HCT Testing and Certification

ACCREDITED CERT #4114.01

TEST REPORT

FCC BT LE Test for VN551ZZZAN
Certification

APPLICANT
Hyundai Mobis Co., Ltd

REPORT NO.
HCT-RF-2505-FC076-R1

DATE OF ISSUE
June 10, 2025

Tested by
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Technical Manager
Jong Seok Lee

Accredited by KOLAS, Republic of KOREA

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BongJai Huh / CEO

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HCT-RF-2505-FC076-R1

DATE OF ISSUE
June 10, 2025

Applicant	Hyundai Mobis Co., Ltd 203, Teheran-ro, Gangnam-gu, Seoul, Republic of Korea
Product Name Model Name	Car infotainment system VN551ZZZAN
FCC ID	TQ8-VN551ZZZAN
Date of Test	February 25, 2025 ~ June 10, 2025
FCC Classification	Digital Transmission System(DTS)
Test Standard Used	FCC Rule Part(s): Part 15 subpart C 15.247
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

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REVISION HISTORY

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

Revision No.	Date of Issue	Description
0	May 16, 2025	Initial Release
1	June 10, 2025	Added the BTLE simultaneous transmission test results.

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 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). When confirmation of authenticity of this test report is required, please contact www.hct.co.kr This test report provides test result(s) under the scope accredited by the Korea Laboratory Accreditation Scheme (KOLAS), which signed the ILAC-MRA. (KOLAS (KS Q ISO/IEC 17025) Accreditation No. KT197) This test report provides test result(s) under the lab's valid Scope of Accreditation by A2LA (American Association for Laboratory Accreditation), signatory of the ILAC-MRA. (A2LA (ISO/IEC 17025) Certificate No. 4114.01)

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1. EUT DESCRIPTION

Model	VN551ZZZAN		
Additional Model	VN550ZZZAN, VN550ZZZXX, VN550ZZZFN, VN550ZZZGX, VN550ZZZKN, VN551ZZZXX, VN551ZZZFN, VN551ZZZGX, VN551ZZZKN, VN555ZZZXX, DA550ZZZGX, DA552ZZZGX, DA551ZZZGX, DA553ZZZGX, DA555ZZZGX		
EUT Type	Car infotainment system		
Power Supply	DC 14.40 V		
Frequency Range	2 402 MHz – 2 480 MHz		
Number of Channels	40 Channels		
Max. RF Output Power (Normal)	Peak	1 M Bit/s:	6.505 dBm (4.47 mW)
	Average	1 M Bit/s:	6.32 dBm (4.29 mW)
Modulation Type	GFSK		
Bluetooth Version	5.3		
Antenna Specification	Type: Printed on FR-4 Peak Gain: -1.34 dBi		
Serial number	Conducted : 00 5V3P100008 Radiated : 00 5V3P100016		

This device supports simultaneous transmission operation.

Simultaneous transmission Scenario	2.4 GHz WiFi	5 GHz WiFi Ant.1	5 GHz WiFi Ant.2	BT	Test Case
Bluetooth + 2.4 GHz WiFi	on	-	-	on(BTLE)	Scenario3
Bluetooth + 5 GHz WiFi MIMO	-	on	on	on(BTLE)	Scenario4
Bluetooth + 5 GHz WiFi SISO Ant.1	-	on	-	on	
Bluetooth + 5 GHz WiFi SISO Ant.2	-	-	on	on	

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2. TEST METHODOLOGY

FCC KDB 558074 D01 15.247 Meas Guidance v05r02 dated April 02, 2019 entitled "guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices and the measurement procedure described in ANSI C63.10(Version : 2013) 'the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices'.

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 15.247 under the FCC Rules Part 15 Subpart C.

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 below 1 GHz. Above 1 GHz with 1.5 m using absorbers between the EUT and receive antenna. 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)

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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's, 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).

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."

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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

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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 (±kHz)
X dB, 99% Bandwidth	95 (Confidence level about 95 %, *k*=2)
Frequency stability	28 (Confidence level about 95 %, *k*=2)

Parameter	Expanded Uncertainty (±dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	1.54 (Confidence level about 95 %, *k=2*)
Conducted Output Power(Power Meter)	0.54 (Confidence level about 95 %, k=2)
Conducted Output Power(Signal Analyzer)	0.68 (Confidence level about 95 %, k=2)
Power Spectral Density	1.03 (Confidence level about 95 %, k=2)
Band Edge (Out of Band Emissions)	0.70 (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)	5.68 (Confidence level about 95 %, *k*=2)
Radiated Disturbance (1 GHz ~ 18 GHz)	5.75 (Confidence level about 95 %, *k*=2)
Radiated Disturbance (18 GHz ~ 40 GHz)	5.82 (Confidence level about 95 %, *k*=2)

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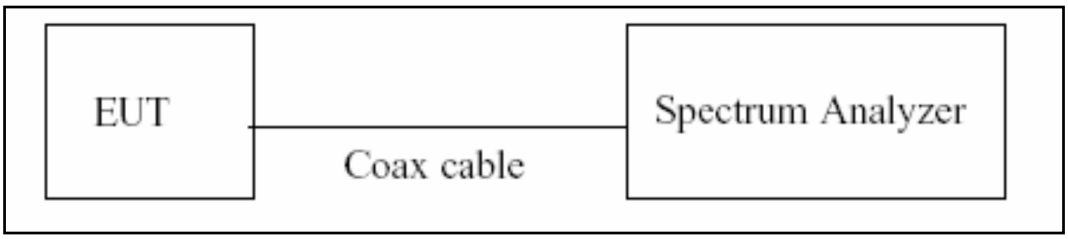
7. DESCRIPTION OF TESTS

7.1. Duty Cycle

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

We tested according to the zero-span measurement method.

The largest available value of RBW is 8 MHz and VBW is 50 MHz.

The zero-span method of measuring duty cycle shall not be used if T ≤ 6.25 microseconds. (50/6.25 = 8)

The zero-span method was used because all measured T data are > 6.25 microseconds and both RBW and VBW are > 50/*T*.

1. RBW = 8 MHz (the largest available value)
2. VBW = 8 MHz (≥ RBW)
3. SPAN = 0 Hz
4. Detector = Average
5. Number of points in sweep > 100
6. Trace mode = Clear write
7. Measure T_{total} and T_{on}
8. Calculate Duty Cycle = T_{on} / T_{total} and Duty Cycle Factor = 10log(1/Duty Cycle)

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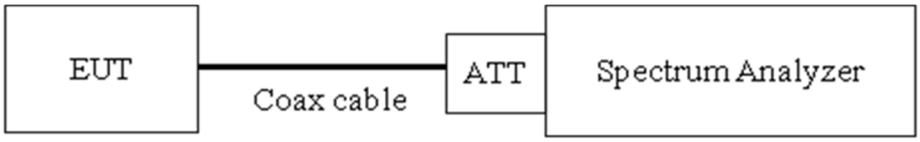
7.2. 6 dB Bandwidth & 99 % Bandwidth

Limit

The minimum permissible 6 dB bandwidth is 500 kHz.

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

The Spectrum Analyzer is set to (Procedure 11.8.1 in ANSI 63.10-2013)

1) RBW = 100 kHz
2) VBW ≥ 3 x RBW
3) Detector = Peak
4) Trace mode = max hold
5) Sweep = auto couple
6) Allow the trace to stabilize
7) We tested 6 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer. X dB is set 6 dB.

Note : We tested OBW using the automatic bandwidth measurement capability of a spectrum analyzer.

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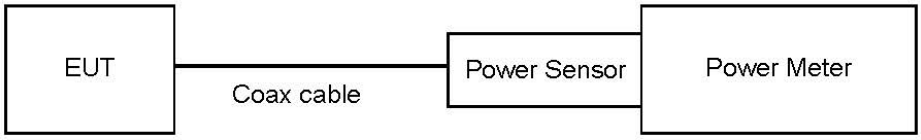
7.3. Output Power

Limit

The maximum permissible conducted output power is 1 Watt.

Test Configuration



Test Procedure

The transmitter output is connected to the Power Meter.

- Peak Power (Procedure 11.9.1.3 in ANSI 63.10-2013)
  : Measure the peak power of the transmitter.

- Average Power (Procedure 11.9.2.3 in ANSI 63.10-2013)
  1) Measure the duty cycle.
  2) Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.
  3) Add 10 log (1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times.

Sample Calculation

- Conducted Output Power(Peak) = Measured Value + ATT loss + Cable loss
- Conducted Output Power(Average) = Measured Value + ATT loss + Cable loss + Duty Cycle Factor

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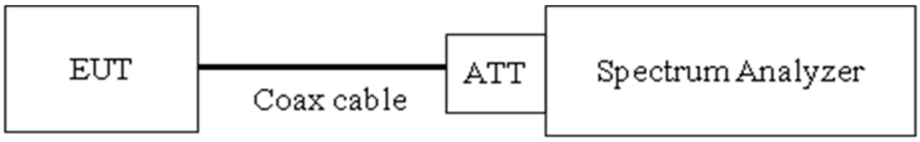
7.4. Power Spectral Density

Limit

The transmitter power density average over 1-second interval shall not be greater than 8 dBm in any 3 kHz BW.

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

We tested according to Procedure 8.4 in KDB 558074 v05r02, Procedure 11.10 in ANSI 63.10-2013.

The spectrum analyzer is set to :

1) Set analyzer center frequency to DTS channel center frequency.
2) Set span to at least 1.5 times the DTS bandwidth.
3) RBW = 3 kHz ≤ RBW ≤ 100 kHz.
4) VBW ≥ 3 x RBW.
5) Sweep = auto couple.
6) Detector = Peak.
7) Trace mode = max hold.
8) Allow trace to fully stabilize.
9) Use the peak marker function to determine the maximum amplitude level within the RBW.
10) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

Sample Calculation

- Power Spectral Density = Measured Value + ATT loss + Cable loss

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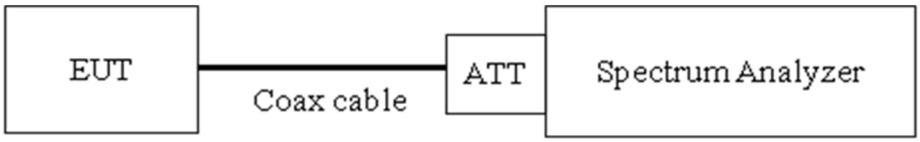
7.5. Conducted Band Edge(Out of Band Emissions) & Conducted Spurious Emissions

Limit

The maximum conducted (Peak) output power was used to demonstrate compliance, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz.

[Conducted > 20 dBc]

Test Configuration



Test Procedure

The transmitter output is connected to the spectrum analyzer.

(Procedure 11.11 in ANSI 63.10-2013)

1) RBW = 100 kHz
2) VBW ≥ 3 x RBW
3) Set span to encompass the spectrum to be examined
4) Detector = Peak
5) Trace Mode = max hold
6) Sweep time = auto couple
7) Ensure that the number of measurement points ≥ 2 x Span/RBW
8) Allow trace to fully stabilize.
9) Use peak marker function to determine the maximum amplitude level.

Measurements are made over the 30 MHz to 25 GHz range with the transmitter set to the lowest, middle, and highest channels.

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Factors for frequency

Freq(MHz)	Factor(dB)
30	10.06
100	10.08
200	10.08
300	10.09
400	10.13
500	10.17
600	10.20
700	10.34
800	10.46
900	10.56
1000	10.58
2000	10.58
2400	10.62
2500	10.62
3000	11.01
4000	11.23
5000	11.46
6000	11.46
7000	12.62
8000	12.63
9000	12.67
10000	12.74
11000	12.73
12000	12.76
13000	12.78
14000	12.91
15000	12.86
16000	12.92
17000	12.96
18000	13.00
19000	13.06
20000	13.10
21000	13.12
22000	13.16
23000	13.23
24000	13.27
25000	13.28

Note : 1. 2400 ~ 2500 MHz is fundamental frequency range.

2. Factor = Attenuator loss + Cable loss

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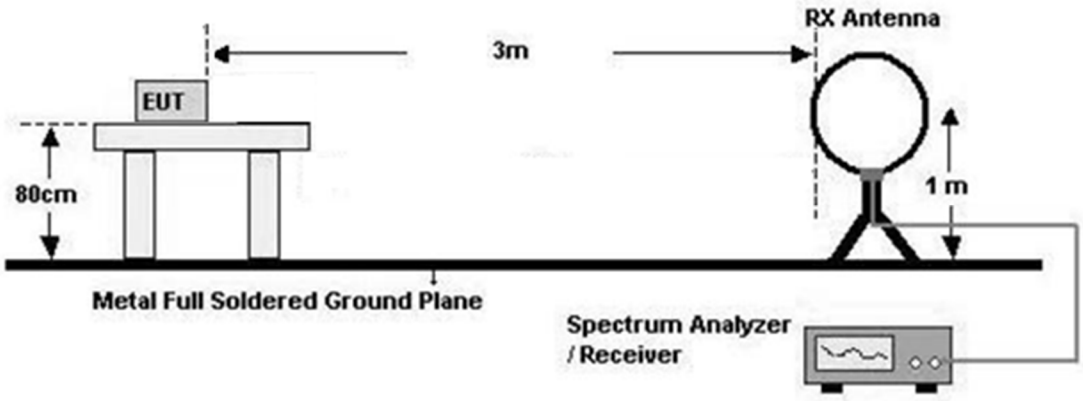
7.6. Radiated Test

Limit

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

Test Configuration

Below 30 MHz



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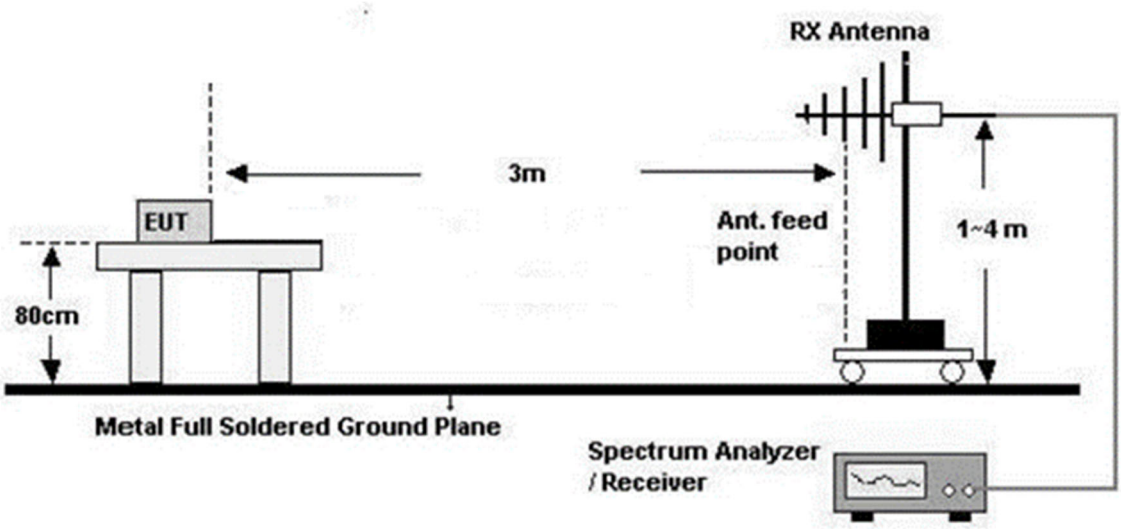
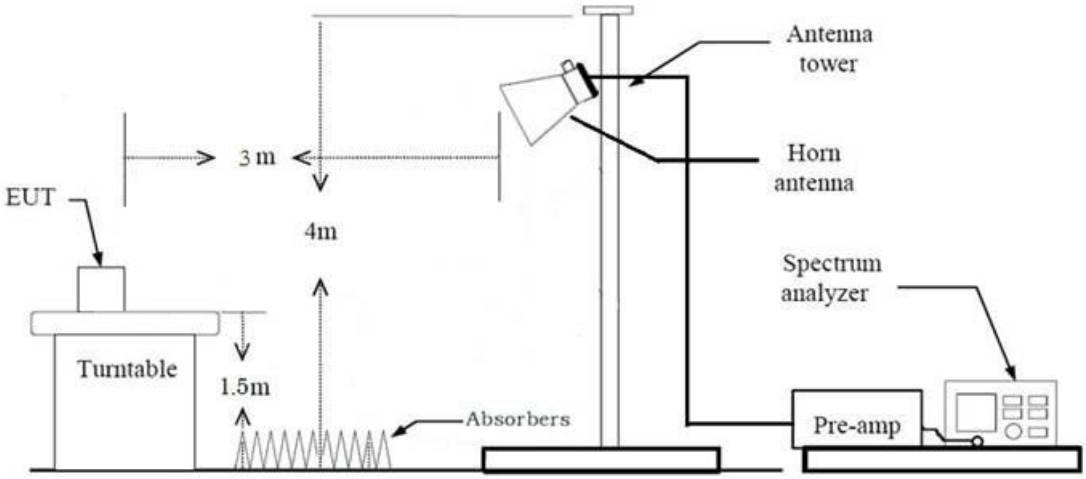
30 MHz - 1 GHz



Above 1 GHz



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Test Procedure of Radiated spurious emissions(Below 30 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 0.8 m 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
   - Frequency Range = 9 kHz ~ 30 MHz
   - Detector = Peak
   - Trace = Max hold
   - RBW = 9 kHz
   - VBW ≥ 3 x RBW
9. Total = 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.

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Test Procedure of Radiated spurious emissions(Below 1 GHz)

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 0.8 m above ground plane.
3. The Hybrid antenna was placed at a location 3 m from the EUT, which is varied from 1m to 4 m 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 = Max hold
      - RBW = 100 kHz
      - VBW ≥ 3 x RBW
   (2) Measurement Type(Quasi-peak):
      - Measured Frequency Range : 30 MHz – 1 GHz
      - Detector = Quasi-Peak
      - RBW = 120 kHz
   In general, (1) is used mainly
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.

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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 1 m to 4 m 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 provied jig and setup guide.
8. Spectrum Setting (Method 8.6 in KDB 558074 v05r02, Procedure 11.12 in ANSI 63.10-2013)
   (1) Measurement Type(Peak):
      - Measured Frequency Range : 1 GHz – 25 GHz
      - Detector = Peak
      - Trace = Max hold
      - RBW = 1 MHz
      - VBW ≥ 3 x RBW
   (2) Measurement Type(Average):
      - Duty cycle < 98 %, duty cycle variations are less than ±2 %
      - Measured Frequency Range : 1 GHz – 25 GHz
      - Detector = RMS
      - Averaging type = power (*i.e.*, RMS)
      - RBW = 1 MHz
      - VBW ≥ 3 x RBW
      - Sweep time = auto.
      - Trace mode = average (at least 100 traces).
      - Correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle.

- Duty Cycle Factor (dB) : Please refer to the please refer to section 9.1

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. Distance extrapolation factor = 20log (test distance / specific distance) (dB)
11. Total (Measurement Type : Peak)
    = Peak Measured Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(A.G) + Distance Factor(D.F)

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Total (Measurement Type : Average)

= Average Measured Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(A.G) + Distance Factor(D.F)

#Note : Used Average measurement method according to KDB 558074 Section11 Q3

Test Procedure of Radiated Restricted Band Edge

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 1 m to 4 m 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 provied jig and setup guide.
8. Spectrum Setting

   (1) Measurement Type(Peak):

   - Measured Frequency Range : 2310 MHz ~ 2390 MHz/ 2483.5 MHz ~ 2500 MHz
   - Detector = Peak
   - Trace = Max hold
   - RBW = 1 MHz
   - VBW ≥ 3 x RBW

   (2) Measurement Type(Average):

   - Duty cycle < 98 %, duty cycle variations are less than ±2 %
   - Measured Frequency Range : 2310 MHz ~ 2390 MHz/ 2483.5 MHz ~ 2500 MHz
   - Detector = RMS
   - Averaging type = power (*i.e.*, RMS)
   - RBW = 1 MHz
   - VBW ≥ 3 x RBW
   - Sweep time = auto.
   - Trace mode = average (at least 100 traces).
   - Correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle.
   - Duty Cycle Factor (dB) : Please refer to the please refer to section 9.1.

9. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific

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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. Distance extrapolation factor = 20log (test distance / specific distance) (dB)

(1)Measurement(Peak)

= Measured Value(Peak)

(2)Measurement(Avg)

= Measured Value(Avg)

- We apply to the offset in range 1 GHz - 18 GHz
- The offset = Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F)

#Note : Used Average measurement method according to KDB 558074 Section11 Q3

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7.7. 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.

Sample Calculation

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

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7.8. Worst case configuration and mode

Radiated test

1. All modes of operation were investigated and the worst case configuration results are reported.
   - Mode : Stand alone + Shark Antenna, Stand alone + Shark Antenna + External accessories
   - Worstcase : Stand alone + Shark Antenna + External accessories
2. EUT Axis:
   - Radiated Spurious Emissions : X
   - Radiated Restricted Band Edge : X
3. All datarate of operation were investigated and the worst case configuration results are reported.
4. All position of loop antenna were investigated and the test result is a no critical peak found at all positions.
   - Position : Horizontal, Vertical, Parallel to the ground plane
5. Radiated Spurious Emission
   - All packet length of operation were investigated and the worst case results are reported.
     Worst case : 1M 255Bytes
6. VN551ZZZAN, Additional Models were tested and the worst case results are reported.
(Worst case : VN551ZZZAN)

AC Power line Conducted Emissions

1. We don't perform powerline conducted emission test. The device only employ battery power for operation.

Conducted test

1. The EUT was configured with data rate of highest power.
2. VN551ZZZAN, Additional Models were tested and the worst case results are reported.
(Worst case : VN551ZZZAN)

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Radiated test(Simultaneous transmission Scenario)

1. All modes of operation were investigated and the worst case configuration results are reported.
   - Mode : Stand alone + Shark Antenna, Stand alone + Shark Antenna + External accessories
   - Worstcase : Stand alone + Shark Antenna + External accessories
2. EUT Axis
   - Radiated Spurious Emissions : X
3. All of Simultaneous transmission Scenario were investigated and the worst case configuration results are reported.

Simultaneous transmission Scenario	2.4 GHz WiFi	5 GHz WiFi Ant.1	5 GHz WiFi Ant.2	BT	Test Case
Bluetooth + 2.4 GHz WiFi	on	-	-	on(BTLE)	Scenario3
Bluetooth + 5 GHz WiFi MIMO	-	on	on	on(BTLE)	Scenario4
Bluetooth + 5 GHz WiFi SISO Ant.1	-	on	-	on	
Bluetooth + 5 GHz WiFi SISO Ant.2	-	-	on	on	

4. The Simultaneous transmission mode test investigated both intermodulation and radiated spurious emissions. And the worst results were reported.
   - Worst result: Radiated spurious emissions
   - Intermodulation: No signals are generated.
   - Radiated spurious emissions: cf. Section 10.6.2

Scenario	Description	Bluetooth Emission	2.4 GHz Emission
3	Antenna	BT/BTLE ANT	WLAN ANT(SISO)
	Channel	39	6
	Data Rate	1 Mbps	1 Mbps
	Mode	1 M Bit/s (255 Bytes)	802.11b

Note : DTS Simultaneous transmission Scenario Data refer to [DTS] Test Report

Scenario	Description	Bluetooth Emission	5 GHz Emission
4	Antenna	BT/BTLE ANT	WLAN ANT(MIMO)
	Channel	39	161
	Data Rate	1 Mbps	MCS 0
	Mode	1 M Bit/s (255 Bytes)	802.11n20

Note : UNII Simultaneous transmission Scenario Data refer to [UNII] Test Report

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8. SUMMARY TEST OF RESULTS

Test Description	FCC Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	§ 15.247(a)(2)	> 500 kHz	Conducted	PASS
Conducted Maximum Output Power	§ 15.247(b)(3)	< 1 Watt		PASS
Power Spectral Density	§ 15.247(e)	< 8 dBm / 3 kHz Band		PASS
Band Edge (Out of Band Emissions)	§ 15.247(d)	Conducted > 20 dBc		PASS
AC Power line Conducted Emissions	§ 15.207	cf. Section 7.7		N/A (Note1)
Radiated Spurious Emissions	§ 15.247(d), 15.205, 15.209	cf. Section 7.6	Radiated	PASS
Radiated Restricted Band Edge	§ 15.247(d), 15.205, 15.209	cf. Section 7.6		PASS

Note

1. The device only employ battery power for operation.
2. The decision rule applies 'simple acceptance'

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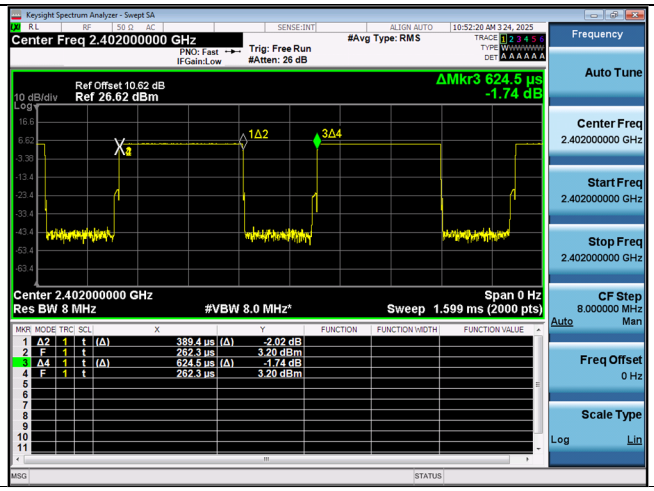
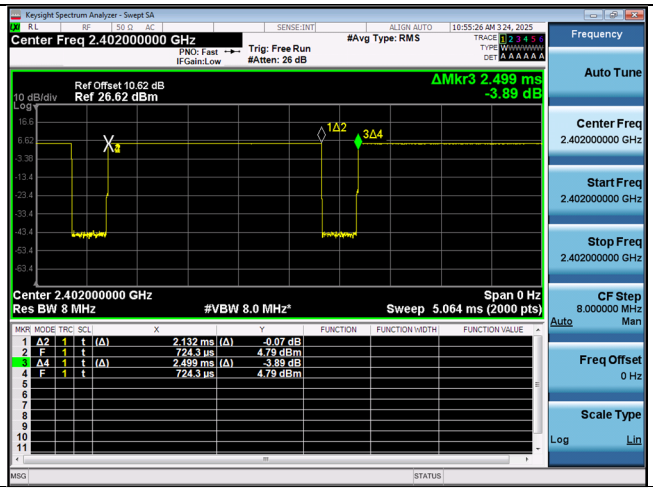
9. TEST RESULT

9.1 DUTY CYCLE

Data rate (Bit/s)	Packet length (Byte)	T_{on} (ms)	T_{total} (ms)	Duty Cycle	Duty Cycle Factor (dB)
1M	37	0.389	0.625	0.624	2.051
	255	2.132	2.499	0.853	0.690

1 M Bit/s (37 Byte) Duty Cycle (Low-CH 0)	1 M Bit/s (255 Byte) Duty Cycle (Low-CH 0)
	

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9.2 6 dB BANDWIDTH

Mode (Bit/s)	Channel	6 dB Bandwidth (kHz)	Limit (kHz)
1M(37)	0	716.3	> 500
	19	707.1	
	39	706.3	
1M(255)	0	665.2	> 500
	19	668.5	
	39	667.1	

Note:

In order to simplify the report, attached plots were only the narrowest 6 dB BW Channel.

- Worst case : 1M Bit/s: 255 Byte

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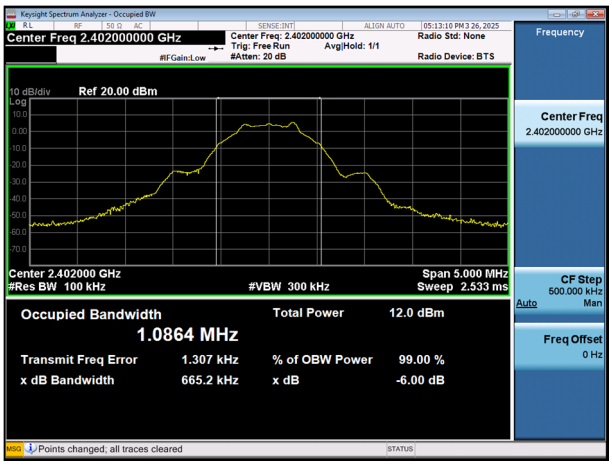
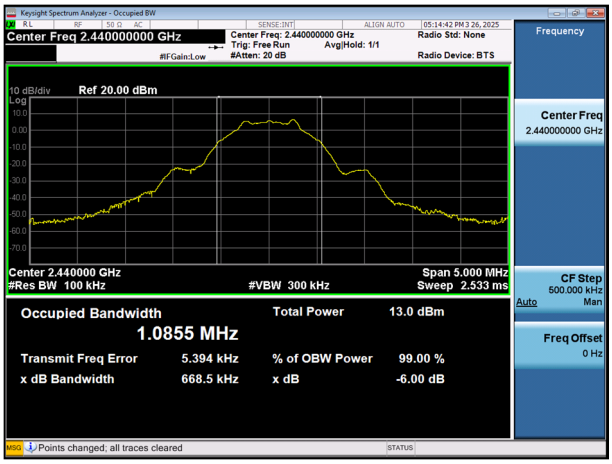
1 MBit/s (255 Byte) Test Plots

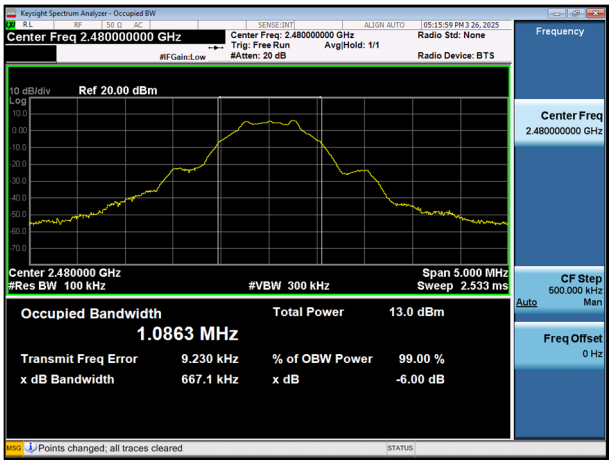
6 dB Bandwidth plot (Low-CH 0)



6 dB Bandwidth plot (Mid-CH 19)



6 dB Bandwidth plot (High-CH 39)



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9.3 OUTPUT POWER

Peak Power

Data rate	Packet length	LE Mode		Peak Power (dBm)	Limit (dBm)
(Bit/s)	(Byte)	Frequency [MHz]	Channel		
1M	37	2402	0	5.269	30
		2440	19	6.496	
		2480	39	6.433	
	255	2402	0	5.489	
		2440	19	6.481	
		2480	39	6.505	

Average Power

Data rate	Packet length	LE Mode		Measured Power (dBm)	Duty Cycle Factor	Result	Limit (dBm)
(Bit/s)	(Byte)	Frequency [MHz]	Channel		(dB)	(dBm)	
1M	37	2402	0	2.59	2.05	4.64	30
		2440	19	3.79	2.05	5.84	
		2480	39	4.25	2.05	6.30	
	255	2402	0	4.15	0.69	4.84	
		2440	19	5.12	0.69	5.81	
		2480	39	5.63	0.69	6.32	

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9.4 POWER SPECTRAL DENSITY

Frequency (MHz)	Channel No.	Mode	Test Result	
			Power Spectral Density (dBm/kHz)	Limit
2402	0	1M Bit/s 37 Byte	2.492	8 dBm / 3 kHz
2440	19		3.764	
2480	39		3.735	
2402	0	1M Bit/s 255 Byte	2.673	
2440	19		3.715	
2480	39		3.650	

Note :

In order to simplify the report, Worst case test plots were attached.

- Worstcase : 1M Bit/s 37 Byte

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▣ 1M Bit/s (37 Byte) Test Plots

Power Spectral Density (Low-CH 0)

Power Spectral Density (Mid-CH 19)

Power Spectral Density (High-CH 39)

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9.5 BAND EDGE/ CONDUCTED SPURIOUS EMISSIONS

[BAND EDGE]

Frequency (MHz)	Mode	Channel No.	Position	Test Result	
				Measured Level (dB)	Limit (dBc)
2402	1M Bit/s 37 Byte	0	Lower	57.205	20
2480		39	Upper	61.715	20
2402	1M Bit/s 255 Byte	0	Lower	58.275	20
2480		39	Upper	62.295	20

Note :

In order to simplify the report, attached plots were only the worst case channel and data rate.
[Lower Banddege Worst case : 1M Bit/s (37 Byte)]
[Upper Bandedge Worst case : 1M Bit/s (37 Byte)]

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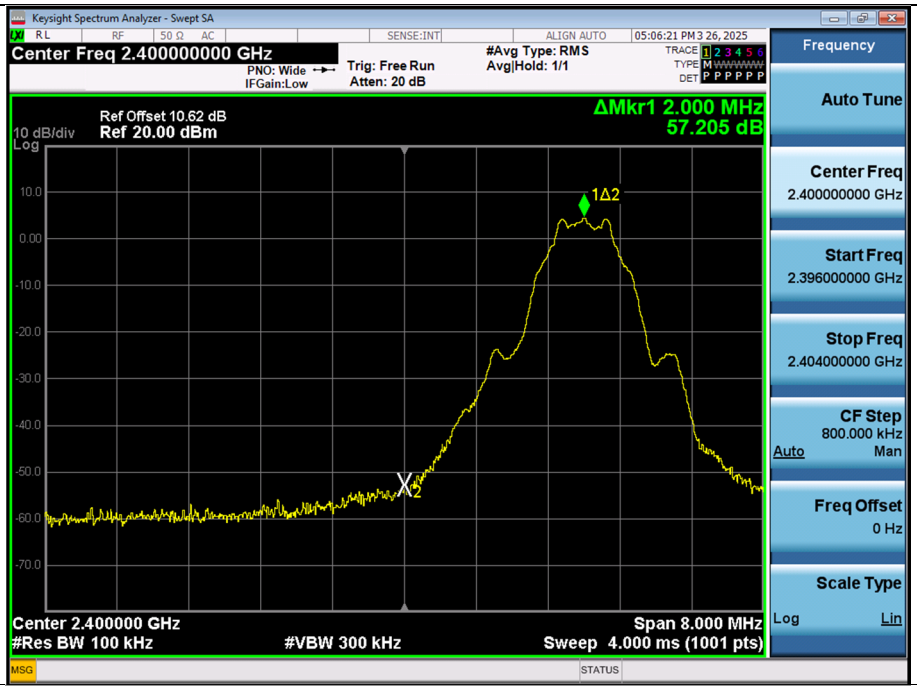
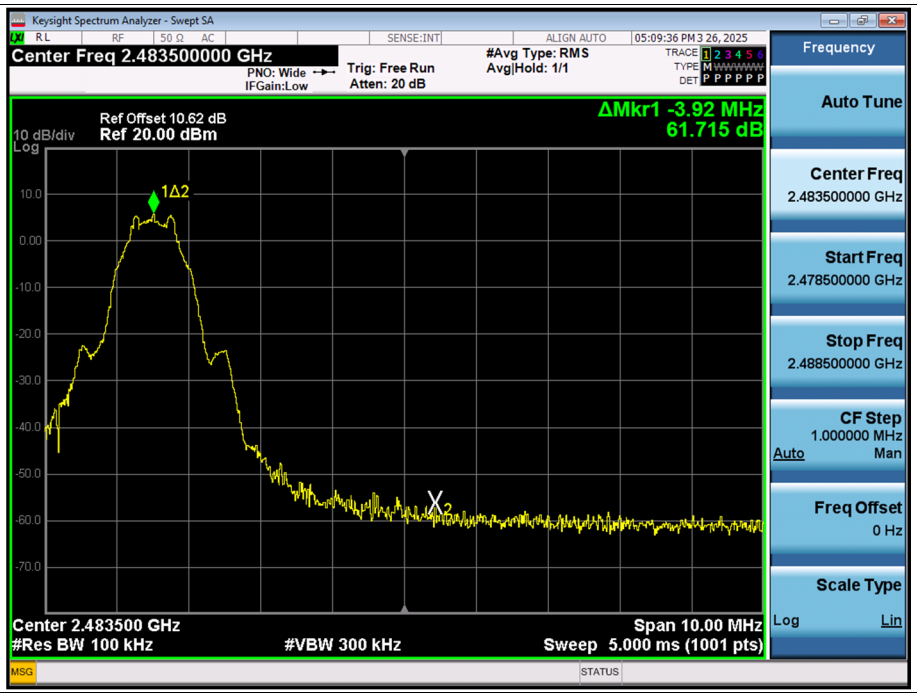
▣ Test Plots - Band Edge

1M Bit/s (37 Byte) Low-CH 0



1M Bit/s (37 Byte) High-CH 39



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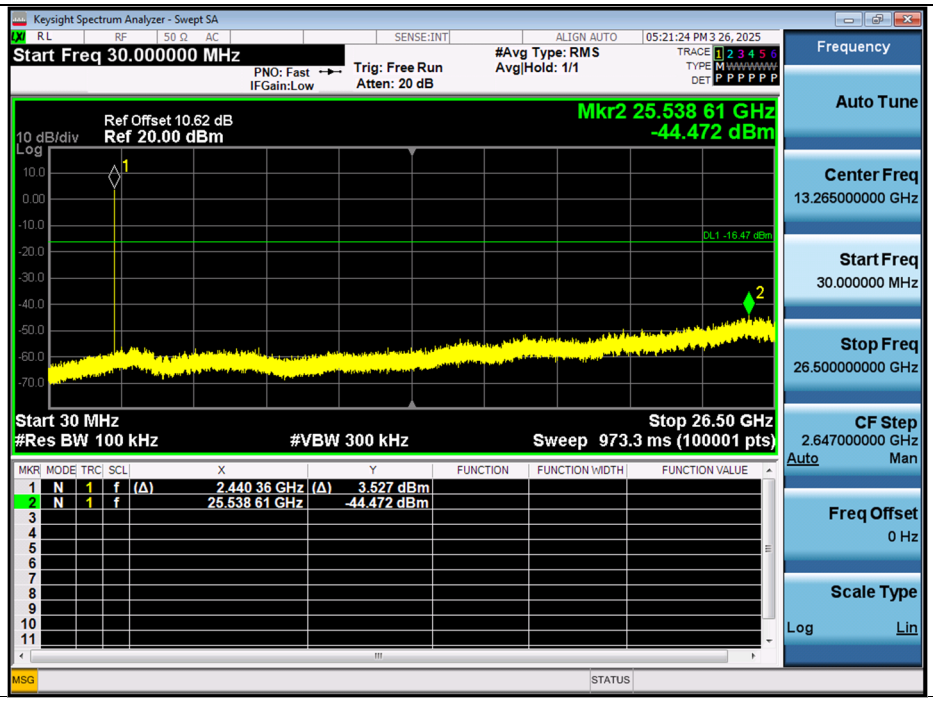
CONDUCTED SPURIOUS EMISSIONS]

Note :

In order to simplify the report, attached plots were only the worst case channel and data rate.
- Worst case : 1M Bit/s 255 Byte

▣ Test Plots - Conducted Spurious Emission (Worst case : 1M Bit/s (255 Byte)_CH.39)

Spurious Emission (30 MHz – 26.5 GHz)



Note:

Limit: -16.473 dBm

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9.6 RADIATED SPURIOUS EMISSIONS

Frequency Range : 9 kHz – 30 MHz

Frequency	Measured Value	A.F+C.L+D.F	POL	Total	Limit	Margin
[MHz]	[dBμV]	[dB/m]	[H/V]	[dBμV/m]	[dBμV/m]	[dB]
No Critical peaks found						

Note:

1. The Measured of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.
2. Distance extrapolation factor = 40log (specific distance / test distance) (dB)
3. Limit line = specific Limits (dBμV) + Distance extrapolation factor

Frequency Range : Below 1 GHz

Frequency	Measured Value	A.F+C.L	POL	Total	Limit	Margin
[MHz]	[dBμV]	[dB/m]	[H/V]	[dBμV/m]	[dBμV/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.

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Frequency Range : Above 1 GHz

CH 0	2402	MHz	Mode :		1 M Bit/s (255 Bytes)		
Frequency [MHz]	Measured value [dBμV]	A.F+C.L-A.G+D.F [dB/m]	Pol. [H/V]	Total [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Measurement Type
4804	48.97	3.16	V	52.13	73.98	21.85	PK
4804	36.63	3.16	V	39.79	53.98	14.19	AV
7206	41.87	9.93	V	51.80	73.98	22.18	PK
7206	29.90	9.93	V	39.83	53.98	14.15	AV
4804	48.19	3.16	H	51.35	73.98	22.63	PK
4804	36.57	3.16	H	39.73	53.98	14.25	AV
7206	41.66	9.93	H	51.59	73.98	22.39	PK
7206	29.53	9.93	H	39.46	53.98	14.52	AV

CH 17	2440	MHz	Mode :		1 M Bit/s (255 Bytes)		
Frequency [MHz]	Measured value [dBμV]	A.F+C.L-A.G+D.F [dB/m]	Pol. [H/V]	Total [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Measurement Type
4880	47.53	4.11	V	51.64	73.98	22.34	PK
4880	36.86	4.11	V	40.97	53.98	13.01	AV
7320	42.48	10.60	V	53.08	73.98	20.90	PK
7320	29.79	10.60	V	40.39	53.98	13.59	AV
4880	47.16	4.11	H	51.27	73.98	22.71	PK
4880	36.44	4.11	H	40.55	53.98	13.43	AV
7320	42.07	10.60	H	52.67	73.98	21.31	PK
7320	29.48	10.60	H	40.08	53.98	13.90	AV

CH 39	2480	MHz	Mode :		1 M Bit/s (255 Bytes)		
Frequency [MHz]	Measured value [dBμV]	A.F+C.L-A.G+D.F [dB/m]	Pol. [H/V]	Total [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Measurement Type
4960	47.96	2.88	V	50.84	73.98	23.14	PK
4960	36.92	2.88	V	39.80	53.98	14.18	AV
7440	43.08	11.34	V	54.42	73.98	19.56	PK
7440	30.01	11.34	V	41.35	53.98	12.63	AV
4960	47.23	2.88	H	50.11	73.98	23.87	PK
4960	36.71	2.88	H	39.59	53.98	14.39	AV
7440	42.10	11.34	H	53.44	73.98	20.54	PK
7440	29.86	11.34	H	41.20	53.98	12.78	AV

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[Simultaneous transmission Scenario]

Scenario 3

BTLE_Ch.39, 1 M Bit/s (255 Bytes) + WLAN 2.4 GHz SISO 802.11b_Ch. 6

Frequency	Measured value	A.F+C.L-A.G+D.F	Pol.	Total	Limit	Margin	Measurement Type
[MHz]	[dBμV]	[dB/m]	[H/V]	[dBμV/m]	[dBμV/m]	[dB]	
4960	43.46	2.88	V	46.34	73.98	27.64	PK
4960	31.16	2.88	V	34.04	53.98	19.94	AV
7440	41.75	11.34	V	53.09	73.98	20.89	PK
7440	29.68	11.34	V	41.02	53.98	12.96	AV
4960	42.98	2.88	H	45.86	73.98	28.12	PK
4960	31.05	2.88	H	33.93	53.98	20.05	AV
7440	41.68	11.34	H	53.02	73.98	20.96	PK
7440	29.57	11.34	H	40.91	53.98	13.07	AV

Scenario 4

BTLE_Ch.39, 1 M Bit/s (255 Bytes) + WLAN 5 GHz MIMO 802.11n20_Ch. 161

Frequency	Measured value	A.F+C.L-A.G+D.F	Pol.	Total	Limit	Margin	Measurement Type
[MHz]	[dBμV]	[dB/m]	[H/V]	[dBμV/m]	[dBμV/m]	[dB]	
4960	42.77	2.88	V	45.65	73.98	28.33	PK
4960	30.80	2.88	V	33.68	53.98	20.30	AV
7440	41.76	11.34	V	53.10	73.98	20.88	PK
7440	29.63	11.34	V	40.97	53.98	13.01	AV
4960	41.92	2.88	H	44.80	73.98	29.18	PK
4960	30.69	2.88	H	33.57	53.98	20.41	AV
7440	41.68	11.34	H	53.02	73.98	20.96	PK
7440	29.55	11.34	H	40.89	53.98	13.09	AV

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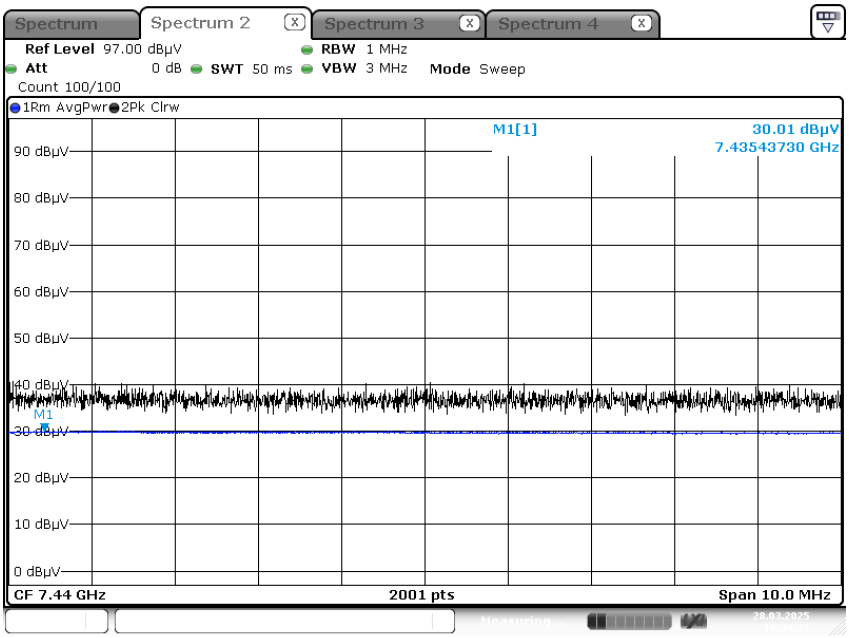
▣ 1 M Bit/s 255 Bytes Test Plots (Worst case : X-V)

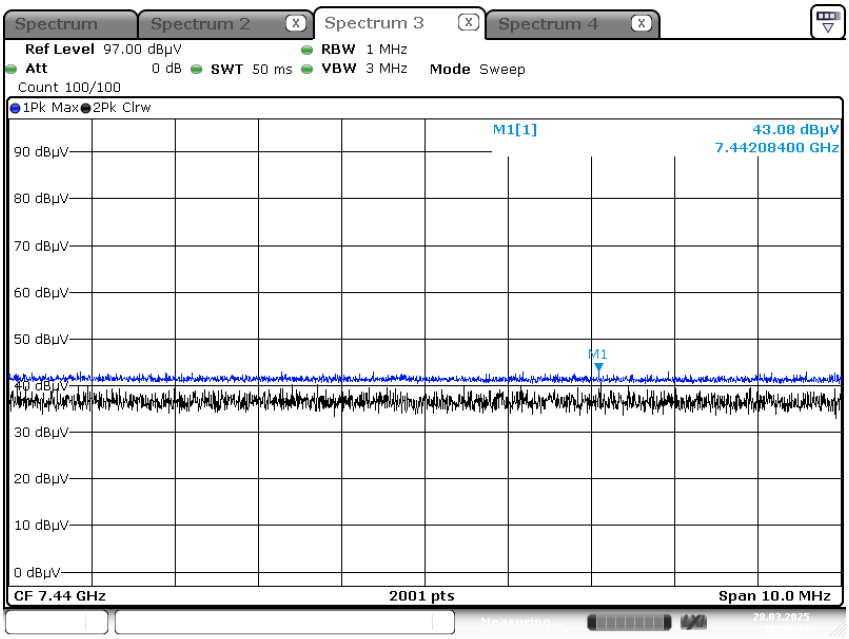
Note: Plots of worst case are only reported.

Radiated Spurious Emissions plot – Average Result (Ch.39 3rd Harmonic)



Date: 28.MAR.2025 10:39:23

Radiated Spurious Emissions plot – Peak Result (Ch.39 3rd Harmonic)



Date: 28.MAR.2025 10:50:38

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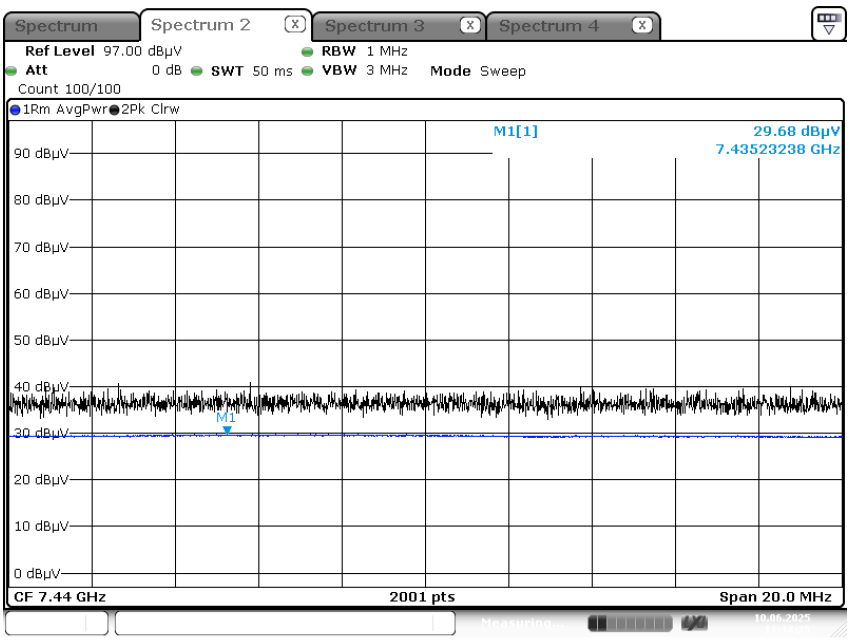
[Simultaneous transmission Scenario]

Scenario 3

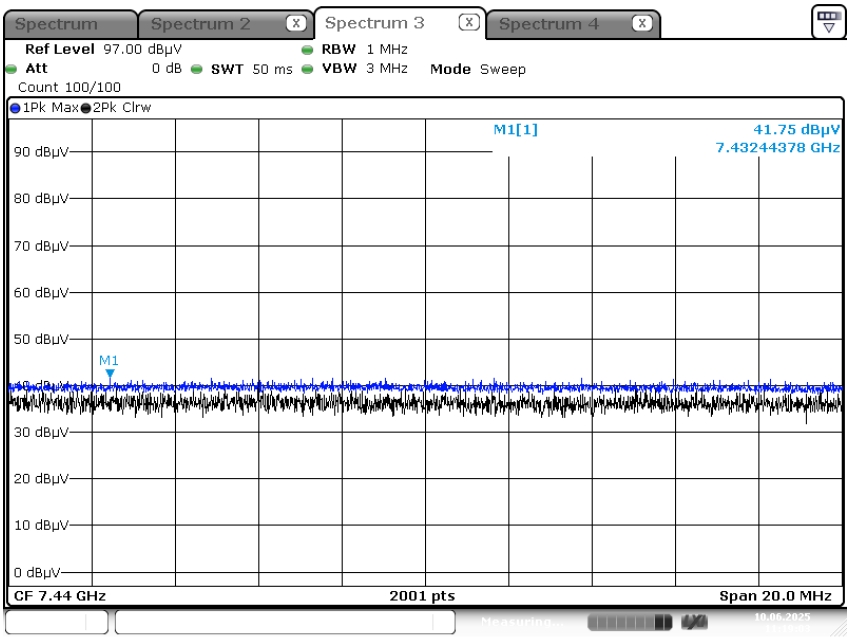
BTLE_Ch.39, 1 M Bit/s (255 Bytes) + WLAN 2.4 GHz SISO 802.11b_Ch. 6

Radiated Spurious Emissions plot – Average Result (Ch.39 3rd Harmonic)



Date: 10.JUN.2025 11:18:25

Radiated Spurious Emissions plot – Peak Result (Ch.39 3rd Harmonic)



Date: 10.JUN.2025 11:19:03

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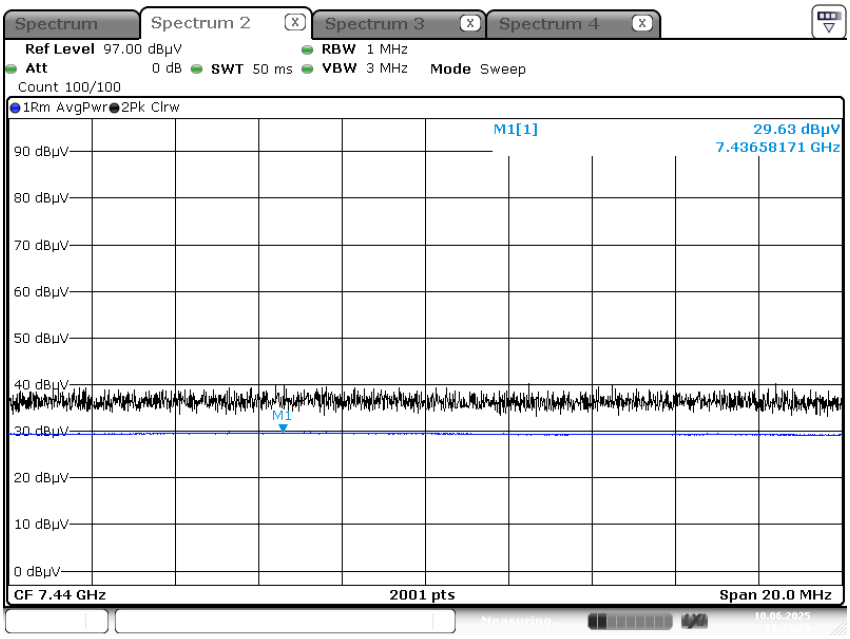
Scenario 4

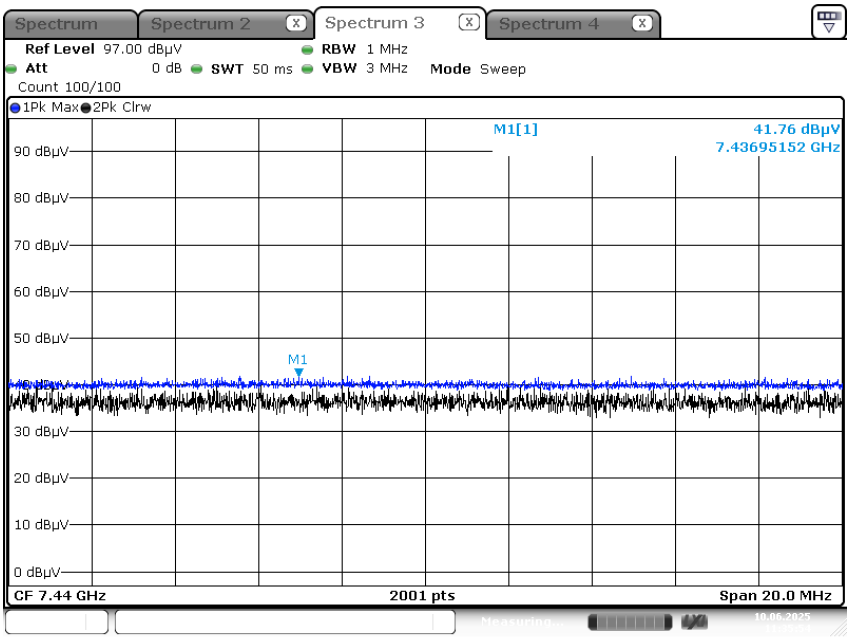
BTLE_Ch.39, 1 M Bit/s (255 Bytes) + WLAN 5 GHz MIMO 802.11n20_Ch. 161

Radiated Spurious Emissions plot – Average Result (Ch.39 3rd Harmonic)



Date: 10.JUN.2025 11:35:26

Radiated Spurious Emissions plot – Peak Result (Ch.39 3rd Harmonic)



Date: 10.JUN.2025 11:35:55

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9.7 RADIATED RESTRICTED BAND EDGES

1 M Bit/s (37 Bytes)							
Channel	0 CH, 39 CH	Channel Frequency	2402 MHz, 2480 MHz				
Frequency [MHz]	Measured Value [dBμV]	A.F+C.L+D.F [dB/m]	Ant. Pol. [H/V]	Total [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Measurement Type
2390.0	56.98	0.00	V	56.98	73.98	17.00	PK
2390.0	44.10	0.00	V	44.10	53.98	9.88	AV
2483.5	60.36	0.00	V	60.36	73.98	13.62	PK
2483.5	44.16	0.00	V	44.16	53.98	9.82	AV

1 M Bit/s (255 Bytes)							
Channel	0 CH, 39 CH	Channel Frequency	2402 MHz, 2480 MHz				
Frequency [MHz]	Measured Value [dBμV]	A.F+C.L+D.F [dB/m]	Ant. Pol. [H/V]	Total [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Measurement Type
2390.0	57.04	0.00	V	57.04	73.98	16.94	PK
2390.0	44.78	0.00	V	44.78	53.98	9.20	AV
2483.5	61.16	0.00	V	61.16	73.98	12.82	PK
2483.5	44.85	0.00	V	44.85	53.98	9.13	AV

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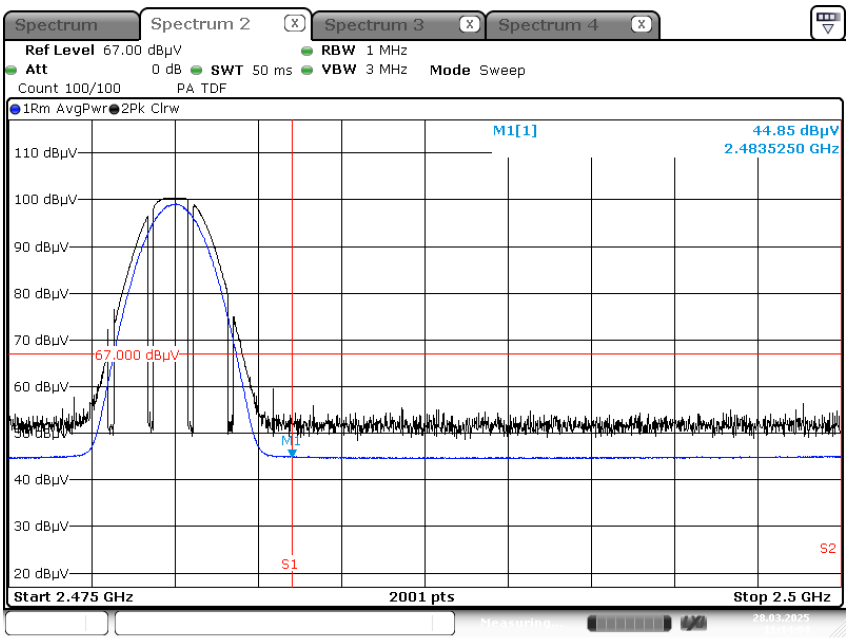
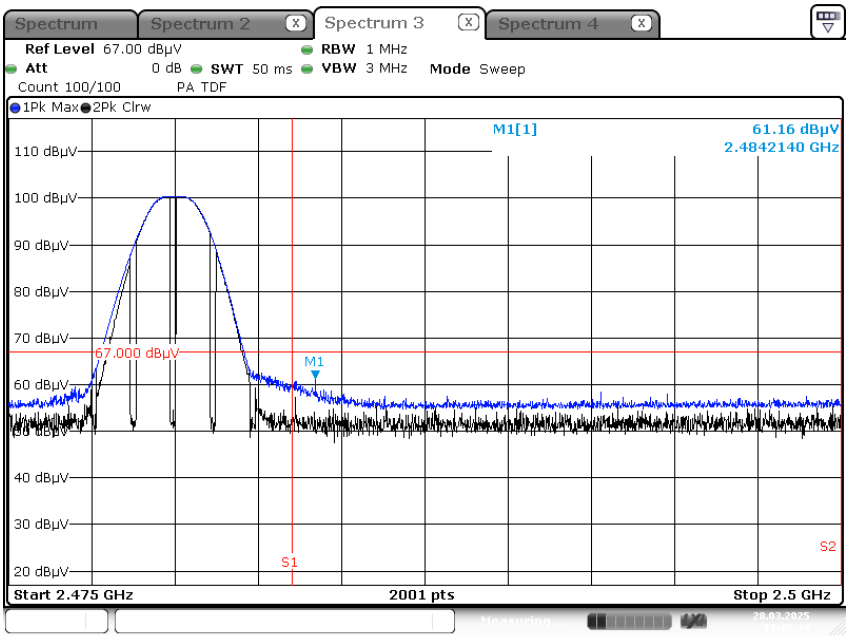
▣ Mode : 1M Bit/s (255 Bytes) Test Plots

Radiated Restricted Band Edges plot – Average Result (Ch.39, X-V)



Date: 28.MAR.2025 11:14:05

Radiated Restricted Band Edges plot – Peak Result (Ch.39, X-V)



Date: 28.MAR.2025 11:15:35

Note:

In order to simplify the report, Plots of worst case were only reported.

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10. LIST OF TEST EQUIPMENT

Conducted Test

Equipment	Model	Manufacturer	Serial No.	Due to Calibration	Calibration Interval
LISN	ENV216	Rohde & Schwarz	102245	07/17/2025	Annual
EMI Test Receiver	ESR	Rohde & Schwarz	101910	07/02/2025	Annual
Temperature Chamber	SU-642	ESPEC	93022487	06/27/2025	Annual
Signal Analyzer	N9030A	Keysight	MY55410508	08/23/2025	Annual
Power Measurement Set	OSP 120	Rohde & Schwarz	100935	08/01/2025	Annual
Power Meter	N1911A	Agilent	MY45100523	02/21/2026	Annual
Power Sensor	N1921A	Agilent	MY57820067	02/04/2026	Annual
Directional Coupler	87300B	Agilent	3116A03621	10/21/2025	Annual
Power Splitter	11667B	Hewlett Packard	10545	01/23/2026	Annual
DC Power Supply	E3632A	Agilent	KR75305528	12/24/2025	Annual
Attenuator(10 dB)(DC-26.5 GHz)	8493C-010	Agilent	08285	05/28/2025	Annual
Attenuator(20 dB)	18N-20dB	Rohde & Schwarz	8	02/18/2026	Annual
Software	EMC32	Rohde & Schwarz	N/A	N/A	N/A
FCC WLAN&BT&BLE Conducted Test Software v3.0	N/A	HCT CO., LTD.	N/A	N/A	N/A
Bluetooth Tester	CBT	Rohde & Schwarz	100752	12/27/2025	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.

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Radiated Test

Equipment	Model	Manufacturer	Serial No.	Due to Calibration	Calibration Interval
Controller	CO3000	Innco system	CO3000-4p	N/A	N/A
Antenna Position Tower	MA4640/800-XP-EP	Innco system	S3AM	07/30/2025	Annual
Turn Table	DS1500-S-1t	Innco system	N/A	N/A	N/A
Loop Antenna	FMZB 1513	Rohde & Schwarz	1513-333	03/07/2026	Biennial
Hybrid Antenna	VULB 9168	Schwarzbeck	9168-0895	08/28/2026	Biennial
Horn Antenna	BBHA 9120D	Schwarzbeck	9120D-1191	11/07/2025	Biennial
Horn Antenna(15 GHz ~ 40 GHz)	BBHA9170	Schwarzbeck	BBHA9170124	03/28/2025	Biennial
Band Reject Filter	WRCJV2400/2483.5-2370/2520-60/12SS	Wainwright Instruments	2	12/26/2025	Annual
Band Reject Filter	WRCJV12-4900-5100-5900-6100-50SS	Wainwright Instruments	5	05/27/2026	Annual
Band Reject Filter	WRCJV12-4900-5100-5900-6100-50SS	Wainwright Instruments	6	05/27/2026	Annual
Band Reject Filter	WRCJV5100/5850-40/50-8EEK	Wainwright Instruments	1	01/09/2026	Annual
Amp & Filter Bank Switch Controller	FBSM-01A	TNM system	0	N/A	N/A
RF Switching System	FBSR-03A (3G HPF+LNA)	T&M SYSTEM	S3L1	10/31/2025	Annual
RF Switching System	FBSR-03A (10dB ATT+LNA)	T&M SYSTEM	S3L2	10/31/2025	Annual
RF Switching System	FBSR-03A (7G HPF+LNA)	T&M SYSTEM	S3L3	10/31/2025	Annual
RF Switching System	FBSR-03A (3dB ATT+LNA)	T&M SYSTEM	S3L4	10/31/2025	Annual
Power Amplifier	CBL18265035	CERNEX	22966	11/07/2025	Annual
Power Amplifier	CBL26405040	CERNEX	25956	02/19/2026	Annual
Bluetooth Tester	TC-3000C	TESCOM	3000C000175	03/12/2026	Annual
Spectrum Analyzer	FSV40 (9 kHz ~ 40 GHz)	Rohde & Schwarz	100900	08/27/2025	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).

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11. ANNEX A_ TEST SETUP PHOTO

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

No.	Description
1	HCT-RF-2505-FC076-P

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