TEST REPORT

FCC/ISED RFID Test for RI23C
Certification

APPLICANT
Panasonic Connect Co.,Ltd.

REPORT NO.
HCT-RF-2406-FI015-R2

DATE OF ISSUE
July 30, 2024

Tested by
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Applicant	**Panasonic Connect Co.,Ltd.** ytv Kyobashi Building, 2-2-33 Shiromi, Chuo-ku, Osaka 540-8553 Japan
Product Name Model Name	RFID Module RI23C
FCC ID IC	ACJ9TGRI23C 216H-CFRI23C
RF Peak Output Power	15.67 dBμV/m @30 m
Frequency of Operation	13.56 MHz
Date of Test	June 04, 2024 ~ June 18, 2024
FCC Classification	Low Power Communication Device Transmitter (DXX)
Test Standard Used	FCC Part 15.225 Subpart C RSS-210 Issue 10_Amendment (April 2020) RSS-Gen Issue 5_Amendment 2 (February 2021)
Location of Test	■ Permanent Testing Lab ☐ On Site Testing Lab (Address: 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Republic of Korea)
Test Results	PASS

REVISION HISTORY

The revision history for this test report is shown in table.

Revision No.	Date of Issue	Description
0	June 21, 2024	Initial Release
1	July 23, 2024	- Revised the antenna requirements (page.8) - Added the note for all simultaneous transmission scenarios (page.20)
2	July 30, 2024	- Revised the note for all simultaneous transmission scenarios (page.20) - Revised the operation mode (page.20)

Notice

Content
Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC/ISED Rules under normal use and maintenance. The results shown in this test report only apply to the sample(s), as received, provided by the applicant, unless otherwise stated. The test results have only been applied with the test methods required by the standard(s). The laboratory is not accredited for the test results marked *. Information provided by the applicant is marked **. Test results provided by external providers are marked ***. When confirmation of authenticity of this test report is required, please contact www.hct.co.kr The test results in this test report are not associated with the ((KS Q) ISO/IEC 17025) accreditation by KOLAS (Korea Laboratory Accreditation Scheme) / A2LA (American Association for Laboratory Accreditation) that are under the ILAC (International Laboratory Accreditation Cooperation) Mutual Recognition Agreement (MRA).

CONTENTS

1. EUT DESCRIPTION

Model	RI23C
Additional model	-
EUT Type	RFID Module
Power Supply	DC 10.80 V
Frequency Range	13.56 MHz
Max. RF Output Power	15.67 dBμV/m @30 m
Modulation Type	ASK
PMN (Product Marketing Number)	RI23C
HVIN (Hardware Version Identification Number)	RI23C
FVIN (Firmware Version Identification Number)	N/A
HMN (Host Marketing Name)	CF-33
EUT serial numbers	Radiated : S0P-24-00229

2. TEST METHODOLOGY

The measurement procedure described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) is used in the measurement of the test device.

EUT CONFIGURATION

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

EUT EXERCISE

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.225 under the FCC Rules Part 15 Subpart C.

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the RSS-Gen issue 5, RSS-210 Issue 10.

GENERAL TEST PROCEDURES

Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2 of ANSI C63.10. (Version :2013) Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz using CISPR Quasi-peak and average detector modes.

Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 6.6.5 of ANSI C63.10. (Version: 2013).

DESCRIPTION OF TEST MODES

The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

3. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment, which is traceable to recognized national standards.
Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2017).

4. FACILITIES AND ACCREDITATIONS

FACILITIES

The SAC(Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA. The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22.
Detailed description of test facility was submitted to the Commission and accepted dated March 11, 2024 (Registration Number: KR0032).
For ISED, test facility was accepted dated March 13, 2024 (CAB identifier: KR0032).

EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements.
Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.
All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference Measuring Apparatus and Measurement Methods.”

5. ANTENNA REQUIREMENTS

According to FCC 47 CFR § 15.203:

"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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."

(1) The antennas of this E.U.T are permanently attached.

(2) The E.U.T Complies with the requirement of § 15.203

According to RSS-Gen(Issue 5) Section 6.8:

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

6. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95 % level of confidence.

The measurement data shown herein meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded Uncertainty (dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	1.98 (Confidence level about 95 %, k=2)
Radiated Disturbance (9 kHz ~ 30 MHz)	4.36 (Confidence level about 95 %, k=2)
Radiated Disturbance (30 MHz ~ 1 GHz)	5.70 (Confidence level about 95 %, k=2)
Radiated Disturbance (1 GHz ~ 18 GHz)	5.52 (Confidence level about 95 %, k=2)
Radiated Disturbance (18 GHz ~ 40 GHz)	5.66 (Confidence level about 95 %, k=2)
Radiated Disturbance (Above 40 GHz)	5.58 (Confidence level about 95 %, k=2)

7. DESCRIPTION OF TESTS

7.1. Radiated Test

Limit (Operation within the band 13.110 MHz – 14.010 MHz)

Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (m)
13.553 – 13.567	15,848	30
13.410 ≤ f ≤ 13.553 13.567 ≤ f ≤ 13.710	334	30
13.110 ≤ f ≤ 13.410 13.710 ≤ f ≤ 14.010	106	30

Note:

1. 15,848 μV/m = 84.0dBμV/m
2. 334 μV/m = 50.47 dBμV/m
3. 106μV/m = 40.51dBμV/m

Limit(Radiated Spurious Emissions)(FCC)

Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30	30	30
30-88	※100	3
88-216	※150	3
216-960	※200	3
Above 960	500	3

※:

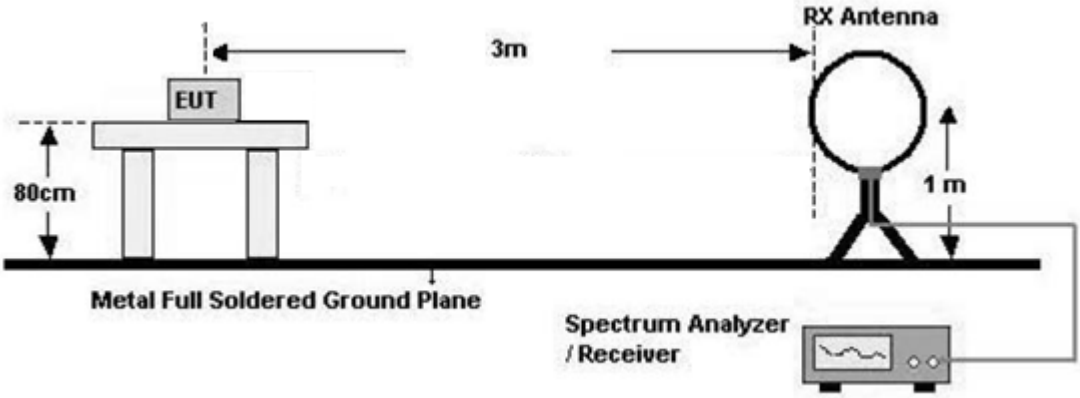
Except as provided in 15.209(g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72MHz, 76-88MHz,174-216MHz or 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g.15.231 and 15.241.

Limit (Radiated Spurious Emissions)(ISED)

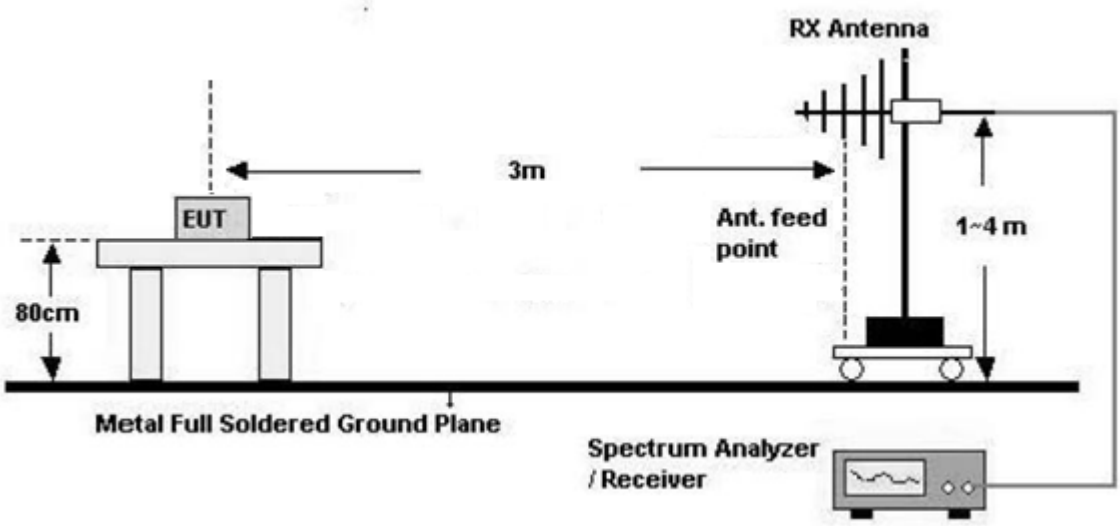
Frequency (MHz)	Field Strength (μA/m)	Measurement Distance (m)
0.009 – 0.490	6.37/F(kHz)	300
0.490 – 1.705	63.7/F(kHz)	30
1.705 – 30	0.08	30

Test Configuration

Below 30 MHz



30 MHz - 1 GHz



Test Procedure of in-band

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The loop antenna was placed at a location 3 m from the EUT
3. The EUT is placed on a turntable, which is 0.8m above ground plane.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization and Parallel to the ground plane in detecting antenna.
5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
6. Distance Correction Factor =40log(3 m/30 m)= - 40 dB
   Measurement Distance : 3 m(Below30 MHz)
7. Spectrum Setting
   1) Frequency Range = 9 kHz ~ 150 kHz
   - Detector = Peak
   - Trace = Maxhold
   - RBW = 300 Hz
   - VBW ≥ 3 x RBW
   2) Frequency Range = 150 kHz ~ 30 MHz
   - Detector = Peak
   - Trace = Maxhold
   - RBW = 10 kHz
   - VBW ≥ 3 x RBW
8. Total = Measured Value + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F)

Test Procedure of Radiated spurious emissions(Below30 MHz)

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The loop antenna was placed at a location 3 m from the EUT
3. The EUT is placed on a turntable, which is 0.8m above ground plane.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization and Parallel to the ground plane in detecting antenna.
5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
6. Distance Correction Factor(0.009 MHz – 0.490 MHz) =40log(3 m/300 m)= - 80 dB
   Measurement Distance : 3 m
7. Distance Correction Factor(0.490 MHz – 30 MHz) =40log(3 m/30 m)= - 40 dB
   Measurement Distance : 3 m
8. Spectrum Setting
   1) Frequency Range = 9 kHz ~ 150 kHz
   - Detector = Peak

- Trace = Maxhold
- RBW = 300 Hz
- VBW ≥ 3 x RBW

2) Frequency Range = 150 kHz ~ 30 MHz
- Detector = Peak
- Trace = Maxhold
- RBW = 10 kHz
- VBW ≥ 3 x RBW

9. Total(Measurement Type : Peak)
= Peak Measured Value + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F)
10. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.

KDB 414788 OFS and Chamber Correlation Justification

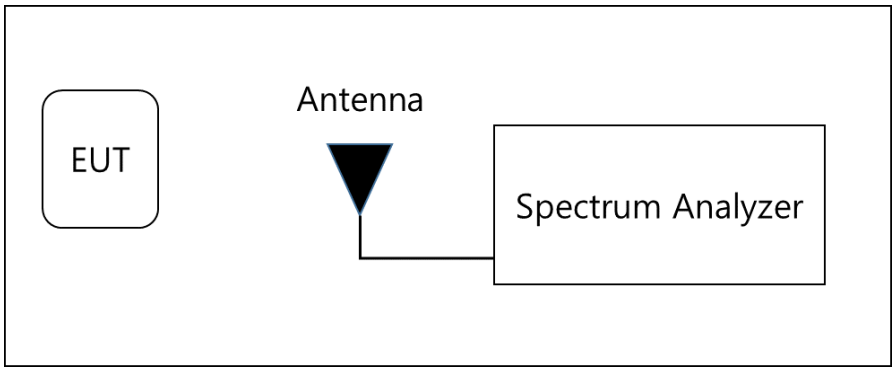
Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.
OFS and chamber correlation testing had been performed and chamber measured test result is the worst case test result.

Test Procedure of Radiated spurious emissions(Above30 MHz)

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The EUT is placed on a turntable, which is 0.8m above ground plane.
3. The Hybrid antenna was placed at a location 3 m from the EUT, which is varied from 1m to 4m to find out the highest emissions.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
6. Spectrum Setting
   - Frequency Range = 30 MHz ~ 1 GHz
   - Detector = Peak
   - Trace = Maxhold
   - RBW = 100 kHz
   - VBW ≥ 3 x RBW
7. Total = Measured Value + Antenna Factor(A.F) + Cable Loss(C.L)
8. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.

7.2. 20 dB Bandwidth

Test Configuration



Test Procedure

The 20 dB bandwidth was measured by using a spectrum analyzer.

(Procedure 6.9.2 in ANSI 63.10-2013)

1) RBW = 1 %~5 % of the OBW
2) VBW = approximately three times RBW
3) Span =between two times and five times the OBW
4) Detector = Peak
5) Trace mode = Max hold
6) Allow the trace to stabilize

Note :

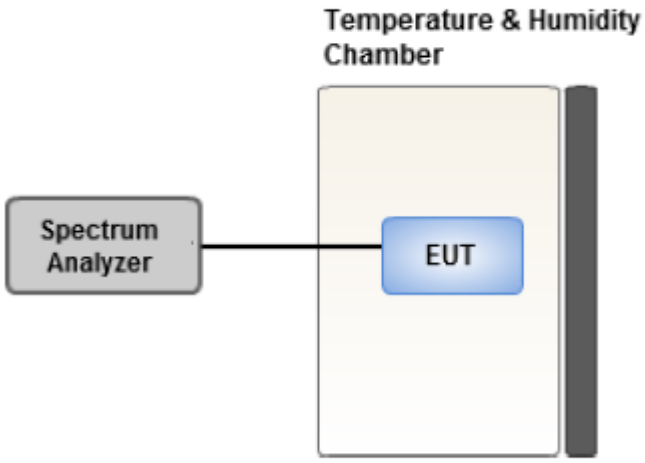
We tested Occupied Bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer.

7.3. Frequency Stability

Limit

The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency.

Test Configuration



Test Procedure.

For battery operated equipment, the equipment tests shall be performed using a new battery.

1) Turn the EUT OFF and place it inside the environmental temperature chamber. For devices that have oscillator heaters, energize only the heater circuit.
2) Set the temperature control on the chamber to the highest specified in the regulatory requirements for the type of device and allow the oscillator heater and the chamber temperature to stabilize.
3) While maintaining a constant temperature inside the environmental chamber, turn the EUT ON and record the operating frequency at startup, and at 2 minutes, 5 minutes, and 10 minutes after the EUT is energized. Four measurements in total are made.
4) The frequency tolerance of the carrier signal shall be maintained within +/- 0.01% of the operating frequency.

Note:

1) Temperature:
The temperature is varied from -20 °C to + 50 °C using an environmental chamber.
2) Primary Supply Voltage :
The primary supply voltage is varied from 85 % to 115 % of the nominal value for non hand-carried battery and AC powered equipment.
For hand-carried, battery-powered equipment, primary supply voltage is reduced to the battery operating end point which shall be specified by the manufacturer.

7.4. AC Power line Conducted Emissions

Limit

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN).

Frequency Range (MHz)	Limits (dBμV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56[(a)]	56 to 46[(a)]
0.50 to 5	56	46
5 to 30	60	50

[(a)]Decreases with the logarithm of the frequency.

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

Test Configuration

See test photographs attached in Annex A for the actual connections between EUT and support equipment.

Test Procedure

1. The EUT is placed on a wooden table 80 cm above the reference ground plane.
2. The EUT is connected via LISN to a test power supply.
3. The measurement results are obtained as described below:
4. Detectors : Quasi Peak and Average Detector.
5. The EUT is the device operating below 30 MHz.
   - For unterminated the Antenna, the AC line conducted tests are performed with the antenna connected
   - For terminated the Antenna, the AC line conducted tests are performed with a dummy load connected to the EUT antenna output terminal.

Sample Calculation

Quasi-peak(Final Result) = Measured Value + Correction Factor

7.5. Receiver Spurious Emissions

Limit

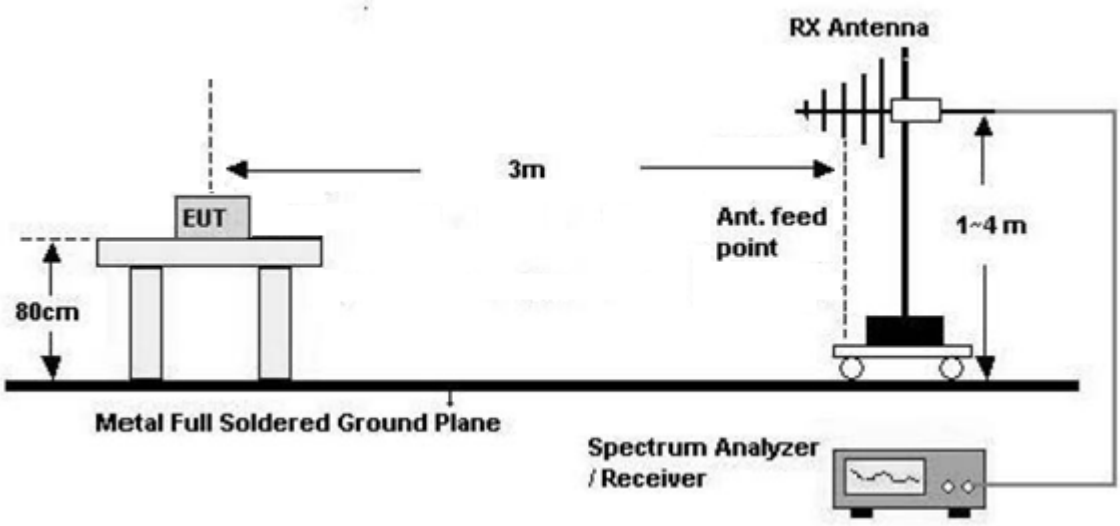
Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (m)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note:

Measurements for compliance with the limits in table may be performed at distances other than 3 metres.

Test Configuration

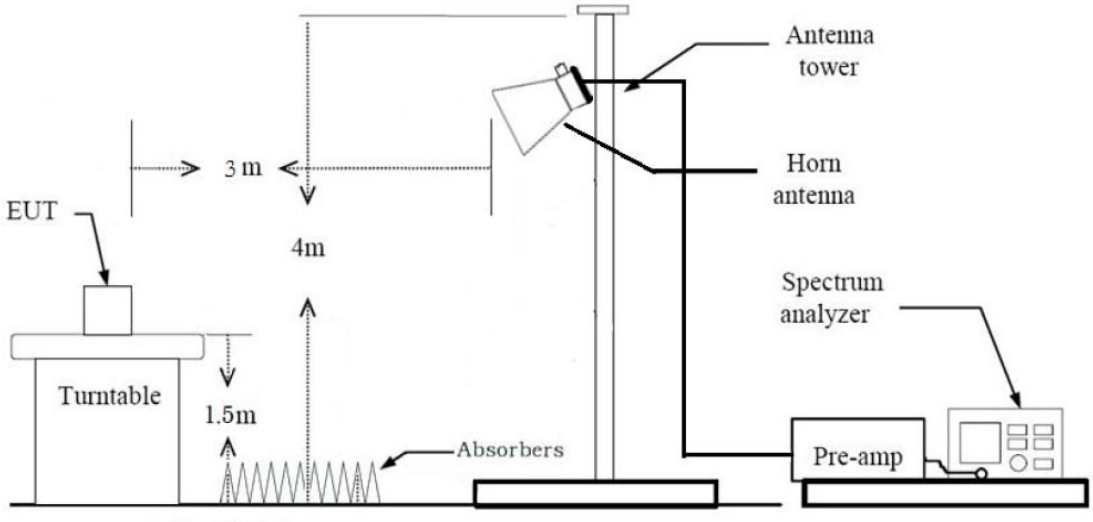
30 MHz - 1 GHz



Test Procedure of Receiver Spurious Emissions (Below 1GHz)

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The EUT is placed on a turntable, which is 0.8m above ground plane.
3. The Hybrid antenna was placed at a location 3m from the EUT, which is varied from 1m to 4m to find out the highest emissions.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
6. Spectrum Setting
   (1) Measurement Type(Peak):
   - Measured Frequency Range : 30 MHz – 1 GHz
   - Detector = Peak
   - Trace = Maxhold
   - RBW = 100 kHz
   - VBW ≥ 3 x RBW
7. Total = Measured Value + Antenna Factor(A.F) + Cable Loss(C.L) – Amp Gain(A.G)

Above 1 GHz



Test Procedure of Radiated spurious emissions (Above 1 GHz)

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
4. EUT is set 3 m away from the receiving antenna, which is varied from 1m to 4m to find out

the highest emissions.

5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. The unit was tested with its standard battery.
8. Spectrum Setting
   (1) Measurement Type(Average):
      - RBW = 1 MHz
      - VBW = 3 MHz
      - Detector = Average(RMS)
      - Trace = Average
      - Trace was allowed to stabilize
9. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
10. Total = Measured Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(A.G) + Distance Factor(D.F)

7.6. Worst case configuration and mode

1. All modes of operation were investigated and the worst case configuration results are reported.
   - Mode : Laptop mode, Tablet mode
   - Modulation : Type A, Type B, FeliCa, ISO15693
   - Worst case : Tablet mode + ISO15693
2. EUT Axis : X
3. All type and bitrate were investigated and the worst case results are reported.
- Worst case : Tablet mode + ISO15693
4. All position of loop antenna were investigated and the worst case configuration results are reported.
   - Position : Horizontal, Vertical, Parallel to the ground plane
   - Worst case : Horizontal
5. All simultaneous transmission scenarios of operation were investigated. WWAN + WLAN 6 GHz simultaneous transmission investigated until 40 GHz. and the test results showed no additional significant emissions relative to the least restrictive limit were observed.

AC Power line Conducted Emissions

1. All modes of operation were investigated and the worst case configuration results are reported.
   - Mode : Laptop mode, Tablet mode
   - Modulation : Type A, Type B, FeliCa, ISO15693
   - Worst case : Tablet mode + ISO15693

20 dB Bandwidth & Frequency Stability

1. All type and bitrate were investigated and the worst case results are reported.

8. TEST SUMMARY

FCC

Regulation	Requirement	Result
Part 15.225 (a)	Radiated Electric Field Emissions (13.553 MHz to 13.567 MHz)	Pass
Part 15.225 (b)	Radiated Electric Field Emissions (13.410 ≤ f ≤ 13.553, 13.567 ≤ f ≤ 13.710)	Pass
Part 15.225 (c)	Radiated Electric Field Emissions (13.110 ≤ f ≤ 13.410, 13.710 ≤ f ≤ 14.010)	Pass
Part 15.209	Radiated Electric Field Emissions (9 kHz to 30 MHz)	Pass
Part 15.209	Radiated Electric Field Emissions (30 MHz to 1 GHz)	Pass
Part 15.225 (e)	Frequency Stability	Pass
Part 15.207	AC power conducted emissions (150 kHz to 30 MHz)	Pass
Part 15.215 (c)	20 dB Bandwidth	Pass

ISED

Test Description	ISED Part Section(s)	Test Result
Radiated Electric Field Emissions (13.553MHz to 13.567MHz)	RSS-210, annex B.6(a)(i)	Pass
Radiated Electric Field Emissions (13.410 ≤ f ≤ 13.553, 13.567 ≤ f ≤ 13.710)	RSS-210, annex B.6(a)(ii)	Pass
Radiated Electric Field Emissions (13.110 ≤ f ≤ 13.410, 13.710 ≤ f ≤ 14.010)	RSS-210, annex B.6(a)(iii)	Pass
Radiated Electric Field Emissions (9kHz to 30MHz)	RSS-GEN, 8.9	Pass
Radiated Electric Field Emissions (30MHz to 1GHz)	RSS-GEN, 8.9	Pass
Frequency Stability	RSS-210, annex B.6(b)	Pass
AC power conducted emissions (150kHz to 30MHz)	RSS-GEN, 8.8	Pass
20 dB Bandwidth	RSS-GEN, 6.7	Pass
Receiver Spurious Emissions	RSS-GEN, 7	Pass

9. TEST RESULT

- Worst Case : ISO 15693

9.1. Operation within the band 13.110 MHz – 14.010 MHz

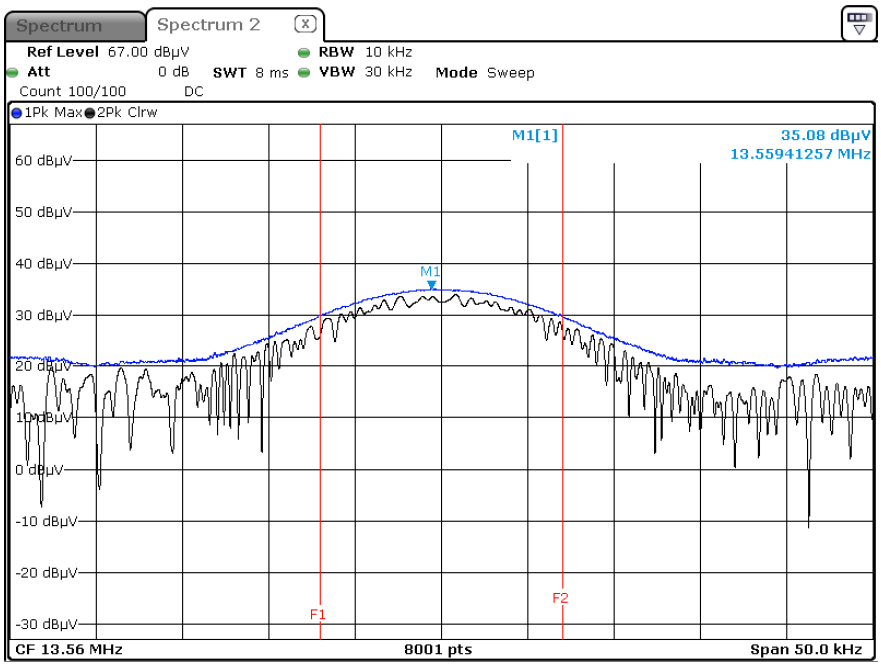
Measured Frequency Range : 13.553 MHz-13.567 MHz							
Frequency (MHz)	Measured Value (dBμV/m) @3 m	Ant. Factor +Cable Loss (dB/m)	Distance Correction (dB)	Ant. POL (H/V)	Total (dBμV/m) @30 m	Limit (dBμV/m) @30 m	Margin (dB)
13.5594	35.08	20.59	-40.00	H	15.67	84.00	68.33
13.5591	31.67	20.59	-40.00	V	12.26	84.00	71.74

Measured Frequency Range : 13.410 MHz-13.553 MHz and 13.567 MHz-13.710 MHz							
Frequency (MHz)	Measured Value (dBμV/m) @3 m	Ant. Factor +Cable Loss (dB/m)	Distance Correction (dB)	Ant. POL (H/V)	Total (dBμV/m) @30 m	Limit (dBμV/m) @30 m	Margin (dB)
13.5529	29.97	20.59	-40.00	H	10.56	50.47	39.91
13.5670	29.56	20.59	-40.00	H	10.15	50.47	40.32

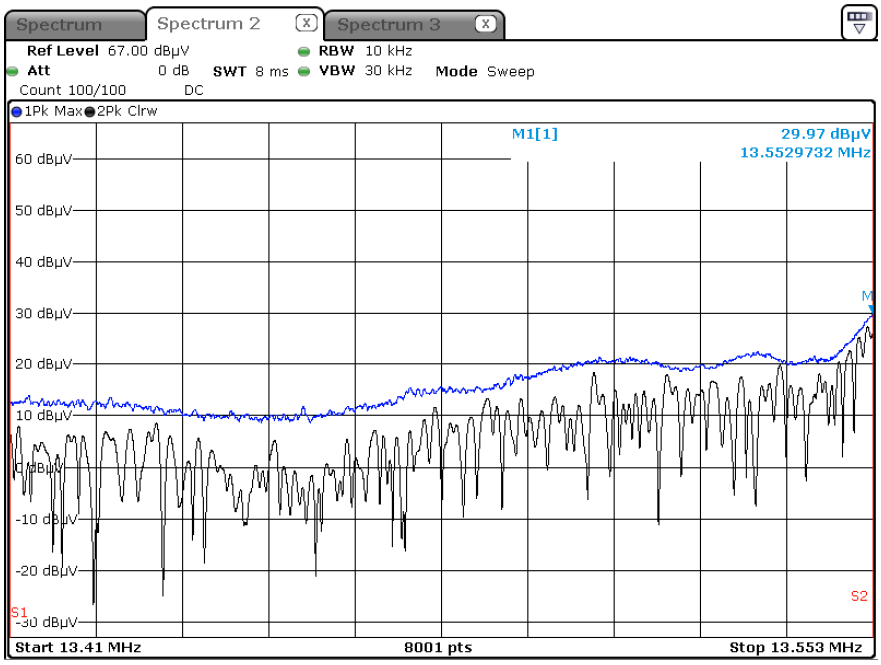
Measured Frequency Range : 13.110 MHz – 13.410 MHz and 13.710 MHz-14.010 MHz							
Frequency (MHz)	Measured Value (dBμV/m) @3 m	Ant. Factor +Cable Loss (dB/m)	Distance Correction (dB)	Ant. POL (H/V)	Total (dBμV/m) @30 m	Limit (dBμV/m) @30 m	Margin (dB)
13.4056	15.28	20.59	-40.00	H	-4.13	40.51	44.64
13.7173	13.22	20.59	-40.00	H	-6.19	40.51	46.70

▣ Test Plot

13.553 MHz ~ 13.567 MHz



Worst Case (13.410 MHz - 13.553 MHz)



Note:

Plot of worst case are only reported.

9.2. Radiated Emission 9kHz – 30 MHz

FCC

Measured Frequency Range : 9 kHz -30 MHz							
Frequency (kHz)	Measured Value (dBµV/m) @3 m	Ant. Factor +Cable Loss (dB/m)	Distance Correction (dB)	Ant. POL (H/V)	Total (dBµV/m) @300 m	Limit (dBµV/m) @300 m	Margin (dB)
9.401	12.12	20.66	-40.00	H	-7.22	29.54	36.76
22.8603	12.71	20.70	-40.00	H	-6.59	29.54	36.13
27.4547	11.46	20.76	-40.00	H	-7.78	29.54	37.32
27.6165	11.26	20.76	-40.00	H	-7.98	29.54	37.52

ISED

Measured Frequency Range : 9 kHz – 30 MHz								
Frequency (MHz)	Measured Value (dBµV/m) @3 m	Ant.Factor + Cable Loss (dB/m)	Distance Correction (dB)	Ant. POL (H/V)	Total (dBµV/m) @30 m	Total (dBµA/m) @30 m	Limit (dBµA/m) @30 m	Margin (dB)
9.401	12.12	20.66	-40.00	H	-7.22	-58.72	-21.94	36.78
22.8603	12.71	20.70	-40.00	H	-6.59	-58.09	-21.94	36.15
27.4547	11.46	20.76	-40.00	H	-7.78	-59.28	-21.94	37.34
27.6165	11.26	20.76	-40.00	H	-7.98	-59.48	-21.94	37.54

Note:

1. dBµA/m = dBµV/m - 51.5 dB

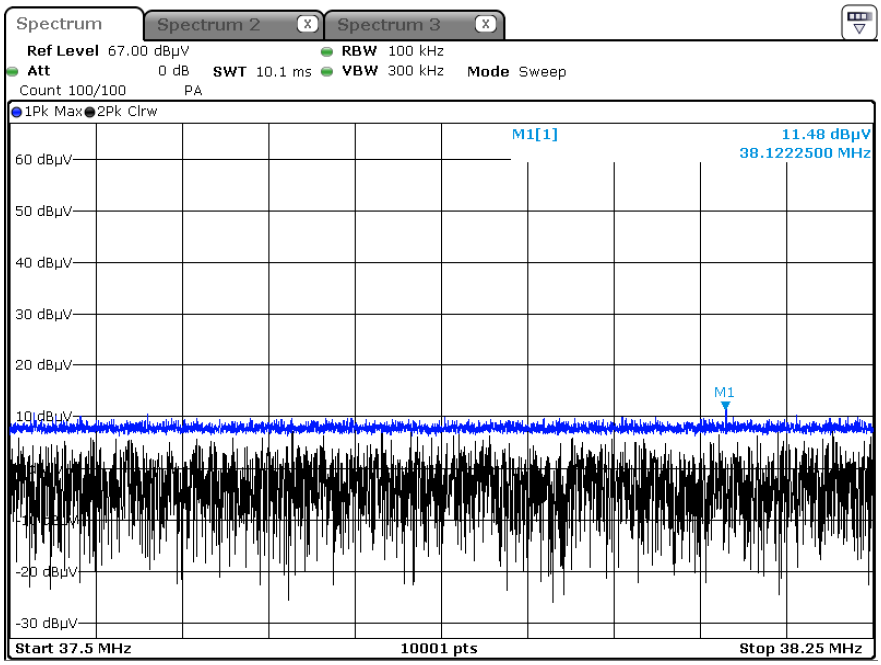
9.3. Radiated Emission 30MHz – 1000 MHz

Measured Frequency Range : 30 MHz - 1000 MHz							
Frequency (MHz)	Measured Value (dBµV/m)	A.F [dB/m]	C.L [dB]	Ant. Pol (H/V)	Total (dBµV/m)	Limit (dBµV/m)	Margin (dB)
#38.1222	11.480	18.46	0.46	H	30.40	40.00	9.60
43.3039	10.520	19.32	0.55	H	30.39	40.00	9.61
74.8528	10.380	17.28	0.63	V	28.29	40.00	11.71
#111.7167	10.110	16.28	0.80	H	27.19	43.50	16.31
#137.7668	10.120	17.98	0.88	H	28.98	43.50	14.52
153.6743	10.240	19.24	0.96	V	30.44	43.50	13.06

Note:

1. # is the result for restricted band.

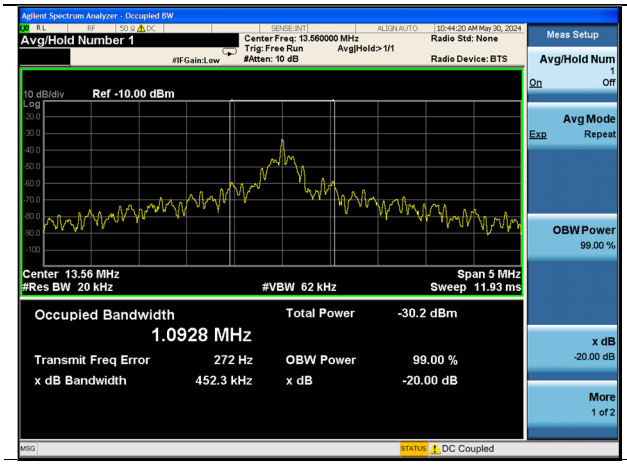
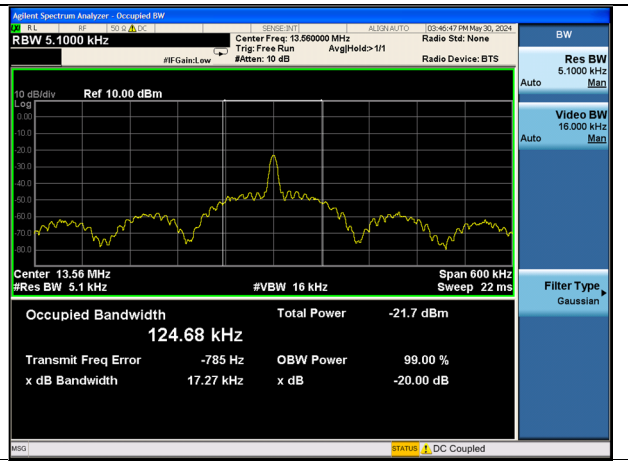
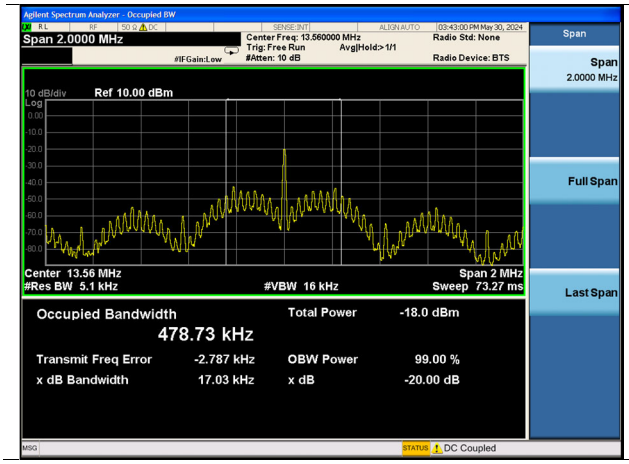
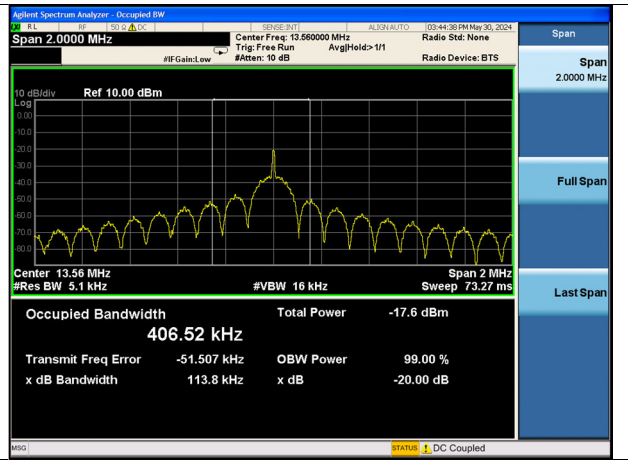
▣ **Test Plot**



Note:

Plot of worst case are only reported

9.4. 20 dB Bandwidth

Type A	Type B
	
Felica	**ISO 15693**
	

9.5. Frequency Stability

Startup

PERATING FREQUENCY: 13.56 MHz

REFERENCE VOLTAGE: 10.80 VDC

DEVIATION LIMIT: ±0.01 % =±1356 Hz

Voltage	Power	Temp.	Frequency	Frequency Dev.	Frequency
(%)	(VDC)	(℃)	(MHz)	(Hz)	Dev (%)
100%	10.80	-20	13.560022	22	0.0001622
100%		-10	13.560066	66	0.0004867
100%		0	13.559939	-61	-0.0004499
100%		+10	13.560045	45	0.0003319
100%		+20(Ref.)	13.560005	5	0.0000369
100%		+30	13.559991	-9	-0.0000664
100%		+40	13.559954	-46	-0.0003392
100%		+50	13.560072	72	0.0005310
LOW	9.00	+20	13.559947	-53	-0.0003909
HIGH	12.60	+20	13.560062	62	0.0004572

2 minutes

PERATING FREQUENCY: 13.56 MHz

REFERENCE VOLTAGE: 10.80 VDC

DEVIATION LIMIT: ±0.01 % =±1356 Hz

Voltage	Power	Temp.	Frequency	Frequency Dev.	Frequency
(%)	(VDC)	(℃)	(MHz)	(Hz)	Dev (%)
100%	10.80	-20	13.560011	11	0.0000811
100%		-10	13.560042	42	0.0003097
100%		0	13.559967	-33	-0.0002434
100%		+10	13.560059	59	0.0004351
100%		+20(Ref.)	13.559948	-52	-0.0003835
100%		+30	13.560074	74	0.0005457
100%		+40	13.560062	62	0.0004572
100%		+50	13.560051	51	0.0003761
LOW	9.00	+20	13.560048	48	0.0003540
HIGH	12.60	+20	13.559956	-44	-0.0003245

5 minutes

PERATING FREQUENCY: 13.56 MHz

REFERENCE VOLTAGE: 10.80 VDC

DEVIATION LIMIT: ±0.01 % =±1356 Hz

Voltage	Power	Temp.	Frequency	Frequency Dev.	Frequency
(%)	(VDC)	(℃)	(MHz)	(Hz)	Dev (%)
100%	10.80	-20	13.560011	11	0.0000811
100%		-10	13.560022	22	0.0001622
100%		0	13.559966	-34	-0.0002507
100%		+10	13.560008	8	0.0000590
100%		+20(Ref.)	13.560062	62	0.0004572
100%		+30	13.559961	-39	-0.0002876
100%		+40	13.560071	71	0.0005236
100%		+50	13.560052	52	0.0003835
LOW	9.00	+20	13.560063	63	0.0004646
HIGH	12.60	+20	13.560077	77	0.0005678

10 minutes

PERATING FREQUENCY: 13.56 MHz

REFERENCE VOLTAGE: 10.80 VDC

DEVIATION LIMIT: ±0.01 % =±1356 Hz

Voltage	Power	Temp.	Frequency	Frequency Dev.	Frequency
(%)	(VDC)	(℃)	(MHz)	(Hz)	Dev (%)
100%	10.80	-20	13.560059	59	0.0004351
100%		-10	13.560042	42	0.0003097
100%		0	13.559968	-32	-0.0002360
100%		+10	13.560028	28	0.0002065
100%		+20(Ref.)	13.560044	44	0.0003245
100%		+30	13.559929	-71	-0.0005236
100%		+40	13.559971	-29	-0.0002139
100%		+50	13.559989	-11	-0.0000811
LOW	9.00	+20	13.560037	37	0.0002729
HIGH	12.60	+20	13.560081	81	0.0005973

9.6. POWERLINE CONDUCTED EMISSIONS

Conducted Emissions

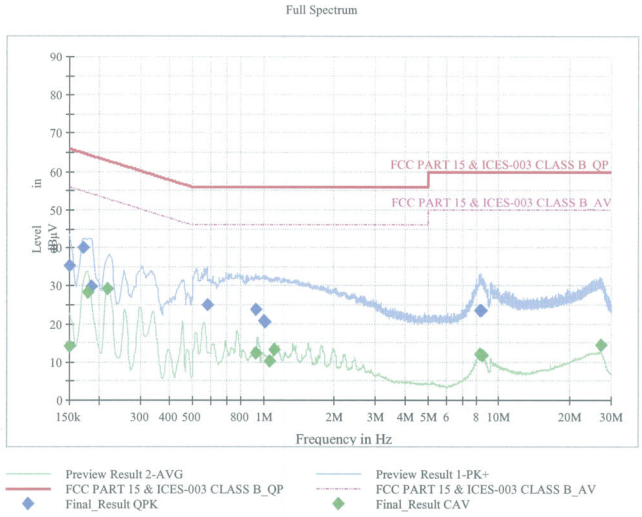
[Term]

RFID 1 / 1

Test Report

Common Information

EUT : CF-33
Operating Conditions : RFID ISO
Comment :



Final_Result_QPK

Frequency (MHz)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.1500	35.20	66.00	30.80	9.000	L1	9.6
0.1725	39.89	64.84	24.95	9.000	L1	9.6
0.1860	29.94	64.21	34.27	9.000	L1	9.6
0.5765	25.07	56.00	30.93	9.000	N	9.7
0.9253	23.81	56.00	32.19	9.000	N	9.7
1.0040	20.75	56.00	35.25	9.000	N	9.7
1.0108	20.52	56.00	35.48	9.000	N	9.7
8.3278	23.60	60.00	36.40	9.000	N	10.0
8.4560	23.47	60.00	36.53	9.000	N	10.0

Final_Result_CAV

Frequency (MHz)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.1500	14.17	56.00	41.83	9.000	N	9.6
0.1793	28.18	54.52	26.34	9.000	N	9.6
0.2175	29.07	52.91	23.85	9.000	N	9.6
0.9253	12.31	46.00	33.69	9.000	N	9.7
1.0603	10.26	46.00	35.74	9.000	N	9.7
1.1053	13.31	46.00	32.69	9.000	N	9.7
8.3390	12.12	50.00	37.88	9.000	N	10.0
8.5550	11.89	50.00	38.11	9.000	L1	10.0
27.0613	14.37	50.00	35.63	9.000	L1	10.6

2024-06-10 오전 11:52:51

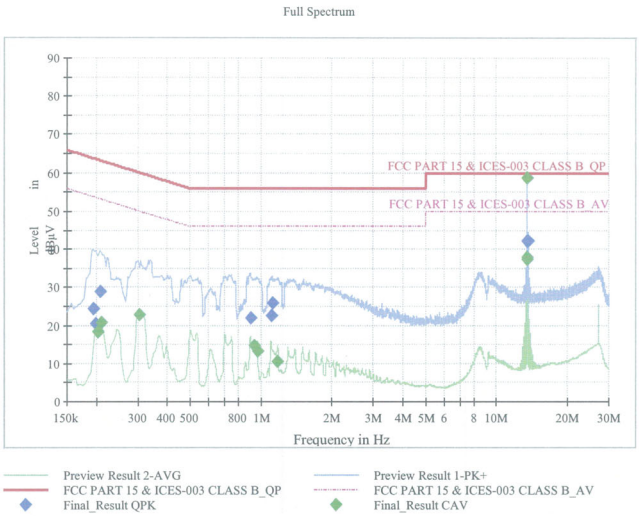
[Unterm]

RFID 1 / 1

Test Report

Common Information

EUT : CF-33
Operating Conditions : RFID ISO
Comment :



Final_Result_QPK

Frequency (MHz)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.1950	24.37	63.82	39.45	9.000	L1	9.6
0.1995	20.50	63.63	43.13	9.000	L1	9.6
0.2085	28.76	63.27	34.50	9.000	N	9.6
0.9073	22.11	56.00	33.89	9.000	L1	9.7
1.1053	22.64	56.00	33.36	9.000	N	9.7
1.1188	25.81	56.00	30.19	9.000	L1	9.7
13.5343	42.17	60.00	17.83	9.000	N	10.2
13.5590	58.84	60.00	1.16	9.000	N	10.2
13.5770	42.13	60.00	17.87	9.000	N	10.2

Final_Result_CAV

Frequency (MHz)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.2040	18.43	53.45	35.01	9.000	N	9.6
0.2108	20.88	53.18	32.29	9.000	N	9.6
0.3030	22.73	50.16	27.43	9.000	N	9.6
0.9410	14.73	46.00	31.27	9.000	N	9.7
0.9658	13.35	46.00	32.65	9.000	N	9.7
1.1795	10.47	46.00	35.53	9.000	N	9.7
13.5298	37.29	50.00	12.71	9.000	N	10.2
13.5433	37.87	50.00	12.13	9.000	N	10.2
13.5590	58.66	50.00	-8.66	9.000	N	10.2

2024-06-10 오전 11:43:40

9.7 RECEIVER SPURIOUS EMISSIONS

Frequency Range : Below 1 GHz

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Note:

1. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.

Frequency Range : Above 1 GHz

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

10. LIST OF TEST EQUIPMENT

Conducted Test

Equipment	Model	Manufacturer	Serial No.	Due to Calibration	Calibration Interval
LISN	ENV216	Rohde & Schwarz	102245	08/02/2024	Annual
EMI Test Receiver	ESCI	Rohde & Schwarz	100584	05/08/2025	Annual
Temperature Chamber	SU-642	ESPEC	0093008124	02/19/2025	Annual
DC Power Supply	E3632A	H.P	KR75303243	04/19/2025	Annual
Attenuator(10 dB)	8493C	Hewlett Packard	07560	06/05/2025	Annual
Software	EMC32	Rohde & Schwarz	N/A	N/A	N/A

Note:

1. Equipment listed above that calibrated during the testing period was set for test after the calibration.
2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.

Radiated Test

Equipment	Model	Manufacturer	Serial No.	Due to Calibration	Calibration Interval
Controller(Antenna mast)	CO3000	Innco system	CO3000-4p	N/A	N/A
Antenna Position Tower	MA4640/800-XP-EP	Innco system	N/A	N/A	N/A
Controller	EM1000	Audix	060520	N/A	N/A
Turn Table	N/A	Audix	N/A	N/A	N/A
Loop Antenna	FMZB 1513	Rohde & Schwarz	1513-333	03/17/2026	Biennial
Hybrid Antenna	VULB 9168	Schwarzbeck	760	02/24/2025	Biennial
Horn Antenna	BBHA 9120D	Schwarzbeck	02299	01/29/2025	Biennial
Spectrum Analyzer	FSV40	Rohde & Schwarz	100901	02/22/2025	Annual
Signal Analyzer	N9030A	Agilent	MY52350879	04/05/2025	Annual
RF Switching System	FMSR-04B (3G HPF+LNA)	T&M SYSTEM	S2L1	12/27/2024	Annual
RF Switching System	FMSR-04B (10dB ATT+LNA)	T&M SYSTEM	S2L2	12/27/2024	Annual
RF Switching System	FMSR-04B (3dB ATT+LNA)	T&M SYSTEM	S2L3	12/27/2024	Annual
Power Amplifier	CBL18265035	CERNEX	22966	11/17/2024	Annual
Power Amplifier	CBL26405040	CERNEX	25956	02/26/2025	Annual

Note:

1. Equipment listed above that calibrated during the testing period was set for test after the calibration.
2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.
3. Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5(Version : 2017).

11. ANNEX A_ TEST SETUP PHOTO

Please refer to test setup photo file no. as follows;

No.	Description
1	HCT-RF-2406-FI015-P