



RF Test Report

FCC ID: 2A4G5-HLM9521

Report No. : TBR-C-202308-0242-23

Applicant : Hangzhou Hylin IoT Technology Co., Ltd.

Equipment Under Test (EUT)

EUT Name : HLM9521-HW4

Model No. : HLM9521

Series Model No. : HLM9521-xxx

Brand Name : ----

Sample ID : HC-C-202308-0242-01-01-1#& HC-C-202308-0242-01-01-2#

Receipt Date : 2023-09-20

Test Date : 2023-09-20 to 2023-11-03

Issue Date : 2023-11-03

Standards : 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 : Wade Lv

Engineer Supervisor : Ivan Su

Engineer Manager : Ray Lai



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

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Revision History

Report No.	Version	Description	Issued Date
TBR-C-202308-0242-23	Rev.01	Initial issue of report	2023-11-03



1. General Information about EUT

1.1 Client Information

Applicant	:	Hangzhou Hylin IoT Technology Co., Ltd.
Address	:	No.80 Pingshui WestRoad xihu District Hangzhou China
Manufacturer	:	Hangzhou Hylin IoT Technology Co., Ltd.
Address	:	No.80 Pingshui WestRoad xihu District Hangzhou China

1.2 General Description of EUT (Equipment Under Test)

EUT Name	:	HLM9521-HW4
Models No.	:	HLM9521, HLM9521-xxx
Model Different	:	All these models are identical in the same PCB, layout and electrical circuit, the only difference is model name.
Product Description	Operation Frequency:	LORA(500KHz): 902.5MHz~926.5MHz
	Number of Channel:	31 channels
	Antenna Gain:	1.03dBi Sucker Antenna
	Bit Rate of Transmitter:	5.47kbps
Power Rating	:	USB Input: DC 5V
Software Version	:	----
Hardware Version	:	V01
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.		



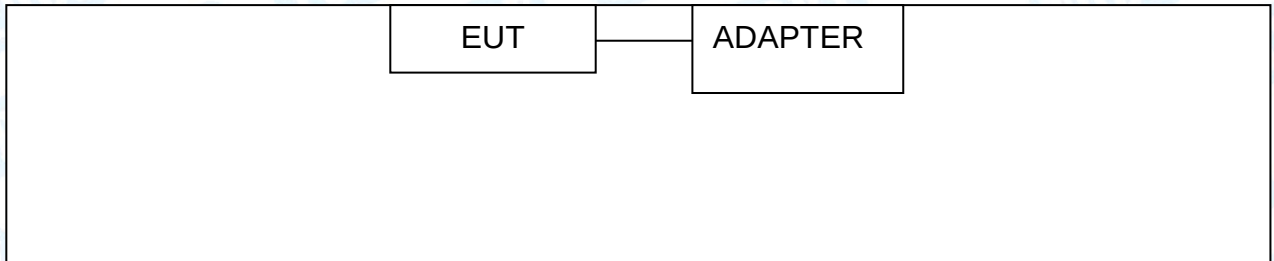
(4) Channel List:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
01	902.5	12	911.3	23	920.1
02	903.3	13	912.1	24	920.9
03	904.1	14	912.9	25	921.7
04	904.9	15	913.7	26	922.5
05	905.7	16	914.5	27	923.3
06	906.5	17	915.3	28	924.1
07	907.3	18	916.1	29	924.9
08	908.1	19	916.9	30	925.7
09	908.9	20	917.7	31	926.5
10	909.7	21	918.5		
11	910.5	22	919.3		

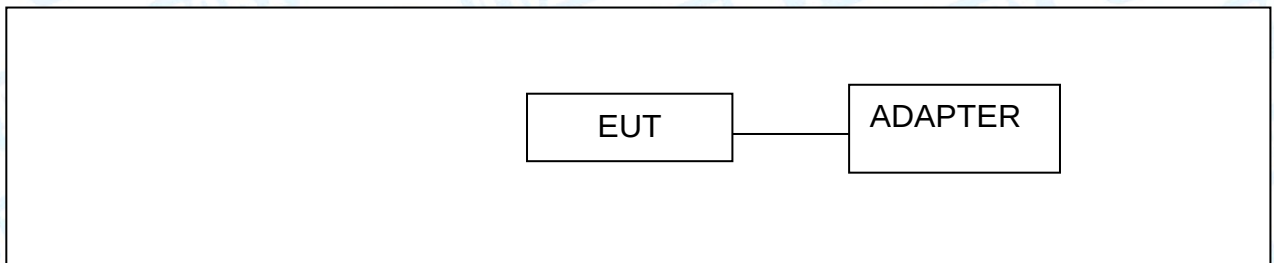


1.3 Block Diagram Showing the Configuration of System Tested

Conducted Test



Radiated Test



1.4 Description of Support Units

Equipment Information				
Name	Model	FCC ID/SDOC	Manufacturer	Used “√”
Adapter	----	----	HUAWEI	√
Cable Information				
Number	Shielded Type	Ferrite Core	Length	Note
Cable 1	Yes	NO	1.0M	Accessory
Note: The cables provided by the Applicant, The adapter provided by the Test Lab.				



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.

For Conducted Test	
Final Test Mode	Description
Mode 1	TX Mode
For Radiated Test	
Final Test Mode	Description
Mode 2	TX Mode
Mode 3	TX Mode (Channel 01/16/31)

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	hl awesome_serial.exe		
Frequency	902.5MHz	914.5MHz	926.5MHz
LORA	11	12	12

1.7 Measurement Uncertainty

The reported uncertainty of measurement $y \pm U$, 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_{Lab})
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	Test Item	Test Sample(s)	Judgment	Remark
FCC				
FCC 15.207(a)	Conducted Emission	HC-C-202308-0242-01-01-1#	PASS	N/A
FCC 15.209 & 15.247(d)	Radiated Unwanted Emissions	HC-C-202308-0242-01-01-1#	PASS	N/A
FCC 15.203	Antenna Requirement	HC-C-202308-0242-01-01-2#	PASS	N/A
FCC 15.247(a)(2)	6dB Bandwidth	HC-C-202308-0242-01-01-2#	PASS	N/A
/	99% Occupied bandwidth	HC-C-202308-0242-01-01-2#	PASS	N/A
FCC 15.247(b)(3)	Peak Output Power and E.I.R.P	HC-C-202308-0242-01-01-2#	PASS	N/A
FCC 15.247(e)	Power Spectral Density	HC-C-202308-0242-01-01-2#	PASS	N/A
FCC 15.207	Conducted Unwanted Emissions	HC-C-202308-0242-01-01-2#	PASS	N/A
FCC 15.247(d)	Emissions in nonrestricted frequency bands	HC-C-202308-0242-01-01-2#	PASS	N/A
/	On Time and Duty Cycle	HC-C-202308-0242-01-01-2#	/	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
Radiation Emission	EZ-EMC	EZ	FA-03A2RE+
RF Conducted Measurement	MTS-8310	MWRFTtest	V2.0.0.0
RF Test System	JS1120	Tonscend	V3.2.22



4. Test Equipment

Conducted Emission Test					
Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Due Date
EMI Test Receiver	Rohde & Schwarz	ESCI	100321	Jun. 20, 2023	Jun. 19, 2024
RF Switching Unit	Compliance Direction Systems Inc	RSU-A4	34403	Jun. 20, 2023	Jun. 19, 2024
AMN	SCHWARZBECK	NNBL 8226-2	8226-2/164	Jun. 20, 2023	Jun. 19, 2024
LISN	Rohde & Schwarz	ENV216	101131	Jun. 20, 2023	Jun. 19, 2024
ISN	SCHWARZBECK	NTFM 8131	8131-193	Jun. 20, 2023	Jun. 19, 2024
ISN	SCHWARZBECK	CAT3 8158	cat3 5158-0094	Jun. 20, 2023	Jun. 19, 2024
ISN	SCHWARZBECK	NTFM5158	NTFM5158 0145	Jun. 06, 2023	Jun. 05, 2024
ISN	SCHWARZBECK	CAT 8158	cat5 8158-179	Jun. 20, 2023	Jun. 19, 2024
Radiation Emission Test (B Site)					
Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Due Date
Spectrum Analyzer	Agilent	N9020A	MY49100060	Aug. 30, 2023	Aug. 29, 2024
Spectrum Analyzer	Rohde & Schwarz	FSV40-N	102197	Jun. 20, 2023	Jun. 19, 2024
EMI Test Receiver	Rohde & Schwarz	ESU-8	100472/008	Feb. 23, 2023	Feb.22, 2024
Bilog Antenna	SCHWARZBECK	VULB 9168	1225	Dec. 05, 2021	Dec. 04, 2023
Horn Antenna	SCHWARZBECK	BBHA 9120 D	2463	Feb. 26, 2022	Feb.25, 2024
Horn Antenna	SCHWARZBECK	BBHA 9170	1118	Jun. 26, 2022	Jun.25, 2024
Loop Antenna	SCHWARZBECK	FMZB 1519 B	1519B-059	Jun. 26, 2022	Jun.25, 2024
HF Amplifier	Tonscend	TAP9E6343	AP21C806117	Aug. 30, 2023	Aug. 29, 2024
HF Amplifier	Tonscend	TAP051845	AP21C806141	Aug. 30, 2023	Aug. 29, 2024
HF Amplifier	Tonscend	TAP0184050	AP21C806129	Aug. 30, 2023	Aug. 29, 2024
Highpass Filter	CD	HPM-6.4/18G	---	N/A	N/A
Highpass Filter	CD	HPM-2.8/18G	---	N/A	N/A
Highpass Filter	XINBO	XBLBQ-HTA67(8-25G)	22052702-1	N/A	N/A
Antenna Conducted Emission					
Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Due Date
Spectrum Analyzer	Agilent	E4407B	MY45106456	Jun. 20, 2023	Jun. 19, 2024
Spectrum Analyzer	Rohde & Schwarz	FSV40-N	102197	Jun. 20, 2023	Jun. 19, 2024
MXA Signal Analyzer	KEYSIGHT	N9020B	MY60110172	Aug. 30, 2023	Aug. 29, 2024
MXA Signal Analyzer	Agilent	N9020A	MY47380425	Aug. 30, 2023	Aug. 29, 2024
Vector Signal Generator	Agilent	N5182A	MY50141294	Aug. 30, 2023	Aug. 29, 2024
Analog Signal Generator	Agilent	N5181A	MY48180463	Aug. 30, 2023	Aug. 29, 2024
Vector Signal Generator	KEYSIGHT	N5182B	MY59101429	Aug. 30, 2023	Aug. 29, 2024
Analog Signal Generator	KEYSIGHT	N5173B	MY61252685	Aug. 30, 2023	Aug. 29, 2024



RF Power Sensor	DARE!! Instruments	RadiPowerRPR3006W	17I00015SNO26	Aug. 30, 2023	Aug. 29, 2024
	DARE!! Instruments	RadiPowerRPR3006W	17I00015SNO29	Aug. 30, 2023	Aug. 29, 2024
	DARE!! Instruments	RadiPowerRPR3006W	17I00015SNO31	Aug. 30, 2023	Aug. 29, 2024
	DARE!! Instruments	RadiPowerRPR3006W	17I00015SNO33	Aug. 30, 2023	Aug. 29, 2024
RF Control Unit	Tonsced	JS0806-1	21C8060380	N/A	N/A
RF Control Unit	Tonsced	JS0806-2	21F8060439	Aug. 30, 2023	Aug. 29, 2024
Power Control Box	Tonsced	JS0806-4ADC	21C8060387	N/A	N/A
Wideband Radio Communication Tester	Rohde & Schwarz	CMW500	144382	Aug. 30, 2023	Aug. 29, 2024
Universal Radio Communication Tester	Rohde&Schwarz	CMW500	168796	Feb. 23, 2023	Feb.22, 2024
Temperature and Humidity Chamber	ZhengHang	ZH-QTH-1500	ZH2107264	Jun. 20, 2023	Jun. 19, 2024



5. Conducted Emission

5.1 Test Standard and Limit

5.1.1 Test Standard

FCC Part 15.207

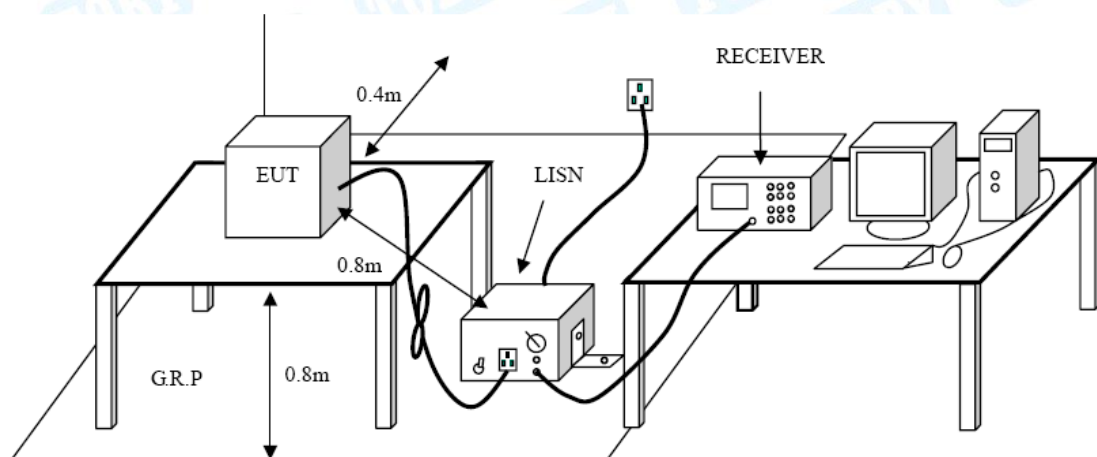
5.1.2 Test Limit

Frequency	Maximum RF Line Voltage (dBμV)	
	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/ 50uH 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

General field strength limits at frequencies Below 30MHz			
Frequency (MHz)	Field Strength (μA/m)*	Field Strength (microvolt/meter)**	Measurement 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 (MHz)	Distance of 3m (dBuV/m)	
	Peak	Average
Above 1000	74	54

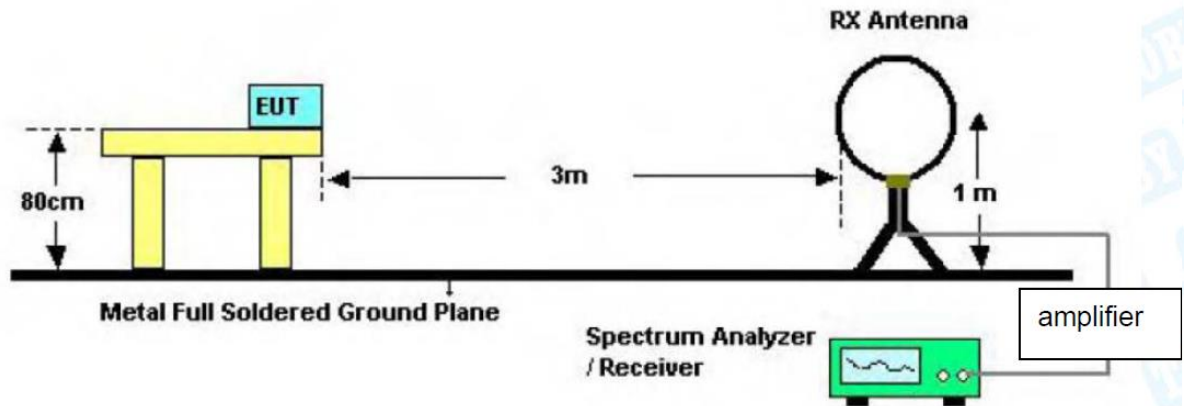
Note:
(1) The tighter limit applies at the band edges.
(2) Emission Level(dBuV/m)=20log Emission Level(uV/m)

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.

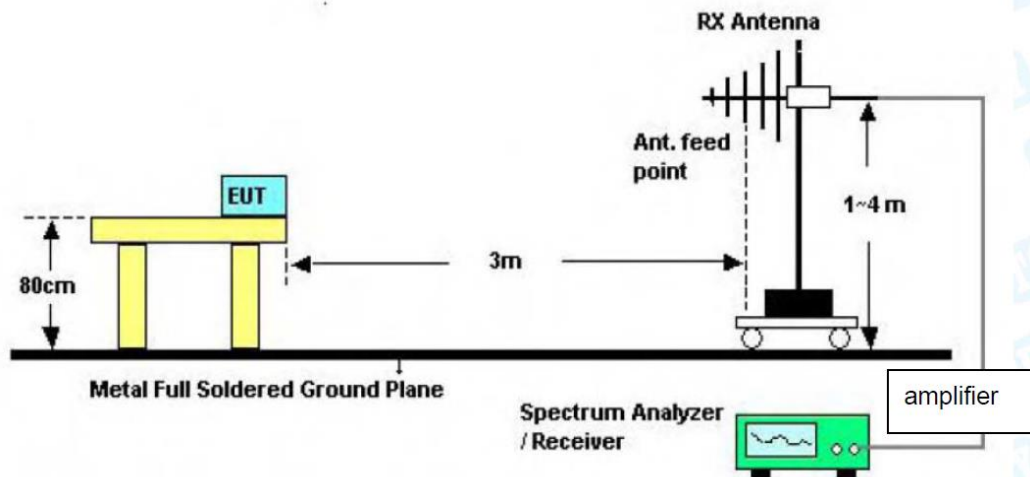


6.2 Test Setup

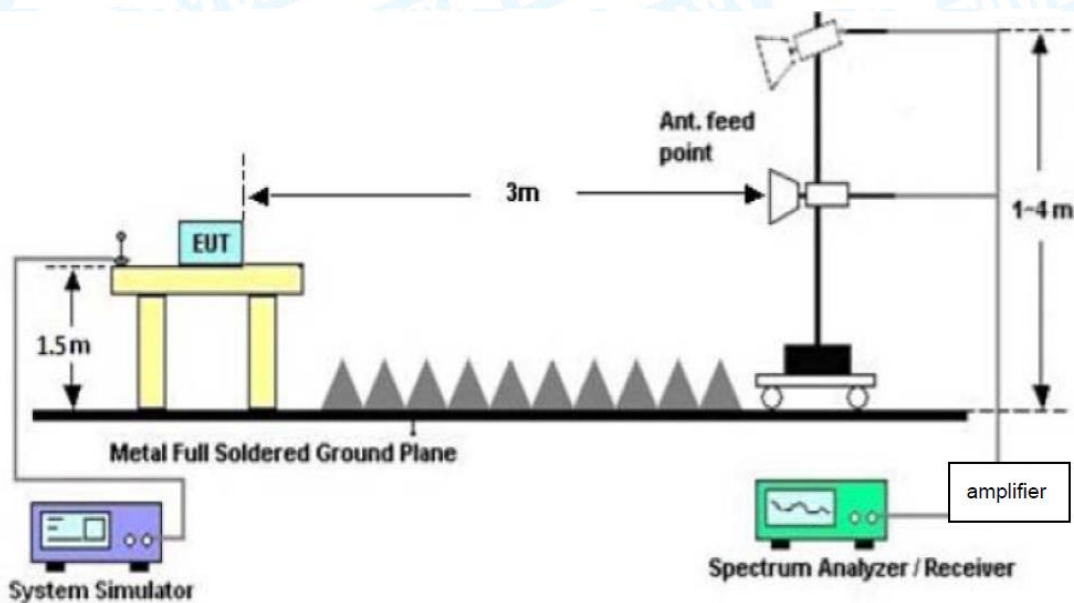
Radiated measurement



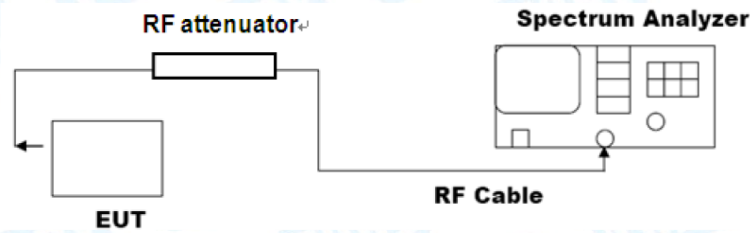
Below 30MHz Test Setup



Below 1000MHz 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 $\geq [3 \times \text{RBW}]$.
- 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 $\geq [3 \times \text{RBW}]$.
- 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

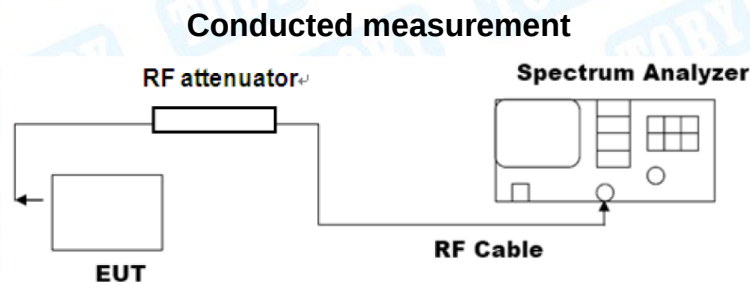
7.1.1 Test Standard

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:

- Set instrument center frequency to DTS channel center frequency.
- Set the span to ≥ 1.5 times the DTS bandwidth.
- Set the RBW = 100 kHz.
- Set the VBW $\geq [3 \times \text{RBW}]$.
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- 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. Bandwidth Test

8.1 Test Standard and Limit

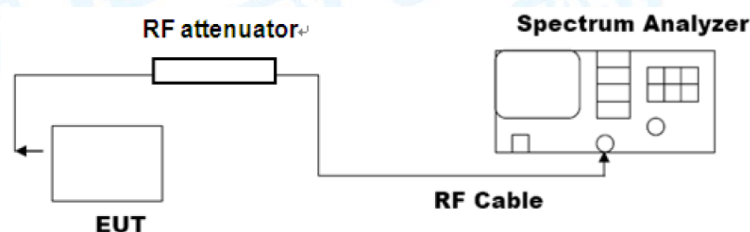
8.1.1 Test Standard

FCC Part 15.205 & FCC Part 15.247(d)

8.1.2 Test Limit

Test Item	Limit
-6dB bandwidth (DTS bandwidth)	≥ 500 KHz
99% occupied bandwidth	/

8.2 Test Setup



8.3 Test Procedure

---DTS bandwidth

● The steps for the first option are as follows:

- Set RBW = 100 kHz.
- Set the VBW $\geq [3 \times \text{RBW}]$.
- Detector = peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

---occupied bandwidth

● 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:

- 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.
- 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 frequency is recorded as the upper frequency. The 99% power bandwidth is the difference 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

9.1 Test Standard and Limit

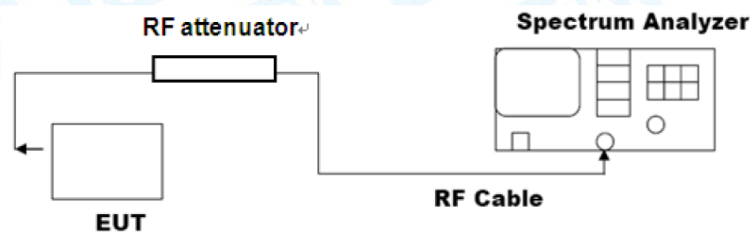
9.1.1 Test Standard

FCC Part 15.247(b)(3)

9.1.2 Test Limit

Test Item	Limit
Peak Output Power	not exceed 1 W or 30dBm
E.I.R.P	not exceed 4 W or 36dBm

9.2 Test Setup



9.3 Test Procedure

---RBW≥DTS bandwidth

● The following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement:

- Set the RBW≥DTS bandwidth.
- Set VBW≥[3*RBW].
- Set span≥[3*RBW].
- Sweep time = auto couple.
- Detector = peak.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use peak marker function to determine the peak amplitude level.

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

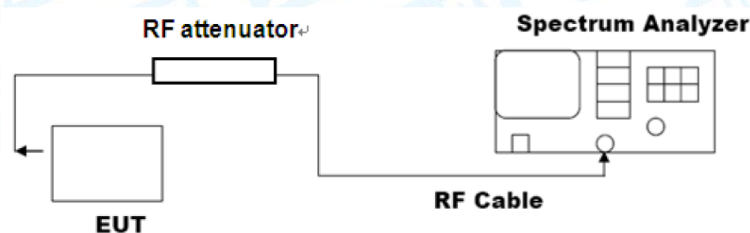
10.1.1 Test Standard

FCC Part 15.247(e)

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:
 - Set analyzer center frequency to DTS channel center frequency.
 - Set the span to 1.5 times the DTS bandwidth.
 - Set the RBW to $3\text{ kHz} \leq \text{RBW} \leq 100\text{ kHz}$.
 - Set the VBW $\geq [3 \times \text{RBW}]$.
 - Detector = peak.
 - Sweep time = auto couple.
 - Trace mode = max hold.
 - Allow trace to fully stabilize.
 - Use the peak marker function to determine the maximum amplitude level within the RBW.
 - If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat.

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. Antenna Requirement

11.1 Test Standard and Limit

11.1.1 Test Standard

FCC Part 15.203

11.1.2 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.

11.2 Deviation From Test Standard

No deviation

11.3 Antenna Connected Construction

The gains of the antenna used for transmitting is 1.03dBi, and the antenna de-signed with Unique connector antenna and consideration of replacement. Please see the EUT photo for details.

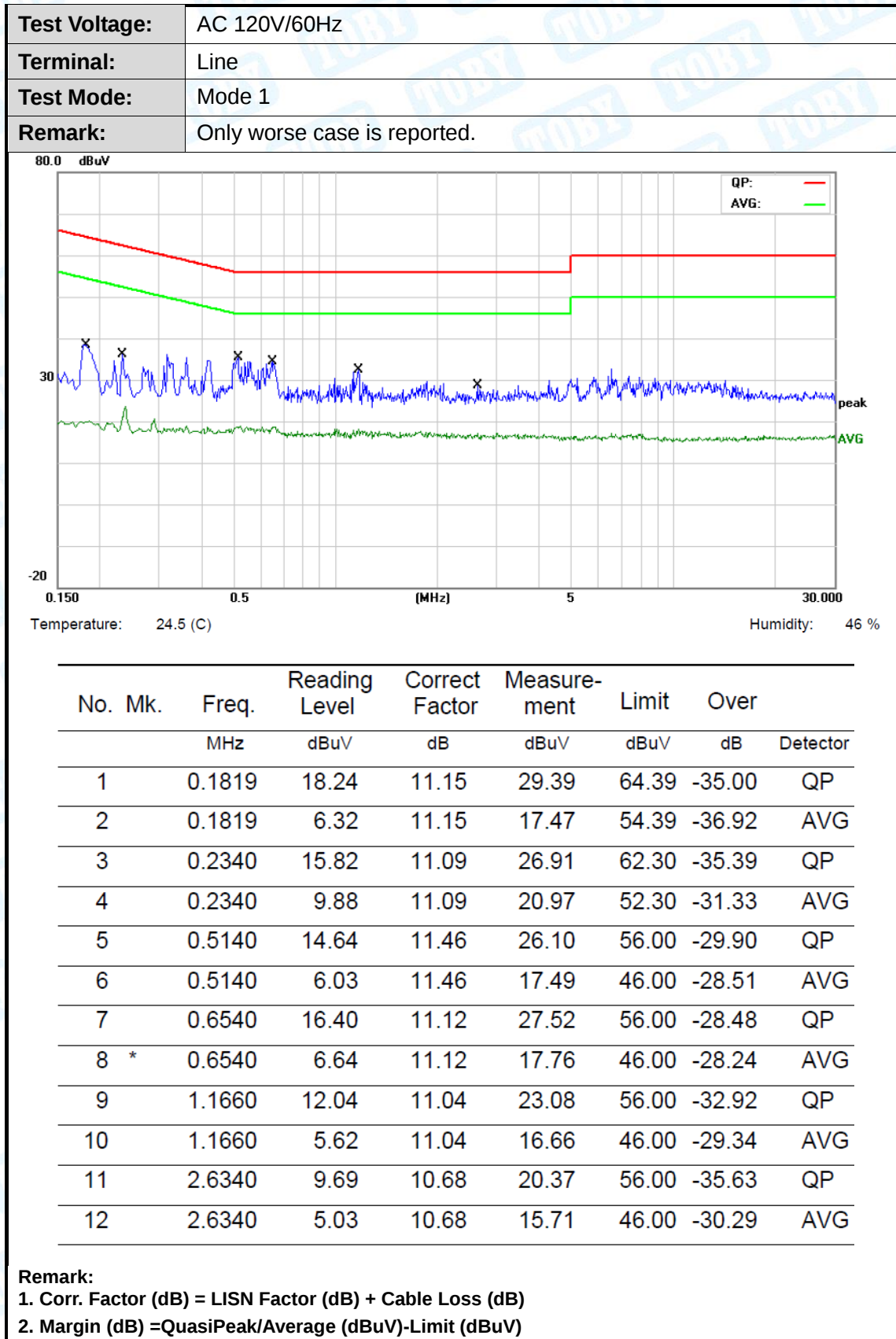
11.4 Test Data

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

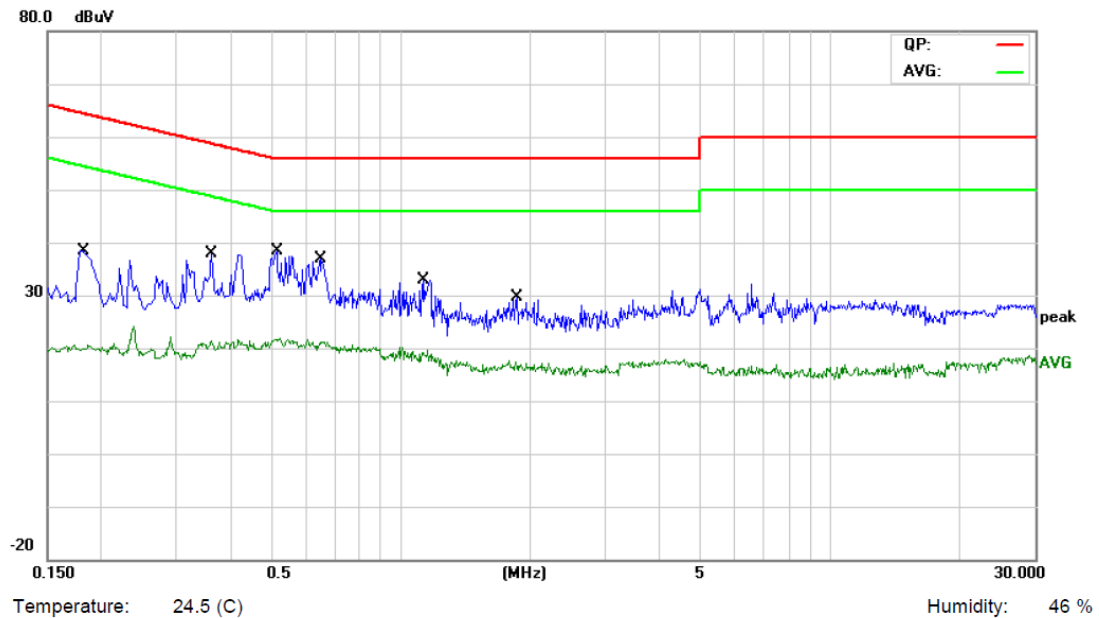
Antenna Type	
☐	Permanent attached antenna
☒	Unique connector antenna
☐	Professional installation antenna



Attachment A-- Conducted Emission Test Data



Test Voltage:	AC 120V/60Hz
Terminal:	Neutral
Test Mode:	Mode 1
Remark:	Only worse case is reported.



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over	
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector
1		0.1819	18.41	11.15	29.56	64.39	-34.83	QP
2		0.1819	6.38	11.15	17.53	54.39	-36.86	AVG
3		0.3620	14.34	11.17	25.51	58.68	-33.17	QP
4		0.3620	5.88	11.17	17.05	48.68	-31.63	AVG
5		0.5140	14.63	11.46	26.09	56.00	-29.91	QP
6		0.5140	6.05	11.46	17.51	46.00	-28.49	AVG
7		0.6540	16.45	11.12	27.57	56.00	-28.43	QP
8	*	0.6540	6.62	11.12	17.74	46.00	-28.26	AVG
9		1.1340	11.22	11.06	22.28	56.00	-33.72	QP
10		1.1340	5.47	11.06	16.53	46.00	-29.47	AVG
11		1.8620	10.08	10.75	20.83	56.00	-35.17	QP
12		1.8620	5.28	10.75	16.03	46.00	-29.97	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

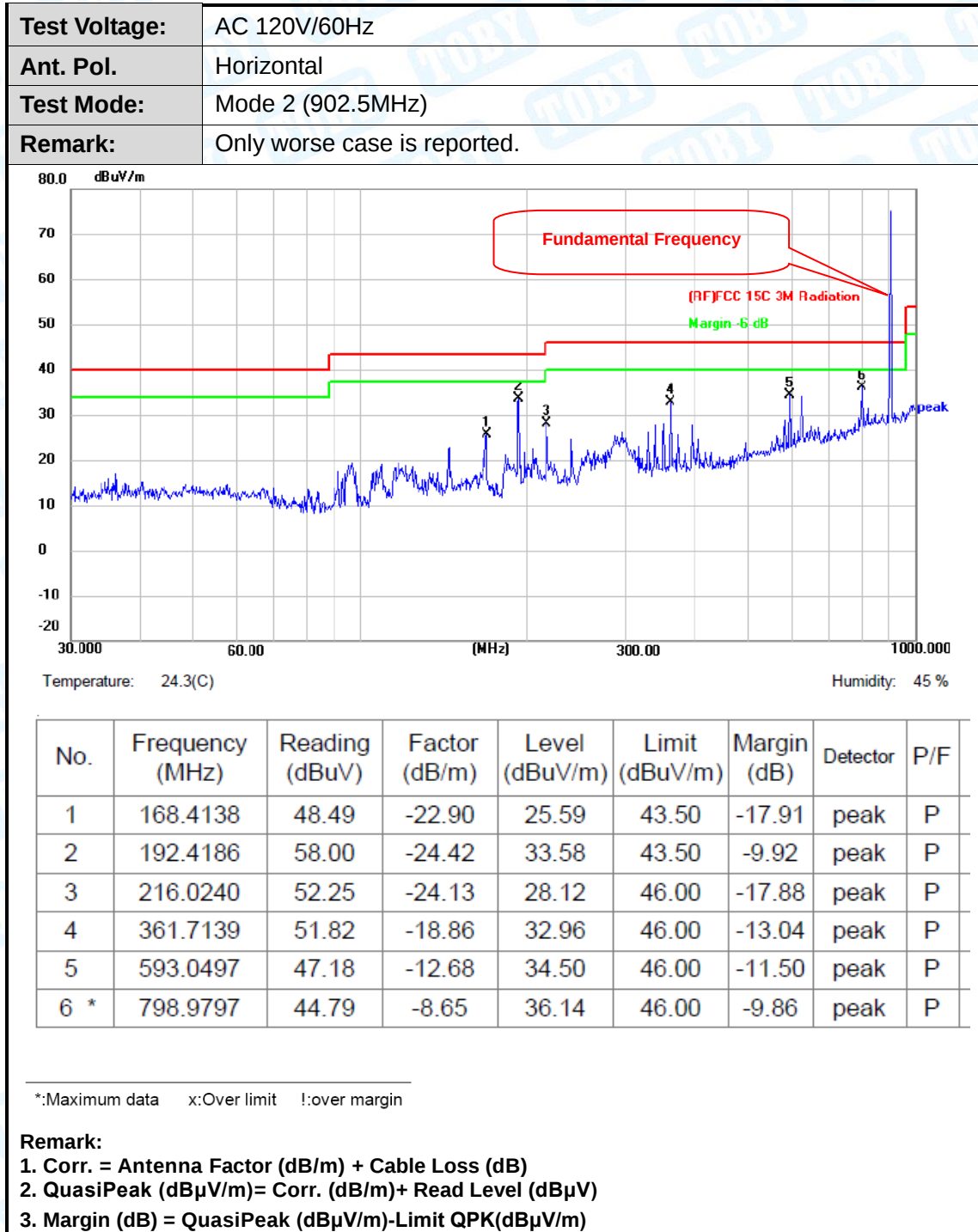
---Radiated Unwanted Emissions

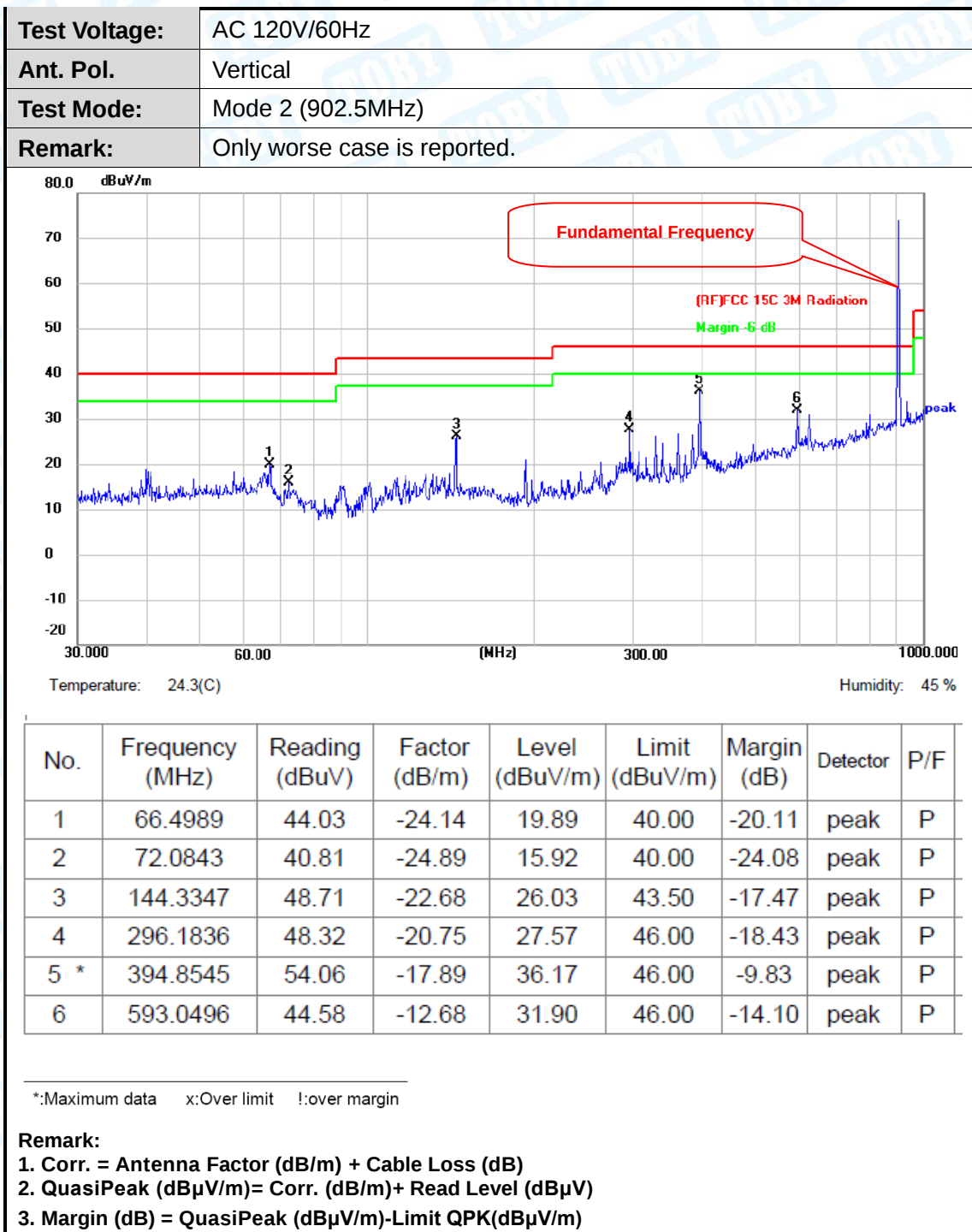
9 KHz~30 MHz

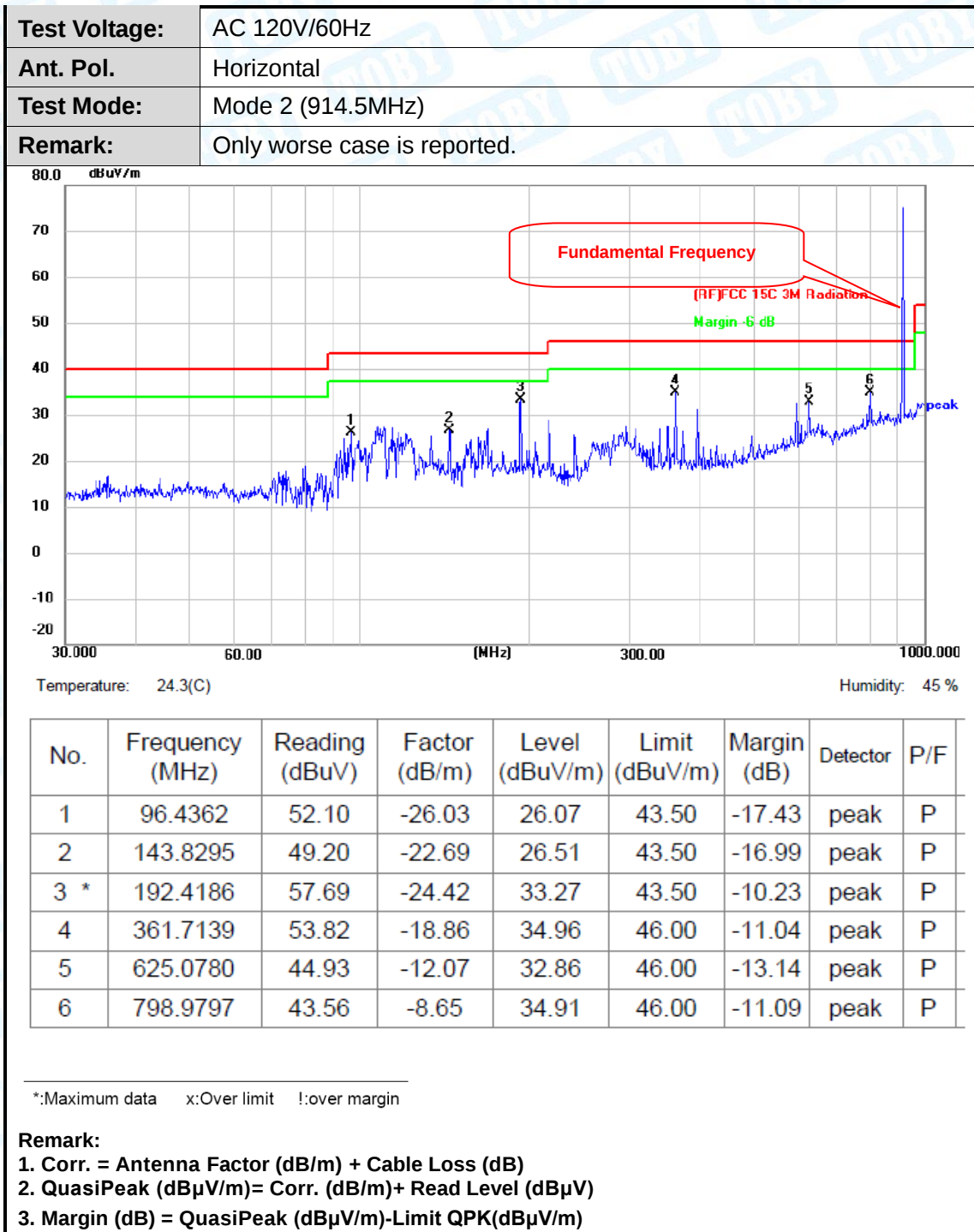
From 9 KHz to 30 MHz: Conclusion: PASS

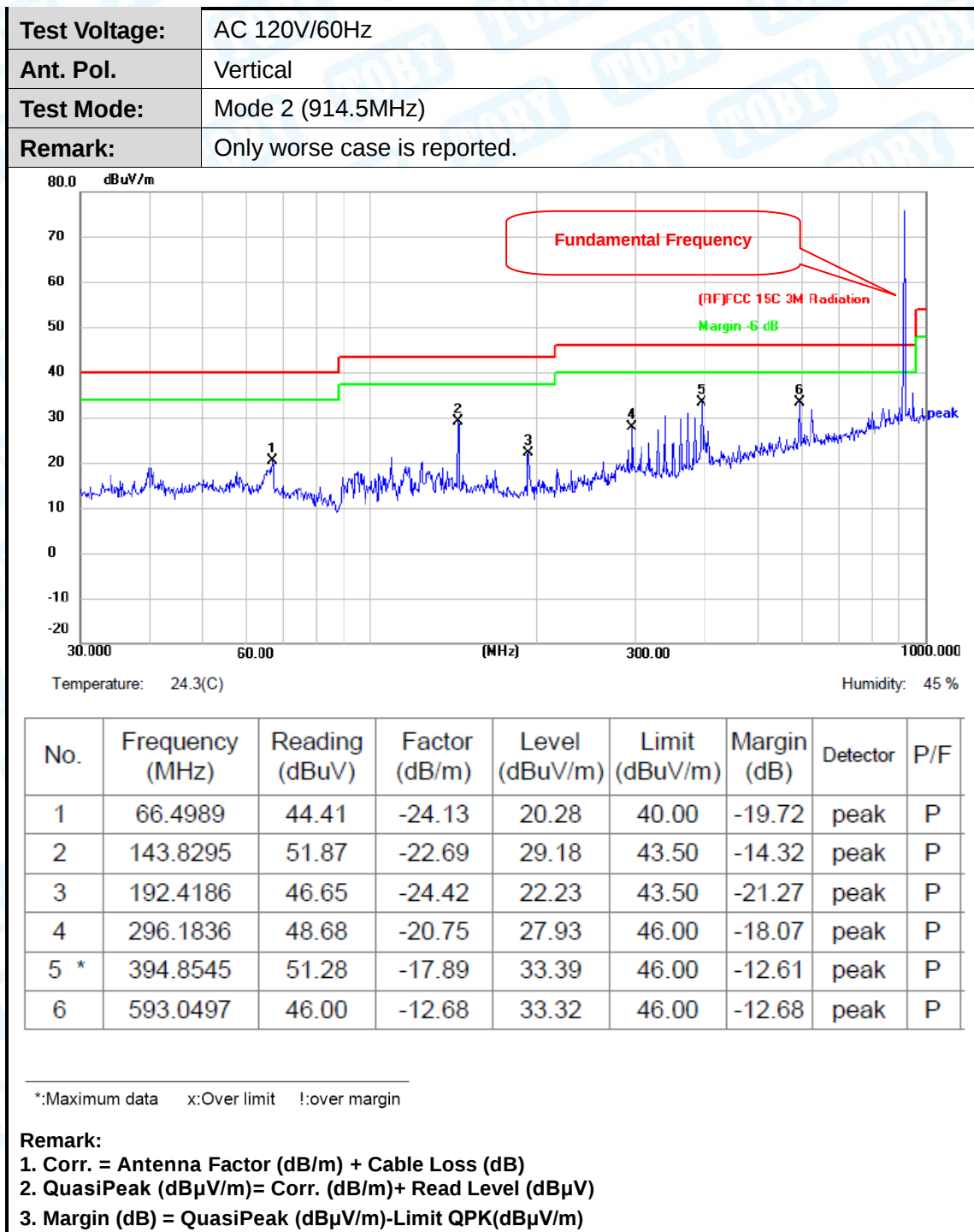
Note: The amplitude of spurious emissions which are attenuated by more than 20dB Below the permissible value has no need to be reported.

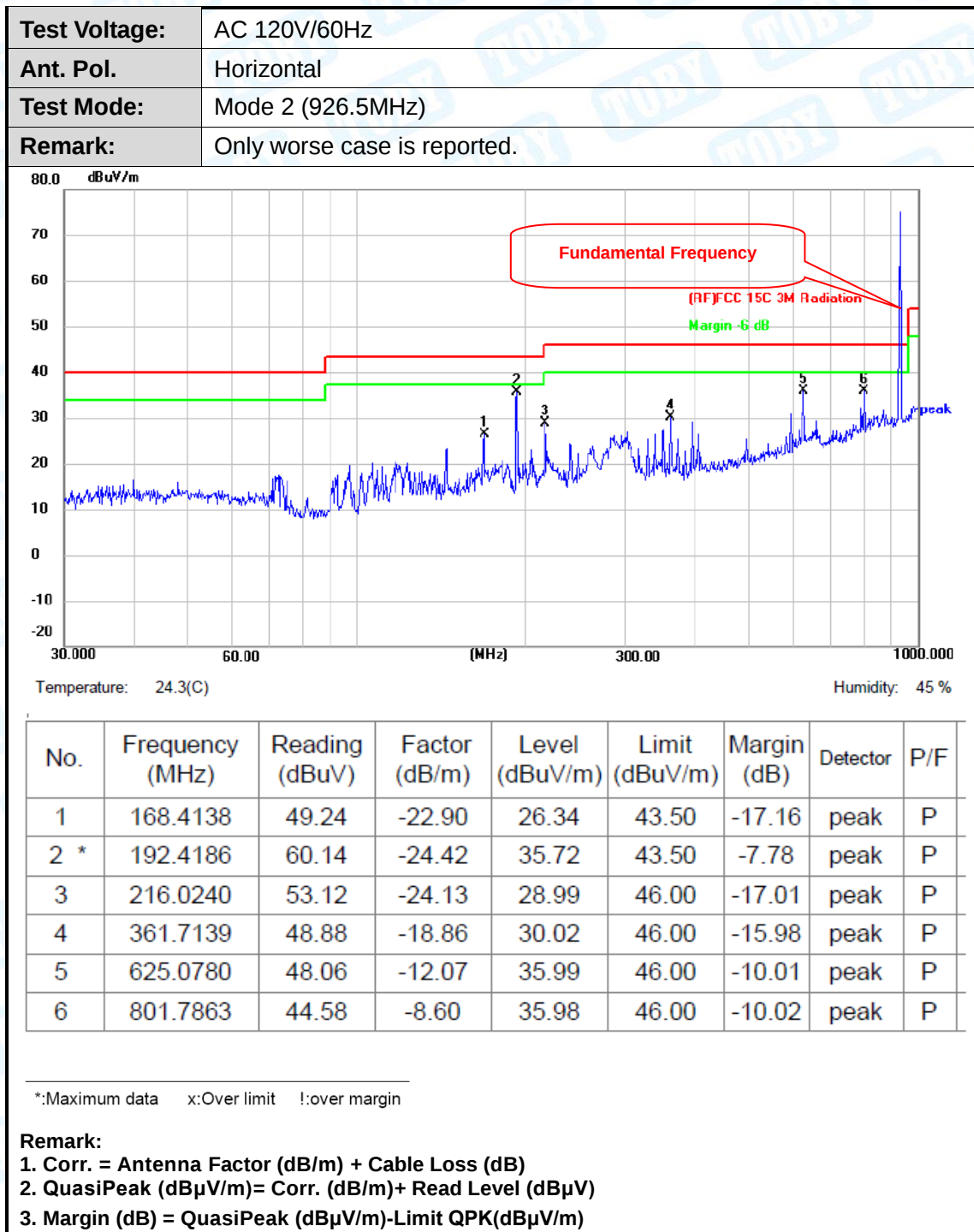
30MHz~1GHz

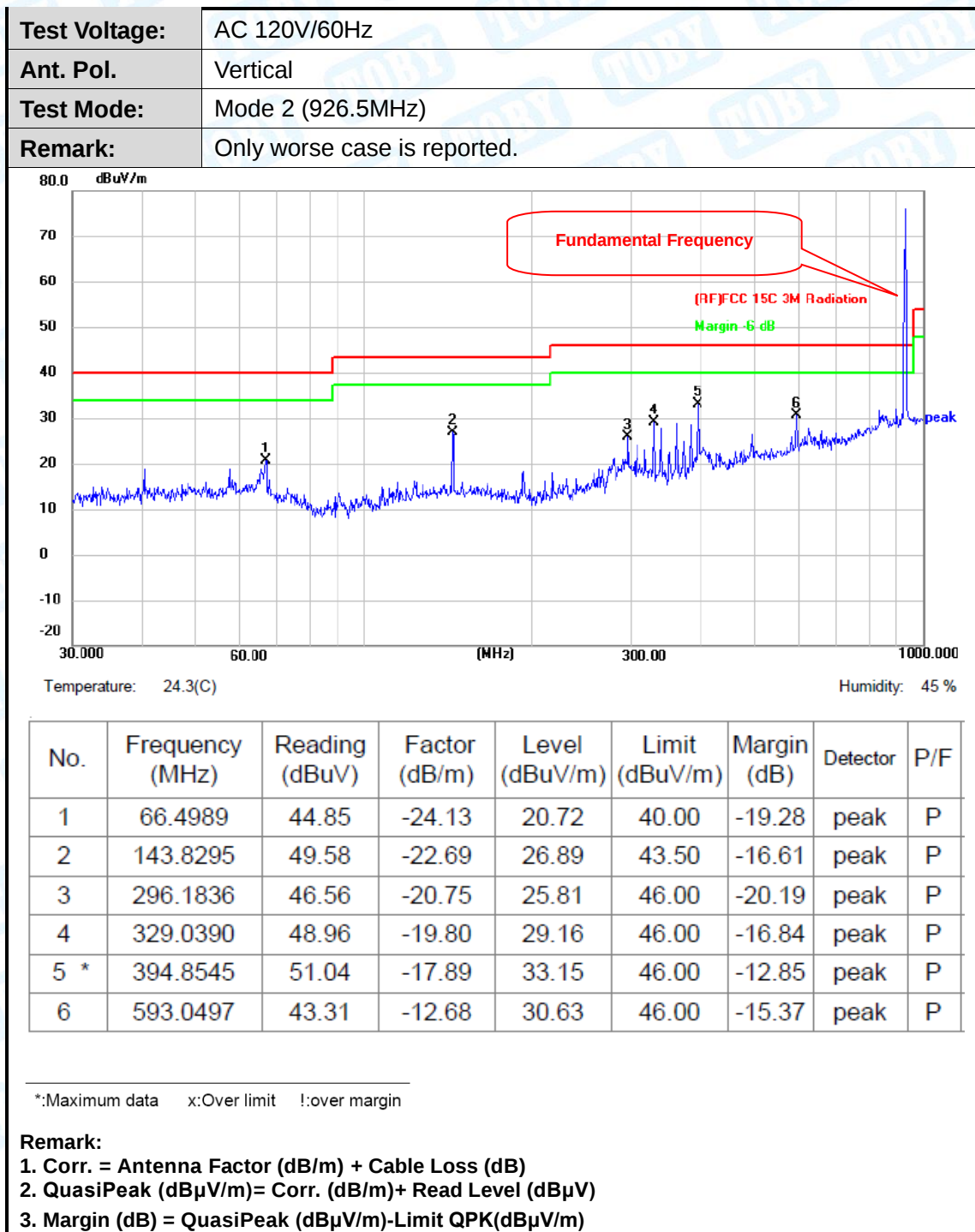












Above 1GHz

Temperature:	26°C	Relative Humidity:	54%
Test Voltage:	DC 5V		
Ant. Pol.	Horizontal		
Test Mode:	TX 902.5MHz		
Remark:	Only worse case is reported.		

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	P/F
1	5581.000	49.76	-18.45	31.31	74.00	-42.69	peak	P
2 *	8137.000	48.19	-12.61	35.58	74.00	-38.42	peak	P

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 evaluated 1-26.5GHz, The testing has been conformed to the 10th harmonic of the highest fundamental frequency.
Test with highpass filter (Pass Frequency: 2.8-18G and 8-25G), and 18GHz-26.5GHz is the noise, No other signals were detected.
5. No report for the emission which below the prescribed limit.
6. The peak value<average limit, So only show the peak value.

Temperature:	26°C	Relative Humidity:	54%
Test Voltage:	DC 5V		
Ant. Pol.	Vertical		
Test Mode:	TX 902.5MHz		

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	P/F
1	4186.000	51.92	-22.01	29.91	74.00	-44.09	peak	P
2 *	7696.000	49.80	-13.06	36.74	74.00	-37.26	peak	P

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 evaluated 1-26.5GHz, The testing has been conformed to the 10th harmonic of the highest fundamental frequency.
Test with highpass filter (Pass Frequency: 2.8-18G and 8-25G), and 18GHz-26.5GHz is the noise, No other signals were detected.
5. No report for the emission which below the prescribed limit.
6. The peak value<average limit, So only show the peak value.



Temperature:	26°C	Relative Humidity:	54%
Test Voltage:	DC 5V		
Ant. Pol.	Horizontal		
Test Mode:	TX 914.5MHz		
Remark:	Only worse case is reported.		

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	P/F
1	4645.000	52.04	-20.62	31.42	74.00	-42.58	peak	P
2 *	7696.000	49.27	-13.06	36.21	74.00	-37.79	peak	P

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 evaluated 1-26.5GHz, The testing has been conformed to the 10th harmonic of the highest fundamental frequency.
Test with highpass filter (Pass Frequency: 2.8-18G and 8-25G), and 18GHz-26.5GHz is the noise, No other signals were detected.
5. No report for the emission which below the prescribed limit.
6. The peak value<average limit, So only show the peak value.

Temperature:	26°C	Relative Humidity:	54%
Test Voltage:	DC 5V		
Ant. Pol.	Vertical		
Test Mode:	TX 914.5MHz		

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	P/F
1	6706.000	48.54	-15.79	32.75	74.00	-41.25	peak	P
2 *	7345.000	50.04	-14.58	35.46	74.00	-38.54	peak	P

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 evaluated 1-26.5GHz, The testing has been conformed to the 10th harmonic of the highest fundamental frequency.
Test with highpass filter (Pass Frequency: 2.8-18G and 8-25G), and 18GHz-26.5GHz is the noise, No other signals were detected.
5. No report for the emission which below the prescribed limit.
6. The peak value<average limit, So only show the peak value.



Temperature:	26°C	Relative Humidity:	54%
Test Voltage:	DC 5V		
Ant. Pol.	Horizontal		
Test Mode:	TX 926.5MHz		
Remark:	Only worse case is reported.		

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	P/F
1	6499.000	50.73	-16.93	33.80	74.00	-40.20	peak	P
2 *	8515.000	48.69	-12.49	36.20	74.00	-37.80	peak	P

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 evaluated 1-26.5GHz, The testing has been conformed to the 10th harmonic of the highest fundamental frequency.
Test with highpass filter (Pass Frequency: 2.8-18G and 8-25G), and 18GHz-26.5GHz is the noise, No other signals were detected.
5. No report for the emission which below the prescribed limit.
6. The peak value < average limit, So only show the peak value.

Temperature:	26°C	Relative Humidity:	54%
Test Voltage:	DC 5V		
Ant. Pol.	Vertical		
Test Mode:	TX 926.5MHz		

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	P/F
1	4834.000	50.46	-19.89	30.57	74.00	-43.43	peak	P
2 *	7606.000	48.83	-13.52	35.31	74.00	-38.69	peak	P

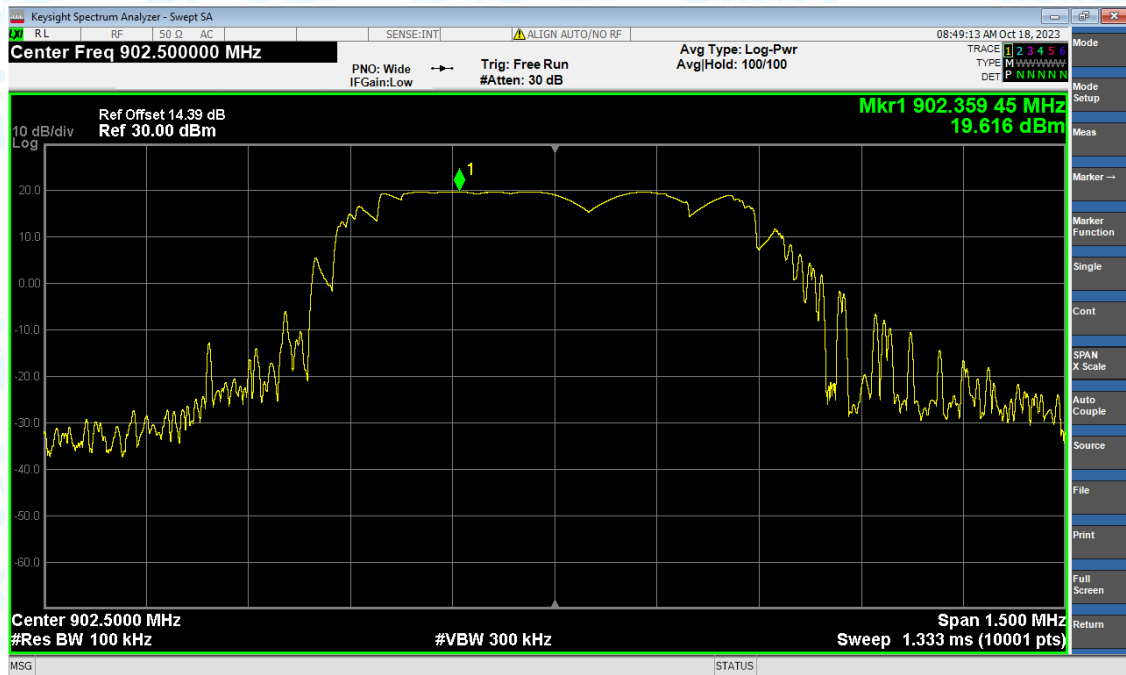
Remark:

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 evaluated 1-26.5GHz, The testing has been conformed to the 10th harmonic of the highest fundamental frequency.
Test with highpass filter (Pass Frequency: 2.8-18G and 8-25G), and 18GHz-26.5GHz is the noise, No other signals were detected.
5. No report for the emission which below the prescribed limit.
6. The peak value < average limit, So only show the peak value.

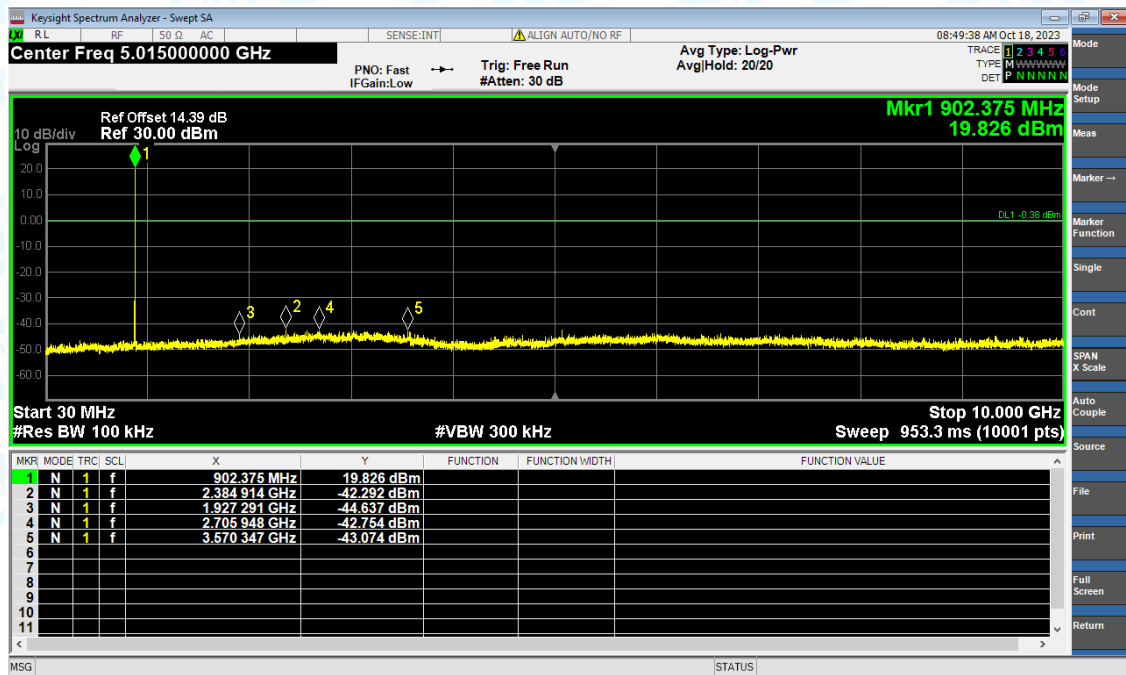


---Conduction Unwanted Emissions

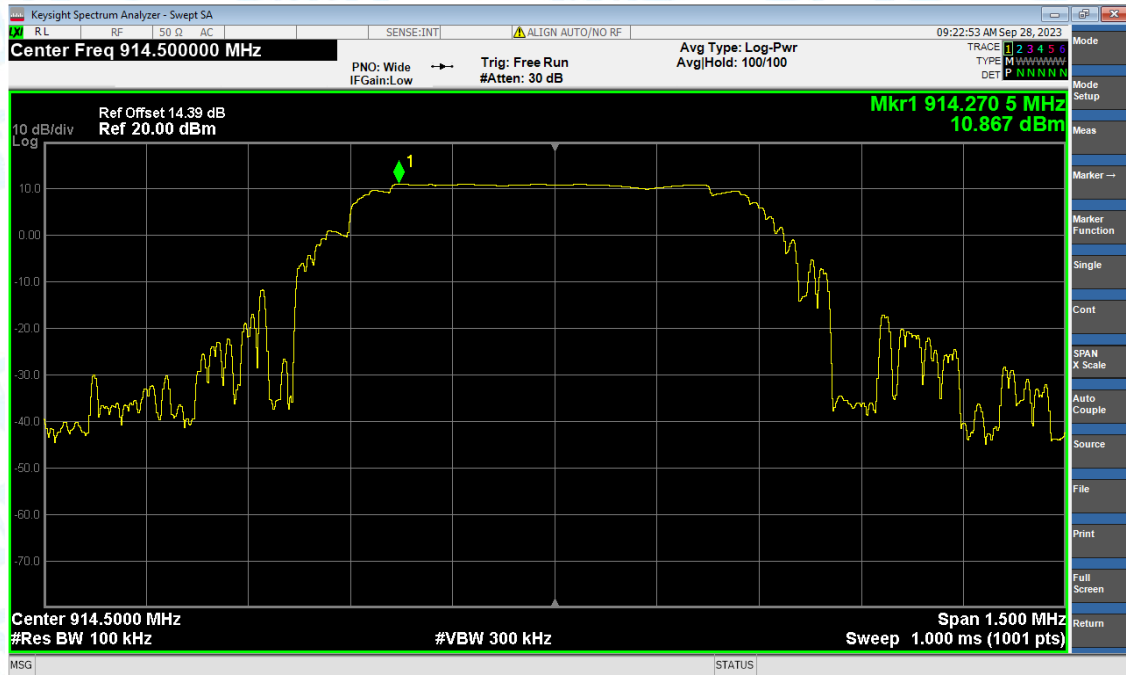
Tx. Spurious NVNT LoRa 902.5MHz Ant1 Ref



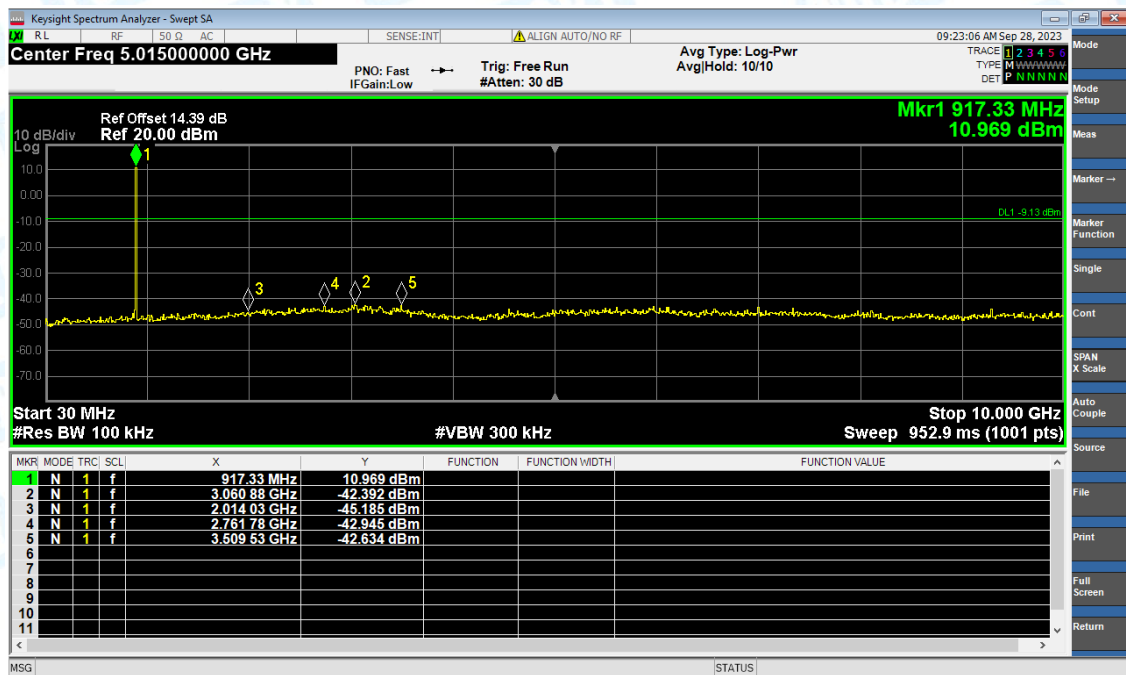
Tx. Spurious NVNT LoRa 902.5MHz Ant1 Emission



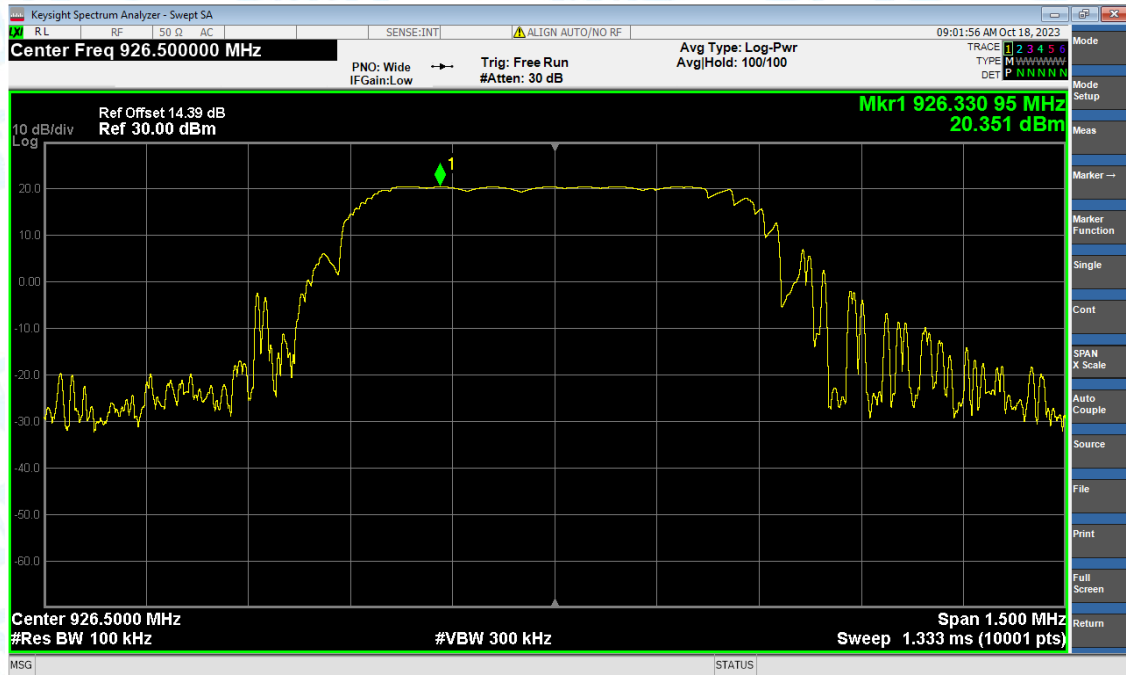
Tx. Spurious NVNT LoRa 914.5MHz Ant1 Ref



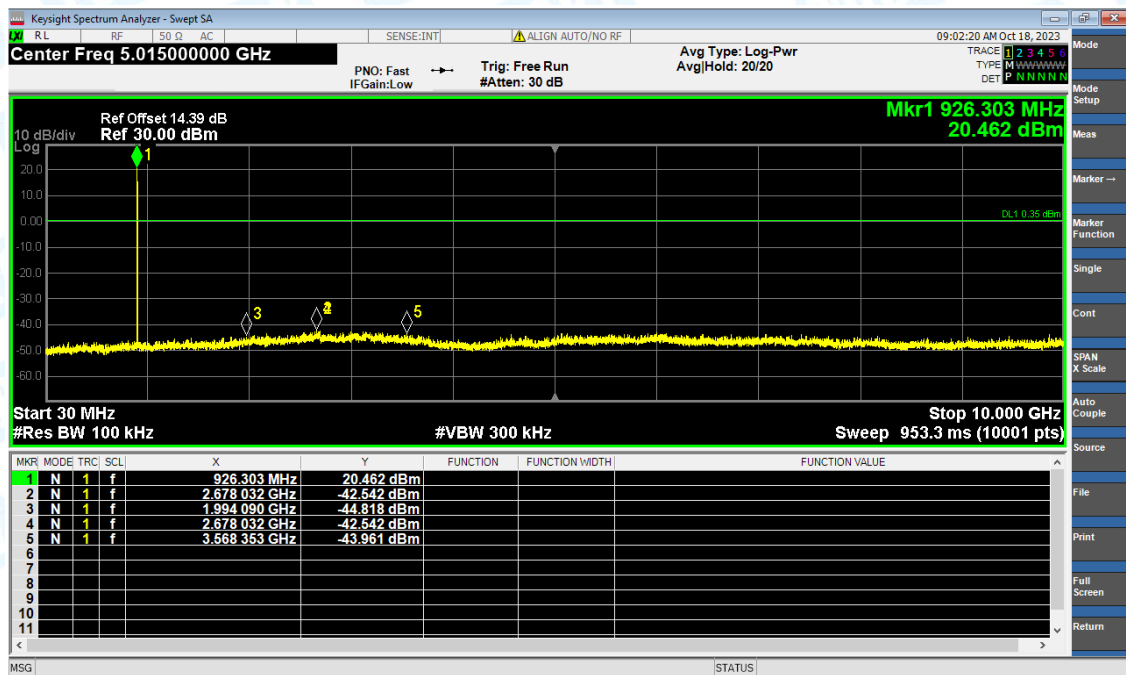
Tx. Spurious NVNT LoRa 914.5MHz Ant1 Emission



Tx. Spurious NVNT LoRa 926.5MHz Ant1 Ref

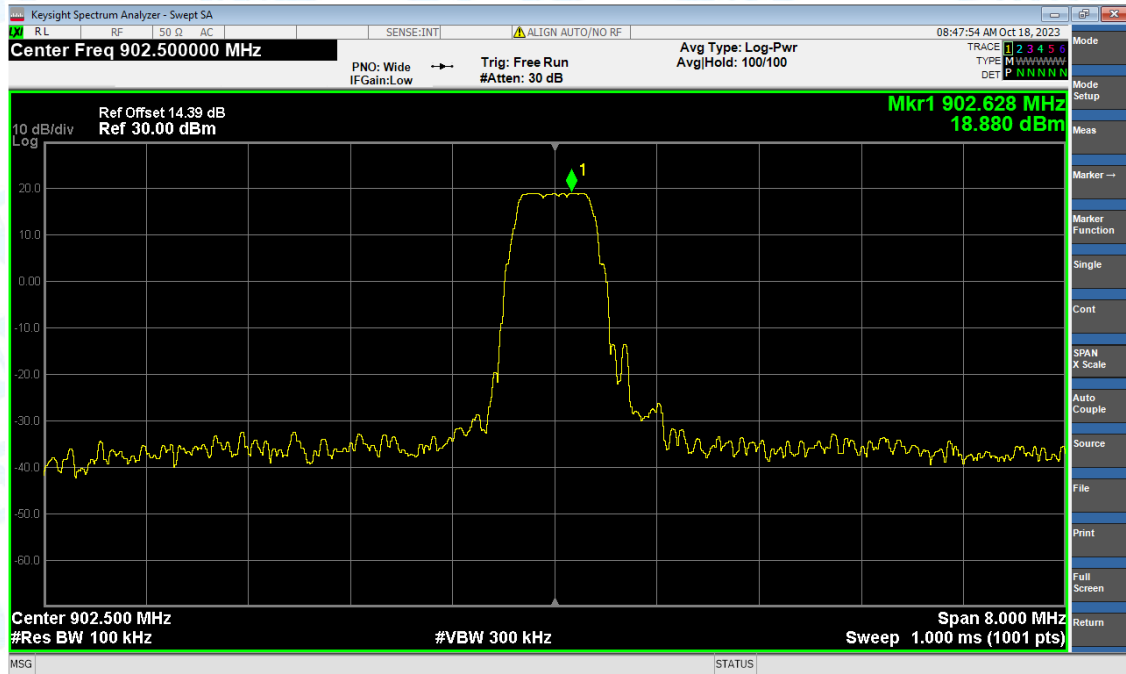


Tx. Spurious NVNT LoRa 926.5MHz Ant1 Emission

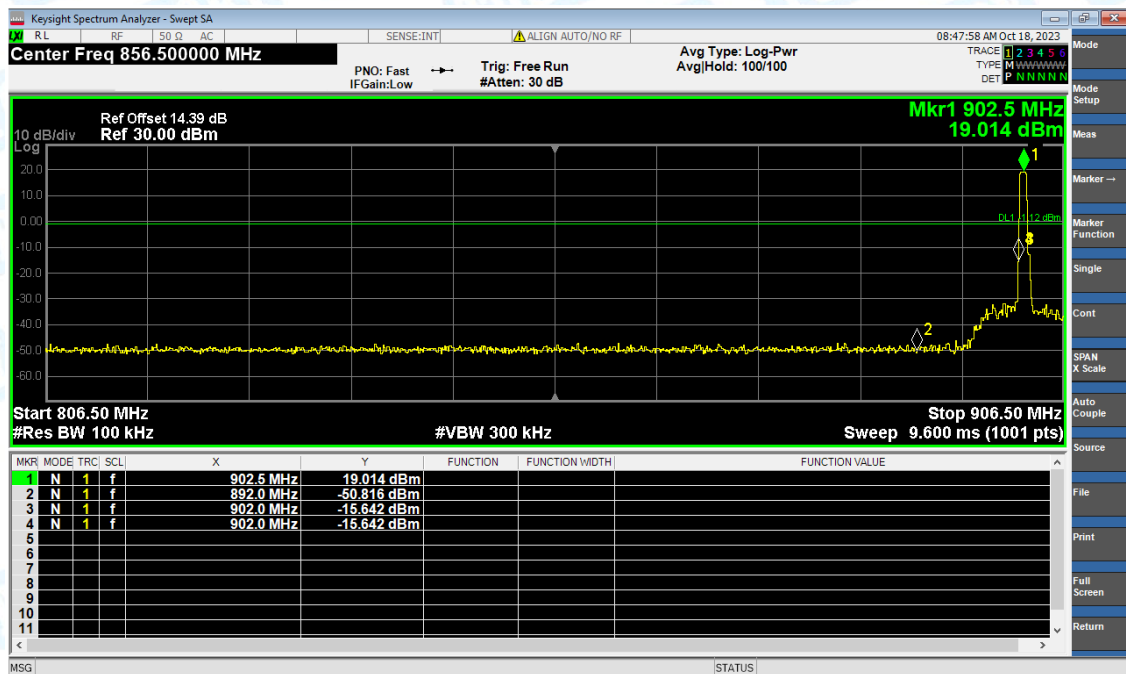


Attachment C-- Emissions In Nonrestricted Frequency Bands Data

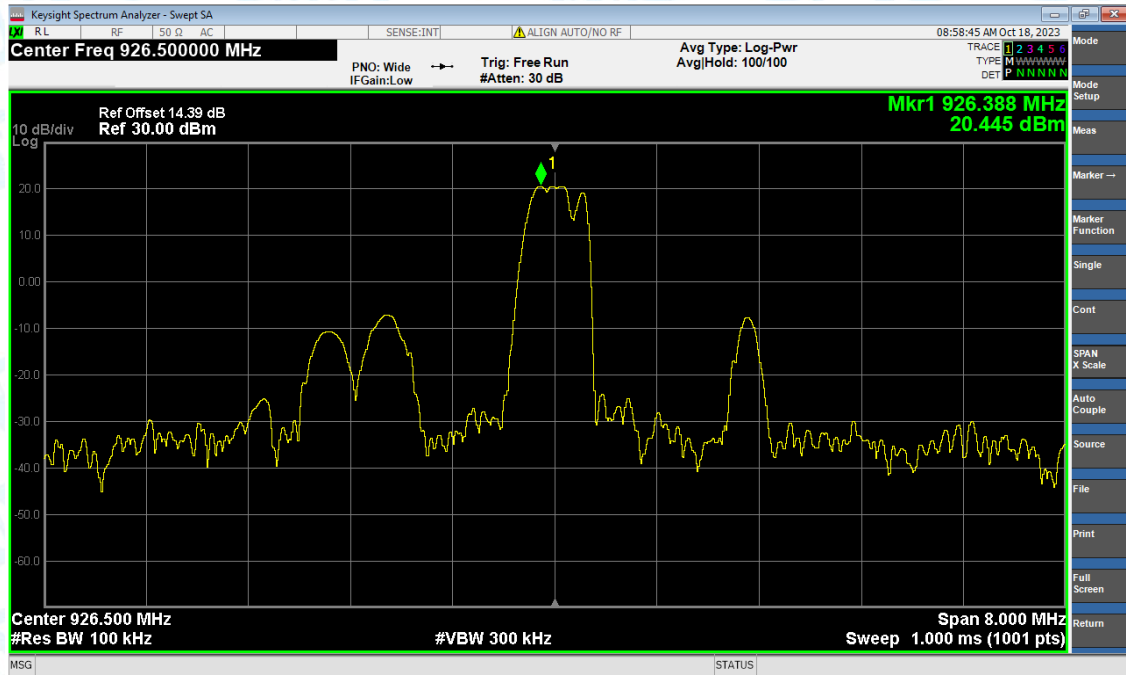
Band Edge NVNT LoRa 902.5MHz Ant1 Ref



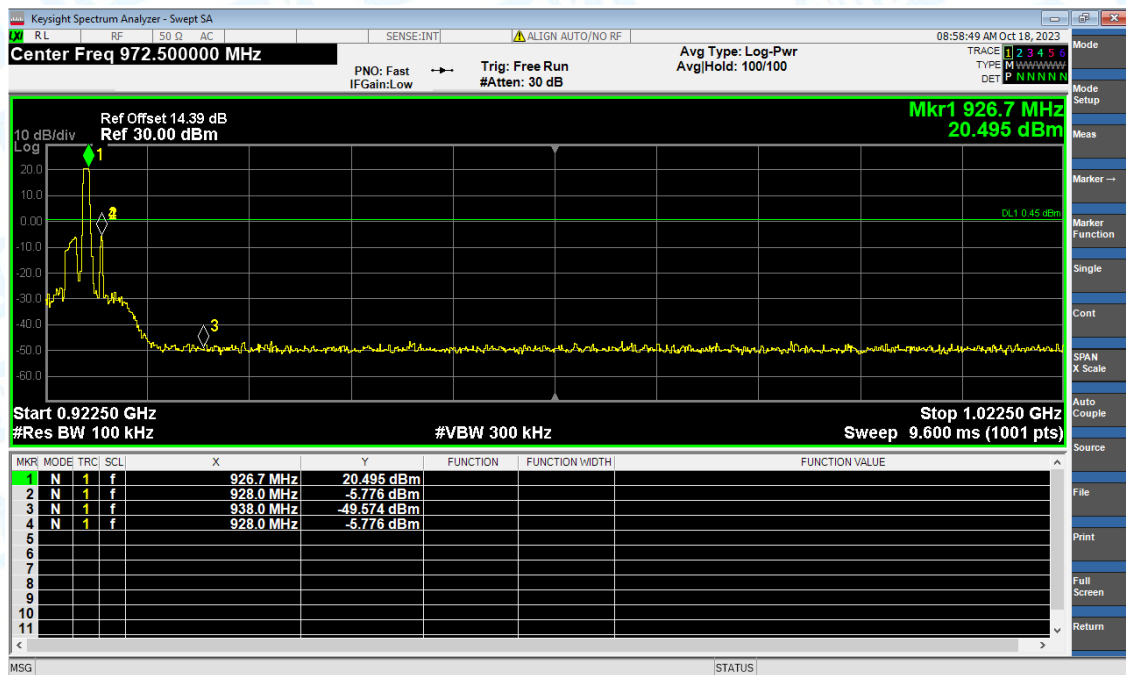
Band Edge NVNT LoRa 902.5MHz Ant1 Emission



Band Edge NVNT LoRa 926.5MHz Ant1 Ref



Band Edge NVNT LoRa 926.5MHz Ant1 Emission



Attachment D-- Bandwidth Data

Temperature:	25℃	Relative Humidity:	55%
Test Voltage:	DC 5V		
Test Mode:	TX Mode		
Channel frequency (MHz)	6dB Bandwidth (kHz)	Limit (kHz)	
902.5	618.3	>=500	
914.5	574.1		
926.5	609.8		
902.5MHz			

Keysight Spectrum Analyzer - Occupied BW

RL

RF

1.50 O

AC

SENSE:INT

ALIGN:AUTO/NO RF

08:47:23 AM Oct 18, 2023

Center Freq 902.500000 MHz

#FGain:Low

Center Freq: 902.500000 MHz

Trig: Free Run

Avg/Hold: 300/300

Radio Std: None

Radio Device: BTS

Ref Offset 14.39 dB

Ref 44.39 dBm

Log

10 dB/div

34.4

24.4

14.4

4.39

-5.61

-15.6

-25.6

-35.6

-45.6

Mkr3 902.812 MHz

12.616 dBm

1

2

3

Center 902.500 MHz

#Res BW 100 kHz

#VBW 300 kHz

Span 2.000 MHz

Sweep 1.333 ms

Occupied Bandwidth

643.26 kHz

Total Power

26.2 dBm

Transmit Freq Error

2.843 kHz

% of OBW Power

99.00 %

x dB Bandwidth

618.3 kHz

x dB

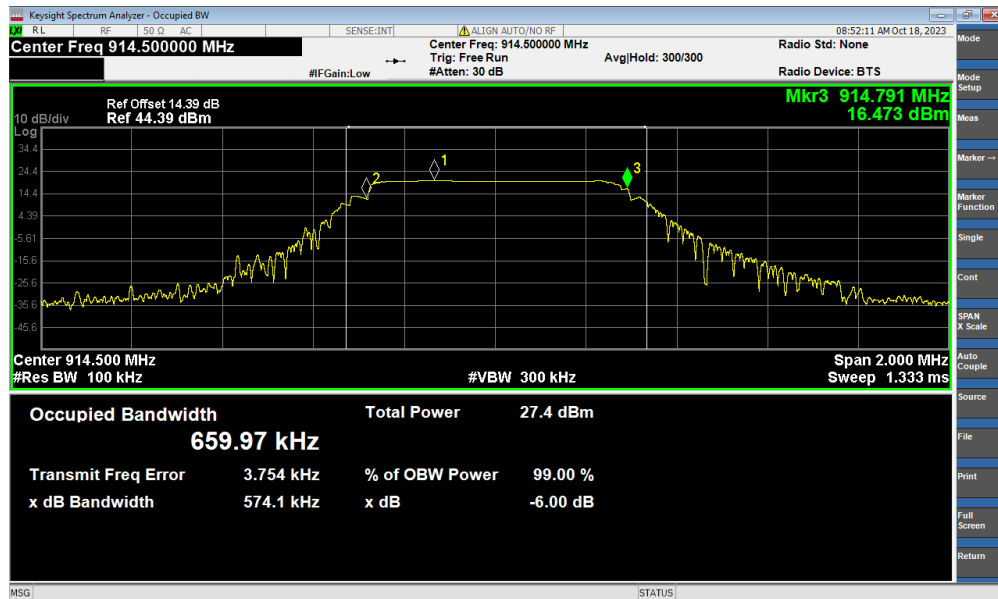
-6.00 dB

MSG

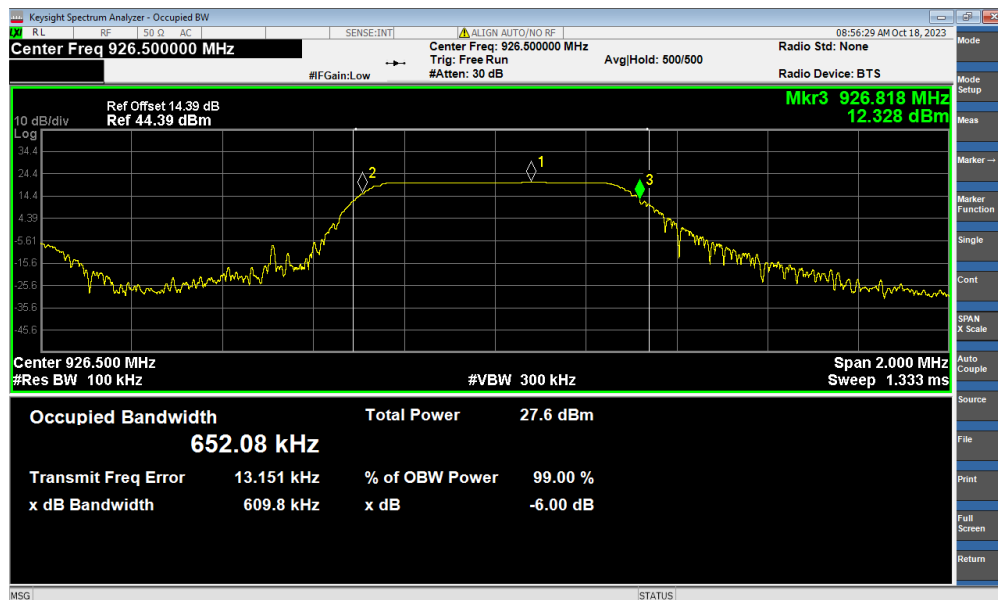
STATUS



914.5MHz



926.5MHz



Temperature:	25°C	Relative Humidity:	55%
Test Voltage:	DC 5V		
Test Mode:	TX Mode		
Channel frequency (MHz)	99% Bandwidth (kHz)	Limit (kHz)	
902.5	522.58	/	
914.5	521.16		
926.5	522.46		
902.5MHz			

Keysight Spectrum Analyzer - Occupied BW

RLRF50QACSENSE:INT

ALIGN AUTO/NO RF

08:47:06 AM Oct 18, 2023

Center Freq 902.500000 MHz

Center Freq: 902.500000 MHz

Radio Std: None

#FGain:Low

Trig: Free Run

Avg|Hold: 300/300

#Atten: 30 dB

Radio Device: BTS

Ref Offset 14.39 dB

Ref 44.39 dBm

10 dB/div

Log

34.4

24.4

14.4

4.39

-5.61

-15.6

-25.6

-35.6

-45.6

Center 902.500 MHz

#Res BW 30 kHz

#VBW 100 kHz

Span 3.000 MHz

Sweep 3.333 ms

Occupied Bandwidth

522.58 kHz

Total Power

30.5 dBm

Transmit Freq Error

504 Hz

% of OBW Power

99.00 %

x dB Bandwidth

658.5 kHz

x dB

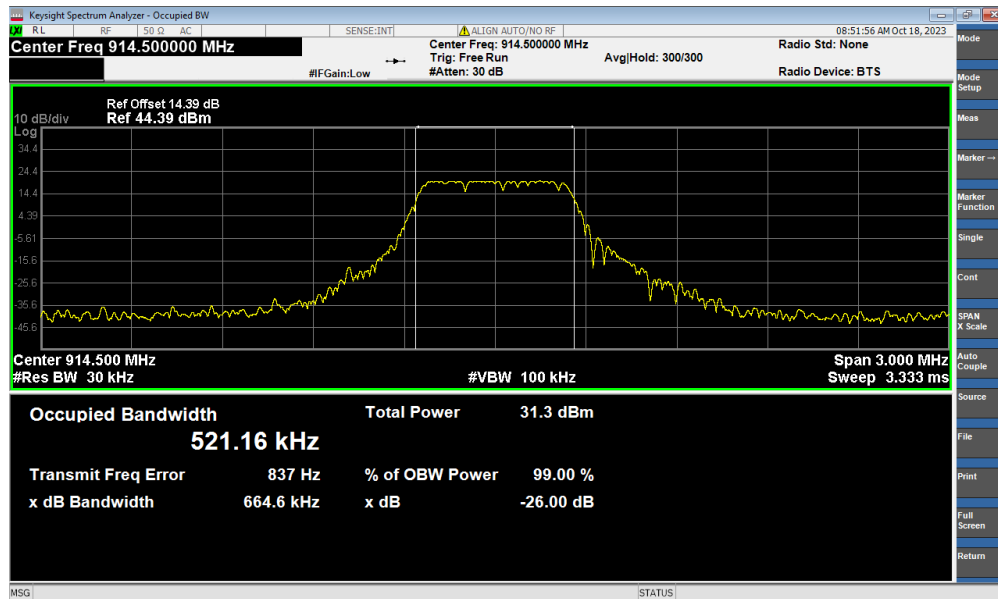
-26.00 dB

MSG

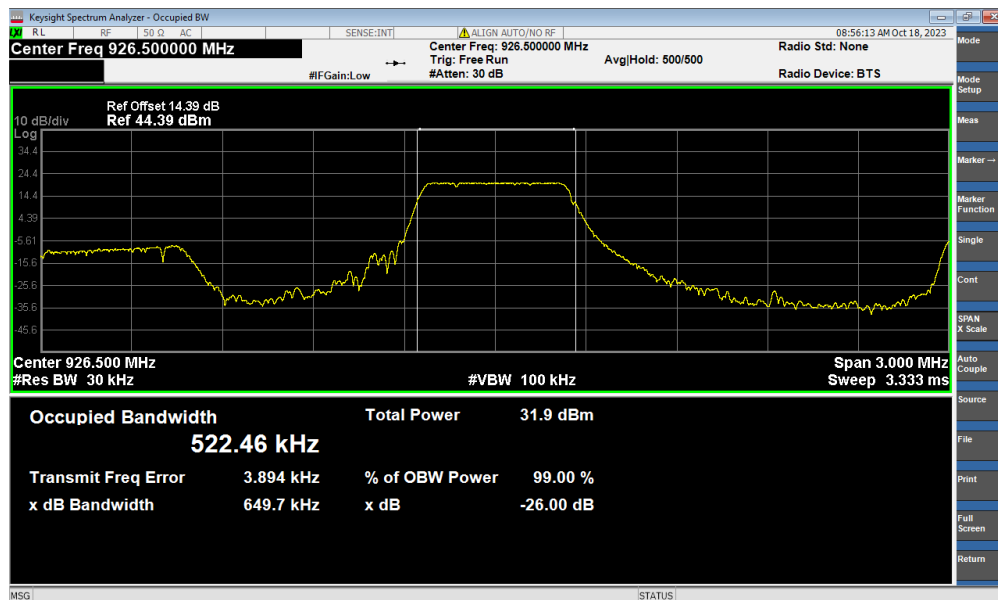
STATUS



914.5MHz



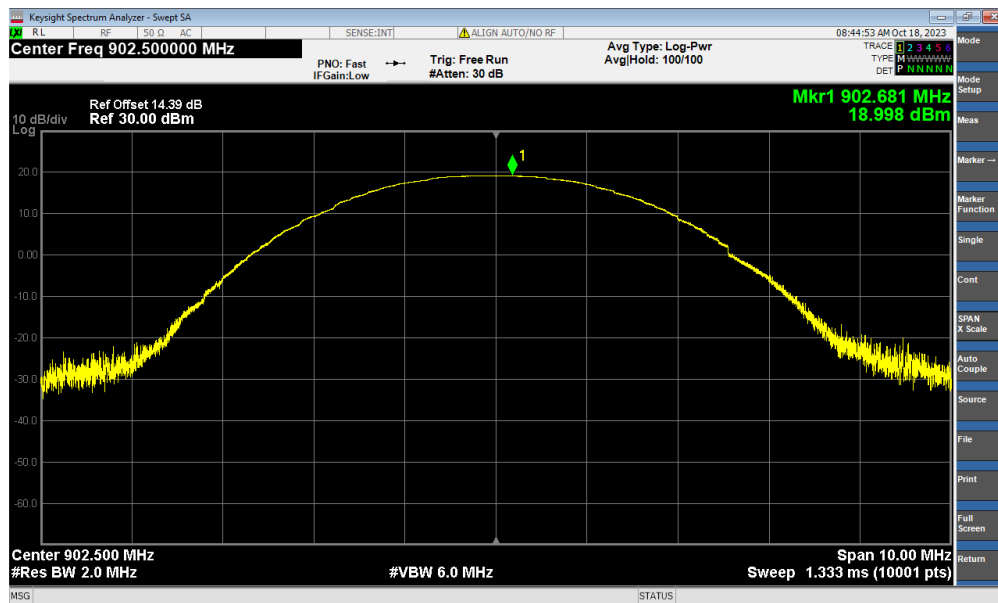
926.5MHz



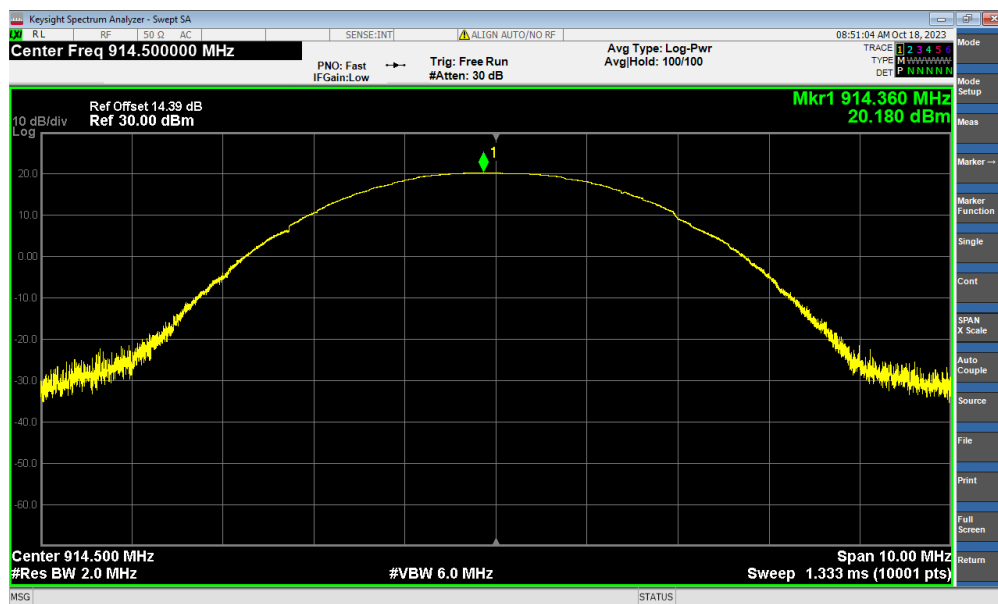
Attachment E-- Peak Output Power Data

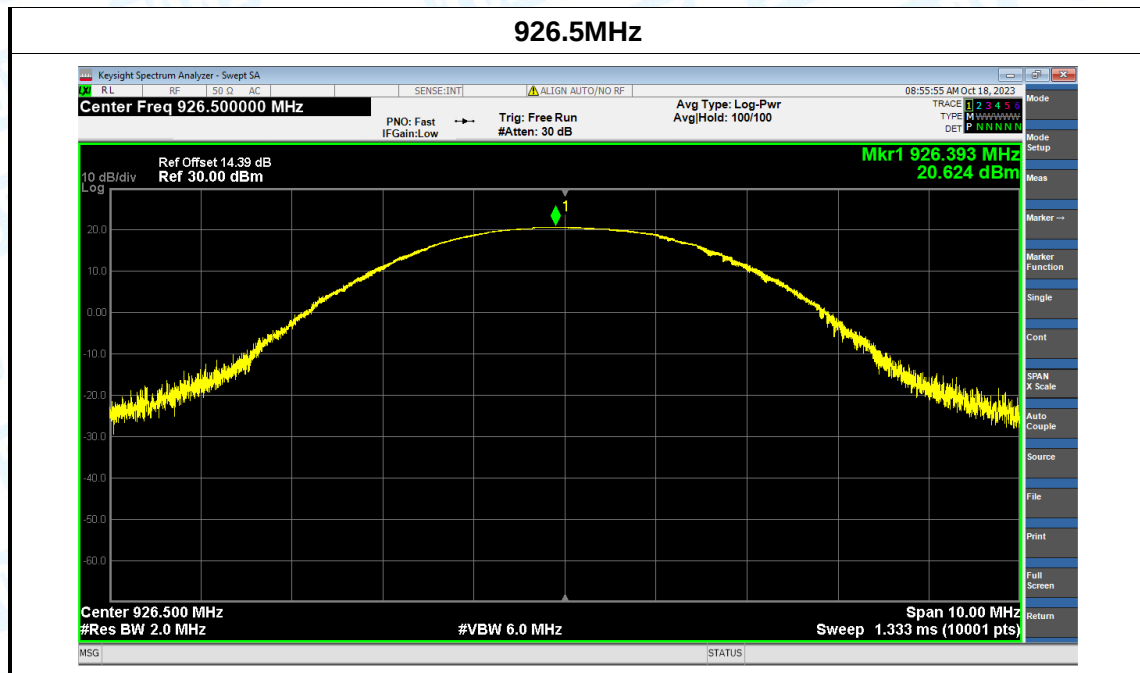
Temperature:	25°C	Relative Humidity:	55%
Test Voltage:	DC 5V		
Test Mode:	TX Mode		
Channel frequency (MHz)	Test Result (dBm)	Limit (dBm)	
902.5	18.998	30	
914.5	20.180		
926.5	20.624		

902.5MHz



914.5MHz





Attachment F-- Power Spectral Density Data

Temperature:	25℃	Relative Humidity:	55%
Test Voltage:	DC 5V		
Test Mode:	TX Mode		
Channel Frequency (MHz)	Power Density (dBm/3kHz)	Limit (dBm/3kHz)	Result
902.5	6.322	8	PASS
914.5	7.705		
926.5	7.774		
902.5MHz			

Keysight Spectrum Analyzer - Swept SA

RL

RF

SO

AC

SENSE:INT

ALIGN AUTO/NO RF

08:45:15 AM Oct 18, 2023

Center Freq 902.500000 MHz

PNO: Wide IF Gain: Low

Trig: Free Run #Atten: 30 dB

Avg Type: Log-Pwr Avg/Hold: 30/30

TRACE 1 2 3 4 5

TYPE M W W W W W W W

DET P H H H H H H H

10 dB/div Log

Ref Offset 14.39 dB

Ref 30.00 dBm

Mkr1 902.707 MHz 6.322 dBm

Center 902.500 MHz

#Res BW 3.0 kHz

#VBW 10 kHz

Span 3.000 MHz

Sweep 316.3 ms (1001 pts)

MSG

STATUS



