RADIO PRE-TEST REPORT

Product	:	Sub-1GHz GFSK RF Transceiver
Model Name	:	BM3603-04-1
Test Regulation	:	FCC 47 CFR Part 15 Subpart C (Section 15.231)
Received Date	:	2022/12/6
Test Date	:	2022/12/13 ~ 2022/12/19
Issued Date	:	2023/1/12
Issued By	:	Underwriters Laboratories Taiwan Co., Ltd. Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

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1. Attestation of Test Results

APPLICANT:	Holtek Semiconductor Inc
EUT DESCRIPTION:	Sub-1GHz GFSK RF Transceiver
MODEL:	BM3603-04-1
SAMPLE STAGE:	Engineering Verification Test sample
DATE of TESTED:	2022/12/13 ~ 2022/12/19

APPLICABLE STANDARDS	
STANDARD	**Test Results**
FCC 47 CFR PART 15 Subpart C (Section 15.231)	PASS

Underwriters Laboratories Taiwan Co., Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by Underwriters Laboratories Taiwan Co., Ltd. based on interpretations and/or observations of test results. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Underwriters Laboratories Taiwan Co., Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Underwriters Laboratories Taiwan Co., Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Prepared By:

Sally Lu Date : 2023/1/12
Project Handler

Approved and Authorized By:

Kent Liu Date : 2023/1/12
Senior Laboratory Engineer

2. Summary of Test Results

Summary of Test Results		
FCC Clause	**Test Items**	**Result**
15.209 / 15.231(b)	Radiated Emissions	PASS
15.231(c)	Emission Bandwidth Test	PASS

3. Facilities and Accreditation

Test Location	Underwriters Laboratories Taiwan Co., Ltd.
Address	Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan
Accreditation Certificate	Underwriters Laboratories Taiwan Co., Ltd. is accredited by TAF, Laboratory Code 3398.

4. Measurement Uncertainty

For statement of conformity, accuracy method (Section 8.2.4 and 8.2.5 of ISO Guide 98-4) was applied as decision rule for measurement in this test report.

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor k=2.

Measurement	Frequency	Uncertainty
Radiated disturbance below 1 GHz	30MHz ~ 1GHz	±5.8 dB
Radiated disturbance above 1 GHz	1GHz ~ 40GHz	±4.8 dB

5. Equipment under Test

5.1. Description of EUT

Product	Sub-1GHz GFSK RF Transceiver
Model Name	BM3603-04-1
Operating Frequency	433.92 MHz
Modulation	GFSK/FSK
Number of Channel	1

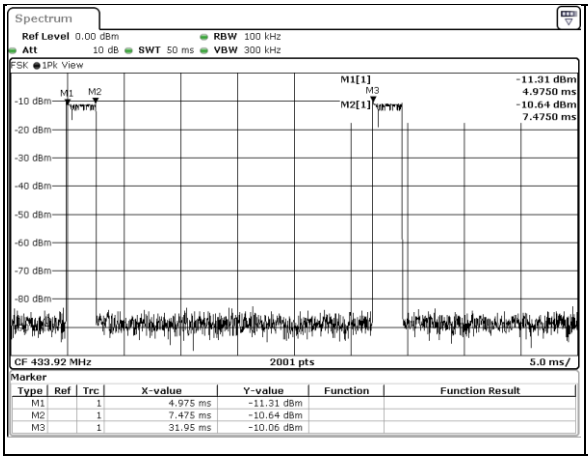
5.2. Channel List

1 channel is provided for this EUT:

Channel	Frequency (MHz)
1	433.92

5.3. Duty Cycle of Test Signal

TX on (ms)	TX on+off (ms)	DutyCycle (%)	Duty Factor (dB)	1/T minimum VBW (kHz)
2.500	26.975	9.27%	10.33	0.400



6. Test Results

6.1. Radiated Spurious Emission

Requirements

Limits of Radiated Emission Measurement

Fundamental Frequency (MHz)	Field Strength of Fundamental		Field Strength of Spurious	
	uV/meter	dBuV/meter	uV/meter	dBuV/meter
40.66 ~ 40.70	2250	67.04	225	48.04
70 ~ 130	1250	61.94	125	41.94
130 ~ 174	1250 ~ 3750	61.94 ~ 71.48	125 ~ 375	41.94 ~ 51.48
174 ~ 260	3750	71.48	375	51.48
260 ~ 470	3750 ~ 12500	71.48 ~ 81.94	375 ~ 1250	51.48 ~ 61.94
Above 470	12500	81.94	1250	61.94

Note:
1. Where F is the frequency in MHz, the formula for calculating the maximum permitted fundamental field strengths are as follows: for the band 130-174 MHz, uV/m at 3 meters = 56.81818(F)-6136.3636; for the band 260-470 MHz, uV/m at 3 meters = 41.6667(F)-7083.3333. The maximum permitted unwanted emission level is 20 dB below the maximum permitted fundamental level.
2. The above field strength limits are specified at a distance of 3meters. The tighter limits apply at the band edges.

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20dB below the highest level of the desired power:

Frequency(MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note:
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

Test Procedures

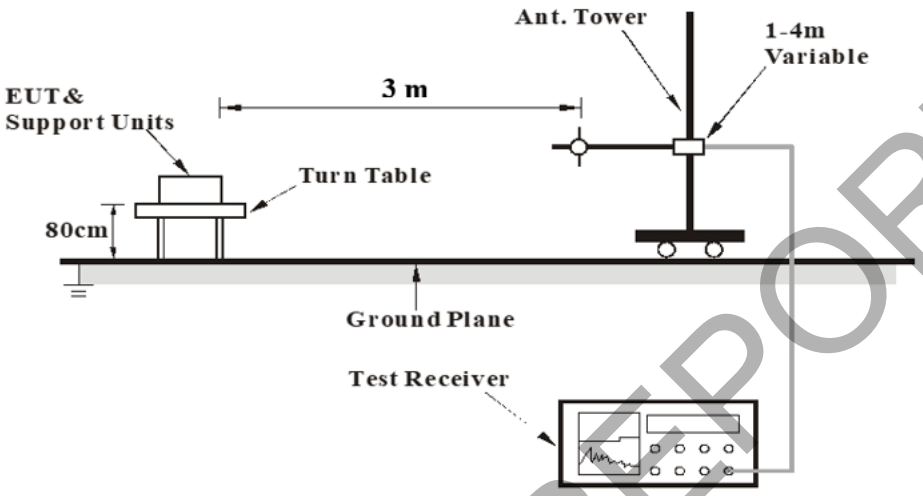
[For above 30 MHz]

a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
e. For measurement below 1GHz, 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 emission level of the EUT measured by the peak detector is lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
f. The test-receiver system was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

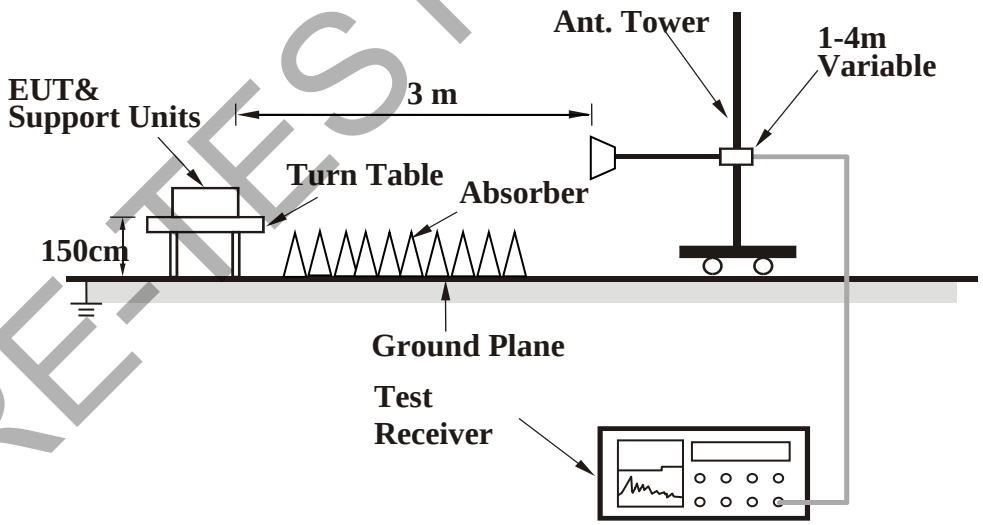
Note:
a. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
b. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
c. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is ≥ 1/T (Duty cycle < 98%) or 10Hz (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz.
d. All modes of operation were investigated (includes all external accessories) and the worst-case emissions are reported, the other emission levels were low against the limit.
e. Test data of Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
f. Test data of Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
g. Test data of Correction Factor (dB/m) = Antenna Factor (dBuV/m) + Cable Loss (dB) - Preamp Factor (dB).
h. Test data of Notation "@" = Fundamental Frequency
i. Test data of Notation " * " = The peak result under 20 dB above and complies with AVG limit, AVG result is deemed to comply with AVG limit.

Test Setup

<Frequency Range 30 MHz ~ 1 GHz >



<Frequency Range above 1 GHz>



For the actual test configuration, please refer to the Setup Configurations.

Test Data

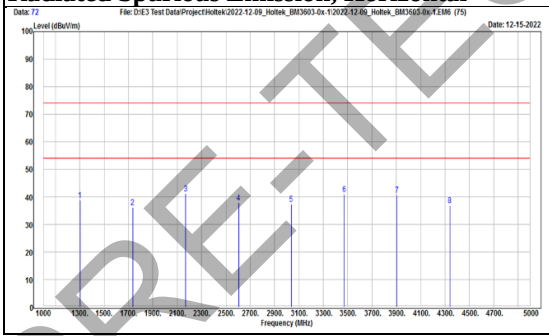
TX mode

Above 1 GHz

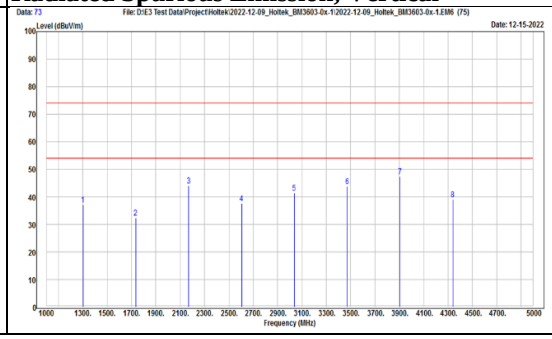
Mode	FSK 433.92M	Channel	1

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal	*	1301.76	47.47	-8.55	38.92	74	-35.08	PK
	*	1735.68	44.04	-7.73	36.31	74	-37.69	PK
	*	2169.6	45.66	-4.43	41.23	74	-32.77	PK
	*	2603.52	41.54	-3.77	37.77	74	-36.23	PK
	*	3037.44	39.4	-2.07	37.33	74	-36.67	PK
	*	3471.36	42.58	-1.65	40.93	74	-33.07	PK
	*	3905.28	40.89	-0.11	40.78	74	-33.22	PK
	*	4339.2	35.94	1.02	36.96	74	-37.04	PK
Vertical	*	1301.76	45.73	-8.55	37.18	74	-36.82	PK
	*	1735.68	40.11	-7.73	32.38	74	-41.62	PK
	*	2169.6	48.38	-4.43	43.95	74	-30.05	PK
	*	2603.52	41.45	-3.77	37.68	74	-36.32	PK
	*	3037.44	43.38	-2.07	41.31	74	-32.69	PK
	*	3471.36	45.47	-1.65	43.82	74	-30.18	PK
	*	3905.28	47.6	-0.11	47.49	74	-26.51	PK
	*	4339.2	38	1.02	39.02	74	-34.98	PK

TX, FSK 433.92M (Ch 1)
Radiated Spurious Emission, Horizontal



TX, FSK 433.92M (Ch 1)
Radiated Spurious Emission, Vertical

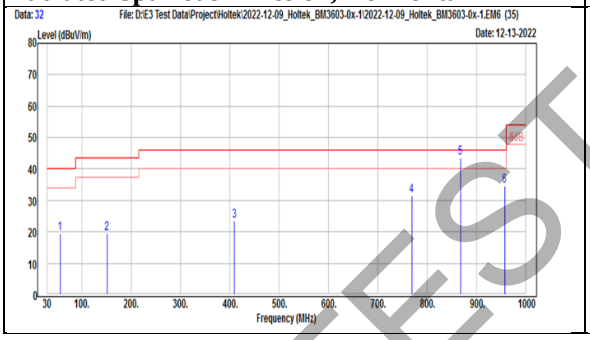


Below 1 GHz

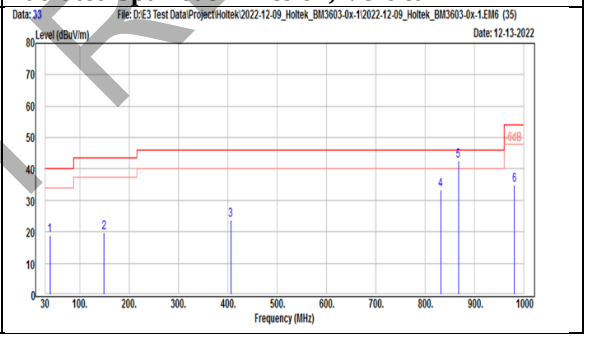
Mode	FSK 433.92M	Channel	1

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		56.19	31.43	-11.96	19.47	40	-20.53	PK
		151.25	31.04	-11.66	19.38	43.5	-24.12	PK
		409.27	31.14	-7.64	23.5	46	-22.5	PK
		769.14	31.47	0.07	31.54	46	-14.46	PK
		868.08	42.02	1.55	43.57	46	-2.43	PK
		957.32	31.34	3.24	34.58	46	-11.42	PK
Vertical		39.7	31.29	-12.58	18.71	40	-21.29	PK
		149.31	31.65	-11.98	19.67	43.5	-23.83	PK
		406.36	31.58	-7.78	23.8	46	-22.2	PK
		832.19	32.35	0.91	33.26	46	-12.74	PK
		868.08	41	1.55	42.55	46	-3.45	PK
		981.57	31.64	3.27	34.91	54	-19.09	PK

TX, FSK 433.92M (Ch 1)
Radiated Spurious Emission, Horizontal



TX, FSK 433.92M (Ch 1)
Radiated Spurious Emission, Vertical



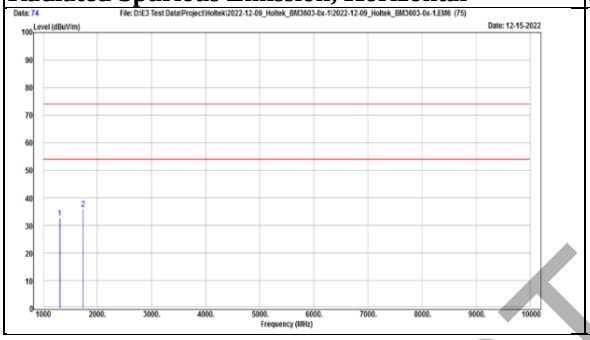
RX mode

Above 1 GHz

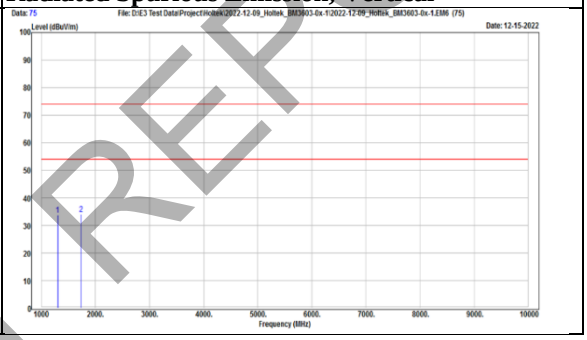
Mode	FSK 433.92M	Channel	1

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal	*	1301.76	41.07	-8.55	32.52	74	-41.48	PK
	*	1735.68	43.78	-7.73	36.05	74	-37.95	PK
Vertical	*	1301.76	42.26	-8.55	33.71	74	-40.29	PK
	*	1735.68	41.8	-7.73	34.07	74	-39.93	PK

RX, FSK 433.92M (Ch 1)
Radiated Spurious Emission, Horizontal



RX, FSK 433.92M (Ch 1)
Radiated Spurious Emission, Vertical

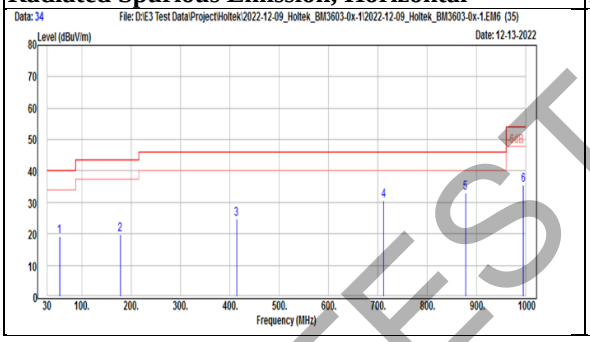


Below 1 GHz

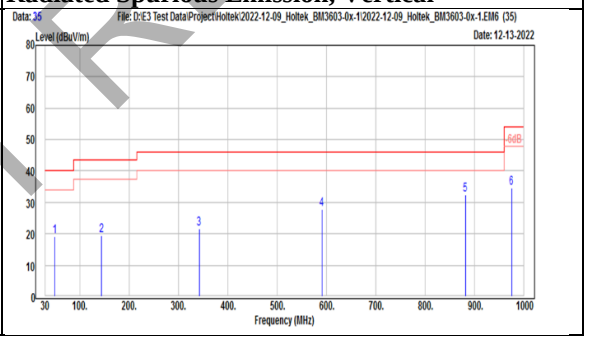
Mode	FSK 433.92M	Channel	1

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		55.22	31.19	-11.96	19.23	40	-20.77	PK
		178.41	32.54	-12.69	19.85	43.5	-23.65	PK
		414.12	32.12	-7.5	24.62	46	-21.38	PK
		711.91	31.65	-0.96	30.69	46	-15.31	PK
		877.78	31.47	1.6	33.07	46	-12.93	PK
		995.15	31.99	3.43	35.42	54	-18.58	PK
Vertical		49.4	31.06	-11.95	19.11	40	-20.89	PK
		144.46	31.57	-12.08	19.49	43.5	-24.01	PK
		342.34	31.32	-9.62	21.7	46	-24.3	PK
		590.66	30.78	-3.05	27.73	46	-18.27	PK
		881.66	30.71	1.6	32.31	46	-13.69	PK
		975.75	31.45	3.3	34.75	54	-19.25	PK

RX, FSK 433.92M (Ch 1)
Radiated Spurious Emission, Horizontal



RX, FSK 433.92M (Ch 1)
Radiated Spurious Emission, Vertical



9 kHz ~ 30 MHz Data:

For 9 kHz to 30 MHz radiated emission have performed all modes of operation were investigated. The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.

No non-compliance noted:

KDB 414788 D01 OATS and Chamber Correlation Justification

- Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.

- OATs and chamber correlation testing had been performed and chamber measured test results is the worst case test result.

Although these tests were performed other than open area test site, adequate comparison measurements were confirmed against 30m open area test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.

6.2. 20dB Bandwidth Measurement

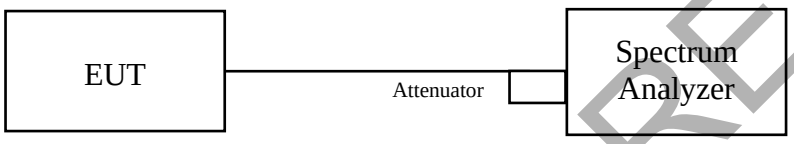
Requirements

Limits of 20dB Bandwidth Measurement

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for device operating above 70 MHz and below 900 MHz.

Fundamental Frequency (MHz)	Limit of Emission Bandwidth (kHz)
433.92	291.8

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Instruments

Refer to section 6 to get information of above instrument.

Test Procedure

a. The EUT was placed on the turn table.
b. The signal was coupled to the spectrum analyzer through an antenna.
c. Set the resolution bandwidth to 10 kHz and video bandwidth to 30 kHz then select Peak function to scan the channel frequency.
d. The emission bandwidth was measured and recorded.

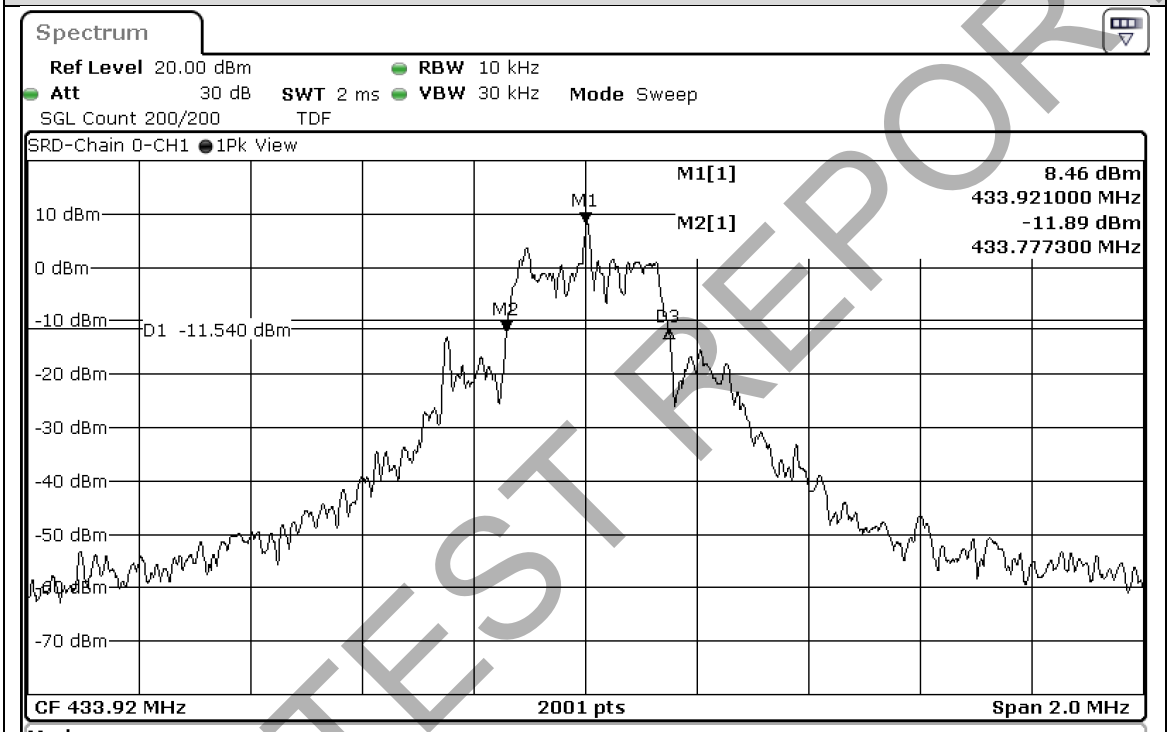
Deviation from Test Standard

No deviation.

Test Data

Channel	Frequency (MHz)	20dB Bandwidth (kHz)	Maximum Limit (MHz)	Pass / Fail
1	433.92	291.8	1084	PASS

SPECTRUM PLOT OF VALUE

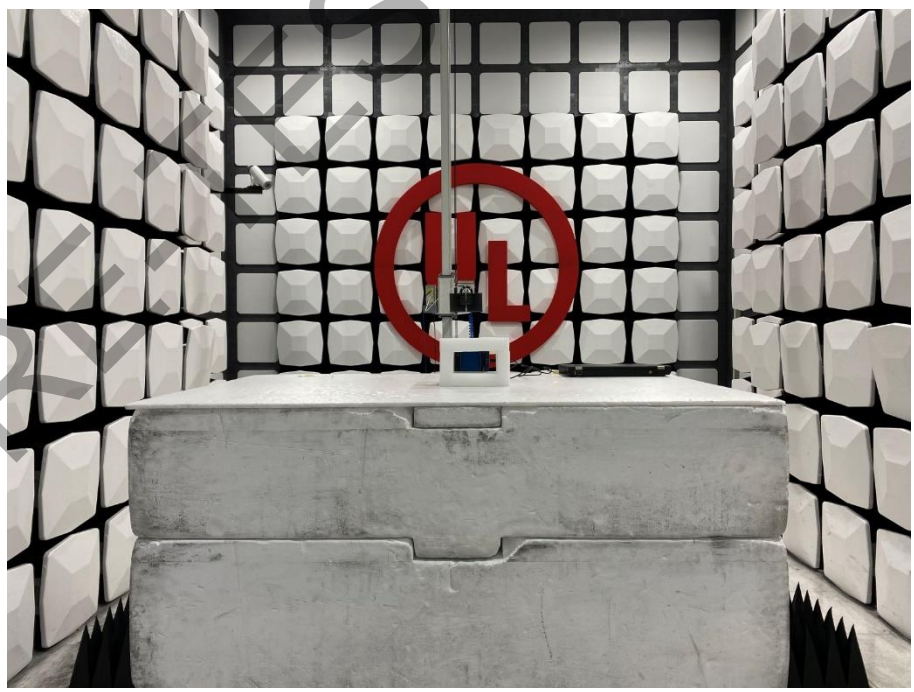


Marker

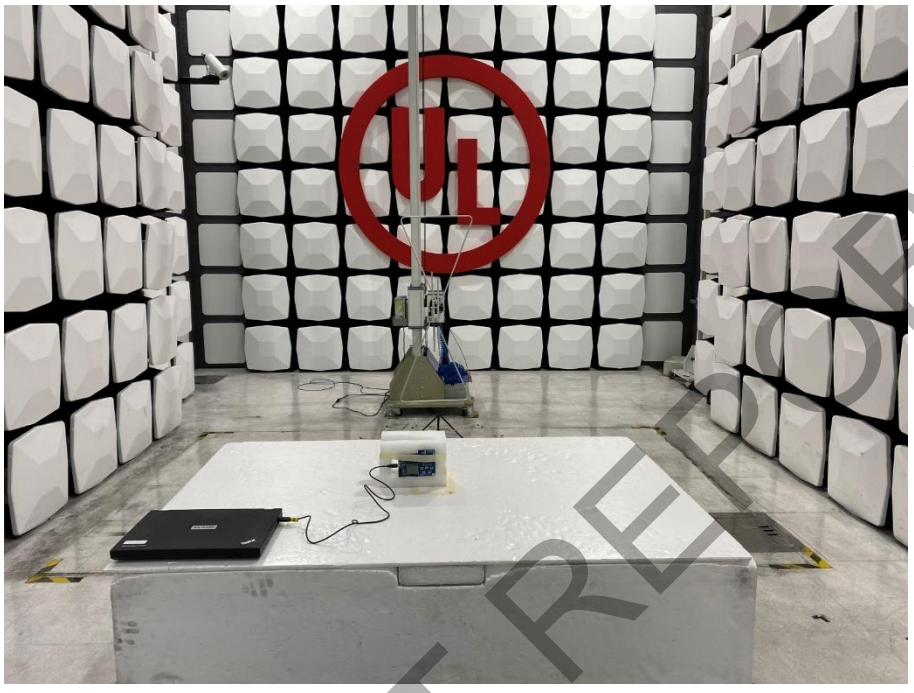
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	433.921 MHz	8.46 dBm		
M2		1	433.7773 MHz	-11.89 dBm		
D3	M2	1	291.8 kHz	0.44 dB		

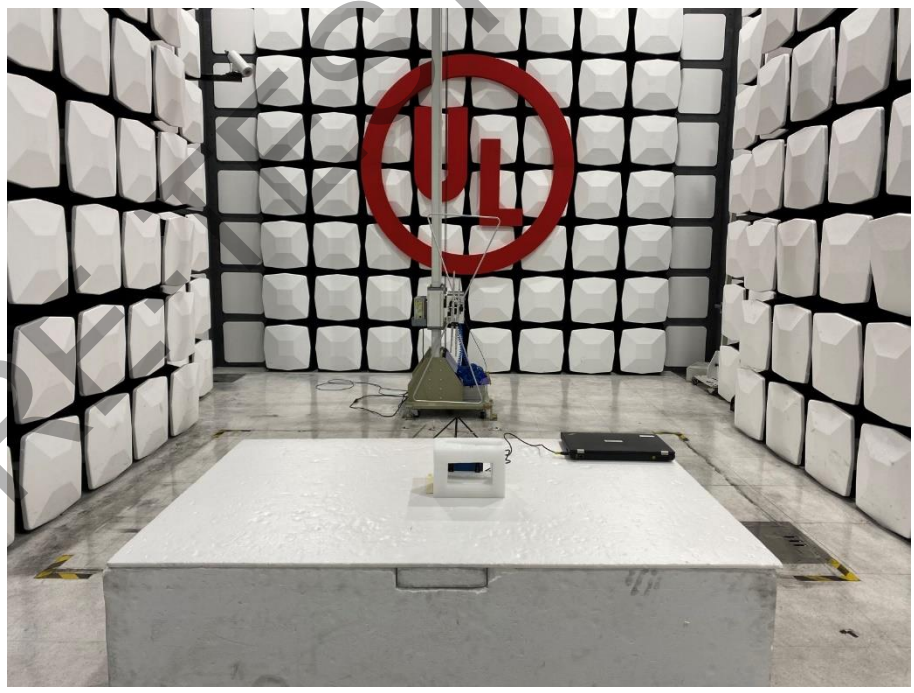
Appendix I Radiated Spurious Emission Setup Configurations

Above 1GHz



Below 1GHz





END OF REPORT