		lundaria and	Dement
FCC	Test Item	Test Sample(s)	Judgment	Remark
FCC 15.207(a)	Conducted Emission	RW-C-202204-0107-1-1#	PASS	N/A
FCC 15.209 & 15.247(d)	Radiated Unwanted Emissions	RW-C-202204-0107-1-1#	PASS	N/A
FCC 15.203	Antenna Requirement	RW-C-202204-0107-1-2#	PASS	N/A
FCC 15.247(a)	99% Occupied Bandwidth & 20dB Bandwidth	RW-C-202204-0107-1-2#	PASS	N/A
FCC 15.247(b)(1)	Peak Output Power	RW-C-202204-0107-1-2#	PASS	N/A
FCC 15.247(f)	Power Spectral Density	RW-C-202204-0107-1-2#	PASS	N/A
FCC 15.247(a)(1)	Carrier frequency separation	RW-C-202204-0107-1-2#	PASS	N/A
FCC 15.247(f)	Time of occupancy	RW-C-202204-0107-1-2#	PASS	N/A
FCC 15.247(b)(1)	Number of Hopping Frequency	RW-C-202204-0107-1-2#	PASS	N/A (2)
FCC 15.247(d)	Band Edge	RW-C-202204-0107-1-2#	PASS	N/A
FCC 15.207	Conducted Unwanted Emissions	RW-C-202204-0107-1-2#	PASS	N/A
FCC 15.205	Emissions in Restricted Bands	RW-C-202204-0107-1-2#	PASS	N/A
FCC 15.247(a)(1)	Hopping function Requirements	RW-C-202204-0107-1-2#	PASS	N/A
	On Time and Duty Cycle	RW-C-202204-0107-1-2#		N/A

Note: N/A is an abbreviation for Not Applicable.

### 3. Test Software

Test Item	Test Software	Manufacturer	Version No.
Conducted Emission	EZ-EMC	EZ	CDI-03A2
Radiation Emission	EZ-EMC	EZ	FA-03A2RE
RF Conducted Measurement	MTS-8310	MWRFtest	V2.0.0.0
RF Test System	JS1120	Tonscend	V2.6.88.0336

### 4. Test Equipment

Conducted Emission	on Test				
Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Due Date
EMI Test Receiver	Rohde & Schwarz	ESCI	100321	Jul. 02, 2021	Jul. 01, 2022
RF Switching Unit	Compliance Direction Systems Inc	RSU-A4	34403	Jul. 02, 2021	Jul. 01, 2022
AMN	SCHWARZBECK	NNBL 8226-2	8226-2/164	Jul. 02, 2021	Jul. 01, 2022
LISN	Rohde & Schwarz	ENV216	101131	Jul. 02, 2021	Jul. 01, 2022
<b>Radiation Emission</b>	n Test (A Site)		÷	•	
Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Due Date
Spectrum Analyzer	Rohde & Schwarz	FSV40-N	102197	Jul. 02, 2021	Jul. 01, 2022
EMI Test Receiver	Rohde & Schwarz	ESPI	100010/007	Jul. 02, 2021	Jul. 01, 2022
Bilog Antenna	ETS-LINDGREN	3142E	00117537	Feb. 27, 2022	Feb. 26, 2024
Horn Antenna	ETS-LINDGREN	3117	00143207	Feb. 26, 2022	Feb. 25, 2024
Horn Antenna	SCHWARZBECK	BBHA 9170	1118	Feb. 26, 2022	Feb. 25, 2024
Loop Antenna	SCHWARZBECK	FMZB 1519 B	1519B-059	Jul. 06, 2021	Jul. 05, 2022
Pre-amplifier	SONOMA	310N	185903	Feb. 26, 2022	Feb. 25, 2023
Pre-amplifier	HP	8449B	3008A00849	Feb. 26, 2022	Feb. 25, 2023
HF Amplifier	Tonscend	TAP0184050	AP21C806129	Sep. 03, 2021	Sep. 02, 2022
<b>Radiation Emission</b>	n Test (B Site)		-	-	-
Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Due Date
Spectrum Analyzer	Rohde & Schwarz	FSV40-N	102197	Jul. 02, 2021	Jul. 01, 2022
MXA Signal Analyzer	Agilent	N9020A	MY47380425	Sep. 03, 2021	Sep. 02, 2022
EMI Test Receiver	Rohde & Schwarz	ESU-8	100472	Feb. 26, 2022	Feb. 25, 2023
Bilog Antenna	SCHWARZBECK	VULB 9168	1225	Dec. 05, 2021	Dec. 04, 2023
Horn Antenna	SCHWARZBECK	BBHA 9120 D	2463	May 20, 2021	May 19, 2022
Horn Antenna	SCHWARZBECK	BBHA 9170	1118	Feb. 26, 2022	Feb. 25, 2024
Loop Antenna	SCHWARZBECK	FMZB 1519 B	1519B-059	Jul. 06, 2021	Jul. 05, 2022
HF Amplifier	Tonscend	TAP9E6343	AP21C806117	Sep. 03, 2021	Sep. 02, 2022
HF Amplifier	Tonscend	TAP051845	AP21C806141	Sep. 03, 2021	Sep. 02, 2022
HF Amplifier	Tonscend	TAP0184050	AP21C806129	Sep. 03, 2021	Sep. 02, 2022
Antenna Conducte	d Emission				
Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Due Date
Spectrum Analyzer	Agilent	E4407B	MY45106456	Jul. 02, 2021	Jul. 01, 2022
Spectrum Analyzer	Rohde & Schwarz	FSV40-N	102197	Jul. 02, 2021	Jul. 01, 2022
MXA Signal Analyzer	Agilent	N9020A	MY49100060	Sep. 03, 2021	Sep. 02, 2022
Spectrum Analyzer	KEYSIGT	N9020B	MY60110172	Sep. 03, 2021	Sep. 02, 2022
	DARE!! Instruments	RadiPowerRPR3006W	17100015SNO26	Sep. 03, 2021	Sep. 02, 2022
	DARE!! Instruments	RadiPowerRPR3006W	17100015SNO29	Sep. 03, 2021	Sep. 02, 2022
RF Power Sensor	DARE!! Instruments	RadiPowerRPR3006W	17100015SNO31	Sep. 03, 2021	Sep. 02, 2022
	DARE!! Instruments	RadiPowerRPR3006W	17100015SNO33	Sep. 03, 2021	Sep. 02, 2022
RF Control Unit	Tonsced	JS0806-2	21F8060439	Sep. 03, 2021	Sep. 02, 2022



### 5. Conducted Emission

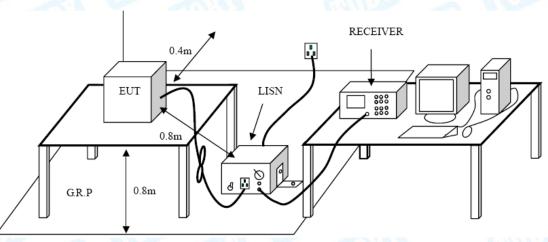
- 5.1 Test Standard and Limit
  - 5.1.1 Test Standard
    - FCC Part 15.207
  - 5.1.2 Test Limit

Francisco	Maximum RF Line Voltage (dBμV)		
Frequency	Quasi-peak Level	Average Level	
150kHz~500kHz	66 ~ 56 *	56 ~ 46 *	
500kHz~5MHz	56	46	
5MHz~30MHz	60	50	

#### Notes:

- (1) \*Decreasing linearly with logarithm of the frequency.
- (2) The lower limit shall apply at the transition frequencies.
- (3) The limit decrease in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

#### 5.2 Test Setup



#### 5.3 Test Procedure

● The EUT was placed 0.8 meters from the horizontal ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments powered from additional LISN(s). The LISN provide 50 Ohm/ 50 uH of coupling impedance for the measuring instrument.

● Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.

●I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.

●LISN at least 80 cm from nearest part of EUT chassis.

●The bandwidth of EMI test receiver is set at 9 kHz, and the test frequency band is from 0.15MHz to 30MHz.



5.4 Deviation From Test Standard

No deviation

5.5 EUT Operating Mode

Please refer to the description of test mode.

5.6 Test Data

Please refer to the Attachment A.



### 6. Radiated and Conducted Unwanted Emissions

- 6.1 Test Standard and Limit
  - 6.1.1 Test Standard

#### FCC Part 15.209 & FCC Part 15.247(d)

6.1.2 Test Limit

Genera	General field strength limits at frequencies Below 30MHz			
Frequency	Field Strength	Field Strength	Measurement	
(MHz)	(µA/m)*	(microvolt/meter)**	Distance (meters)	
0.009~0.490	6.37/F (F in kHz)	2400/F(KHz)	300	
0.490~1.705	63.7/F (F in kHz)	24000/F(KHz)	30	
1.705~30.0	0.08	30	30	

**Note:** 1, The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

2, \*is for RSS Standard, \*\*is for FCC Standard.

General field strength limits at frequencies above 30 MHz			
Frequency (MHz)	Field strength (μV/m at 3 m)	Measurement Distance (meters)	
30~88	100	3	
88~216	150	3	
216~960	200	3	
Above 960	500	3	

General field strength limits at frequencies Above 1000MHz			
Frequency	Distance of 3m (dBuV/m)		
(MHz)	Peak	Average	
Above 1000	74	54	

Note:

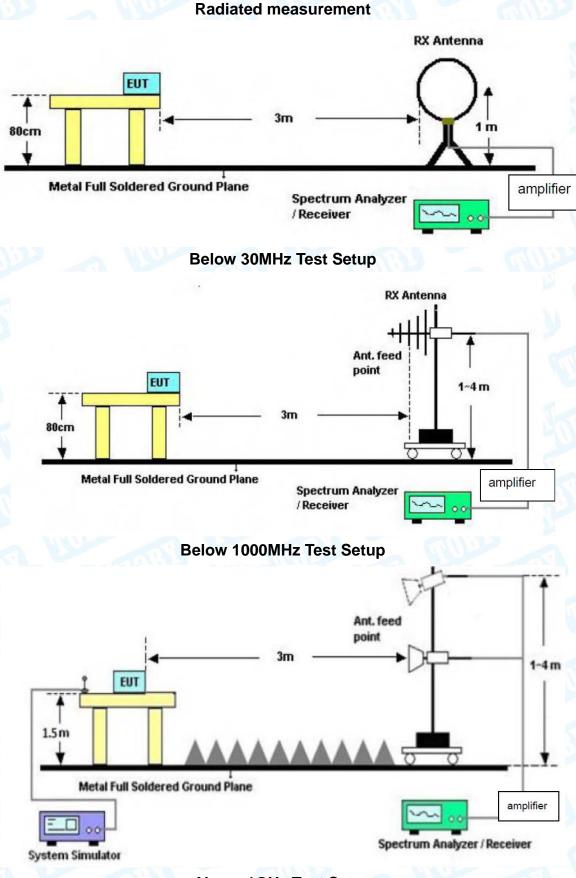
(1) The tighter limit applies at the band edges.

(2) Emission Level(dBuV/m)=20log Emission Level(uV/m)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.



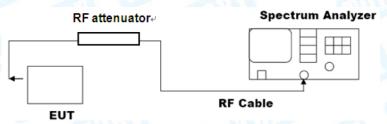
#### 6.2 Test Setup



Above 1GHz Test Setup



#### **Conducted measurement**



#### 6.3 Test Procedure

#### ---Radiated measurement

● The measuring distance of 3m shall be used for measurements at frequency up to 1GHz and above 1 GHz. The EUT was placed on a rotating 0.8m high above ground, the table was rotated 360 degrees to determine the position of the highest radiation.

• Measurements at frequency above 1GHz. The EUT was placed on a rotating 1.5m high above the ground. RF absorbers covered the ground plane with a minimum area of 3.0m by 3.0m between the EUT and measurement receiver antenna. The RF absorber shall not exceed 30cm in high above the conducting floor. The table was rotated 360 degrees to determine the position of the highest radiation.

• The Test antenna shall vary between 1m and 4m, Both Horizontal and Vertical antenna are set to make measurement.

● The initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured.

● If the Peak Mode measured value compliance with and lower than Quasi Peak Mode Limit Below 1 GHz, the EUT shall be deemed to meet QP Limits and then no additional QP Mode measurement performed. But the Peak Value and average value both need to comply with applicable limit above 1 GHz.

● Testing frequency range 30MHz-1GHz the measuring instrument use VBW=120 kHz with Quasi-peak detection. Testing frequency range 9KHz-150Hz the measuring instrument use VBW=200Hz with Quasi-peak detection. Testing frequency range 9KHz-30MHz the measuring instrument use VBW=9kHz with Quasi-peak detection.

● Testing frequency range above 1GHz the measuring instrument use RBW=1 MHz and VBW=3 MHz with Peak Detector for Peak Values, and use RBW=1 MHz and VBW=10 Hz with Peak Detector for Average Values.

•For the actual test configuration, please see the test setup photo.



#### --- Conducted measurement

#### Reference level measurement

- Establish a reference level by using the following procedure:
- a) Set instrument center frequency to DTS channel center frequency.
- b) Set the span to≥1.5 times the DTS bandwidth.
- c) Set the RBW = 100 kHz.
- d) Set the VBW≥[3\*RBW].
- e) Detector = peak.
- 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 PSD level.

Note that the channel found to contain the maximum PSD level can be used to establish the reference level.

#### • Emission level measurement

Establish an emission level by using the following procedure:

- a) Set the center frequency and span to encompass frequency range to be measured.
- b) Set the RBW = 100 kHz.
- c) Set the VBW≥[3\*RBW].
- d) Detector = peak.
- e) Sweep time = auto couple.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.

h) Use the peak marker function to determine the maximum amplitude level. Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) is attenuated by at least the minimum requirements specified in 11.11. Report the three highest emissions relative to the limit.

#### 6.4 Deviation From Test Standard

No deviation

#### 6.5 EUT Operating Mode

Please refer to the description of test mode.

#### 6.6 Test Data

Please refer to the Attachment B.



### 7. Emissions in nonrestricted frequency bands

#### 7.1 Test Standard and Limit

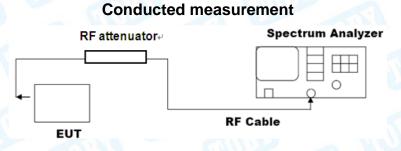
#### 7.1.1 Test Standard

#### FCC Part 15.205 & FCC Part 15.247(d)

7.1.2 Test Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

#### 7.2 Test Setup



#### 7.3 Test Procedure

#### **Reference level measurement**

Establish a reference level by using the following procedure:

- a) Set instrument center frequency to DTS channel center frequency.
- b) Set the span to  $\geq$ 1.5 times the DTS bandwidth.
- c) Set the RBW = 100 kHz.
- d) Set the VBW≥[3\*RBW].
- e) Detector = peak.
- 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 PSD level.

Note that the channel found to contain the maximum PSD level can be used to establish the reference level.



#### **Emission level measurement**

- Establish an emission level by using the following procedure:
- a) Set the center frequency and span to encompass frequency range to be measured.
- b) Set the RBW = 100 kHz.
- c) Set the VBW  $\geq$  [3\*RBW].
- d) Detector = peak.
- e) Sweep time = auto couple.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.
- h) Use the peak marker function to determine the maximum amplitude level.

#### 7.4 Deviation From Test Standard

No deviation

7.5 EUT Operating Mode

Please refer to the description of test mode.

#### 7.6 Test Data

Please refer to the Attachment C.



### 8. 99% Occupied and 20dB Bandwidth

#### 8.1 Test Standard and Limit

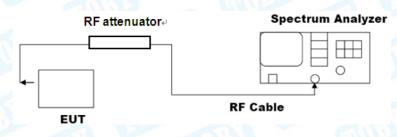
8.1.1 Test Standard

#### FCC Part 15.205 & FCC Part 15.247(a)

8.1.2 Test Limit

There are no limits for 20dB bandwidth and 99% occupied bandwidth.

#### 8.2 Test Setup



#### 8.3 Test Procedure

● The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:

a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.

b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.

c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.

d) Step a) through step c) might require iteration to adjust within the specified range.

e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.

f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.

g) If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequence between these two frequencies.

h) The occupied bandwidth shall be reported by providing plot(s) of the measuring



instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

8.4 Deviation From Test Standard

No deviation

8.5 EUT Operating Mode

Please refer to the description of test mode.

#### 8.6 Test Data

Please refer to the Attachment D.

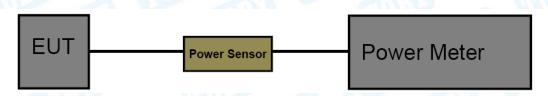


### 9. Peak Output Power Test

- 9.1 Test Standard and Limit
  - 9.1.1 Test Standard FCC Part 15.247(b)(1)
  - 9.1.2 Test Limit

Test Item	Limit	Frequency Range(MHz)
	P <sub>max-pk</sub> ≤ 1 W	
	$N_{ch} \ge 50$	
all b	f ≥ MAX {25 kHz, BW20dB}	
	BW20dB ≤250KHz	
Dook Output Dowor	$tch \le 0.4$ s for $T = 20s$	002 028
Peak Output Power	<i>P</i> <sub>max-pk</sub> ≤ 0.25W	902~928
	25≤Nch<50	
A TUNA	$f \ge MAX \{25 \text{ kHz}, BW_{20dB}\}$	
	250KHz <bw20db td="" ≤500khz<=""><td></td></bw20db>	
	$tch \le 0.4  ext{ s for } T = 10  ext{ s}$	
$t_{ch}$ = average time of occupancy; $T$ = period; $N_{ch}$ = # hopping frequencies; BW = bandwidth;		
	f = hopping channel carrier frequency s	eparation

#### 9.2 Test Setup



#### 9.3 Test Procedure

• The EUT was connected to RF power meter via a broadband power sensor as show the block above. The power sensor video bandwidth is greater than or equal to the DTS bandwidth of the equipment.

#### 9.4 Deviation From Test Standard

No deviation

9.5 EUT Operating Mode

Please refer to the description of test mode.

9.6 Test Data

Please refer to the Attachment E.



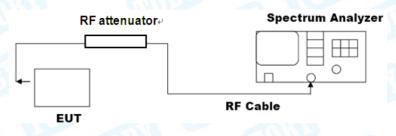
### 10. Power Spectral Density

10.1 Test Standard and Limit

10.1.1 Test Standard **FCC Part 15.247(f)** 10.1.2 Test Limit

Test Item	Limit
Power Spectral Density	8dBm(in any 3 kHz)

10.2 Test Setup



#### 10.3 Test Procedure

• The following procedure shall be used if maximum peak conducted output power was used to determine compliance, and it is optional if the maximum conducted (average) output power was used to determine compliance:

- 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  $\geq$ [3\*RBW].
- e) Detector = rms.
- f) Sweep time = auto couple.
- g) Employ trace averaging (rms) mode over a minimum of 100 traces.
- h) Allow trace to fully stabilize.
- i) Use the peak marker function to determine the maximum amplitude level.

j) If the measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced).

#### 10.4 Deviation From Test Standard

No deviation

#### 10.5 Antenna Connected Construction

Please refer to the description of test mode.

#### 10.6 Test Data

Please refer to the Attachment F.



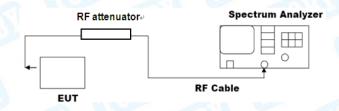
### 11. Carrier frequency separation

#### 11.1 Test Standard and Limit

- 11.1.1 Test Standard FCC Part 15.247(a)(1)
- 11.1.2 Test Limit

Test Item	Limit	Frequency Range(MHz)	
	P <sub>max-pk</sub> ≤ 1 W		
	$N_{ch} \ge 50$		
augu a	f ≥ MAX { 25 kHz, BW20dB }		
	BW20dB ≤250KHz		
Carrier frequency separation	$tch \le 0.4  ext{ s for } T = 20  ext{ s}$	003 038	
	P <sub>max-pk</sub> ≤ 0.25W	902~928	
	25≤ <i>N</i> <sub>ch</sub> <50		
A MULT	f ≥ MAX { 25 kHz, BW20dB }		
	250KHz <bw₂0db td="" ≤500khz<=""><td></td></bw₂0db>		
	$tch \le 0.4  ext{ s for } T = 10  ext{ s}$		
$t_{ch}$ = average time of occupancy; $T$ = period; $N_{ch}$ = # hopping frequencies; BW = bandwidth;			
	f = hopping channel carrier frequency s	separation	

#### 11.2 Test Setup



#### 11.3 Test Procedure

• The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: Wide enough to capture the peaks of two adjacent channels.

b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.

c) Video (or average) bandwidth (VBW)  $\ge$  RBW.

- d) Sweep: Auto.
- e) Detector function: Peak.
- f) Trace: Max hold.
- g) Allow the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.



11.4 Deviation From Test Standard

No deviation

11.5 Antenna Connected Construction

Please refer to the description of test mode.

11.6 Test Data

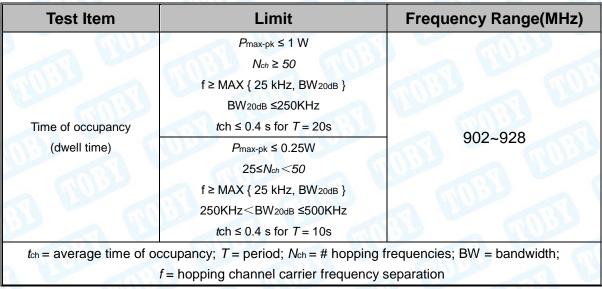
Please refer to the Attachment G.



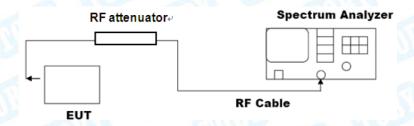
### 12. Time of occupancy (Dwell time)

#### 12.1 Test Standard and Limit

- 12.1.1 Test Standard FCC Part 15.247(f)
- 12.1.2 Test Limit



#### 12.2 Test Setup



#### 12.3 Test Procedure

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: Zero span, centered on a hopping channel.

b) RBW shall be 

channel spacing and where possible RBW should be set >> 1 / T, where

T is the expected dwell time per channel.

c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.

d) Detector function: Peak.

e) Trace: Max hold.

Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping



channels, etc.), then repeat this test for each variation in transmit time.

Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:

(Number of hops in the period specified in the requirements) =

(number of hops on spectrum analyzer)x(period specified in the requirements / analyzer sweep time)

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation.

The measured transmit time and time between hops shall be consistent with the values described in the operational description for the EUT.

#### 12.4 Deviation From Test Standard

No deviation

12.5 Antenna Connected Construction

Please refer to the description of test mode.

#### 12.6 Test Data

Please refer to the Attachment H.



### 13. Number of hopping frequencies

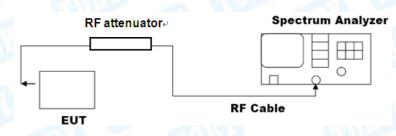
#### 13.1 Test Standard and Limit

#### 13.1.1 Test Standard FCC Part 15.247(b)(1)

13.1.2 Test Limit

Test Item	Limit	Frequency Range(MHz)		
	P <sub>max-pk</sub> ≤ 1 W			
	$N_{ch} \ge 50$			
GUUD A	f ≥ MAX { 25 kHz, BW20dB }			
0131	BW20dB ≤250KHz			
Carrier frequency	$tch \le 0.4  ext{ s for } T = 20  ext{ s}$	902~928		
separation	<i>P</i> <sub>max-pk</sub> ≤ 0.25W	902~928		
	25≤N <sub>ch</sub> <50			
	f ≥ MAX { 25 kHz, BW20dB }			
B C	250KHz <bw20db td="" ≤500khz<=""><td></td></bw20db>			
	$tch \le 0.4$ s for $T = 10s$			
tch = average time of oc	ccupancy; $T = \text{period}; N_{ch} = \# \text{hopping fr}$	requencies; BW = bandwidth;		
	f = hopping channel carrier frequency separation			
There is no minimum number of hopping channels associated with this type of hybrid system. While				
there is not a specific min	there is not a specific minimum limit, the hop sequence is required to appear as pseudorandom per			
Section 15.247(a)(1) (see Section 3 of this document).				

### 13.2 Test Setup



#### 13.3 Test Procedure

• The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.

b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.

c) VBW  $\geq$  RBW.

- d) Sweep: Auto.
- e) Detector function: Peak.
- f) Trace: Max hold.



g) Allow the trace to stabilize.

It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies.

Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A plot of the data shall be included in the test report.

#### 13.4 Deviation From Test Standard

No deviation

#### 13.5 Antenna Connected Construction

Please refer to the description of test mode.

#### 13.6 Test Data

Please refer to the Attachment I.



### 14. Hopping function Requirements

#### 14.1 Test Standard and Limit

- 14.1.1 Test Standard FCC Part 15.247(a)(1)
- 14.1.2 Test Limit

The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hop-ping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

#### 14.4 Deviation From Test Standard

No deviation

#### 14.6 Test Data

The transmitter follows the LoRa alliance protocol which complies with the pseudo-random hop sequence, equal use of each frequency, and receiver matching bandwidth and synchronization requirements.



### 15. Antenna Requirement

#### 15.1 Test Standard and Limit

#### 15.1.1 Test Standard FCC Part 15.203

15.1.2 Requirement

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 use of a standard antenna jack or electrical connector is prohibited.

#### 15.2 Deviation From Test Standard

No deviation

#### 15.3 Antenna Connected Construction

The gains of the antenna used for transmitting is 3.0dBi, and the antenna de-signed with Unique connector antenna and consideration of replacement. Please see the EUT photo for details.

#### 15.4 Test Data

The EUT antenna is a Dipole antenna. It complies with the standard requirement.

	Antenna Type					
Jun -	Permanent attached antenna					
	Unique connector antenna					
2	Professional installation antenna					

### **Attachment A-- Conducted Emission Test Data**

Temperature:	<b>24.5</b> ℃		Relativ	e Humic	dity:	44%		
Fest Voltage:	AC 120V/60	0Hz		122		-	1	1
Ferminal:	Line	6	CEIN			UL	100	-
Fest Mode:	Mode 1		1	60			60	A D
Remark:	Only worse	e case is repo	orted.	NU-		51		
80.0 dBuV								
							QP: AVG:	-
							A¥ū.	
					,			
30 × ×	× · · · ·	×						
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30 × × × × × × × × × × × × × × × × × × ×	0.5	Chan y and an a series					My all and	

No	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over	
	iviix.	•						Detector
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector
1		0.1620	17.84	11.63	29.47	65.36	-35.89	QP
2		0.1620	3.68	11.63	15.31	55.36	-40.05	AVG
3		0.2140	15.52	11.65	27.17	63.04	-35.87	QP
4		0.2140	4.10	11.65	15.75	53.04	-37.29	AVG
5	*	0.4100	21.79	11.45	33.24	57.65	-24.41	QP
6		0.4100	7.43	11.45	18.88	47.65	-28.77	AVG
7		0.8220	14.02	11.32	25.34	56.00	-30.66	QP
8		0.8220	1.23	11.32	12.55	46.00	-33.45	AVG
9		6.2619	15.78	10.09	25.87	60.00	-34.13	QP
10		6.2619	3.09	10.09	13.18	50.00	-36.82	AVG
11		7.7740	15.73	10.14	25.87	60.00	-34.13	QP
12		7.7740	4.19	10.14	14.33	50.00	-35.67	AVG

#### Remark:

1. Corr. Factor (dB) = LISN Factor (dB) + Cable Loss (dB)

2. Margin (dB) =QuasiPeak/Average (dBuV)-Limit (dBuV)

TOBY

Temperature:	<b>24.5</b> ℃	Relative Humidity	: 44%
Test Voltage:	AC 120V/60Hz		
Terminal:	Neutral	1	
Test Mode:	Mode 1	and a l	
Remark:	Only worse case is re	ported.	CUD.
80.0 dBuV			QP:
30 × MMMM MMMM -20	Multimation of the second seco		AV
0.150	0.5	(MHz) 5	30.000

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure- ment	Limit	Over	
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector
1		0.1580	16.50	11.60	28.10	65.56	-37.46	QP
2		0.1580	4.61	11.60	16.21	55.56	-39.35	AVG
3		0.4180	23.25	11.48	34.73	57.49	-22.76	QP
4	*	0.4180	13.71	11.48	25.19	47.49	-22.30	AVG
5		0.9540	10.81	11.24	22.05	56.00	-33.95	QP
6		0.9540	3.23	11.24	14.47	46.00	-31.53	AVG
7		1.3140	12.29	10.97	23.26	56.00	-32.74	QP
8		1.3140	3.78	10.97	14.75	46.00	-31.25	AVG
9		5.8340	15.69	10.05	25.74	60.00	-34.26	QP
10		5.8340	0.28	10.05	10.33	50.00	-39.67	AVG
11		11.4940	3.59	10.20	13.79	60.00	-46.21	QP
12		11.4940	-2.82	10.20	7.38	50.00	-42.62	AVG

Remark: 1. Corr. Factor (dB) = LISN Factor (dB) + Cable Loss (dB)

2. Margin (dB) =QuasiPeak/Average (dBuV)-Limit (dBuV)



### **Attachment B--Unwanted Emissions Data**

#### ---Radiated Unwanted Emissions

#### 9 KHz~30 MHz

From 9 KHz to 30 MHz: Conclusion: PASS

Note: The amplitude of spurious emissions which are attenuated by more than 20dB Below the permissible value has no need to be reported.

#### 30MHz~1GHz

Temperature:	<b>24.3</b> ℃	Relative Humidity:	45%
Test Voltage:	AC 120V/60Hz		
Ant. Pol.	Horizontal		
Test Mode:	Mode 2 (902.3MHz)		
Remark:	Only worse case is r	eported.	1100 A
80.0 dBuV/m			
70 60 50		Fundamental Frequency (RF)FCI	C 15C 3M Radiation
40		2	6
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-20			
30.000	60.00	(MHz) 300.00	1000.0

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1 *	67.6751	<u>59.68</u>	-24.14	35.54	40.00	-4.46	peak
2	191.0738	59.86	-23.65	36.21	43.50	-7.29	peak
3	375.9385	50.34	-19.03	31.31	46.00	-14.69	peak
4	401.8385	49.69	-18.40	31.29	46.00	-14.71	peak
5	687.1507	37.07	-11.95	25.12	46.00	-20.88	peak
6	729.3583	45.24	-11.26	33.98	46.00	-12.02	peak

\*:Maximum data x:Over limit !:over margin

#### Remark:

- 1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
- 2. QuasiPeak (dBµV/m)= Corr. (dB/m)+ Read Level (dBµV)
- 3. Margin (dB) = QuasiPeak (dB $\mu$ V/m)-Limit QPK(dB $\mu$ V/m)



Tempera	ature:	24.3℃	2	R	elative Hun	nidity:	45%	
Test Vol		AC 12	20V/60Hz			28.9		CINA
Ant. Pol		Vertica	al	2	a 10		12	1
Test Mo	de:	Mode	2 (902.3MH	łz)			1.2	
Remark	:		worse case i		-		1	NOP
80.0 dB	}uV/m				1			
70					Fundamental Fr	equency		
60 50						(RF)FCC 150 Margin -6 dE	C 3M Radiation	
						4 5		
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20 10 -10 -20	Frequ (MF	60.00	Reading (dBuV)			00 Limit	Margin	
20 10 -10 -20 30.000	Frequ	60.00 Iency Hz)	Reading	(мн₂) Factor	300.0 Level	00 Limit	Margin	1000.000
20 10 -10 -20 30.000 NO.	Frequ (MF	60.00 iency Hz) 278	Reading (dBuV)	(мн₂) Factor (dB/m)	300.0 Level (dBuV/m)	00 Limit (dBuV/m)	Margin (dB)	1000.000 Detector
20 10 0 -10 -20 30.000 No. 1 *	Frequ (MH 35.1)	60.00 iency Hz) 278 325	Reading (dBuV) 51.59	(мн₂) Factor (dB/m) -23.06	300.0 Level (dBuV/m) 28.53	00 Limit (dBuV/m) 40.00	Margin (dB) -11.47	1000.000 Detector peak
20 10 0 -10 -20 30.000 No. 1 * 2	Frequ (MH 35.11 66.7	60.00 iency Hz) 278 325 7450	Reading (dBuV) 51.59 51.54	(мн <sub>2</sub> ) Factor (dB/m) -23.06 -24.08	300.0 Level (dBuV/m) 28.53 27.46	00 Limit (dBuV/m) 40.00 40.00	Margin (dB) -11.47 -12.54	1000.000 Detector peak peak
20 10 0 -10 -20 30.000 No. 1 * 2 3	Frequ (MH 35.1) 66.7 191.7	60.00 1ency 1z) 278 325 7450 2500	Reading (dBuV) 51.59 51.54 50.47	(мн <sub>2</sub> ) Factor (dB/m) -23.06 -24.08 -23.68	300.1 Level (dBuV/m) 28.53 27.46 26.79	DUD Limit (dBuV/m) 40.00 40.00 43.50	Margin (dB) -11.47 -12.54 -16.71	Detector peak peak peak

\*:Maximum data x:Over limit !:over margin

#### Remark:

- Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
   QuasiPeak (dBμV/m)= Corr. (dB/m)+ Read Level (dBμV)
- 3. Margin (dB) = QuasiPeak (dBµV/m)-Limit QPK(dBµV/m)

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empera	ature:	24.3°C	2		Relative Hu	umidity:	45%	
est Vol	tage:	AC 12	20V/60Hz			RU C		
Ant. Pol		Horizo	ontal	10	aV		1.	199
est Mo	de:	Mode	2 (908.5MH	łz)			12 B	
Remark:		Only	worse case i	is reported.		1	1	NOP
80.0 dBu	i¥/m							· · · · · · · · · · · · · · · · · · ·
70								
60				ſ	Fundamental Fre	equency		
							C 3M Radiation	·
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10 /////// 0 ///////////////////////////	humminint	60.00	"hullen"	(MHz)	300.			1000.00
10	Frequ	60.00 ency	Reading (dBuV)		300. Level		Margin (dB)	1000.0
10 ////////////////////////////////////	Frequ	ency łz)	Reading	(MHz) Factor	300. Level	00 Limit	Margin	1000.0
10	Frequ (MF	60.00 ency 1z) 382	Reading (dBuV)	<sup>[MH₂]</sup> Factor (dB/m)	300. Level (dBuV/m)	∞ Limit (dBuV/m)	Margin (dB)	1000.0 Detecto
10	Frequ (MF	60.00 ency 1z) 382 725	Reading (dBuV) 58.81	(MHz) Factor (dB/m) -24.12	300. Level (dBuV/m) 34.69	00 Limit (dBuV/m) 40.00	Margin (dB) -5.31	1000.0 Detecto peak peak
10	Freque (MH 67.43 117.7	60.00 ency 1z) 382 725 7450	Reading (dBuV) 58.81 49.62	(MHz) Factor (dB/m) -24.12 -23.50	300. Level (dBuV/m) 34.69 26.12	00 Limit (dBuV/m) 40.00 43.50	Margin (dB) -5.31 -17.38	1000.00 Detecto peak peak
10 MMM 0 -10 -20 30.000 NO. 1 * 2 3	Frequ (MF 67.43 117.7 191.7	60.00 ency 12) 382 725 7450 9753	Reading (dBuV) 58.81 49.62 59.35	(MHz) Factor (dB/m) -24.12 -23.50 -23.68	<sup>300.</sup> Level (dBuV/m) 34.69 26.12 35.67	00 Limit (dBuV/m) 40.00 43.50 43.50	Margin (dB) -5.31 -17.38 -7.83	1000.00 Detecto peak peak peak

39.54

-13.63

46.00

-6.46

peak

\*:Maximum data !:over margin x:Over limit

586.8437

Remark:

6

- Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
   QuasiPeak (dBμV/m)= Corr. (dB/m)+ Read Level (dBμV)

53.17

3. Margin (dB) = QuasiPeak (dBµV/m)-Limit QPK(dBµV/m)



	2				<u></u>	CO.	
Temperature:	<b>24.3</b> ℃	ND Y	R	elative Hur	nidity:	45%	-
Test Voltage:	AC 120	V/60Hz					aus
Ant. Pol.	Vertical						
Test Mode:	Mode 2	2 (908.5M⊢	lz)	12			
Remark:	Only w	orse case i	is reported.	11		In In	NOD
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0 -10 -20 30.000	60.00		(MHz)	300	.00		1000.000
No. Frequ (MF		Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1 33.7	986	49.21	-23.12	26.09	40.00	-13.91	peak
2 * 66.7	325	52.31	-24.08	28.23	40.00	-11.77	peak
3 167.2	368	44.41	-22.02	22.39	43.50	-21.11	peak
4 191.7	450	50.41	-23.68	26.73	43.50	-16.77	peak
5 349.2	2500	48.00	-19.64	28.36	46.00	-17.64	peak
6 622.8	3900	44.83	-12.90	31.93	46.00	-14.07	peak

\*:Maximum data x:Over limit !:over margin

### Remark:

- Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
   QuasiPeak (dBμV/m)= Corr. (dB/m)+ Read Level (dBμV)
- 3. Margin (dB) = QuasiPeak (dBµV/m)-Limit QPK(dBµV/m)

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ſem	npera	ture:	24	<b>Ⅰ.3</b> ℃	2				Relative H	umidity:	45%			5
est	t Volt	age:	A	C 12	20V/	60⊦	łz		a			9	$\{ i \}$	Z
۹nt.	. Pol.		Ho	orizo	ontal		U		a v	-				
est	t Moo	le:	M	ode	2 (9	914.	9MH	z)			1 to	1		2
Ren	nark:		O	nly v	wors	se c	ase i	s reported.	- OF			117	E	P
80.0	dBu	//m	·,											
70									Fundamer	ntal Frequency				
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30 20 10 0 -10 -20 30		Freq	ueno	0.00	Re	ead		(MH2) Factor	Level	0.00 Limit	Margir			).00
30 20 10 -10 -20 30	0.000 No.	Freq (N	ueno 1Hz)	0.00	Re (d	ead	V)	(мн₂) Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margir (dB)			0.00 Or
30 20 10 -10 -20 30	0.000	Freq (N	ueno	0.00	Re (d	ead Bu	V) )8	(MH2) Factor	Level	0.00 Limit	Margir		1000	0.00 Or
30 20 10 -10 -20 30	0.000 No.	Freq (N	ueno 1Hz)	0.00 Cy	Re (d	ead	V) )8	(мн₂) Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margir (dB)			0.00 Or
30 20 10 -10 -20 30	0.000 No.	Freq (N 66. 83.	60 Jueno 1Hz) 9669	0.00 Cy D	Re (d 6	ead Bu	V) )8 )4	(мн <sub>2</sub> ) Factor (dB/m) -24.09	Level (dBuV/m) 35.99	Limit (dBuV/m) 40.00	Margir (dB) -4.01	л <sub>De</sub>	1000	0.00 or

46.00

46.00

-14.52

-13.13

peak

peak

31.48

32.87

\*:Maximum data x:Over limit !:over margin

406.0880

729.3583

### Remark:

5

6

- Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
   QuasiPeak (dBμV/m)= Corr. (dB/m)+ Read Level (dBμV)

49.78

44.13

-18.30

-11.26

3. Margin (dB) = QuasiPeak (dBµV/m)-Limit QPK(dBµV/m)

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empera	ature:	24.3°C	2	R	elative Hur	nidity:	45%	
est Vol	tage:	AC 12	20V/60Hz			13.2		CUID
nt. Po		Vertic	al		aV		12	5
est Mo	de:	Mode	2 (914.9MH	łz)	50	- QU	1.10	-01
emark	:	Only	worse case i	is reported.	90		1	NOC
80.0 dE	lu¥/m							
70					Fundamental Fi	equency		
60 50						(RF)FCC 15 Margin -6-d	iC 3M Radiatio B	in [
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10	M. Mun	60.00	Yomushamushallad	(MH2)	N			
10 mm	Frequ	60.00	Reading (dBuV)		300 Level	Limit (dBuV/m)	Margin (dB)	
10 0 -10 -20 30.000	Frequ	60.00 Iency Hz)	Reading	(мн₂) Factor	300 Level	Limit	Margin	1000.00
10 0 -10 -20 30.000 NO.	Frequ (Mł	662	Reading (dBuV)	(мн₂) Factor (dB/m)	300 Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	1000.00 Detector
10 mm 0 -10	Frequ (MH 36.7	60.00 iency Hz) 6662 765	Reading (dBuV) 51.30	(мн₂) Factor (dB/m) -23.07	300 Level (dBuV/m) 28.23	Limit (dBuV/m) 40.00	Margin (dB) -11.77	1000.00 Detector peak
10	Frequ (MH 36.7 41.2	60.00 iency Hz) 662 765 751	Reading (dBuV) 51.30 53.34	(мн₂) Factor (dB/m) -23.07 -22.98	300 Level (dBuV/m) 28.23 30.36	Limit (dBuV/m) 40.00 40.00	Margin (dB) -11.77 -9.64	1000.00 Detector peak peak
10	Frequ (MH 36.7 41.2 67.6	60.00 iency Hz) 662 765 751 7450	Reading (dBuV) 51.30 53.34 54.72	(мн₂) Factor (dB/m) -23.07 -22.98 -24.14	300 Level (dBuV/m) 28.23 30.36 30.58	Limit (dBuV/m) 40.00 40.00 40.00	Margin (dB) -11.77 -9.64 -9.42	1000.00 Detector peak peak peak

\*:Maximum data x:Over limit !:over margin

### Remark:

- Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
   QuasiPeak (dBμV/m)= Corr. (dB/m)+ Read Level (dBμV)
- 3. Margin (dB) = QuasiPeak (dBµV/m)-Limit QPK(dBµV/m)

## Above 1GHz

Temperature:	<b>26</b> ℃	Relative Humidity:	54%
Test Voltage:	AC 120V/60Hz	TUP'S	2 100
Ant. Pol.	Horizontal		
Test Mode:	TX 902.3MHz		
Remark:	Only worse case is r	eported.	

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	1804.843	64.14	-7.79	56.35	74.00	-17.65	peak
2 *	1804.984	50.63	-7.79	42.84	54.00	-11.16	AVG

### Remark:

1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB) 2. Peak/AVG (dBμV/m)= Corr. (dB/m)+ Read Level (dBμV)

3. Margin (dB) = Peak/AVG (dBµV/m)-Limit PK/AVG(dBµV/m)

4. The tests evaluated1-10GHz, The testing has been conformed to the 10th harmonic of the highest fundamental frequency.

5. No report for the emission which more than 20dB below the prescribed limit.

Temperature:	<b>26</b> ℃	Relative Humidity:	54%				
Test Voltage:	AC 120V/60Hz		TUCK I				
Ant. Pol.	Vertical	CORUS A					
Test Mode:	TX 902.3MHz	TX 902.3MHz					
Remark:	Only worse case is reported	ed.					

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)		Margin (dB)	Detector
1	1804.248	62.60	-7.79	54.81	74.00	-19.19	peak
2 *	1804.612	51.37	-7.79	43.58	54.00	-10.42	AVG

### Remark:

1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB)

2. Peak/AVG (dBµV/m)= Corr. (dB/m)+ Read Level (dBµV)

3. Margin (dB) = Peak/AVG (dB $\mu$ V/m)-Limit PK/AVG(dB $\mu$ V/m)

4. The tests evaluated1-10GHz, The testing has been conformed to the 10th harmonic of the highest fundamental frequency.

5. No report for the emission which more than 20dB below the prescribed limit.



Temperature:	<b>26</b> °C	Relative Humidity:	54%
Test Voltage:	AC 120V/60Hz	THUE A	
Ant. Pol.	Horizontal		133
Test Mode:	TX 908.5MHz		
Remark:	Only worse case is report	ted.	2 100

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)		Margin (dB)	Detector
1	1817.218	62.50	-7.69	54.81	74.00	-19.19	peak
2 *	1817.341	48.97	-7.69	41.28	54.00	-12.72	AVG

### Remark:

- 1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB) 2. Peak/AVG (dBμV/m)= Corr. (dB/m)+ Read Level (dBμV)
- 3. Margin (dB) = Peak/AVG (dB $\mu$ V/m)-Limit PK/AVG(dB $\mu$ V/m) 4. The tests evaluated1-10GHz,The testing has been conformed to the 10th harmonic of the highest fundamental frequency.

5. No report for the emission which more than 20dB below the prescribed limit.

<b>26</b> °C	Relative Humidity:	54%
AC 120V/60Hz		NU.
Vertical	CORUS -	CUL:
TX 908.5MHz	2	TON IN
Only worse case is reported	ed.	
	AC 120V/60Hz Vertical TX 908.5MHz	AC 120V/60Hz Vertical

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)		Margin (dB)	Detector
1	1817.328	63.04	-7.69	55.35	74.00	-18.65	peak
2 *	1817.481	51.96	-7.68	44.28	54.00	-9.72	AVG

### Remark:

- 1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
- 2. Peak/AVG (dBµV/m)= Corr. (dB/m)+ Read Level (dBµV)
- 3. Margin (dB) = Peak/AVG (dB $\mu$ V/m)-Limit PK/AVG(dB $\mu$ V/m)
- 4. The tests evaluated1-10GHz, The testing has been conformed to the 10th harmonic of the highest fundamental frequency.
- 5. No report for the emission which more than 20dB below the prescribed limit.



Temperature:	<b>26</b> ℃	Relative Humidity:	54%
Test Voltage:	AC 120V/60Hz	THUE A	
Ant. Pol.	Horizontal		133
Test Mode:	TX 914.9MHz		
Remark:	Only worse case is repor	ted.	2 100

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)		Margin (dB)	Detector
1 *	1830.165	51.86	-7.58	44.28	54.00	-9.72	AVG
2	1830.248	62.45	-7.58	54.87	74.00	-19.13	peak

### Remark:

- 1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB) 2. Peak/AVG (dBμV/m)= Corr. (dB/m)+ Read Level (dBμV)
- 3. Margin (dB) = Peak/AVG (dBµV/m)-Limit PK/AVG(dBµV/m)
- 4. The tests evaluated1-10GHz, The testing has been conformed to the 10th harmonic of the highest fundamental frequency.

5. No report for the emission which more than 20dB below the prescribed limit.

Temperature:	<b>26</b> ℃	Relative Humidity:	54%
Test Voltage:	AC 120V/60Hz	anits a	TUCK -
Ant. Pol.	Vertical	Con Bu	CUIP.
Test Mode:	TX 914.9MHz	200	No.
Remark:	Only worse case is reported	ed.	

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)		Margin (dB)	Detector
1 *	1830.038	51.47	-7.58	43.89	54.00	-10.11	AVG
2	1830.125	61.86	-7.58	54.28	74.00	-19.72	peak

### Remark:

1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB)

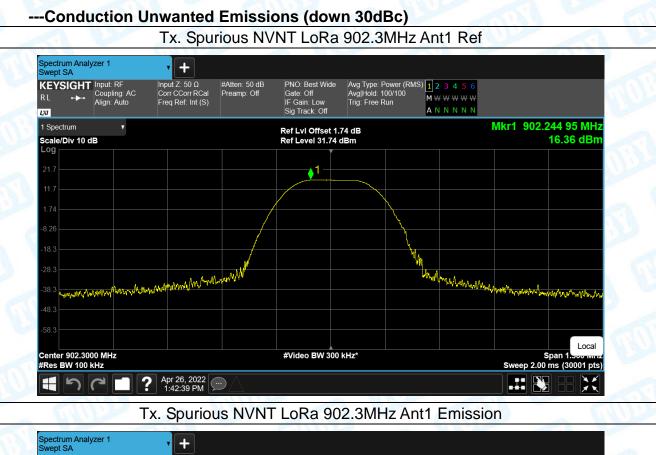
2. Peak/AVG (dBµV/m)= Corr. (dB/m)+ Read Level (dBµV)

3. Margin (dB) = Peak/AVG (dB $\mu$ V/m)-Limit PK/AVG(dB $\mu$ V/m)

4. The tests evaluated1-10GHz, The testing has been conformed to the 10th harmonic of the highest fundamental frequency.

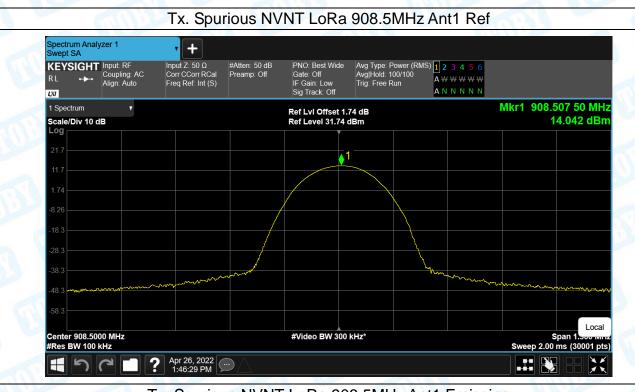
5. No report for the emission which more than 20dB below the prescribed limit.



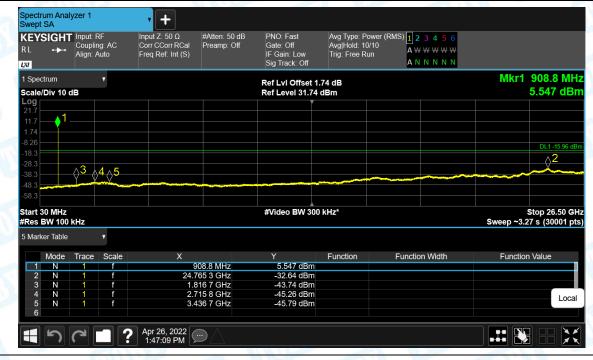




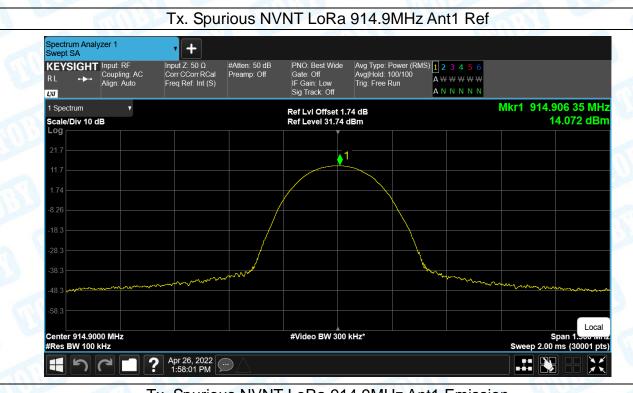




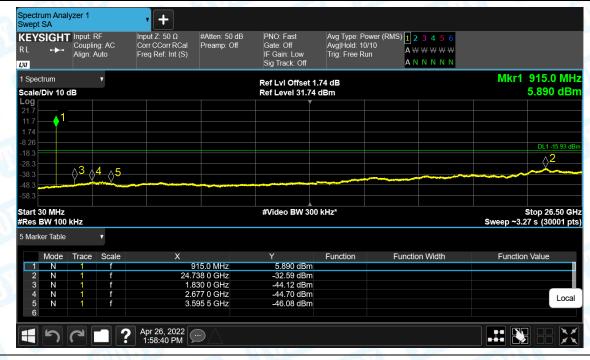
## Tx. Spurious NVNT LoRa 908.5MHz Ant1 Emission







## Tx. Spurious NVNT LoRa 914.9MHz Ant1 Emission





# Attachment C—Emissions In Nonrestricted Frequency Data

## ----(down 30dBc)



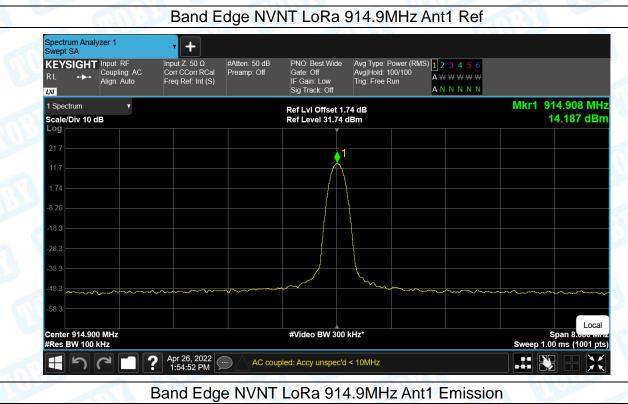
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## TB-RF-074-1.0



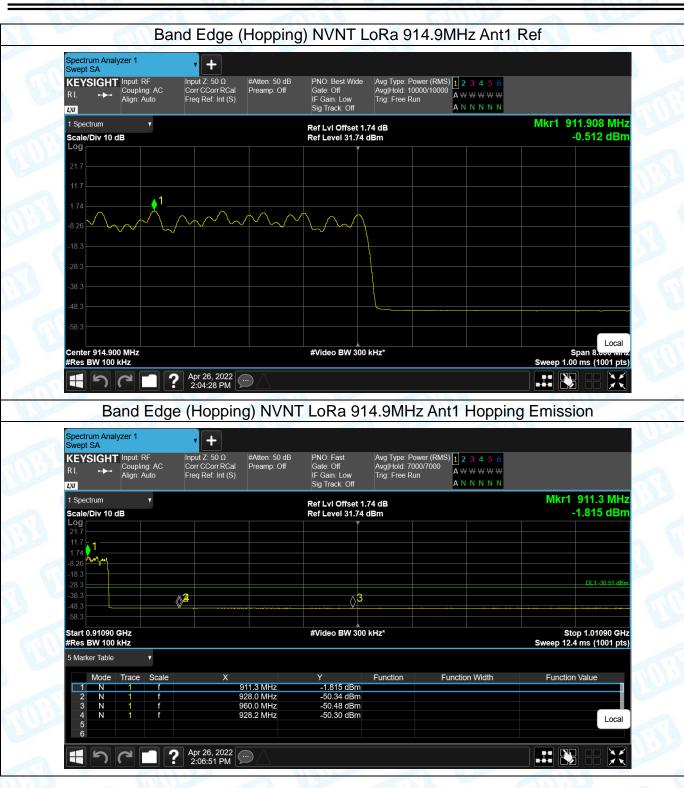
- n c -

**?** Apr 26, 2022 2:02:38 PM



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# Attachment D—99% Occupied and 20dB Bandwidth Data

Temperature:	<b>25</b> ℃		Relative Humidity:	55%	
Test Voltage:	DC 5	SV AND			
Test Mode:	TX N	lode			
Channel frequency		20dB Bandwidth	20dB Bandwidth	Limit	
(MHz)		(kHz)	*2/3 (kHz)	(kHz)	
902.3		140.4	93.6		
908.5		140.7	93.8	500	
914.9		135.6	90.4		

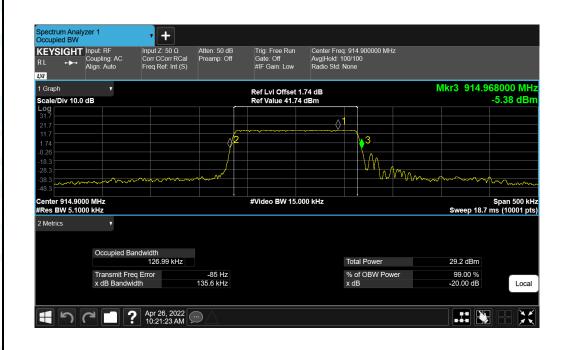
### 902.3MHz







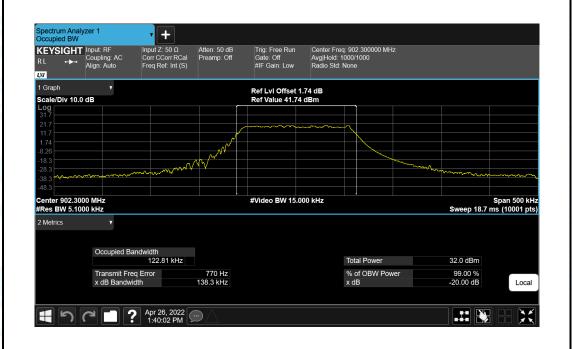
### 914.9MHz





Temperature:	<b>25</b> ℃		Relative Humidity:		55%	6110	
Test Voltage:	DC 5		100				
Test Mode:	TX M	ode		33 6	UP	-	
Channel frequency			99% Bandwidth			Limit	
(MHz)			(kł	Hz)		(kHz)	
902.3			122	2.81			
908.5	908.5		129	9.05		/	
914.9			130	).06			
	1						

## 902.3MHz





908.5MHz Spectrum Analyzer 1 Occupied BW • + KEYSIGHT Input: RF RL ↔ Coupling: AC Align: Auto Input Z: 50 Ω Corr CCorr RCal Freq Ref: Int (S) Atten: 50 dB Preamp: Off 
 Trig: Free Run
 Center Freq: 908.500000 MHz

 Gate: Off
 Avg|Hold: 100/100

 #IF Gain: Low
 Radio Std: None
 L)(I Ref LvI Offset 1.74 dB Ref Value 41.74 dBm Scale/Div 10.0 dB LMm Span 500 kHz Sweep 18.7 ms (10001 pts) Center 908.5000 MHz #Res BW 5.1000 kHz #Video BW 15.000 kHz 2 Metrics Occupied Bandwidth 129.05 kHz Total Power 28.8 dBm % of OBW Power x dB Transmit Freq Error x dB Bandwidth -35 Hz 137.8 kHz 99.00 % -20.00 dB Local モ っ c I ? Apr 26, 2022 💬 X

### 914.9MHz



# Attachment E—Peak Output Power Data

Temperature:	<b>25℃</b>	Relative Hum	idity:	55%		
Test Voltage:	DC 5V					
Test Mode:	TX Mode					
Channel frequency (MHz)		Test Result (dBm)		Limit (dBm)		
902.3		16.22				
908.5		15.24		30		
914.9		15.61				

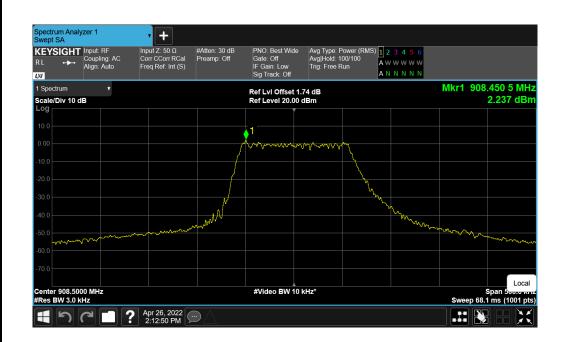
# Attachment F—Power Spectral Density Data

Temperature:	<b>25</b> ℃	Relative Hu	Relative Humidity:		6102	
Test Voltage:	DC 5V			3		
Test Mode:	TX Mode			1 P		
Channel Frequency		Power Density	Limit		Result	
(MHz)		(dBm/3kHz)	(dBm/3kHz)		Result	
902.3		6.662				
908.5		2.237	8		PASS	
914.9		3.016				
		902.3MHz				

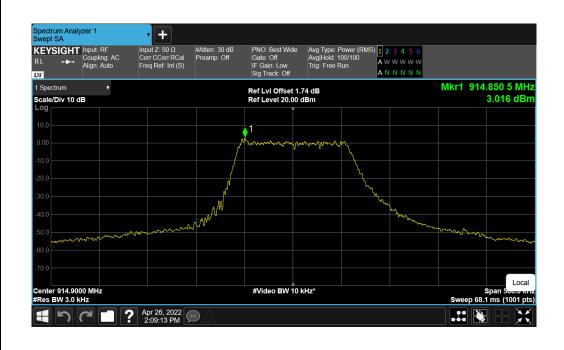
bectrum Analyzer 1 wept SA • + Input Z: 50 Ω Corr CCorr RCal Freq Ref: Int (S) KEYSIGHT Input: RF #Atten: 30 dB Preamp: Off IS) **1** 2 3 4 5 6 A \overline W \overline W A N N N N N + LXI Mkr1 902.352 5 MHz 6.662 dBm 1 Spectrum Ref LvI Offset 1.74 dB Ref Level 20.00 dBm Scale/Div 10 dB M Local #Video BW 10 kHz\* Center 902.3000 MHz #Res BW 3.0 kHz Span 500.0 Km2 Sweep 68.1 ms (1001 pts) Hってこ? Apr 26, 2022 💬 X



### 908.5MHz



### 914.9MHz



# **Attachment G—Carrier Frequency Separation Data**

Temperature:	<b>25</b> ℃	Re	elative Humidity:	55%					
Test Voltage:	DC 5V	DC 5V							
Test Mode:	Hopping I	Hopping Mode							
Channel frequ	Jency	Separation Read	Value Sep	aration Limit					
(MHz)		(kHz)		(kHz)					
908.5		298		93.8					
Hopping Mode									

### 908.5MHz





# Attachment H—Time of Occupancy(Dwell Time) Data

	Number of	Observation Pe		Max. Durati			nber of Burst		Average Time of	Limi
Test Mode	Channel	(0.4s* Number		Each Bu	ist	-	etition During		Occupancy on any	(s)
		Channel) (s)		(s)		Obse	ervation Perio	d	Channel	,
Hopping Mode	64	25.6		0.0365	5		7		0.25585	0.4
				Burst Du	ration					
	Spectrum Analyzer 1	• +								
	Swept SA KEYSIGHT Input:	. RF Input Z: 50 Ω	Atten: 30 dB			: Log-Power	1 2 3 4 5 6			
		ling: AC Corr CCorr RCal Auto Freq Ref: Int (S)	Preamp: Off	Gate: Off IF Gain: Low Sig Track: Off	Trig: Free		₩₩₩₩₩₩₩ ₽ N N N N N			
	1 Spectrum	v		Cig Huon. On				ΔMk	r1 36.55 ms	
	Scale/Div 10 dB			Ref Level 20.	00 dBm				-0.73 dB	
	10.0					~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	m	~~~~~	<u>∽~-1</u>	
	0.00									
	-10.0									
	-20.0									
	-30.0									
	-40.0									
	-50.0 40/mb////	whyther have X2							1A2	
	-70.0									
	Center 908.500000 I #Res BW 1.0 MHz								Span 0 Hz 0.0 ms (1001 pts)	
	<b>1 1</b>	Apr 29, 2022 4:14:15 PM	$\Box \triangle$							
		Burst Repeti	tion D	uring Obs	servati	on Per	iod Durati	on		
	Spectrum Analyzer 1	• +								
	Swept SA KEYSIGHT Input		Atten: 40 dB		Avg Type Trig: Free		1 2 3 4 5 6			
	RL ↔→ Align:	: Auto Freq Ref: Int (S)	Preamp: Off	IF Gain: Low Sig Track: Off	ing. rice		₩₩₩₩₩₩ ₽ N N N N N			
	1 Spectrum	Y		Ref LvI Offset						
	Scale/Div 10 dB			Ref Level 90.0	0 dBm					
	80.0									
	70.0									
	60.0									
	50.0									
	40.0									
	30.0					ſ	y Ing			
	20.0 mg (Heloward)	month ward with the month	and the shame	mathing the second base	ամ կտարով՝ Ն	www.	www.was	w burnet	warring harring harring	
	0.00									
	Center 908.500000 I	MHz								
	#Res BW 1.0 MHz		~						25.6 s (1001 pts)	
	<b>1</b> 5 C	Apr 29, 2022 1:56:03 PM								

# **Attachment I—Number of Hopping Frequency**

			0.081				
Temperature:	<b>25</b> ℃			Relative H	umidity:	55%	
Test Voltage:	DC 5V	N.V.	-				
Test Mode:	Hopping	Mode	ALL			- Di	
Frequency Range Test Mode			Qu	antity of H Channe		Limit	
902MHz~928MH	lz	LoRa		64		50	
Spectrum Analyzer 1 Swept SA KEYSIGHT RL + Coupling: Act Align: Auto	Input Ζ: 50 Ω Corr CCorr RCa Freq Ref: Int (S	I Preamp: Off Gate ) IF G	e:Off A		1 2 3 4 5 6 M W W W W W P N N N N N		
1 Spectrum v Scale/Div 10 dB		_vl Offset 1.74 ( _evel 31.74 dBr			Mkr1 902.260 MHz 16.48 dBm		
217 11.7 -8.26 -18.3 -28.3 -38.3 -48.3 -58.3						~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	
Start 901.000 MHz #Res BW 100 kHz		#Vi	deo BW 300 kH	Z		Stop 916.000 MHz Sweep 1.47 ms (1001 pts)	
5 Marker Table v Mode Trace Scale 1 N 1 f 2 N 1 f 3 4 5 6	9	14.935 MHz	Fi 16.48 dBm 15.85 dBm	unction Fun	nction Width	Function Value	
	<b>?</b> Apr 26, 2022 11:00:57 AM	$\square$				# 🚯 🔀	

Note: The EUT is hybrid system and there is no minimum number of hopping channels associated with this type of hybrid system.

-----END OF REPORT-----