RADIO PRE-TEST REPORT

Product	:	Sub-1GHz GFSK RF Transceiver
Model Name	:	BM3603-04-1
Test Regulation	:	ETSI EN 300 220-2 V3.1.1 (2017-02)
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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Summary of Test Results		
Clause	**Test Item**	**Results**
Clause 4.2.1 (ETSI EN 300 220-2)	Operating Frequency	See client's declaration on section 6.1
Clause 4.3.1 (ETSI EN 300 220-2)	Effective Radiated Power	PASS
Clause 4.3.3 (ETSI EN 300 220-2)	Duty Cycle	PASS
Clause 4.3.4 (ETSI EN 300 220-2)	Occupied Bandwidth	PASS
Clause 4.3.5 (ETSI EN 300 220-2)	TX Out of Band Emissions	PASS
Clause 4.3.6 (ETSI EN 300 220-2)	Transient Power	PASS
Clause 4.2.2 (ETSI EN 300 220-2)	Unwanted Emissions in the Spurious Domain	PASS
Clause 4.4.2 (ETSI EN 300 220-2)	Blocking	PASS

Notes:
1. The EUT has been tested according to the following specifications.
2. The EUT is a Receiver Category 2 device.

Receiver Category	Description
1	Category 1 is a high performance level of receiver. In particular to be used where the operation of a SRD may have inherent safety of human life implications.
1.5	Category 1.5 is an improved performance level of receiver category 2.
2	Category 2 is standard performance level of a receiver.
3	Category 3 is a low performance level of receiver. Manufacturers have to be aware that category 3 receivers are not able to work properly in case of coexistence with some services such as mobile radio service in adjacent bands. The manufacturer shall provide another mean to overcome the weakness of the radio link or accept the failure.

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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**
ETSI EN 300 220-2 V3.1.1 (2017-02)	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

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2. Test Methodology and Reference Procedures

The tests documented in this report were performed in accordance with ETSI EN 300 220-1 V3.1.1 (2017-02)、ETSI EN 300 220-2 V3.1.1 (2017-02).

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.

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4. Calibration and Uncertainty

4.1. Measuring Instrument Calibration

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. 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.

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus.

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

Parameter	Uncertainty
RF power, conducted	±1.3 dB
Radiated emission of transmitter, valid up to 6GHz	±4.9 dB
Radiated emission of receivers, valid up to 6GHz	±4.9 dB

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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
Number of Channels	1
Modulation Type	FSK/GFSK
Temperature Operating Range	25 ℃

5.2 Carrier Frequency and Channel

1 channel provided to this EUT

Channel	Frequency (MHz)
1	433.92

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6. Test Result

6.1 Operating Frequency

6.1.1 Requirements

The Operating Frequency of the Equipment Under Test shall be entirely within the operation frequency bands as shown below:

Operating Frequency Band
433.050MHz – 434.790MHz

6.1.2 Test Data

The client, Holtek Semiconductor Inc declares the nominal operating frequency of the Equipment Under Test is 433.92 MHz

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6.2 Effective Radiated Power

6.2.1 Requirements

Limit of Power Spectral Density

Frequency Band	Limit (e.r.p.)
433.050MHz – 434.790MHz	10 mW

6.2.2 Test Setup

The test setup has been constructed as the normal use condition. Controlling software (provided by manufacturer) has been activated to set the EUT on specific status.

6.2.3 Test Procedure

Refer to chapter 5.2.2 of EN 300 220-1 V3.1.1.

Measurement Method	
☒Conducted measurement	☐Radiated measurement

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6.2.4 Test Data

Test Condition		ERP Power (dBm)
Channel	Frequency (MHz)	Tnom(℃)
		25
		Vnom (V)
1	433.92	8.49

Note: ERP Power (dBm) = Conducted power (dBm) + Antenna gain (dBi) – 2.15

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6.3 Duty Cycle

6.3.1 Requirements

The Duty Cycle at the operating frequency shall not be greater than values in EN 300 220-2 V3.1.1 annex B or C for the chosen operational frequency band(s).

6.3.2 Test Setup

The EUT was operated in normal operation condition.

6.3.3 Test Procedure

Refer to chapter 5.4.2 of EN 300 220-1 V3.1.1.

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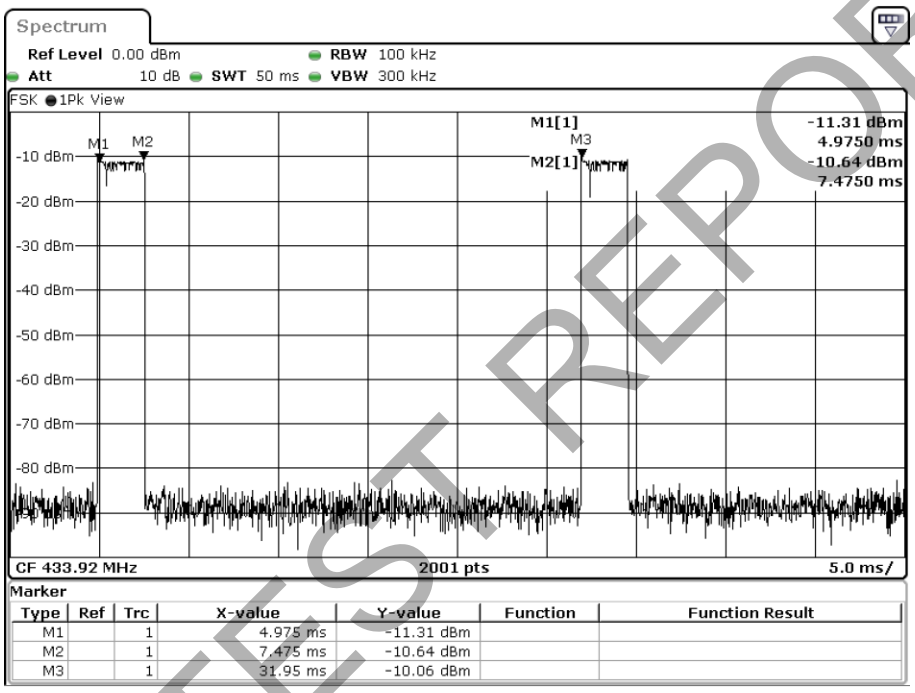
6.3.4 Test Data

Duty cycle under normal operation condition = 2.575/27.05 = 9.52%

On time (ms)	Period (ms)	Duty Cycle (%)
2.575	27.05	9.52%



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6.4 Occupied Bandwidth

6.4.1 Requirements

The Maximum Occupied Bandwidth at 99 % shall reside entirely within the Operating Channel defined by F_{low} and F_{high}.

6.4.2 Test Setup

The test setup has been constructed as the normal use condition. Controlling software (provided by manufacturer) has been activated to set the EUT on specific status.

6.4.3 Test Procedure

Refer to chapter 5.6.3 of EN 300 220-1 V3.1.1.

Measurement	
☒ Conducted measurement	☐ Radiated measurement

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6.4.4 Test Data

Channel	Test Frequency (MHz)	Occupied Bandwidth (MHz)
1	433.92	0.297

Test Condition		Measured frequencies (lowest and highest)	Limit (MHz)
Mode	Test Frequency (MHz)		
F_{low}	433.92	FL = 433.9197	F_L > 433.05
F_{high}	433.92	FH = 433.9206	F_H < 434.79

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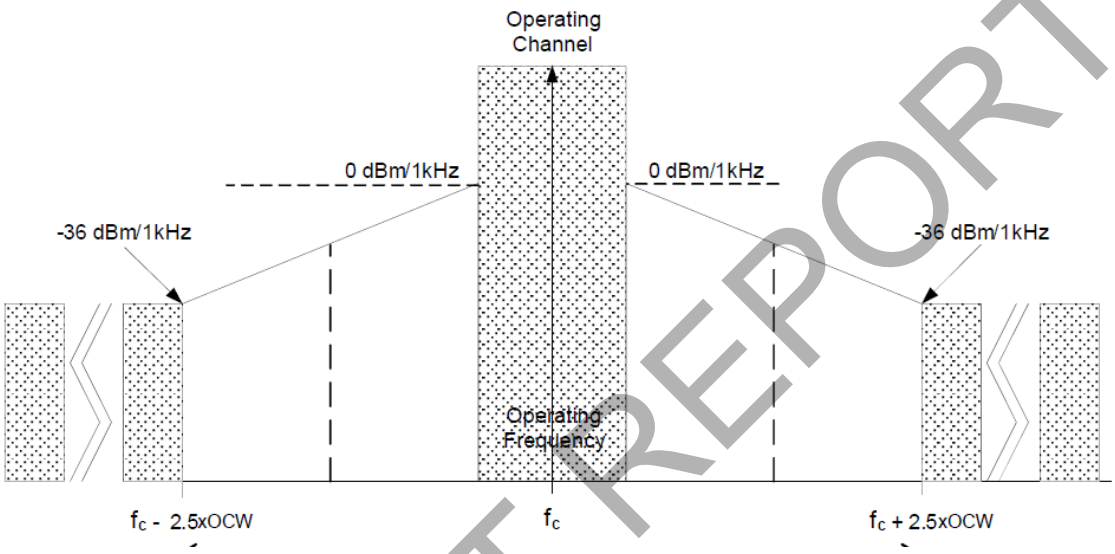
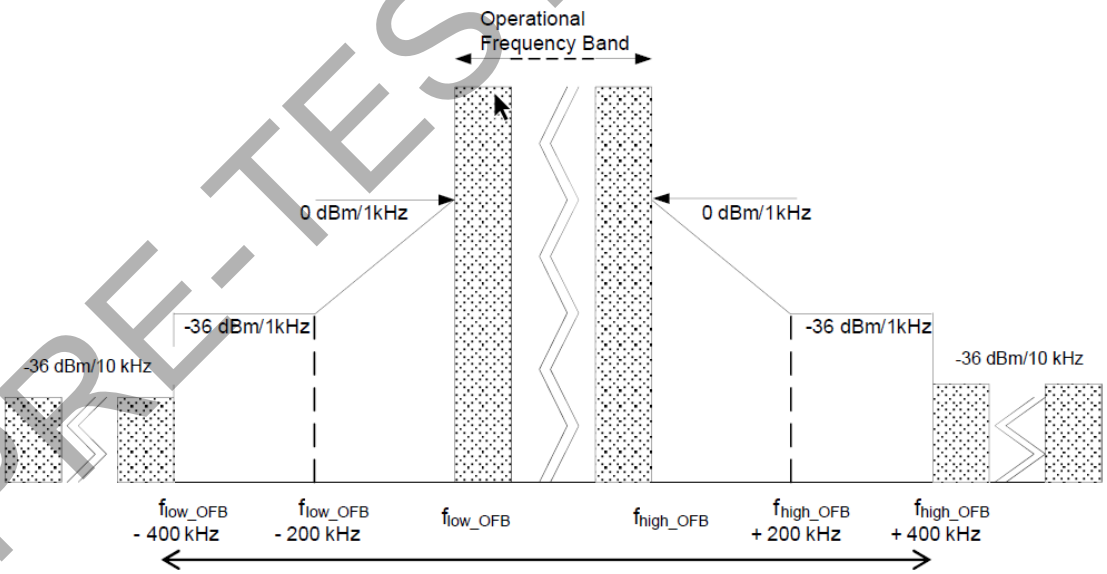
6.5 Transmitter Out-of-Band Emissions

6.5.1 Requirements

The unwanted emissions in the out-of-band domain shall not exceed the values provided by the transmit mask as shown below.



Out-of-Band Domain for Operating Channel with Reference Bandwidth



Out-of-Band Domain for Operating Frequency Band with Reference Bandwidth

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Domain	Frequency Range	RBW_{REF}	Max power limit
OOB limits applicable to Operational Frequency Band	$f \le f_{low\_OFB}$ - 400 kHz	10 kHz	-36 dBm
	F_{low_OFB} - 400 kHz ≤ f ≤ f_{low_OFB} - 200 kHz	1 kHz	-36 dBm
	f_{low} - 200 kHz ≤ f < f_{low_OFB}	1 kHz	See Figure 6
	$f = f_{low\_OFB}$	1 kHz	0 dBm
	$f = f_{high\_OFB}$	1 kHz	0 dBm
	$F_{high\_OFB} < f \le f_{high\_OFB}$ + 200 kHz	1 kHz	See Figure 6
	F_{high_OFB} + 200 kHz ≤ f ≤ f_{high_OFB} + 400 kHz	1 kHz	-36 dBm
	F_{high_OFB} + 400 kHz ≤ f	10 kHz	-36 dBm
OOB limits applicable to Operating Channel	$f = f_c$ - 2.5 x OCW	1 kHz	-36 dBm
	f_c - 2,5 x OCW ≤ f ≤ f_c - 0,5 x OCW	1 kHz	See Figure 5
	$f = f_c$ - 0,5 x OCW	1 kHz	0 dBm
	$f = f_c$ + 0,5 x OCW	1 kHz	0 dBm
	f_c + 0,5 x OCW ≤ f ≤ f_c + 2,5 x OCW	1 kHz	See Figure 5
	$f = f_c$ + 2,5 x OCW	1 kHz	-36 dBm
NOTE: f is the measurement frequency. f_c is the Operating Frequency. F_{low_OFB} is the lower edge of the Operational Frequency Band. F_{high_OFB} is the upper edge of the Operational Frequency Band. OCW is the operating channel bandwidth.			

6.5.2 Test Setup

The test setup has been constructed as the normal use condition. Controlling software (provided by manufacturer) has been activated to set the EUT on specific status.

6.5.3 Test Procedure

Refer to chapter 5.8.3 of EN 300 220-1 V3.1.1.

Measurement Method	
☒ Conducted measurement	☐ Radiated measurement

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6.5.4 Test Data

Out-of-Band Domain for Operating Channel Emission					
Mode	Test Freq. (MHz)	Measured Frequency (MHz)	Reading (dBm) Tnom(℃) 25 Vnom	Measured Frequencies Range	Limit (dBm)
F_{low}	433.92	433.07695	-67.25	< Fc - 2.5 × OCW	-36.00
		433.67226	-30.33	Fc - 2.5 × OCW to Fc - 0.5 × OCW	-6.02
F_{high}	433.92	434.17214	-30.39	Fc + 0.5 × OCW to Fc + 2.5 × OCW	-6.29
		434.75665	-66.70	> Fc - 2.5 × OCW	-36.00

Out-of-Band Domain for Operating Frequency Band Emission					
Mode	Test Freq. (MHz)	Measured Frequency (MHz)	Reading (dBm) Tnom(℃) 25 Vnom	Measured Frequencies Range	Limit (dBm)
F_{low}	433.92	432.42525	-60.49	< F_L_OFB - 400kHz	-36.00 /10kHz
		432.72553	-69.41	F_L_OFB - 400kHz to F_L_OFB - 200kHz	-36.00
		433.04565	-68.12	F_L_OFB - 200kHz to F_L_OFB	-0.78
F_{high}	433.92	434.86886	-69.02	F_H_OFB to F_H_OFB + 200kHz	-14.19
		434.99676	-69.02	F_H_OFB + 200kHz to F_H_OFB + 400kHz	-36.00
		435.29224	-60.47	> F_H_OFB + 400kHz	-36.00 /10kHz

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6.6 Transient Power

6.6.1 Requirements

Limit of Transient Power

Absolute offset from center frequency	RBW_{REF}	Peak power limit applicable at measurement points
≤ 400 kHz	1 kHz	0 dBm
> 400 kHz	1 kHz	-27 dBm

6.6.2 Test Setup

The test setup has been constructed as the normal use condition. Controlling software (provided by manufacturer) has been activated to set the EUT on specific status.

6.6.3 Test Procedures

Refer to chapter 5.10.3 of EN 300 220-1 V3.1.1.

Measurement Method	
☒ Conducted measurement	☐ Radiated measurement

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6.6.4 Test Data

Test Lowest Frequency: 433.92MHz

Offset from Centre Frequency (MHz)		Reading (dBm)	Limit (dBm)
Fc - 0,5 × OCW - 3kHz	433.7686	-45.03	0
Fc - 12.5kHz or OCW (whichever is the greater)	433.6232	-51.45	0
Fc - 0,5 × OCW - 400kHz	433.3716	-70.02	-27
Fc - 0,5 × OCW - 1200kHz	432.5716	-83.17	-27
Pass/Fail		PASS	

Test Highest Frequency: 433.92MHz

Offset from Centre Frequency (MHz)		Reading (dBm)	Limit (dBm)
Fc + 0,5 × OCW + 3kHz	434.0714	-41.05	0
Fc + 12.5kHz or OCW (whichever is the greater)	434.2169	-50.62	0
Fc + 0,5 × OCW + 400kHz	434.4684	-68.92	-27
Fc + 0,5 × OCW + 1200kHz	435.2684	-82.98	-27
Pass/Fail		PASS	

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6.7 Unwanted emissions in the spurious domain

6.7.1 Requirements

Limits of Transmitter Spurious Emissions

State	Frequency Range		
	47MHz to 74MHz 87.5MHz to 118MHz 174MHz to 230MHz 470MHz to 790MHz	Other Frequencies Below 1GHz	Frequencies Above 1GHz
TX mode	4nW (–54dBm)	250nW (–36dBm)	1μW (–30dBm)
RX and all other modes	2nW (–57dBm)	2nW (–57dBm)	20nW (–47dBm)

6.7.2 Test Setup

1. For the actual test configuration, please refer to the related Item in this test report (Photographs of the Test Configuration).
2. The equipment was configured to operate under its worst case situation with respect to output power.
3. The test setup has been constructed as the normal use condition. Controlling (provided by manufacturer) software has been activated to set the EUT on specific status.

6.7.3 Test Procedures

Refer to chapter 5.9.3 of EN 300 220-1 V3.1.1.

Measurement Method	
☐ Conducted measurement	☒ Radiated measurement

Note:

1. Result value (dBm) = Reading value (dBm) + Correction Factor (dB).
2. Margin(dB) = Result value (dBm) - Limit value (dBm).
3. The other emission levels were very low against the limit.

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6.7.4 Test Data

TX mode

Above 1 GHz

Mode	FSK 433.92M	Channel	0

Polarization	Frequency (MHz)	Reading (dBm)	Correct dB	Result (dBm)	Limit (dBm)	Margin (dB)	Remark
Horizontal	1756.833	-56.36	4.96	-51.40	-30.00	-21.40	PK
	2394.000	-57.41	7.37	-50.04	-30.00	-20.04	PK
	2818.000	-59.57	8.13	-51.44	-30.00	-21.44	PK
	3173.500	-60.53	9.37	-51.16	-30.00	-21.16	PK
	3471.167	-55.90	9.80	-46.10	-30.00	-16.10	PK
	3904.333	-58.33	11.24	-47.09	-30.00	-17.09	PK
Vertical	2170.000	-55.58	6.63	-48.95	-30.00	-18.95	PK
	2396.667	-50.75	7.35	-43.40	-30.00	-13.40	PK
	3037.333	-59.27	9.23	-50.04	-30.00	-20.04	PK
	3470.500	-57.12	9.80	-47.32	-30.00	-17.32	PK
	3904.333	-53.14	11.24	-41.90	-30.00	-11.90	PK
	4339.667	-59.02	12.22	-46.80	-30.00	-16.80	PK

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Below 1 GHz

Mode	FSK 433.92M	Channel	0

Polarization	Frequency (MHz)	Reading (dBm)	Correct dB	Result (dBm)	Limit (dBm)	Margin (dB)	Remark
Horizontal	105.7893	-71.67	-0.16	-71.83	-54.00	-17.83	PK
	326.2703	-71.01	2.66	-68.35	-36.00	-32.35	PK
	553.8970	-71.85	5.93	-65.92	-54.00	-11.92	PK
	631.6910	-72.23	7.13	-65.10	-54.00	-11.10	PK
	764.7749	-71.44	9.32	-62.12	-54.00	-8.12	PK
	897.3740	-66.84	11.08	-55.76	-36.00	-19.76	PK
Vertical	103.2349	-72.52	-0.07	-72.59	-54.00	-18.59	PK
	230.8870	-71.73	1.76	-69.97	-36.00	-33.97	PK
	341.3376	-71.68	3.61	-68.07	-36.00	-32.07	PK
	617.2703	-72.30	7.56	-64.74	-54.00	-10.74	PK
	762.8673	-71.67	9.37	-62.30	-54.00	-8.30	PK
	896.3393	-70.02	11.00	-59.02	-36.00	-23.02	PK

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RX mode

Above 1 GHz

Mode	FSK 433.92M	Channel	0

Polarization	Frequency (MHz)	Reading (dBm)	Correct dB	Result (dBm)	Limit (dBm)	Margin (dB)	Remark
Horizontal	1972.500	-65.63	7.39	-58.24	-47.00	-11.24	PK
	2360.667	-66.01	7.64	-58.37	-47.00	-11.37	PK
	2877.667	-65.02	8.26	-56.76	-47.00	-9.76	PK
	3511.500	-67.65	9.87	-57.78	-47.00	-10.78	PK
	4104.500	-68.97	11.64	-57.33	-47.00	-10.33	PK
	4975.667	-71.23	13.94	-57.29	-47.00	-10.29	PK
Vertical	1327.667	-63.34	4.22	-59.12	-47.00	-12.12	PK
	1962.833	-66.27	7.37	-58.90	-47.00	-11.90	PK
	2399.333	-62.63	7.33	-55.30	-47.00	-8.30	PK
	3439.500	-63.76	9.76	-54.00	-47.00	-7.00	PK
	4010.333	-67.60	11.39	-56.21	-47.00	-9.21	PK
	4010.333	-67.60	11.39	-56.21	-47.00	-9.21	PK
	4961.500	-70.95	13.90	-57.05	-47.00	-10.05	PK

PRE-TEST REPORT

Below 1 GHz

Mode	FSK 433.92M	Channel	0

Polarization	Frequency (MHz)	Reading (dBm)	Correct dB	Result (dBm)	Limit (dBm)	Margin (dB)	Remark
Horizontal	90.3250	-64.53	-2.04	-66.57	-57.00	-9.57	PK
	145.2175	-64.03	-2.76	-66.79	-57.00	-9.79	PK
	227.1500	-68.95	1.58	-67.37	-57.00	-10.37	PK
	307.7500	-68.49	1.87	-66.62	-57.00	-9.62	PK
	392.2173	-68.77	3.78	-64.99	-57.00	-7.99	PK
	437.5224	-69.11	4.98	-64.13	-57.00	-7.13	PK
Vertical	55.2900	-66.82	3.55	-63.27	-57.00	-6.27	PK
	165.4650	-60.42	-2.30	-62.72	-57.00	-5.72	PK
	230.1400	-69.17	1.79	-67.38	-57.00	-10.38	PK
	343.6949	-69.47	3.66	-65.81	-57.00	-8.81	PK
	403.7875	-68.76	4.19	-64.57	-57.00	-7.57	PK
	526.9950	-69.42	5.85	-63.57	-57.00	-6.57	PK

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6.8 Blocking

6.8.1 Requirements

Limit of Receiver Spurious Radiation

Receiver category 1	
Requirement	**Limits**
Blocking at ±2 MHz from Centre Frequency	≥ -20 dBm
Blocking at ±10 MHz from Centre Frequency	≥ -20 dBm
Blocking at ±5 % of Centre Frequency or 15 MHz, whichever is the greater	≥ -20 dBm

Receiver category 1.5	
Requirement	**Limits**
Blocking at ±2 MHz from OC edge f_{high} and f_{low}	≥ -43 dBm
Blocking at ±10 MHz from OC edge f_{high} and f_{low}	≥ -33 dBm
Blocking at ±5 % of Centre Frequency or 15 MHz, whichever is the greater	≥ -33 dBm

Receiver category 2	
Requirement	**Limits**
Blocking at ±2 MHz from OC edge f_{high} and f_{low}	≥ -69 dBm
Blocking at ±10 MHz from OC edge f_{high} and f_{low}	≥ -44 dBm
Blocking at ±5 % of Centre Frequency or 15 MHz, whichever is the greater	≥ -44 dBm

Receiver category 3	
Requirement	**Limits**
Blocking at ±2 MHz from OC edge f_{high} and f_{low}	≥ -80 dBm
Blocking at ±10 MHz from OC edge f_{high} and f_{low}	≥ -60 dBm
Blocking at ±5 % of Centre Frequency or 15 MHz, whichever is the greater	≥ -60 dBm

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6.8.2 Test Setup

1. Testing was performed when the equipment was in a receive-only mode.
2. The test setup has been constructed as the normal use condition. Controlling software (provided by manufacturer) has been activated to set the EUT on specific status.

6.8.3 Test Procedures

Refer to chapter 5.18.6 of EN 300 220-1 V3.1.1.

Measurement Method	
☒ Conducted measurement	☐ Radiated measurement

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6.8.4 Test Data

EUT define Receiver category 2

Test Lowest Frequency: 433.92MHz

Offset from Centre Frequency (MHz)		Minimum Blocking Level (dBm)	Measured Blocking Level (dBm)	Result	Pmin (dBm)
-2 MHz from CF	431.05	-69.00	-36.50	PASS	-92.27
-10 MHz from CF	423.05	-44.00	-25.00	PASS	
-5 % of CF or -15MHz (whichever is the greater)	412.22	-44.00	-20.80	PASS	

Test Highest Frequency: 433.92MHz

Offset from Centre Frequency (MHz)		Minimum Blocking Level (dBm)	Measured Blocking Level (dBm)	Result	Pmin (dBm)
+2 MHz from CF	436.79	-69.00	-36.00	PASS	-92.27
+10 MHz from CF	444.79	-44.00	-20.05	PASS	
+5 % of CF or +15MHz (whichever is the greater)	455.62	-44.00	-19.20	PASS	

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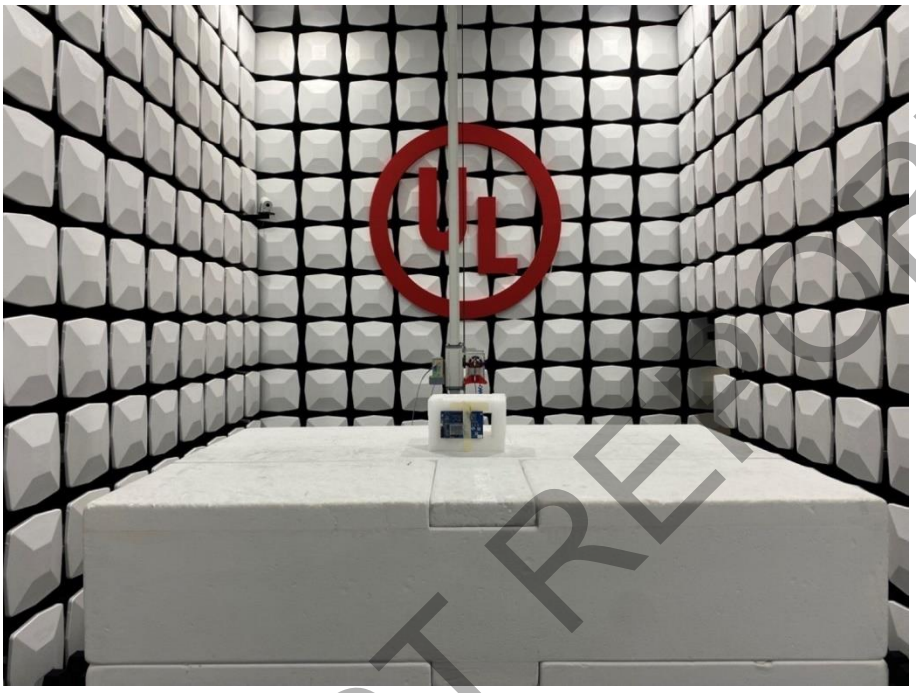
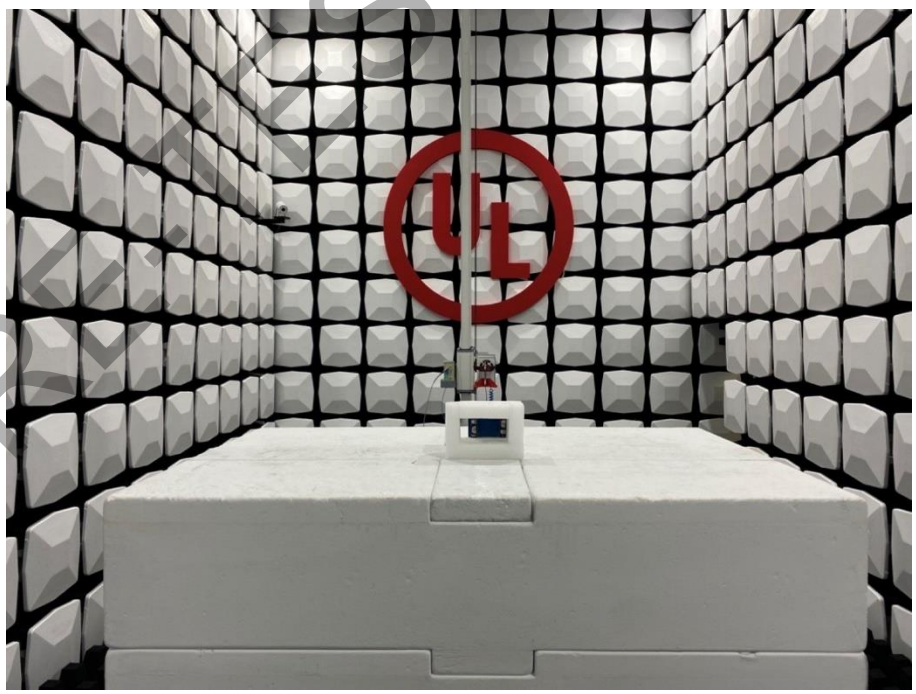
Appendix I Radiated Emission Measurement Setup Configurations

Above 1GHz





PRE-TEST REPORT

Below 1GHz

PRELIMINARY TEST REPORT

END OF REPORT