FCC RADIO TEST REPORT

FCC ID	:	**UZ72119976501**
Equipment	:	**RFID Reader**
Brand Name	:	**ZEBRA**
Model Name	:	**21-199765-01**
Applicant	:	**Zebra Technologies Corporation 1 Zebra Plaza, Holtsville, NY 11742**
Manufacturer	:	**Zebra Technologies Corporation 1 Zebra Plaza, Holtsville, NY 11742**
Standard	:	**FCC Part 15 Subpart C §15.247**

The product was received on Mar. 07, 2024 and testing was performed from Mar. 16, 2024 to Mar. 27, 2024. We, Sporton International Inc. EMC & Wireless Communications Laboratory, would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this partial report apply exclusively to the tested model / sample. Without written approval from Sporton International Inc. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

Louis Wu

Approved by: Louis Wu

Sporton International Inc. EMC & Wireless Communications Laboratory
No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.)

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History of this test report

Report No.	Version	Description	Issue Date
FR430652	01	Initial issue of report	Apr. 03, 2024
FR430652	02	Revise Section 2.1, Section 3.1.5, and Section 3.5.5 This report is an updated version, replacing the report issued on Apr. 03, 2024.	Apr. 09, 2024
FR430652	03	Revise Section 3.5.1 This report is an updated version, replacing the report issued on Apr. 09, 2024.	Apr. 10, 2024

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	15.247(a)(1)	Number of Channels	Pass	-
3.2	15.247(a)(1)	Hopping Channel Separation	Pass	-
3.3	15.247(a)(1)	Dwell Time of Each Channel	Pass	-
3.4	15.247(a)(1)	20dB Bandwidth	Pass	-
3.4	2.1049	99% Occupied Bandwidth	Reporting Only	-
3.5	15.247(b)(2)	Output Power	Pass	-
3.6	15.247(d)	Conducted Band Edges	Pass	-
3.7	15.247(d)	Conducted Spurious Emission	Pass	-
3.8	15.247(d)	Radiated Band Edges and Radiated Spurious Emission	Pass	3.03 dB under the limit at 2781.75 MHz
3.9	15.203 15.247(b)	Antenna Requirement	Pass	-

Conformity Assessment Condition:

1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacturer who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account.
2. The measurement uncertainty please refer to each test result in the section “Measurement Uncertainty”.

Disclaimer:

The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.

Reviewed by: Wei Chen

Report Producer: Rebecca Wu

1 General Description

1.1 Product Feature of Equipment Under Test

Product Feature	
Equipment	RFID Reader
Brand Name	ZEBRA
Model Name	21-199765-01
FCC ID	UZ72119976501
EUT supports Radios application	UHF RFID
HW Version	REV: A
SW Version	3.24.52.0
MFD	16JAN24
EUT Stage	Identical Prototype

Remark: The above EUT's information was declared by manufacturer.

Supported Unit used in test configuration and system				
POE adapter	**Brand Name**	Zebra	**Model Name**	PD-9001GR/AT/AC

1.2 Product Specification of Equipment Under Test

Product Specification is subject to this standard	
Tx/Rx Frequency Range	902.75 MHz ~ 927.25 MHz
Number of Channels	50
Maximum Output Power to Antenna	28.26 dBm (0.6699W)
20dB Bandwidth	0.202 MHz
99% Occupied Bandwidth	0.278 MHz
Antenna Type / Gain	Patch Antenna with gain 7.5 dBi
Type of Modulation	ASK

Remark: The above EUT's information was declared by manufacturer. Please refer to Disclaimer in report summary.

1.3 Modification of EUT

No modifications made to the EUT during the testing.

1.4 Testing Location

Test Site	Sporton International Inc. EMC & Wireless Communications Laboratory
Test Site Location	No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.) TEL: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	**Sporton Site No.**
	03CH07-HY

Note: The test site complies with ANSI C63.4 2014 requirement.

Test Site	Sporton International Inc. Wensan Laboratory
Test Site Location	No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	**Sporton Site No.**
	TH05-HY (TAF Code: 3786)
Remark	The Conducted Spurious Emissions test item subcontracted to Sporton International Inc. Wensan Laboratory.

FCC designation No.: TW1190 and TW3786

1.5 Applicable Standards

According to the specifications declared by the manufacturer, the EUT must comply with the requirements of the following standards:

- FCC Part 15 Subpart C §15.247
- FCC KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02
- FCC KDB 414788 D01 Radiated Test Site v01r01
- ANSI C63.10-2013

Remark:

1. All the test items were validated and recorded in accordance with the standards without any modification during the testing.
2. The TAF code is not including all the FCC KDB listed without accreditation.
3. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

2 Test Configuration of Equipment Under Test

2.1 Carrier Frequency Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
902.75-927.25 MHz	1	902.75	28	916.25
	2	903.25	29	916.75
	3	903.75	30	917.25
	4	904.25	31	917.75
	5	904.75	32	918.25
	6	905.25	33	918.75
	7	905.75	34	919.25
	8	906.25	35	919.75
	9	906.75	36	920.25
	10	907.25	37	920.75
	11	907.75	38	921.25
	12	908.25	39	921.75
	13	908.75	40	922.25
	14	909.25	41	922.75
	15	909.75	42	923.25
	16	910.25	43	923.75
	17	910.75	44	924.25
	18	911.25	45	924.75
	19	911.75	46	925.25
	20	912.25	47	925.75
	21	912.75	48	926.25
	22	913.25	49	926.75
	23	913.75	50	927.25
	24	914.25		
	25	914.75		
	26	915.25		
	27	915.75		

2.2 Test Mode

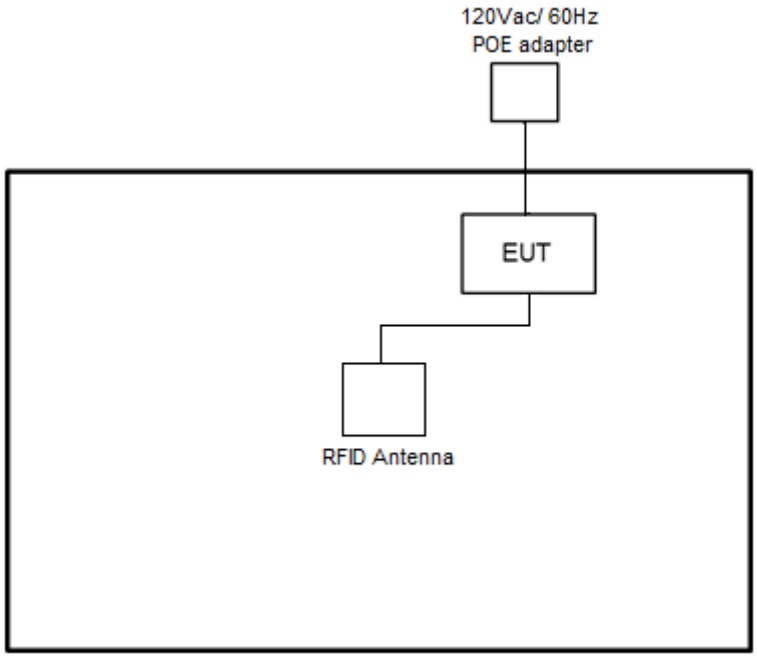
a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, the measured emission level of the EUT was maximized by rotating the EUT on a turntable, adjusting the orientation of the EUT and EUT antenna in three orthogonal axis (X: flat, Y: portrait, Z: landscape), and adjusting the measurement antenna orientation, following C63.10 exploratory test procedures and only the worst case emissions were reported in this report.

The following summary table is showing all test modes to demonstrate in compliance with the standard.

Summary table of Test Cases	
Test Item	**Data Rate / Modulation**
Conducted Test Cases	**Bluetooth – LE / GFSK**
	Mode 1: UHF RFID Tx 902.75 MHz Mode 2: UHF RFID Tx 915.75 MHz Mode 3: UHF RFID Tx 927.25 MHz
Radiated Test Cases	Mode 1: UHF RFID Tx 902.75 MHz Mode 2: UHF RFID Tx 915.75 MHz Mode 3: UHF RFID Tx 927.25 MHz

2.3 Connection Diagram of Test System

<Radiated Spurious Emission Mode>



2.4 EUT Operation Test Setup

The RF test items, utility “Putty 0.70” was installed in Notebook which was programmed in order to make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

2.5 Measurement Results Explanation Example

For all conducted test items:

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

Example :

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

Following shows an offset computation example with cable loss 4.2 dB and 10 dB attenuator.

Offset(dB) = RF cable loss(dB) + attenuator factor(dB).

= 4.2 + 10 = 14.2 (dB)

3 Test Result

3.1 Number of Channel Measurement

3.1.1 Limits of Number of Hopping Frequency

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies.

3.1.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.1.3 Test Procedure

1. The testing follows ANSI C63.10-2013 clause 7.8.3.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings: Span = the frequency band of operation; RBW = 300 kHz; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold.
6. The number of hopping frequency used is defined as the number of total channel.
7. Record the measurement data derived from spectrum analyzer.

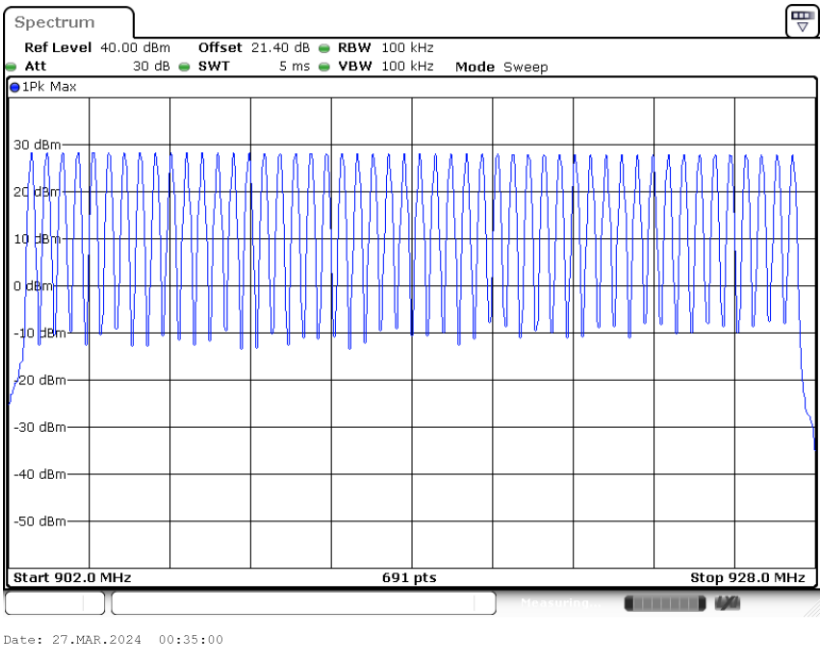
3.1.4 Test Setup

3.1.5 Test Result of Number of Hopping Frequency

Test Mode :	UHF RFID	Temperature :	20~25℃
Test Engineer :	Shiming Liu	Relative Humidity :	50~56%

Number of Hopping (Channel)	Limits (Channel)	Pass/Fail
50	≧50	Pass

Number of Hopping Channel Plot on Channel 00 - 49



3.2 Hopping Channel Separation Measurement

3.2.1 Limit of Hopping Channel Separation

Frequency hopping systems operating in the 902 – 928 MHz band shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

3.2.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

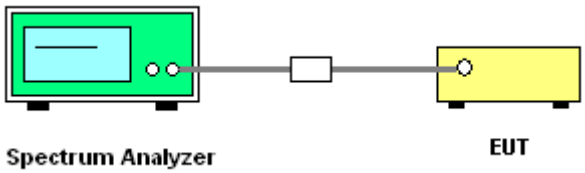
3.2.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.2.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings:

   Span = wide enough to capture the peaks of two adjacent channels;

   RBW = 100 kHz; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold.
6. Measure and record the results in the test report.

3.2.4 Test Setup

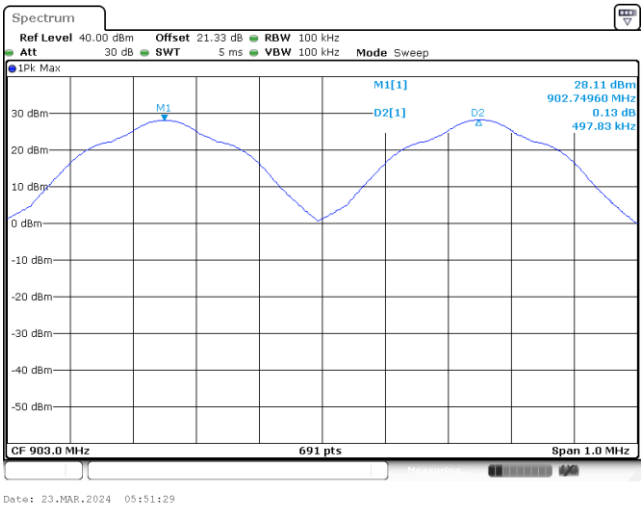


3.2.5 Test Result of Hopping Channel Separation

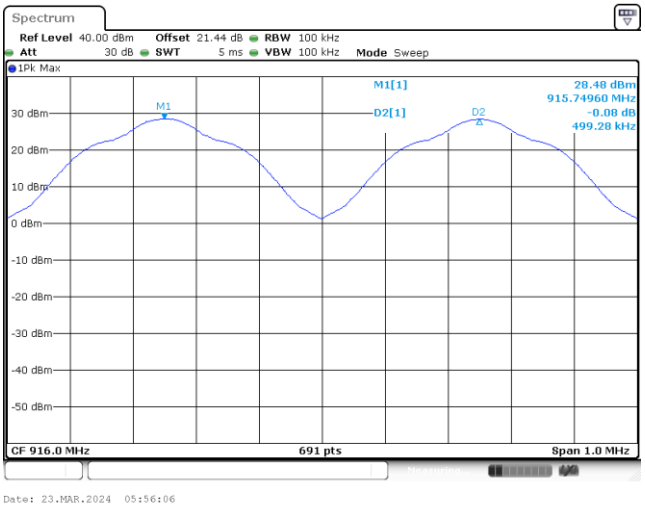
Test Mode :	UHF RFID	Temperature :	20~25℃
Test Engineer :	Shiming Liu	Relative Humidity :	50~56%

Mod.	NTX	Freq. (MHz)	Hopping Channel Separation Measurement (MHz)	Hopping Channel Separation Measurement Limit (MHz)	Pass/Fail
UHF RFID	1	902.75	0.498	0.1956	Pass
UHF RFID	1	915.75	0.499	0.1938	Pass
UHF RFID	1	927.25	0.499	0.2016	Pass

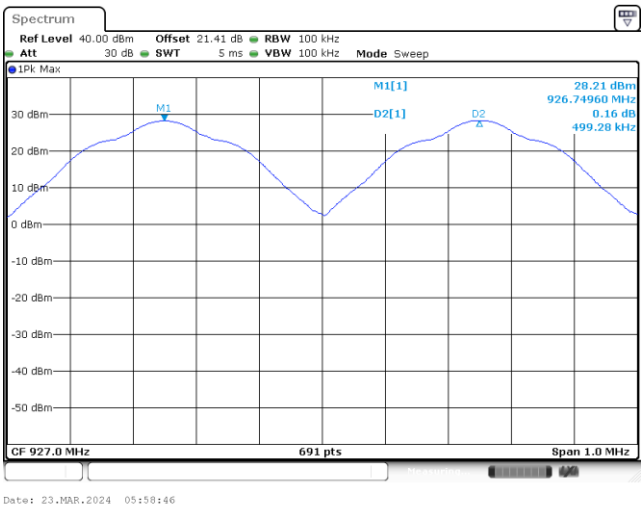
Channel Separation Plot on 902.75 MHz



Channel Separation Plot on 915.75 MHz



Channel Separation Plot on 927.25 MHz



3.3 Dwell Time Measurement

3.3.1 Limit of Dwell Time

If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

3.3.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.3.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.4.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings: Span = zero span, centered on a hopping channel; RBW = 1 MHz; VBW ≥ RBW; Sweep = as necessary to capture the entire dwell time per hopping channel; Detector function = peak; Trace = max hold.
6. Measure and record the results in the test report.

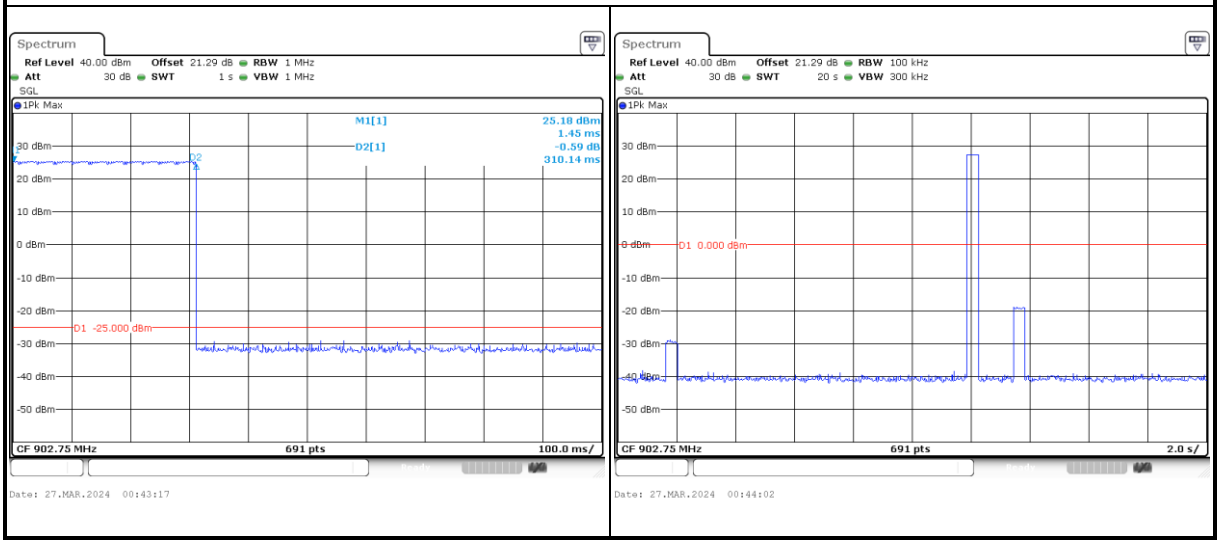
3.3.4 Test Setup

3.3.5 Test Result of Dwell Time

Test Mode :	UHF RFID	Temperature :	20~25℃
Test Engineer :	Shiming Liu	Relative Humidity :	50~56%

Mod.	Channel Number Rate	Package Transfer Time (msec)	Hops Over Occupancy Time (hops)	Dwell Time (sec)	Limits (sec)	Pass/Fail
Nomal	50	310.14	1.00	0.310	0.4	Pass

Package Transfer Time Plot



Remark: Dwell Time(s) = Hops Over Occupancy Time (hops) x Package Transfer Time

3.4 20dB and 99% Bandwidth Measurement

3.4.1 Limit of 20dB and 99% Bandwidth

Reporting only

3.4.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.4.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 6.9.2 and 6.9.3.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Use the following spectrum analyzer settings for 20 dB Bandwidth measurement.

Span = approximately 2 to 5 times the 20 dB bandwidth, centered on a hopping channel;
RBW ≥ 1% of the 20 dB bandwidth; VBW ≥ RBW; Sweep = auto; Detector function = peak;
Trace = max hold.

5. Use the following spectrum analyzer settings for 99 % Bandwidth measurement.

Span = approximately 1.5 to 5 times the 99% bandwidth, centered on a hopping channel;
RBW ≥ 1-5% of the 99% bandwidth; VBW ≥ 3 * RBW; Sweep = auto; Detector function = peak;
Trace = max hold.

6. Measure and record the results in the test report.

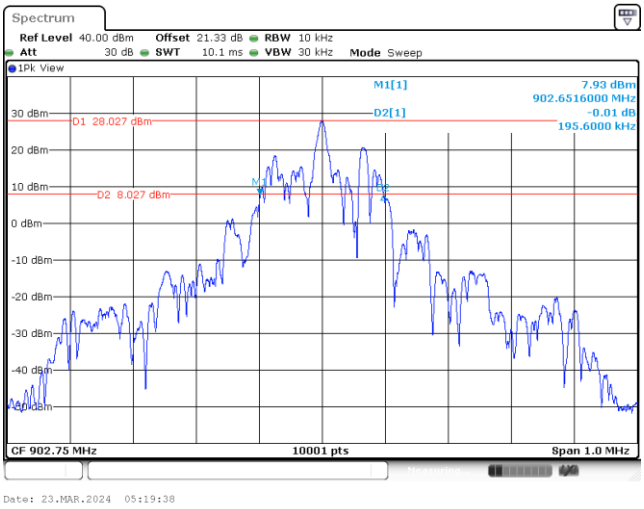
3.4.4 Test Setup

3.4.5 Test Result of 20dB Bandwidth

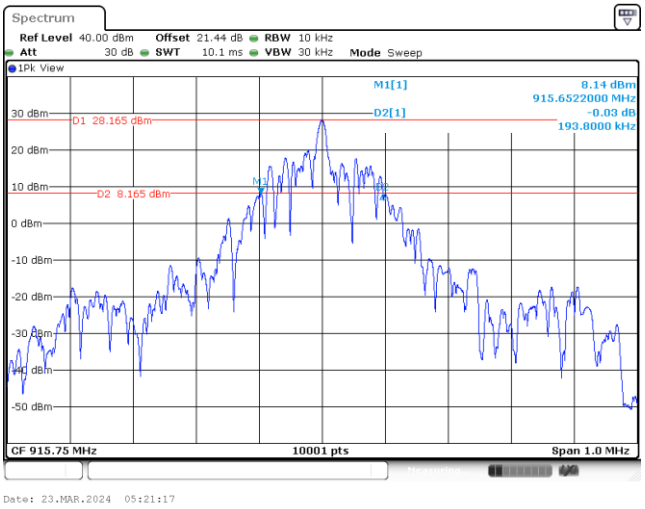
Test Mode :	UHF RFID	Temperature :	20~25℃
Test Engineer :	Shiming Liu	Relative Humidity :	50~56%

Mod.	NTX	Freq.(MHz)	20db BW (MHz)	Pass/Fail
UHF RFID	1	902.75	0.196	Pass
UHF RFID	1	915.75	0.194	Pass
UHF RFID	1	927.25	0.202	Pass

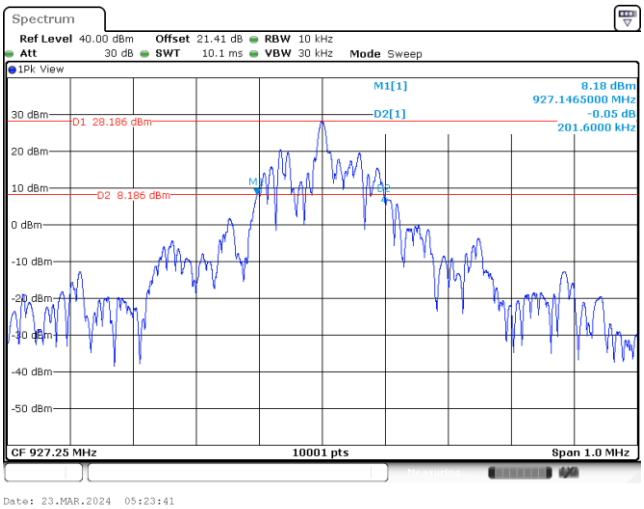
20 dB Bandwidth Plot on 902.75 MHz



20 dB Bandwidth Plot on 915.75 MHz



20 dB Bandwidth Plot on 927.25 MHz

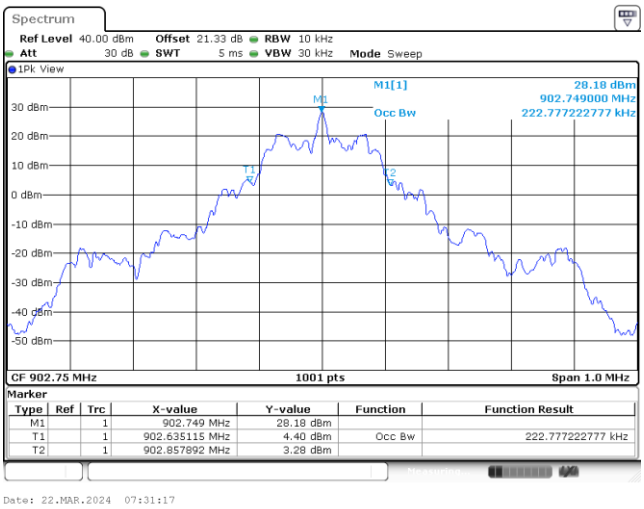


3.4.6 Test Result of 99% Occupied Bandwidth

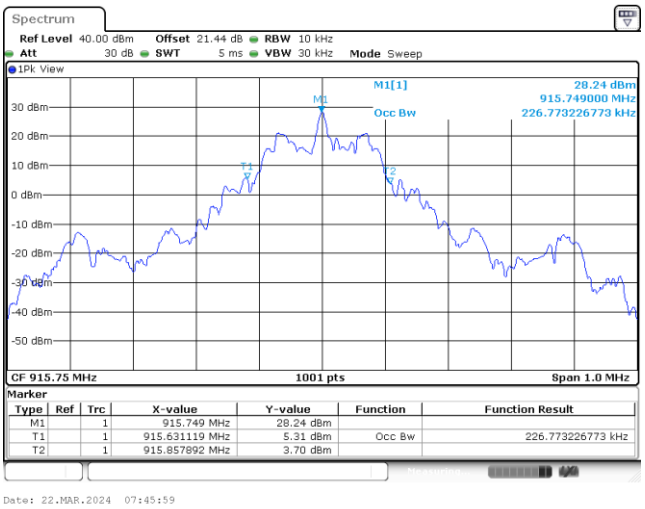
Test Mode :	UHF RFID	Temperature :	20~25℃
Test Engineer :	Shiming Liu	Relative Humidity :	50~56%

Mod.	NTX	Freq. (MHz)	99% Bandwidth (MHz)	Pass/Fail
UHF RFID	1	902.75	0.223	Reporting Only
UHF RFID	1	915.75	0.227	Reporting Only
UHF RFID	1	927.25	0.278	Reporting Only

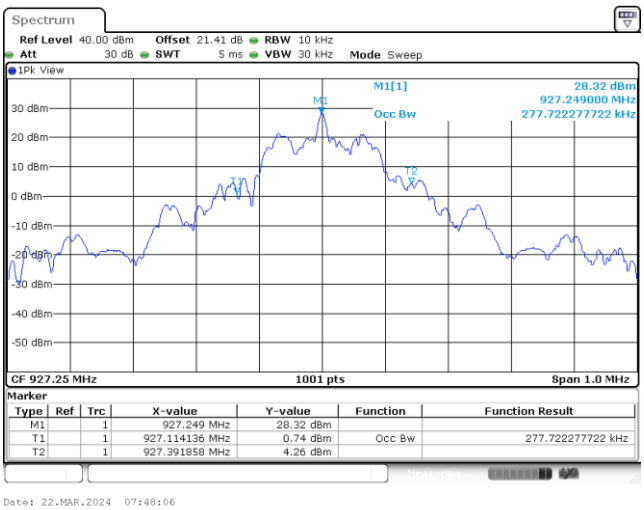
99% Occupied Bandwidth Plot on 902.75 MHz



99% Occupied Bandwidth Plot on 915.75 MHz



99% Occupied Bandwidth Plot on 927.25 MHz



Note: The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

3.5 Output Power Measurement

3.5.1 Limit of Output Power

Section 15.247 (a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions: (1)(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Section 15.247 (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following: (2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

Conducted output power limit specified in paragraph 15.247 (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b) (1), (b) (2), and (b) (3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Power limit reduction = Ant gain – 6dBi
= 7.5dBi – 6dBi
Conducted power limit = 28.5dBm

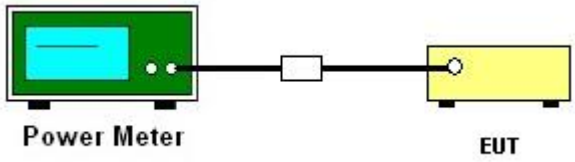
3.5.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.5.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.5.
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Measure the conducted output power with cable loss and record the results in the test report.
5. Measure and record the results in the test report.

3.5.4 Test Setup



3.5.5 Test Result of Output Power

Test Mode :	UHF RFID	Temperature :	20~25℃
Test Engineer :	Shiming Liu	Relative Humidity :	50~56%

Frequency (MHz)	RF Power (dBm)		
	UHF	Max. Limits (dBm)	Pass/Fail
902.75	28.23	28.5	Pass
914.75	28.25	28.5	Pass
927.25	28.26	28.5	Pass

3.6 Conducted Band Edges Measurement

3.6.1 Limit of Band Edges

In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.

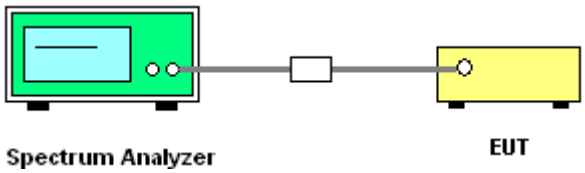
3.6.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.6.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.6.
2. Set the maximum power setting and enable the EUT to transmit continuously.
3. Set RBW = 100 kHz, VBW = 300 kHz. Band edge emissions must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW. The attenuation shall be 30 dB instead of 20 dB when RMS conducted output power procedure is used.
4. Enable hopping function of the EUT and then repeat step 2 and 3.
5. Measure and record the results in the test report.

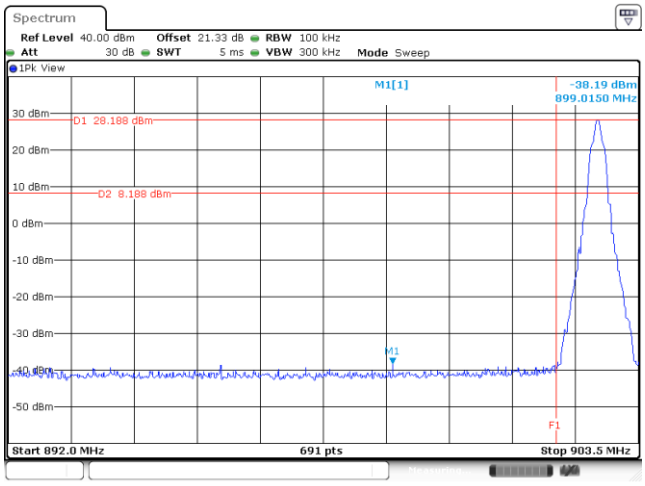
3.6.4 Test Setup



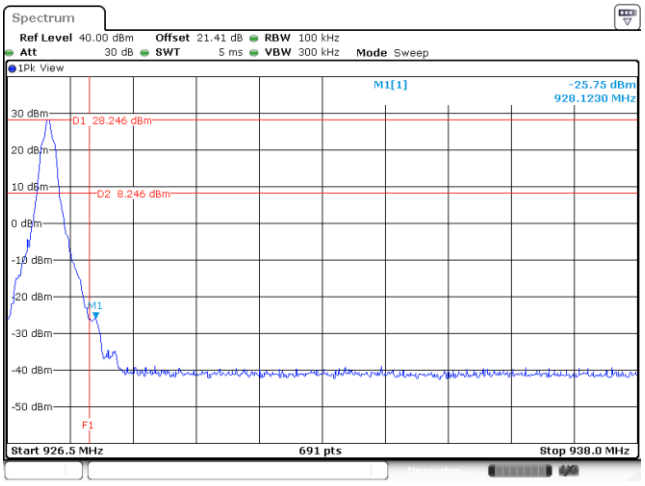
3.6.5 Test Result of Conducted Band Edges

Test Mode :	UHF RFID	Temperature :	20~25℃
Test Engineer :	Shiming Liu	Relative Humidity :	50~56%

Low Band Edge Plot on 902.75 MHz



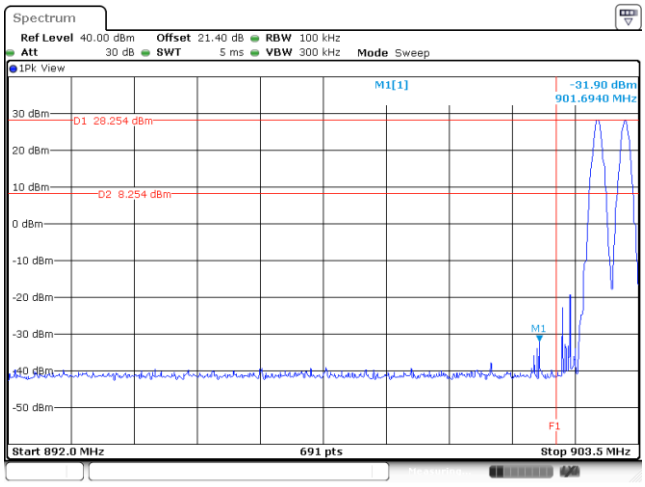
High Band Edge Plot on 927.25 MHz



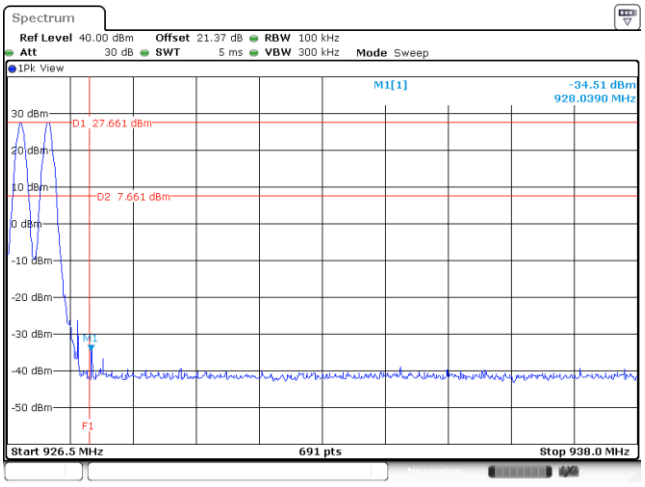
3.6.6 Test Result of Conducted Hopping Mode Band Edges

Test Mode :	UHF RFID	Temperature :	20~25℃
Test Engineer :	Shiming Liu	Relative Humidity :	50~56%

Hopping Mode Low Band Edge Plot on 902.75 MHz



Hopping Mode Low Band Edge Plot on 927.25 MHz



3.7 Conducted Spurious Emission Measurement

3.7.1 Limit of Spurious Emission Measurement

In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.

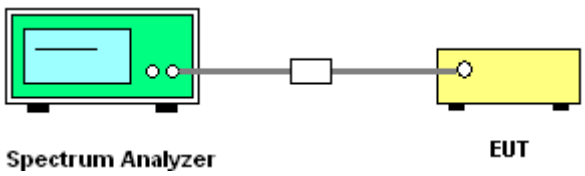
3.7.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.7.3 Test Procedure

1. The testing follows ANSI C63.10-2013 clause 7.8.8.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Set RBW = 100 kHz, VBW = 300 kHz, scan up through 10th harmonic. All harmonics / spurs must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW.
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

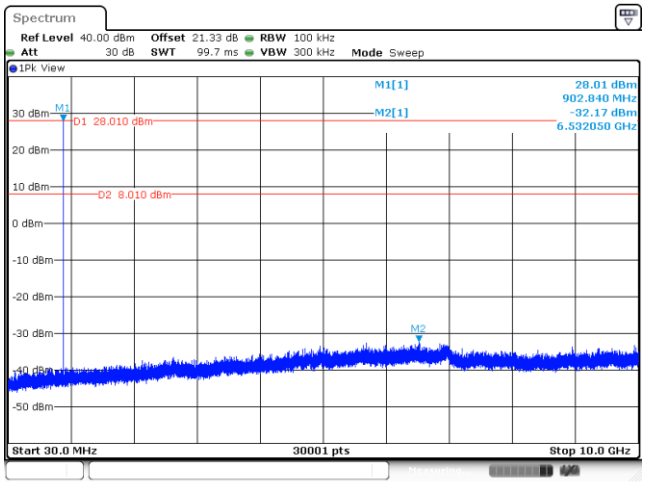
3.7.4 Test Setup



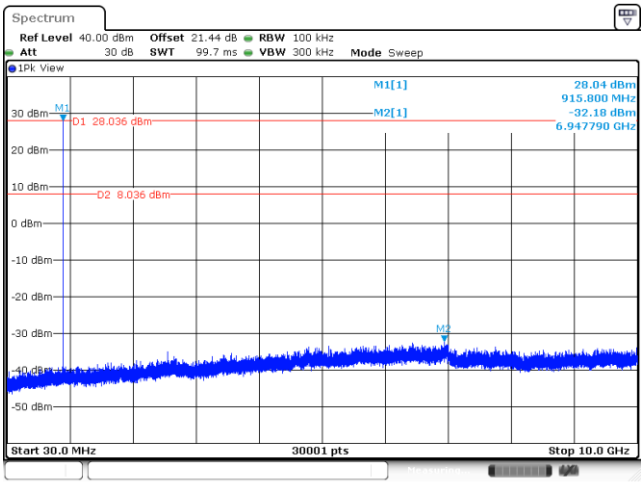
3.7.5 Test Result of Conducted Spurious Emission

Test Mode :	UHF RFID	Temperature :	20~25℃
Test Engineer :	Shiming Liu	Relative Humidity :	50~56%

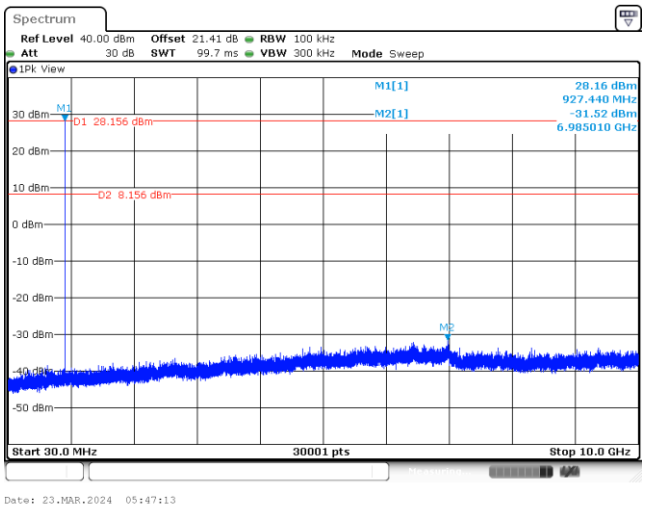
CSE Plot on 902.75 MHz between 30MHz ~ 10 GHz



CSE Plot on 915.75 MHz between 30MHz ~ 10 GHz



CSE Plot on 927.25 MHz between 30MHz ~ 10 GHz



3.8 Radiated Band Edges and Spurious Emission Measurement

3.8.1 Limit of Radiated Band Edges and Spurious Emission

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics / spurious must be at least 20 dB below the highest emission level within the authorized band. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

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

3.8.2 Measuring Instruments

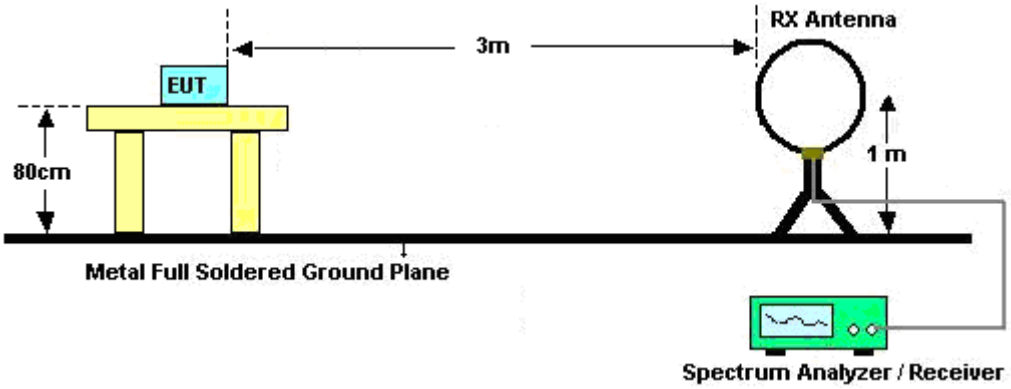
Please refer to the measuring equipment list in this test report.

3.8.3 Test Procedures

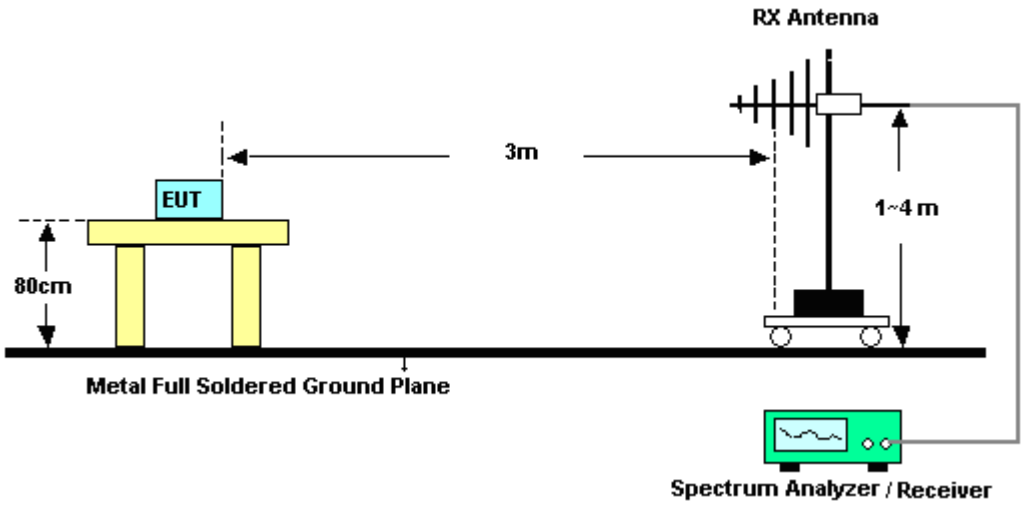
1. The EUT is placed on a turntable with 0.8 meter for frequency below 1 GHz and 1.5 meter for frequency above 1 GHz respectively above ground.
2. The EUT is set 3 meters away from the receiving antenna, which is mounted on the top of a variable height antenna tower.
3. For each suspected emission, the EUT is arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.
4. Set the maximum power setting and enable the EUT to transmit continuously.
5. Use the following spectrum analyzer settings:
   (1) Span shall wide enough to fully capture the emission being measured;
   (2) Set RBW = 100 kHz for f < 1 GHz, RBW = 1 MHz for f>1 GHz ; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold for peak
   (3) For average measurement: use duty cycle correction factor method per 15.35(c).
   Duty cycle = On time/100 milliseconds
   On time = $N_1*L_1+N_2*L_2+...+N_{n-1}*LN_{n-1}+N_n*L_n$
   Where N_1 is number of type 1 pulses, L_1 is length of type 1 pulses, etc.
   Average Emission Level = Peak Emission Level + 20*log (Duty cycle)
6. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
7. Radiated testing below 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading. When there is no suspected emission found and the emission level is with at least 6 dB margin against QP limit line, the position is marked as "-".
8. Radiated testing above 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading for scanning all frequencies. When there is no suspected emission found and the harmonic emission level is with at least 6 dB margin against average limit line, the position is marked as "-".

3.8.4 Test Setup

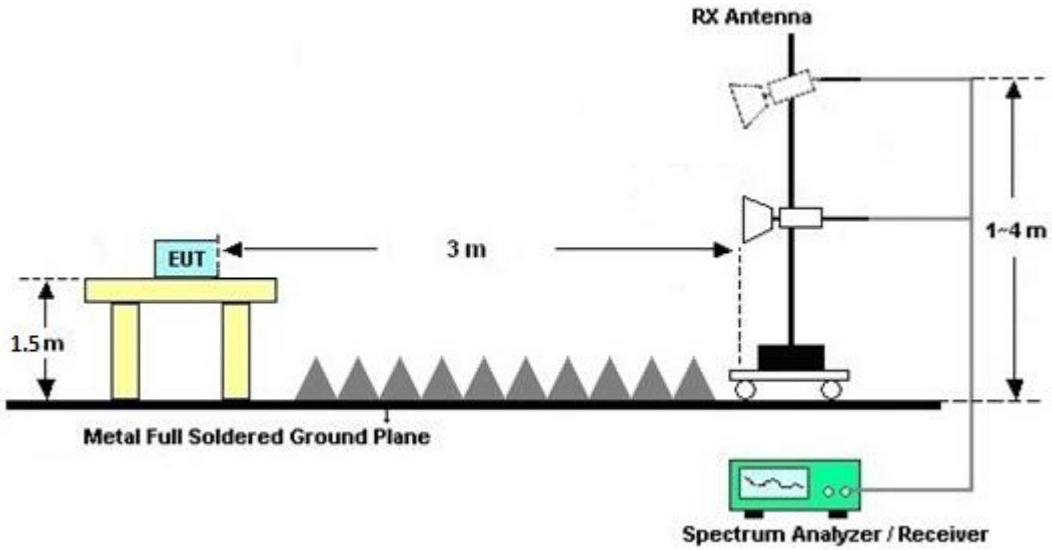
For radiated test below 30MHz



For radiated test from 30MHz to 1GHz



For radiated test above 1GHz



3.8.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

The low frequency, which starts from 9 kHz to 30 MHz, is pre-scanned and the result which is 20 dB lower than the limit line is not reported.

There is adequate comparison measurement of both open-field test site and alternative test site - semi-Anechoic chamber according to 414788 D01 Radiated Test Site v01r01, and the result comes out very similar.

3.8.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix A and B.

3.8.7 Duty Cycle

Please refer to Appendix C.

3.8.8 Test Result of Radiated Spurious Emission

Please refer to Appendix A and B.

3.9 Antenna Requirements

3.9.1 Standard Applicable

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 rule.

3.9.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

4 List of Measuring Equipment

Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Bilog Antenna	TESEQ	CBL 6111D & 00800N1D01N -06	35419 & 03	30MHz~1GHz	Apr. 23, 2023	Mar. 20, 2024~ Mar. 21, 2024	Apr. 22, 2024	Radiation (03CH07-HY)
Double Ridge Horn Antenna	ETS-Lindgren	3117	00075962	1GHz ~ 18GHz	Nov. 27, 2023	Mar. 20, 2024~ Mar. 21, 2024	Nov. 26, 2024	Radiation (03CH07-HY)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100315	9 kHz~30 MHz	Feb. 23, 2024	Mar. 20, 2024~ Mar. 21, 2024	Feb. 22, 2025	Radiation (03CH07-HY)
Preamplifier	MITEQ	AMF-7D-0010 1800-30-10P	1590075	1GHz~18GHz	Apr. 20, 2023	Mar. 20, 2024~ Mar. 21, 2024	Apr. 19, 2024	Radiation (03CH07-HY)
Preamplifier	COM-POWER	PA-103A	161241	10MHz~1GHz	Oct. 02, 2023	Mar. 20, 2024~ Mar. 21, 2024	Oct. 01, 2024	Radiation (03CH07-HY)
Preamplifier	Agilent	8449B	3008A02362	1GHz~26.5GHz	Mar. 24, 2023	Mar. 20, 2024~ Mar. 21, 2024	Mar. 23, 2024	Radiation (03CH07-HY)
Spectrum Analyzer	Agilent	N9030A	MY52350276	3Hz~44GHz	Mar. 28, 2023	Mar. 20, 2024~ Mar. 21, 2024	Mar. 27, 2024	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY28655/4 MY24971/4 MY15682/4	30MHz to 18GHz	Feb. 21, 2024	Mar. 20, 2024~ Mar. 21, 2024	Feb. 20, 2025	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY28655/4 MY24971/4	9kHz to 30MHz	Feb. 21, 2024	Mar. 20, 2024~ Mar. 21, 2024	Feb. 20, 2025	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 126	532078/126E	30MHz~18GHz	Sep. 15, 2023	Mar. 20, 2024~ Mar. 21, 2024	Sep. 14, 2024	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	801606/2	9KHz ~ 40GHz	Apr. 20, 2023	Mar. 20, 2024~ Mar. 21, 2024	Apr. 19, 2024	Radiation (03CH07-HY)
Controller	EMEC	EM1000	N/A	Control Ant Mast	N/A	Mar. 20, 2024~ Mar. 21, 2024	N/A	Radiation (03CH07-HY)
Controller	MF	MF-7802	N/A	Control Turn table	N/A	Mar. 20, 2024~ Mar. 21, 2024	N/A	Radiation (03CH07-HY)
Antenna Mast	EMEC	AM-BS-4500E	N/A	Boresight mast 1M~4M	N/A	Mar. 20, 2024~ Mar. 21, 2024	N/A	Radiation (03CH07-HY)
Turn Table	ChainTek	Chaintek 3000	N/A	0~360 Degree	N/A	Mar. 20, 2024~ Mar. 21, 2024	N/A	Radiation (03CH07-HY)
Software	Audix	E3	N/A	N/A	N/A	Mar. 20, 2024~ Mar. 21, 2024	N/A	Radiation (03CH07-HY)
USB Data Logger	TECPEL	TR-32	HE17XD1148	N/A	Nov. 02, 2023	Mar. 20, 2024~ Mar. 21, 2024	Nov. 01, 2024	Radiation (03CH07-HY)
Hygrometer	TECPEL	DTM-303A	TP201996	N/A	Nov. 07, 2023	Mar. 16, 2024~ Mar. 27, 2024	Nov. 06, 2024	Conducted (TH05-HY)
Power Meter	Anritsu	ML2495A	1036004	N/A	Jul. 27, 2023	Mar. 16, 2024~ Mar. 27, 2024	Jul. 26, 2024	Conducted (TH05-HY)
Power Sensor	Anritsu	MA2411B	1027253	300MHz~40GHz	Jul. 27, 2023	Mar. 16, 2024~ Mar. 27, 2024	Jul. 26, 2024	Conducted (TH05-HY)
Signal Analyzer	Rohde & Schwarz	FSV40	101566	10Hz~40GHz	Aug. 23, 2023	Mar. 16, 2024~ Mar. 27, 2024	Aug. 22, 2024	Conducted (TH05-HY)

5 Measurement Uncertainty

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**6.3 dB**

Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**4.6 dB**

Appendix A. Radiated Spurious Emission

Test Engineer :	Stan Hsieh and Ken Wu	Temperature :	20.6~22.3°C
		Relative Humidity :	40.7~48.8%

UHF RFID

RFID (Band Edge @ 3m)

UHF RFID	Note	Frequency	Level	Margin	Limit Line	Read Level	Antenna Factor	Path Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
RFID 902.75MHz		48.09	31.31	-8.69	40	44.71	15.18	1.34	29.92	-	-	P	H
		69.42	29.55	-10.45	40	45.67	12.21	1.58	29.91	-	-	P	H
		174.18	36.51	-6.99	43.5	48.53	15.34	2.47	29.83	-	-	P	H
		360.2	36.83	-9.17	46	42.57	20.66	3.41	29.81	-	-	P	H
		411.3	37.42	-8.58	46	41.25	22.36	3.62	29.81	-	-	P	H
		554.8	38.37	-7.63	46	38.42	25.45	4.22	29.72	-	-	P	H
	*	902.75	119.96	-	-	114.92	28.59	5.28	28.83	128	0	P	H
													H
													H
													H
													H
													H
		35.67	35.57	-4.43	40	42.66	21.67	1.16	29.92	100	0	Q	V
		69.69	33.7	-6.3	40	49.78	12.24	1.59	29.91	-	-	P	V
		176.88	35.78	-7.72	43.5	47.94	15.18	2.49	29.83	-	-	P	V
		413.4	39.32	-6.68	46	43.07	22.43	3.63	29.81	-	-	P	V
		563.2	38.73	-7.27	46	38.38	25.84	4.24	29.73	-	-	P	V
		628.3	32.45	-13.55	46	31.71	26	4.46	29.72	-	-	P	V
	*	902.75	118.33	-	-	113.29	28.59	5.28	28.83	200	36	P	V
													V
													V
													V
													V

UHF RFID	Note	Frequency (MHz)	Level (dBµV/m)	Margin (dB)	Limit Line (dBµV/m)	Read Level (dBµV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
RFID 915.75MHz		47.82	32.26	-7.74	40	45.51	15.33	1.34	29.92	-	-	P	H
		70.23	30.69	-9.31	40	46.75	12.26	1.59	29.91	-	-	P	H
		173.37	36.7	-6.8	43.5	48.69	15.38	2.46	29.83	-	-	P	H
		405.7	39.87	-6.13	46	44.01	22.09	3.59	29.82	-	-	P	H
		552	39.14	-6.86	46	39.6	25.04	4.21	29.71	-	-	P	H
		620.6	35.58	-10.42	46	35.2	25.68	4.44	29.74	-	-	P	H
	*	915.75	120.18	-	-	114.89	28.77	5.31	28.79	127	0	P	H
													H
													H
													H
													H
													H
		35.4	35.19	-4.81	40	42.15	21.8	1.16	29.92	100	9	Q	V
		70.5	33.33	-6.67	40	49.38	12.26	1.6	29.91	-	-	P	V
		177.42	36.8	-6.7	43.5	48.99	15.15	2.49	29.83	-	-	P	V
		407.1	39.66	-6.34	46	43.72	22.16	3.6	29.82	-	-	P	V
		547.1	39.07	-6.93	46	40.21	24.39	4.19	29.72	-	-	P	V
		640.9	31.97	-14.03	46	30.86	26.29	4.5	29.68	-	-	P	V
	*	915.75	118.34	-	-	113.05	28.77	5.31	28.79	210	31	P	V
													V
													V
													V
													V
													V

UHF RFID	Note	Frequency (MHz)	Level (dBμV/m)	Margin (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
RFID 927.25MHz		48.09	33.58	-6.42	40	46.98	15.18	1.34	29.92	-	-	P	H
		70.23	28.92	-11.08	40	44.98	12.26	1.59	29.91	-	-	P	H
		173.37	36.56	-6.94	43.5	48.55	15.38	2.46	29.83	-	-	P	H
		356	40	-6	46	45.92	20.49	3.39	29.8	-	-	P	H
		576.5	38.46	-7.54	46	38.32	25.61	4.29	29.76	-	-	P	H
		671.7	36	-10	46	34.8	26.23	4.6	29.63	-	-	P	H
	*	927.25	120.5	-	-	114.71	29.2	5.34	28.75	141	8	P	H
													H
													H
													H
													H
													H
		35.94	35.47	-4.53	40	42.69	21.54	1.16	29.92	100	28	Q	V
		71.04	32.21	-7.79	40	48.26	12.26	1.6	29.91	-	-	P	V
		173.1	36.97	-6.53	43.5	48.95	15.39	2.46	29.83	-	-	P	V
		411.3	39.53	-6.47	46	43.36	22.36	3.62	29.81	-	-	P	V
		559.7	39.41	-6.59	46	39.02	25.89	4.23	29.73	-	-	P	V
		699.7	33.08	-12.92	46	31.75	26.25	4.68	29.6	-	-	P	V
	*	927.25	118.41	-	-	112.62	29.2	5.34	28.75	207	341	P	V
													V
													V
													V
													V
													V

Remark

1. No other spurious found.
2. All results are PASS against limit line.
3. Non restricted band limit is radio frequency level down 20db.
4. The emission position marked as "-" means no suspected emission found and emission level has at least 6dB margin against limit or emission is noise floor only.

UHF RFID

RFID (Harmonic @ 3m)

UHF RFID	Note	Frequency (MHz)	Level (dBµV/m)	Margin (dB)	Limit Line (dBµV/m)	Read Level (dBµV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
RFID 902.75MHz		2708.25	52.25	-21.75	74	69.29	32.33	9.59	58.96	177	344	P	H
		2708.25	50.47	-3.53	54	67.51	32.33	9.59	58.96	177	344	A	H
		3611	41.31	-32.69	74	57.13	32.77	10.84	59.43	-	-	P	H
		4513.75	43.02	-30.98	74	56.28	33.98	12.29	59.53	-	-	P	H
		5416.5	41.29	-32.71	74	50.43	34.73	13.33	57.2	-	-	P	H
		8124.75	41.2	-32.8	74	46.82	36	15.87	57.49	-	-	P	H
		9027.5	43.29	-30.71	74	48.94	36.15	16.83	58.63	-	-	P	H
		2708.25	50.71	-23.29	74	67.75	32.33	9.59	58.96	300	165	P	V
		2708.25	48.64	-5.36	54	65.68	32.33	9.59	58.96	300	165	A	V
		3611	41.82	-32.18	74	57.64	32.77	10.84	59.43	-	-	P	V
		4513.75	44.93	-29.07	74	58.19	33.98	12.29	59.53	-	-	P	V
		5416.5	41.34	-32.66	74	50.48	34.73	13.33	57.2	-	-	P	V
		8124.75	41.03	-32.97	74	46.65	36	15.87	57.49	-	-	P	V
		9027.5	42.97	-31.03	74	48.62	36.15	16.83	58.63	-	-	P	V
RFID 914.75MHz		2747.25	50.05	-23.95	74	67.12	32.2	9.68	58.95	306	295	P	H
		2747.25	47.72	-6.28	54	64.79	32.2	9.68	58.95	306	295	P	H
		3663	42.63	-31.37	74	58.17	33.03	10.88	59.45	-	-	P	H
		4578.75	45.45	-28.55	74	58.2	34.26	12.41	59.42	-	-	P	H
		7326	42.65	-31.35	74	49.09	35.8	15.34	57.58	-	-	P	H
		8241.75	42.48	-31.52	74	48.24	35.82	15.93	57.51	-	-	P	H
		9157.5	42.7	-31.3	74	48.11	36.19	17.26	58.86	-	-	P	H
		2747.25	52.44	-21.56	74	69.51	32.2	9.68	58.95	218	319	P	V
		2747.25	50.68	-3.32	54	67.75	32.2	9.68	58.95	218	319	P	V
		3663	44.97	-29.03	74	60.51	33.03	10.88	59.45	-	-	P	V
		4578.75	44.42	-29.58	74	57.17	34.26	12.41	59.42	-	-	P	V
		7326	42.28	-31.72	74	48.72	35.8	15.34	57.58	-	-	P	V
		8241.75	43.57	-30.43	74	49.33	35.82	15.93	57.51	-	-	P	V
		9157.5	44.16	-29.84	74	49.57	36.19	17.26	58.86	-	-	P	V

UHF RFID	Note	Frequency (MHz)	Level (dBµV/m)	Margin (dB)	Limit Line (dBµV/m)	Read Level (dBµV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
		2781.75	50.68	-23.32	74	67.57	32.3	9.75	58.94	200	344	P	H
		2781.75	48.96	-5.04	54	65.85	32.3	9.75	58.94	200	344	A	H
		3709	41.04	-32.96	74	56.48	33.12	10.91	59.47	-	-	P	H
		4636.25	43.85	-30.15	74	56.53	34.15	12.49	59.32	-	-	P	H
		7418	42.3	-31.7	74	48.89	35.66	15.42	57.67	-	-	P	H
		8345.25	42.64	-31.36	74	48.47	35.7	16	57.53	-	-	P	H
RFID													
927.25MHz		2781.75	53.01	-20.99	74	69.9	32.3	9.75	58.94	209	324	P	V
		2781.75	50.97	-3.03	54	67.86	32.3	9.75	58.94	209	324	A	V
		3709	44.2	-29.8	74	59.64	33.12	10.91	59.47	-	-	P	V
		4636.25	45.36	-28.64	74	58.04	34.15	12.49	59.32	-	-	P	V
		7418	43.68	-30.32	74	50.27	35.66	15.42	57.67	-	-	P	V
		8345.25	43.63	-30.37	74	49.46	35.7	16	57.53	-	-	P	V

Remark

1. No other spurious found.
2. All results are PASS against Peak and Average limit line.
3. Non restricted band limit is radio frequency level down 20db.
4. The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only.

Note symbol

*	**Fundamental Frequency** which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is **Margin** line.
P/A	**P**eak or **A**verage
H/V	**H**orizontal or **V**ertical

A calculation example for radiated spurious emission is shown as below:

UHF RFID	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
UHF RFID		2781.75	50.68	-23.32	74	67.57	32.3	9.75	58.94	200	344	P	H
927.25MHz		2781.75	48.96	-5.04	54	65.85	32.3	9.75	58.94	200	344	A	H

1. Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)
2. Level(dBμV/m) =

Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

3. Margin(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)

= 55.45 (dBμV/m)

2. Margin(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 55.45(dBμV/m) – 74(dBμV/m)

= -18.55(dB)

For Average Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 42.6(dBμV) – 35.86 (dB)

= 43.54 (dBμV/m)

2. Margin(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 43.54(dBμV/m) – 54(dBμV/m)

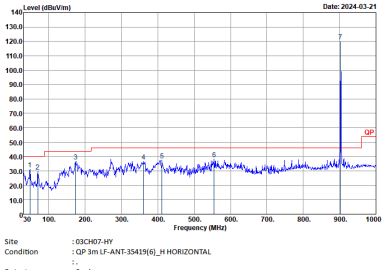
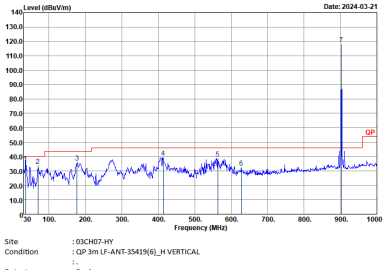
= -10.46(dB)

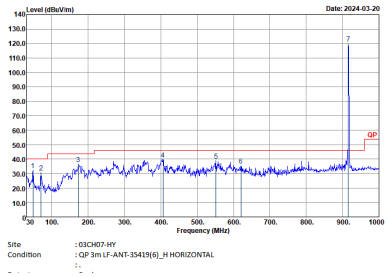
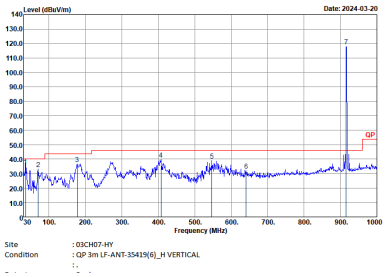
Both peak and average measured complies with the limit line, so test result is “PASS”.

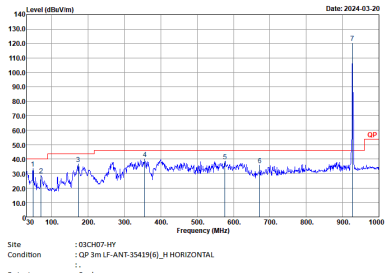
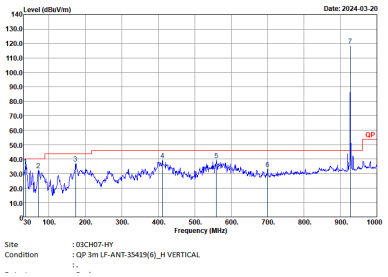
Appendix B. Radiated Spurious Emission Plots

Test Engineer :	Stan Hsieh and Ken Wu	**Temperature :**	20.6~22.3°C
		Relative Humidity :	40.7~48.8%

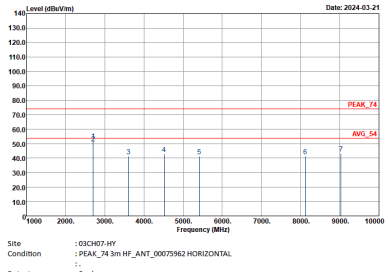
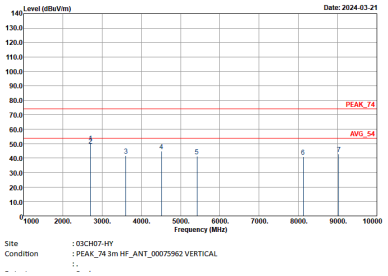
RFID (Band Edge @ 3m)

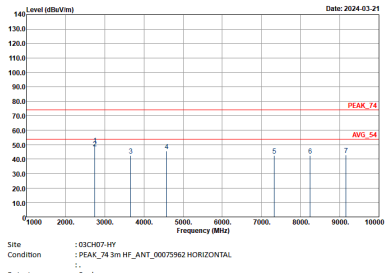
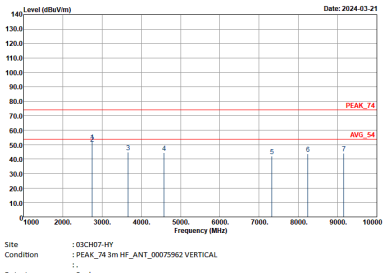
RFID	**RFID**	
	RFID 902.75MHz	
	Horizontal	**Vertical**
QP / Peak		

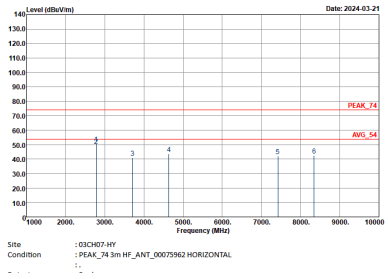
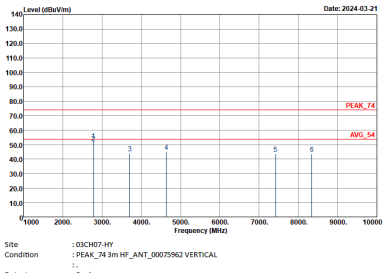
RFID	RFID	
	RFID 915.75MHz	
	Horizontal	Vertical
QP / Peak		

RFID	RFID	
	RFID 927.25MHz	
	Horizontal	Vertical
Peak Avg.		

RFID (Harmonic @ 3m)

RFID	RFID	
	RFID 902.75MHz	
	Horizontal	Vertical
Peak Avg.		

RFID	RFID	
	RFID 915.75MHz	
	Horizontal	Vertical
Peak Avg.		

RFID	RFID	
	RFID 927.25MHz	
	Horizontal	Vertical
Peak Avg.		

Appendix C. Duty Cycle Plots

Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
UHF RFID	86.26	49400	0.02	30Hz

UHF RFID