

RF TEST REPORT

FCC

APPLICANT

Whisper.AI Inc

MODEL NAME

Whisper Brain

FCC ID

2AT97W1K

REPORT NUMBER

HA191101-ATL-001-R03-01

TEST REPORT

Date of Issue
August 14, 2020

Test Site
Hyundai C-Tech, Inc. dba HCT America, Inc.
1726 Ringwood Ave, San Jose, CA 95131, USA

Applicant	Whiser.AI Inc
Applicant Address	260 8 th Street, San Francisco, CA 94103, U.S.A.
FCC ID	2AT97W1K
Model Name	Whisper Brain
EUT Type	Nordic Proprietary
Modulation Type	GFSK
FCC Classification	Digital Transmission System (DTS)
FCC Rule Part(s)	Part 15.247
Test Procedure	ANSI C63.10-2013, KDB 558074 D01 v05r02

The device bearing the trade name and model specified above, has been shown to comply with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures required. The results of testing in this report apply only to the product which was tested. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Hyundai C-Tech, Inc. dba HCT America, Inc. certifies that no party to application has been denied the FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C 862

Tested By

Steve In

Test Engineer

Reviewed By

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Technical Manager

REVISION HISTORY

The revision history for this document is shown in table.

TEST REPORT NO.	DATE	DESCRIPTION
HA191101-ATL-001-R03	August 14, 2020	Initial Issue
HA191101-ATL-001-R03-01	Oct 9, 2020	Update product information

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1. GENERAL INFORMATION

EUT DESCRIPTION

Model	Whisper Brain
EUT Type	Pocket Unit
Power Supply	DC 3.7 V, 3000 mAh (Li-ION Rechargeable Battery)
RF Specification	T1 : Nordic Proprietary (RIGHT) T2 : Nordic Proprietary (LEFT) T3 : Bluetooth BDR / Bluetooth LE (FCC ID : 2AFDI-ITCNFA324)
Operating Environment	Indoor / Outdoor
Operating Temperature	0 °C – 35 °C

RF SPECIFICATION SUBJECT TO THE REPORT

RF Specification	T1 : Nordic Proprietary (2 Mbps) T2 : Nordic Proprietary (2 Mbps)		
Frequency Range	2402 MHz - 2480 MHz		
Max. RF Output Power ¹⁾	T1	Ant A	Peak : 13.489 dBm (22.33 mW)
		Ant B	Peak : 12.614 dBm (18.26 mW)
	T2	Ant C	Peak : 14.675 dBm (29.34 mW)
		Ant D	Peak : 13.926 dBm (24.69 mW)
Modulation Type	GFSK		
Number of Channels	40 Channels		
Antenna Specification ²⁾	Antenna Type : Chip antenna Peak Gain : 1.0 dBi		
Firmware Version ³⁾	3.0.3.0		
Hardware Version ³⁾	820-00010 PVT		
Accessories ⁴⁾	AC charger	Model : HDP-QB05010U Input : 100 – 240 VAC, 50/60 Hz, 0.15 A	
Date(s) of Tests	July 1, 2020 ~ July 24, 2020		

Note :

1. The modules (T1 and T2) transmit either one of two antenna ports selectively, not transmitting at the same time.
2. Antenna information is based on the document provided.
3. Firmware and Hardware Versions are provided by the client.
4. AC charger is supplied with the EUT

2. METHODOLOGY

FCC KDB 558074 D01 DTS Measurement Guidance v05r02 dated April 2nd, 2019 entitled “Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) 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 30MHz 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 1GHz. Above 1GHz with 1.5m 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. Also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the maximum emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 8 of ANSI C63.10. (Version: 2013)

Conducted Antenna Terminal

KDB 558074 D01 v05r02

DESCRIPTION OF TEST MODES

The channels, output power setting, continuous TX were controlled on the command line using python. The EUT is equipped with Bluetooth proprietary modules with datarate 2 Mbps.

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 1726 Ringwood Avenue, San Jose, California 95131, USA.

The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22.



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 antenna of this E.U.T is permanently attached and there is no provision for connection to an external antenna.
- (2) The E.U.T Complies with the requirement of §15.203

6. MEASUREMENT UNCERTAINTY

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

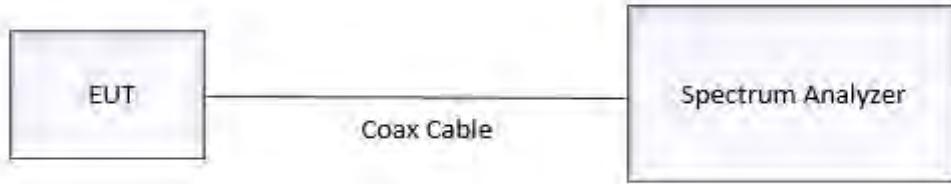
All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95 % level of confidence. The measurement data shown herein meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded Uncertainty (\pm dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	2.55
Radiated Disturbance (9 kHz ~ 30 MHz)	3.20
Radiated Disturbance (30 MHz ~ 1 GHz)	4.73
Radiated Disturbance (1 GHz ~ 18 GHz)	5.21
Radiated Disturbance (18 GHz ~ 40 GHz)	5.18

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, 6 (b) in KDB 558074 D01 v05r02.

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 $T \leq 6.25$ 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 $> 50/T$.

- RBW = 8 MHz (the largest available value)
- VBW = 8 MHz (\geq RBW)
- SPAN = 0 Hz
- Detector = Peak
- Number of points in sweep > 100
- Trace mode = Clear write
- Measure T_{total} and T_{on}
- Calculate Duty Cycle = T_{on}/T_{total} and Duty Cycle Factor = $10 \cdot \log(1/\text{Duty Cycle})$

7.2. 6 dB BANDWIDTH

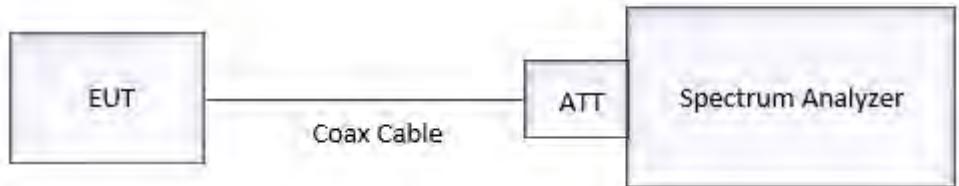
Limit

Test Requirements and limit, §15.247(a)(2)

The bandwidth at 6 dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the receive antenna while the EUT is operating in transmission mode at the appropriate frequencies.

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 (Section 8.2 in KDB 558074 D01 v05r02, Subclause 11.8 in ANSI 63.10-2013)

- RBW = 100 kHz
- VBW $\geq 3 \times$ RBW
- Detector = Peak
- Trace mode = max hold
- Sweep = auto couple
- Allow the trace to stabilize
- We tested 6 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer, setting X dB as 6 dB.

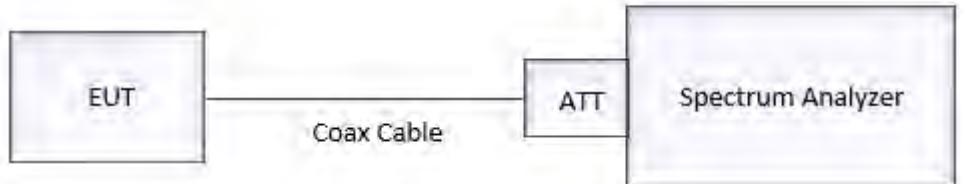
7.3. OUTPUT POWER

Limit

Test Requirements and limit, §15.247(b)(3)

The maximum permissible conducted output power is 1 Watt.

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

TX condition of the EUT is the actual operating mode by BT LE test program.

The Spectrum Analyzer is set to

Peak Power (Section 8.3.1.1 in KDB 558074 D01 v05r02, Subclause 11.9.1.1 in ANSI 63.10-2013)

- $RBW \geq DTS$ Bandwidth
- $VBW \geq 3 \times RBW$
- $SPAN \geq 3 \times RBW$
- Detector Mode = Peak
- Sweep = auto couple
- Trace Mode = max hold
- Allow trace to fully stabilize.
- Use peak marker function to determine the peak amplitude level

Average Power (Section 8.3.2.2 in KDB 558074 D01 v05r02, Subclause 11.9.2.2 in ANSI 63.10-2013)

- We use the spectrum analyzer's integrated band power measurement function.
- Measure the duty cycle.
- Set span to at least 1.5 times the OBW.
- $RBW = 1-5\%$ of the OBW, not to exceed 1 MHz
- $VBW \geq 3 \times RBW$
- Number of points in sweep $\geq 2 \times \text{span} / RBW$. (This gives bin-to-bin spacing $\leq RBW/2$, so that narrowband signals are not lost between frequency bins.)
- Sweep time = auto.
- Detector = RMS (i.e., power averaging)
- Do not use sweep triggering. Allow the sweep to "free run".
- Trace average at least 100 traces in power averaging (RMS) mode.
- Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function with band limits set equal to the OBW band edges.
- 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) = Reading Value + ATT loss + Cable loss
- Conducted Output Power (Average) = Reading Value + ATT loss + Cable loss + Duty Cycle Factor

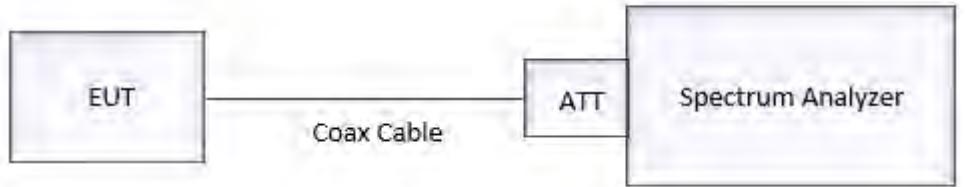
7.4. POWER SPECTRAL DENSITY

Limit

Test Requirements and limit, §15.247(e)

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

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

We tested according to Procedure 8.4 in KDB 558074 D01 v05r02, Procedure 11.10 in ANSI 63.10-2013.

The spectrum analyzer is set to :

- Set analyzer center frequency to DTS channel center frequency.
- Set span to at least 1.5 times the OBW.
- $RBW = 3 \text{ kHz} \leq RBW \leq 100 \text{ kHz}$.
- $VBW \geq 3 \times RBW$.
- Sweep = auto couple
- Detector = power averaging (rms) or sample detector (when rms not available).
- Ensure that the number of measurement points in the sweep $\geq [2 \times \text{span} / RBW]$.
- Employ trace averaging (rms) mode over a minimum of 100 traces
- Use the peak marker function to determine the maximum amplitude level.
- Use the peak marker function to determine the maximum amplitude level within the RBW. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.
- if then duty factor shall be added to adjust the result if the duty cycle is less than 98%

7.5. CONDUCTED BAND EDGE (OUT OF BAND EMISSIONS) / CONDUCTED SPURIOUS EMISSIONS

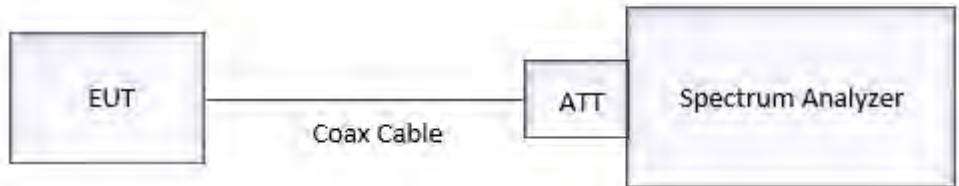
Limit

Test Requirements and limit, §15.247(d)

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 8.5 in KDB 558074 D01 v05r02, Procedure 11.11 in ANSI 63.10-2013)

- RBW = 100 kHz
- VBW \geq 3 x RBW
- Set span to encompass the spectrum to be examined
- Detector = Peak
- Trace Mode = max hold
- Sweep time = auto couple
- Ensure that the number of measurement points \geq 2*Span/RBW
- Allow trace to fully stabilize.
- 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.

7.6. RADIATED EMISSIONS

Radiated Emission Limits

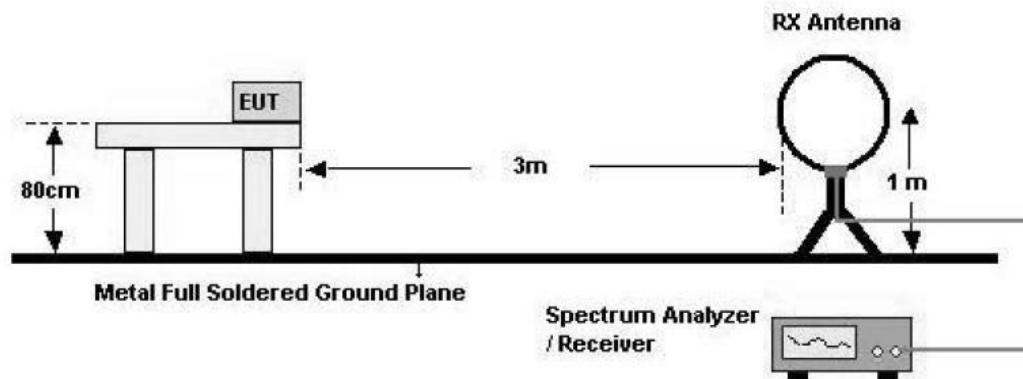
FCC : 47 CFR § 15.209		
Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Restricted Bands of Operation

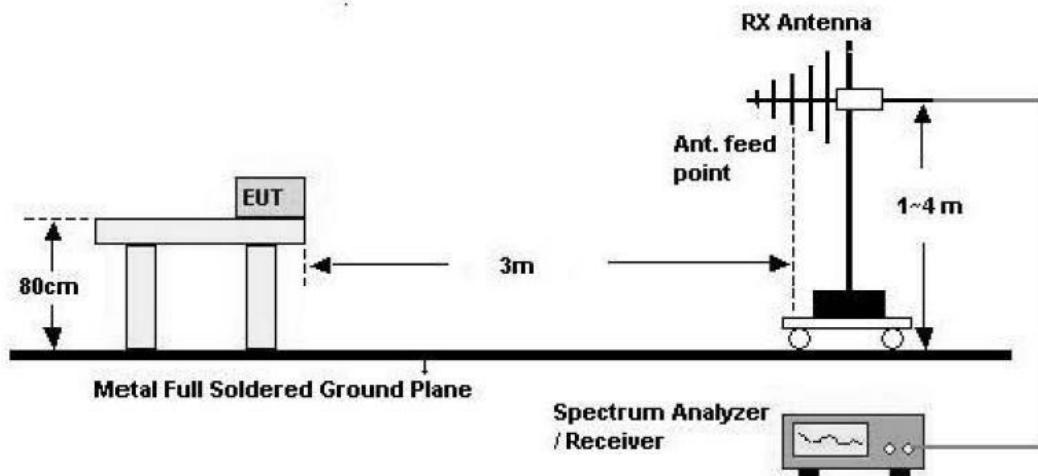
FCC : 47 CFR § 15.205(a)				
Frequency (MHz)	Frequency (MHz)	Frequency (MHz)	Frequency (MHz)	Frequency (MHz)
0.090 – 0.110	12.29-12.293	149.9 - 150.05	1660.0 - 1710.0	8025 – 8500
0.495 - 0.505	12.51975-12.52025	156.52475 - 156.52525	1718.8 - 1722.2	9000 – 9200
2.1735 – 2.1905	12.57675-12.57725	156.7 - 156.9	2200.0 - 2300.0	9300 – 9500
4.125 - 4.128	13.36-13.41	162.0125 - 167.17	2310.0 - 2390.0	10600 - 12700
4.17725-4.17775	16.42-16.423	167.72 - 173.2	2483.5 – 2500.0	13250 – 13400
4.20725-4.20775	16.69475-16.69525	240.0 - 285.0	2690.0 - 2900.0	14470 – 14500
6.215-6.218	16.80425-16.80475	322.0 - 335.4	3260.0 – 3267.0	15350 – 16200
6.26775-6.26825	25.5-25.67	399.9 - 410.0	3332.0 – 3339.0	17700 – 21400
6.31175-6.31225	37.5-38.25	608.0 - 614.0	3345.8 – 3358.0	22010 – 23120
8.291-8.294	73 - 74.6	960.0 - 1240.0	3600.0 – 4400.0	23600 – 24000
8.362-8.366	74.8 - 75.2	1300.0 - 1427.0	4500.0 – 5150.0	31200 – 31800
8.37625-8.38675	108 - 121.94	1435.0 - 1626.5	5350.0 – 5460.0	36430 – 36500
8.41425-8.41475	123 - 138	1645.5 - 1646.5	7250.0 – 7750.0	Above 38600

Test Configuration

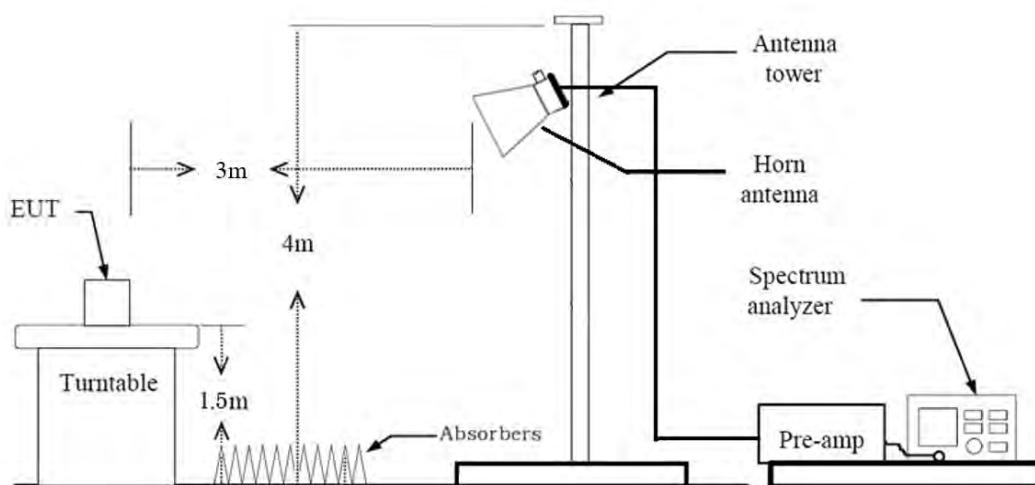
Below 30 MHz



30 MHz - 1 GHz



Above 1 GHz



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 3m 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 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) = $40 * \log(3 \text{ m}/300 \text{ m}) = -80 \text{ dB}$
Measurement Distance: 3 m
7. Distance Correction Factor (0.490 MHz – 30 MHz) = $40 * \log(3 \text{ m}/30 \text{ m}) = -40 \text{ dB}$
Measurement Distance: 3 m
8. Spectrum Setting
 - Frequency Range = 9 kHz ~ 30 MHz
 - Detector = Peak
 - Trace = Max hold
 - RBW = 9 kHz
 - VBW $\geq 3 * \text{RBW}$
9. Total = Reading Value + Antenna Factor (A.F) + Cable Loss (C.L)

Adequate comparison measurements were confirmed against an open field site since the test was performed at alternative site (3m SAC) other than the open area test site. Sufficient test was made to demonstrate that the alternative site produces result that correlate with the one of test made at the open field site based on KDB 414788.

Test Procedure of Radiated 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 0.8 m above ground plane.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
4. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
5. Spectrum Setting

(1) Measurement Type (Peak):

- Measured Frequency Range: 30 MHz – 1 GHz
- Detector = Peak
- Trace = Max hold
- RBW = 100 kHz
- VBW $\geq 3 \times \text{RBW}$

(2) Measurement Type(Quasi-peak):

- Measured Frequency Range: 30 MHz – 1 GHz
- Detector = Quasi-Peak
- RBW = 120 kHz

In general, the method (1) is mainly used

6. Total = Reading Value + Antenna Factor (A.F) + Cable Loss (C.L)

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(Peak):

- Measured Frequency Range : 1 GHz – 25 GHz
- Detector = Peak
- Trace = Max hold
- RBW = 1 MHz
- VBW \geq 3*RBW

(2) Measurement Type(Average): Duty cycle \geq 98%

- Measured Frequency Range : 1 GHz – 25 GHz
- Detector = RMS
- Averaging type = power (*i.e.*, RMS)
- RBW = 1 MHz
- VBW \geq 3*RBW
- Sweep time = auto.
- Trace mode = average (at least 100 traces).

(3) Measurement Type(Average): Duty cycle $<$ 98%, duty cycle variations are less than $\pm 2\%$

- Measured Frequency Range : 1 GHz – 25 GHz
- Detector = RMS
- Averaging type = power (*i.e.*, RMS)
- RBW = 1 MHz
- VBW \geq 3*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 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.

10. Measurement value only up to 6 maximum emissions noted or would be lesser if no specific emissions from the EUT are recorded (*i.e.*: margin $>$ 20 dB from the applicable limit) and considered that is already beyond the background noise floor.

11. Sample Calculation

- (1) Total (Peak) = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G)
- (2) Total (Average, Duty \geq 98%) = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G)
- (3) Total (Average, Duty $<$ 98%) = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Duty Cycle Factor

Test Procedure of Radiated Restricted Band Edge

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

- Detector = Peak
- Trace = Max hold
- RBW = 1 MHz
- VBW \geq 3*RBW

(2) Measurement Type(Average): Duty cycle \geq 98%,

- Measured Frequency Range : 2310 MHz – 2390 MHz / 2483.5 MHz – 2500 MHz
- Detector = RMS
- Averaging type = power (*i.e.*, RMS)
- RBW = 1 MHz
- VBW \geq 3*RBW
- Sweep time = auto.
- Trace mode = average (at least 100 traces).

(3) Measurement Type(Average): Duty cycle $<$ 98%, duty cycle variations are less than $\pm 2\%$

- Measured Frequency Range : 2310 MHz – 2390 MHz / 2483.5 MHz – 2500 MHz
- Detector = RMS
- Averaging type = power (*i.e.*, RMS)
- RBW = 1 MHz
- VBW \geq 3*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 (*i.e.*: margin $>$ 20 dB from the applicable limit) and considered that's already beyond the background noise floor.

10. Sample Calculation

(1) Total (Peak) = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L)

(2) Total (Average, Duty \geq 98%) = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G)

(3) Total (Average, Duty $<$ 98%) = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Duty Cycle Factor

7.7. AC POWER LINE CONDUCTED EMISSIONS

Limit

47 CFR § 15.207

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 μ H/50 ohms line impedance stabilization network (LISN).

Frequency Range (MHz)	Limits (dB μ V)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56*	56 to 46*
0.50 to 5	56	46
5 to 30	60	50

*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.

According to FCC KDB 174176 D01 Line Conducted FAQ v01r01 :

Devices Operating Above 30 MHz

For a device with a permanent or detachable antenna operating above 30 MHz, measurements must be performed with the antenna connected as specified in clause 6.2 of ANSI C63.10-2013.

Devices Operating Below 30 MHz

For a device with a permanent or detachable antenna operating at or below 30 MHz, the FCC will accept measurements performed with a suitable dummy load in lieu of the antenna under the following conditions:

- (1) Perform the AC power-line conducted tests with the antenna connected to determine compliance with Section 15.207 limits outside the transmitter's fundamental emission band;
- (2) Retest with a dummy load in lieu of the antenna to determine compliance with Section 15.207 limits within the transmitter's fundamental emission band. For a detachable antenna, remove the antenna and connect a suitable dummy load to the antenna connector. For a permanent antenna, remove the antenna and terminate the RF output with a dummy load or network which simulates the antenna in the fundamental frequency band. All measurements must be performed as specified in clause 6.2 of ANSI C63.10-2013.

Sample Calculation

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

8. SUMMARY OF TEST RESULTS

Test Description	FCC Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	§15.247(a)(2)	≥ 500 kHz	Conducted	PASS
Occupied Bandwidth	N/A	N/A		PASS
Conducted Maximum Peak Output Power	§15.247(b)(3)	≤ 1 W		PASS
Maximum e.i.r.p.	N/A	≤ 4 W e.i.r.p.		PASS
Power Spectral Density	§15.247(e)	≤ 8 dBm / 3 kHz		PASS
Band Edge (Out of Band missions)	§15.247(d)	≥ 20 dBc		PASS
AC Power line Conducted Emissions	§15.207	cf. Section 7.7		PASS
Radiated Spurious Emissions	§15.247(d), §15.209	cf. Section 7.6	Radiated	PASS
Radiated Restricted Band Edge	§15.247(d), §15.205(a)	cf. Section 7.6		PASS

WORST CASE CONFIGURATION

Radiated test

1. EUT Axis

- Radiated Spurious Emissions: Z
- Radiated Restricted Band Edge: Z

All X, Y, and Z positions for horizontal / vertical antenna polarization were investigated to find the worst-case position.

2. Modes

- Charging mode : Worst case
- Standalone

Full testing was performed at charging which is the worst case. Then spot testing was conducted in standalone mode at the worst channel found from the charging mode.

3. Chains

- T1 module : Ant A / Ant B => Ant A was picked for the worst case after testing both Ant A and B
- T2 module : Ant C / Ant D => Ant C was picked for the worst case after testing both Ant C and D

Conducted test

1. AC Line Conducted Emission was performed at the worst case mode with all transmitters were turned on.

OUTPUT POWER SETTING

Nordic Proprietary 2M		PLS			
Frequency (MHz)	Channel	T1 (Ant A)	T1 (Ant B)	T2 (Ant C)	T2 (Ant D)
2402	0	2	2	2	2
2440	19	2	2	2	2
2480	39	2	2	2	2

9. TEST RESULT

9.1 DUTY CYCLE

Mode		T _{ON} (ms)	T _{TOTAL} (ms)	Duty Cycle	Duty Factor (dB)
T1	Ant A	1.0580	1.1780	0.8981	0.47
	Ant B	1.0589	1.1780	0.8989	0.46
T2	Ant C	1.0589	1.1780	0.8989	0.46
	Ant D	1.0580	1.1780	0.8981	0.47

TEST PLOTS



9.2. 6 dB BANDWIDTH

T1 (Ant A)		99% Bandwidth (kHz)	6 dB Bandwidth (kHz)	
Frequency (MHz)	Channel	Result	Result	Limit
2402	0	1854.5	865.0	≥ 500
2440	19	1830.3	851.4	
2480	39	1801.2	802.2	

T1 (Ant B)		99% Bandwidth (kHz)	6 dB Bandwidth (kHz)	
Frequency (MHz)	Channel	Result	Result	Limit
2402	0	1833.1	833.4	≥ 500
2440	19	1796.7	856.2	
2480	39	1818.8	873.4	

T2 (Ant C)		99% Bandwidth (kHz)	6 dB Bandwidth (kHz)	
Frequency (MHz)	Channel	Result	Result	Limit
2402	0	1844.5	836.0	≥ 500
2440	19	1832.4	833.2	
2480	39	1840.6	799.3	

T2 (Ant D)		99% Bandwidth (kHz)	6 dB Bandwidth (kHz)	
Frequency (MHz)	Channel	Result	Result	Limit
2402	0	1868.8	859.6	≥ 500
2440	19	1847.7	847.6	
2480	39	1851.5	847.1	

TEST PLOTS (6 dB Bandwidth)

T1 (Ant A) : 6 dB BW	T1 (Ant B) : 6 dB BW
CHO : 2402 MHz	CHO : 2402 MHz
	
CH19 : 2440 MHz	CH19 : 2440 MHz
	
CH39 : 2480 MHz	CH39 : 2480 MHz
	

TEST PLOTS (6 dB Bandwidth)

T2 (Ant C) : 6 dB BW CHO : 2402 MHz	T2 (Ant D) : 6 dB BW CHO : 2402 MHz
<p>Keylight Spectrum Analyzer - Occupied BW</p> <p>Center Freq 2.402000000 GHz</p> <p>Center Freq: 2.402000000 GHz Radio Std: None</p> <p>Trig: Free Run Avg/Hold: 1/1 Radio Device: BTS</p> <p>#IFGain:1,low #Att: 10 dB</p> <p>Frequency</p> <p>10 dB/div Ref 30.00 dBm</p> <p>Log</p> <p>20.0 10.0 0.0 -10.0 -20.0 -30.0 -40.0 -50.0</p> <p>Center 2.402 GHz #Res BW 100 kHz #VBW 300 kHz Span 5 MHz Sweep 1 ms</p> <p>Occupied Bandwidth 1.8931 MHz Total Power 21.7 dBm</p> <p>Transmit Freq Error -716 Hz OBW Power 99.00 %</p> <p>x dB Bandwidth 836.0 kHz x dB -6.00 dB</p> <p>CF Step 500.000 kHz Man</p> <p>Freq Offset 0 Hz</p> <p>Points changed; all traces cleared STATUS</p>	<p>Keylight Spectrum Analyzer - Occupied BW</p> <p>Center Freq 2.402000000 GHz</p> <p>Center Freq: 2.402000000 GHz Radio Std: None</p> <p>Trig: Free Run Avg/Hold: 1/1 Radio Device: BTS</p> <p>#IFGain:1,low #Att: 10 dB</p> <p>Frequency</p> <p>10 dB/div Ref 30.00 dBm</p> <p>Log</p> <p>20.0 10.0 0.0 -10.0 -20.0 -30.0 -40.0 -50.0</p> <p>Center 2.402 GHz #Res BW 100 kHz #VBW 300 kHz Span 5 MHz Sweep 1 ms</p> <p>Occupied Bandwidth 1.9176 MHz Total Power 21.3 dBm</p> <p>Transmit Freq Error -1.156 kHz OBW Power 99.00 %</p> <p>x dB Bandwidth 859.6 kHz x dB -6.00 dB</p> <p>CF Step 500.000 kHz Man</p> <p>Freq Offset 0 Hz</p> <p>Points changed; all traces cleared STATUS</p>
<p>Keylight Spectrum Analyzer - Occupied BW</p> <p>Center Freq 2.440000000 GHz</p> <p>Center Freq: 2.440000000 GHz Radio Std: None</p> <p>Trig: Free Run Avg/Hold: 1/1 Radio Device: BTS</p> <p>#IFGain:1,low #Att: 10 dB</p> <p>Frequency</p> <p>10 dB/div Ref 30.00 dBm</p> <p>Log</p> <p>20.0 10.0 0.0 -10.0 -20.0 -30.0 -40.0 -50.0</p> <p>Center 2.44 GHz #Res BW 100 kHz #VBW 300 kHz Span 5 MHz Sweep 1 ms</p> <p>Occupied Bandwidth 1.8754 MHz Total Power 21.1 dBm</p> <p>Transmit Freq Error -3.185 kHz OBW Power 99.00 %</p> <p>x dB Bandwidth 833.2 kHz x dB -6.00 dB</p> <p>CF Step 500.000 kHz Man</p> <p>Freq Offset 0 Hz</p> <p>Points changed; all traces cleared STATUS</p>	<p>Keylight Spectrum Analyzer - Occupied BW</p> <p>Center Freq 2.440000000 GHz</p> <p>Center Freq: 2.440000000 GHz Radio Std: None</p> <p>Trig: Free Run Avg/Hold: >1 Radio Device: BTS</p> <p>#IFGain:1,low #Att: 10 dB</p> <p>Frequency</p> <p>10 dB/div Ref 30.00 dBm</p> <p>Log</p> <p>20.0 10.0 0.0 -10.0 -20.0 -30.0 -40.0 -50.0</p> <p>Center 2.44 GHz #Res BW 100 kHz #VBW 300 kHz Span 5 MHz Sweep 1 ms</p> <p>Occupied Bandwidth 1.9070 MHz Total Power 20.7 dBm</p> <p>Transmit Freq Error -3.891 kHz OBW Power 99.00 %</p> <p>x dB Bandwidth 847.6 kHz x dB -6.00 dB</p> <p>CF Step 500.000 kHz Man</p> <p>Freq Offset 0 Hz</p> <p>Points changed; all traces cleared STATUS</p>
<p>Keylight Spectrum Analyzer - Occupied BW</p> <p>Center Freq 2.480000000 GHz</p> <p>Center Freq: 2.480000000 GHz Radio Std: None</p> <p>Trig: Free Run Avg/Hold: 1/1 Radio Device: BTS</p> <p>#IFGain:1,low #Att: 10 dB</p> <p>Frequency</p> <p>10 dB/div Ref 30.00 dBm</p> <p>Log</p> <p>20.0 10.0 0.0 -10.0 -20.0 -30.0 -40.0 -50.0</p> <p>Center 2.48 GHz #Res BW 100 kHz #VBW 300 kHz Span 5 MHz Sweep 1 ms</p> <p>Occupied Bandwidth 1.8607 MHz Total Power 20.7 dBm</p> <p>Transmit Freq Error -10.498 kHz OBW Power 99.00 %</p> <p>x dB Bandwidth 799.3 kHz x dB -6.00 dB</p> <p>CF Step 500.000 kHz Man</p> <p>Freq Offset 0 Hz</p> <p>Points changed; all traces cleared STATUS</p>	<p>Keylight Spectrum Analyzer - Occupied BW</p> <p>Center Freq 2.480000000 GHz</p> <p>Center Freq: 2.480000000 GHz Radio Std: None</p> <p>Trig: Free Run Avg/Hold: 1/1 Radio Device: BTS</p> <p>#IFGain:1,low #Att: 10 dB</p> <p>Frequency</p> <p>10 dB/div Ref 30.00 dBm</p> <p>Log</p> <p>20.0 10.0 0.0 -10.0 -20.0 -30.0 -40.0 -50.0</p> <p>Center 2.48 GHz #Res BW 100 kHz #VBW 300 kHz Span 5 MHz Sweep 1 ms</p> <p>Occupied Bandwidth 1.9011 MHz Total Power 20.4 dBm</p> <p>Transmit Freq Error -570 Hz OBW Power 99.00 %</p> <p>x dB Bandwidth 847.1 kHz x dB -6.00 dB</p> <p>CF Step 500.000 kHz Man</p> <p>Freq Offset 0 Hz</p> <p>Points changed; all traces cleared STATUS</p>

9.3. OUTPUT POWER

Peak Power

T1 (Ant A)		Test Result		
Frequency (MHz)	Channel No.	Measured Power (dBm)	Limit (dBm)	Result
2402	0	13.489	30	Compliant
2440	19	13.100	30	Compliant
2480	39	12.760	30	Compliant

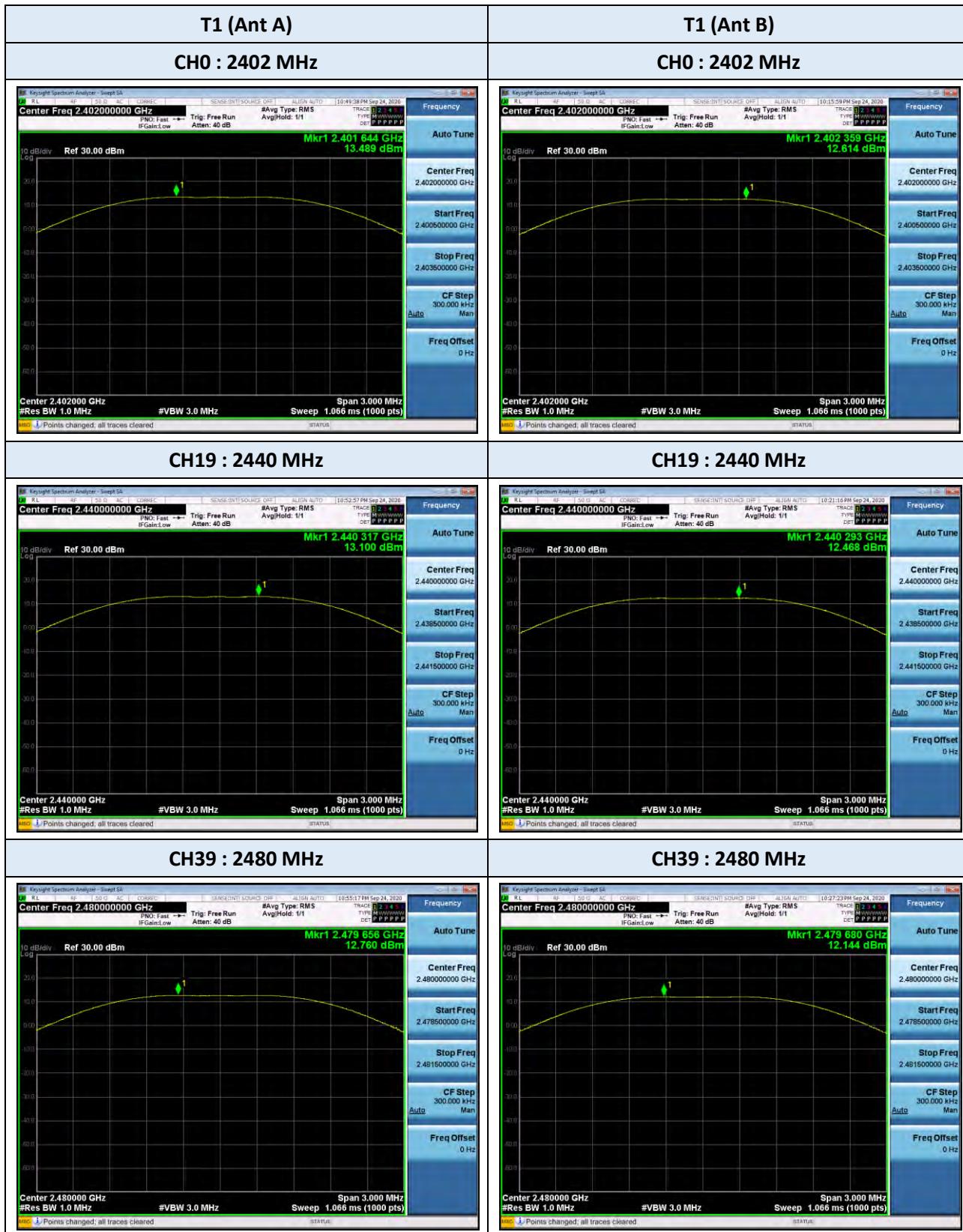
T1 (Ant B)		Test Result		
Frequency (MHz)	Channel No.	Measured Power (dBm)	Limit (dBm)	Result
2402	0	12.614	30	Compliant
2440	19	12.468	30	Compliant
2480	39	12.144	30	Compliant

T2 (Ant C)		Test Result		
Frequency (MHz)	Channel No.	Measured Power (dBm)	Limit (dBm)	Result
2402	0	14.675	30	Compliant
2440	19	14.070	30	Compliant
2480	39	13.756	30	Compliant

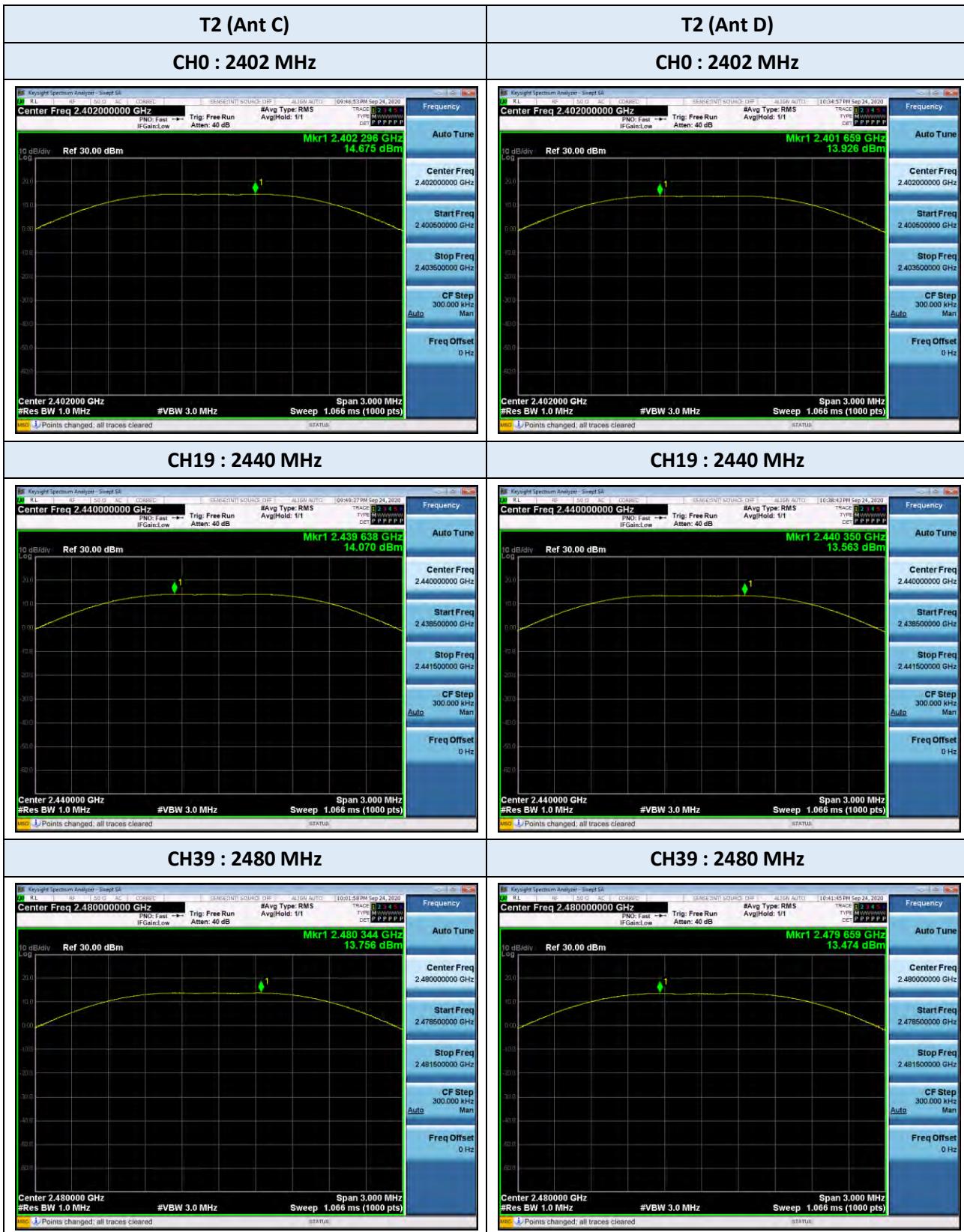
T2 (Ant D)		Test Result		
Frequency (MHz)	Channel No.	Measured Power (dBm)	Limit (dBm)	Result
2402	0	13.926	30	Compliant
2440	19	13.563	30	Compliant
2480	39	13.474	30	Compliant

Note :

1. The output power results in plot include the spectrum offset, which is a combination loss of the attenuator and the cable used for testing

TEST PLOTS (Peak Power)


TEST PLOTS (Peak Power)



9.4. POWER SPECTRAL DENSITY

T1 (Ant A)		Test Result				
Frequency (MHz)	Channel No.	Measured Level (dBm/3kHz)	Duty Factor (dB)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Result
2402	0	-0.318	0.47	0.149	≤ 8.000	Compliant
2440	19	-0.564	0.47	-0.097	≤ 8.000	Compliant
2480	39	-0.710	0.47	-0.243	≤ 8.000	Compliant

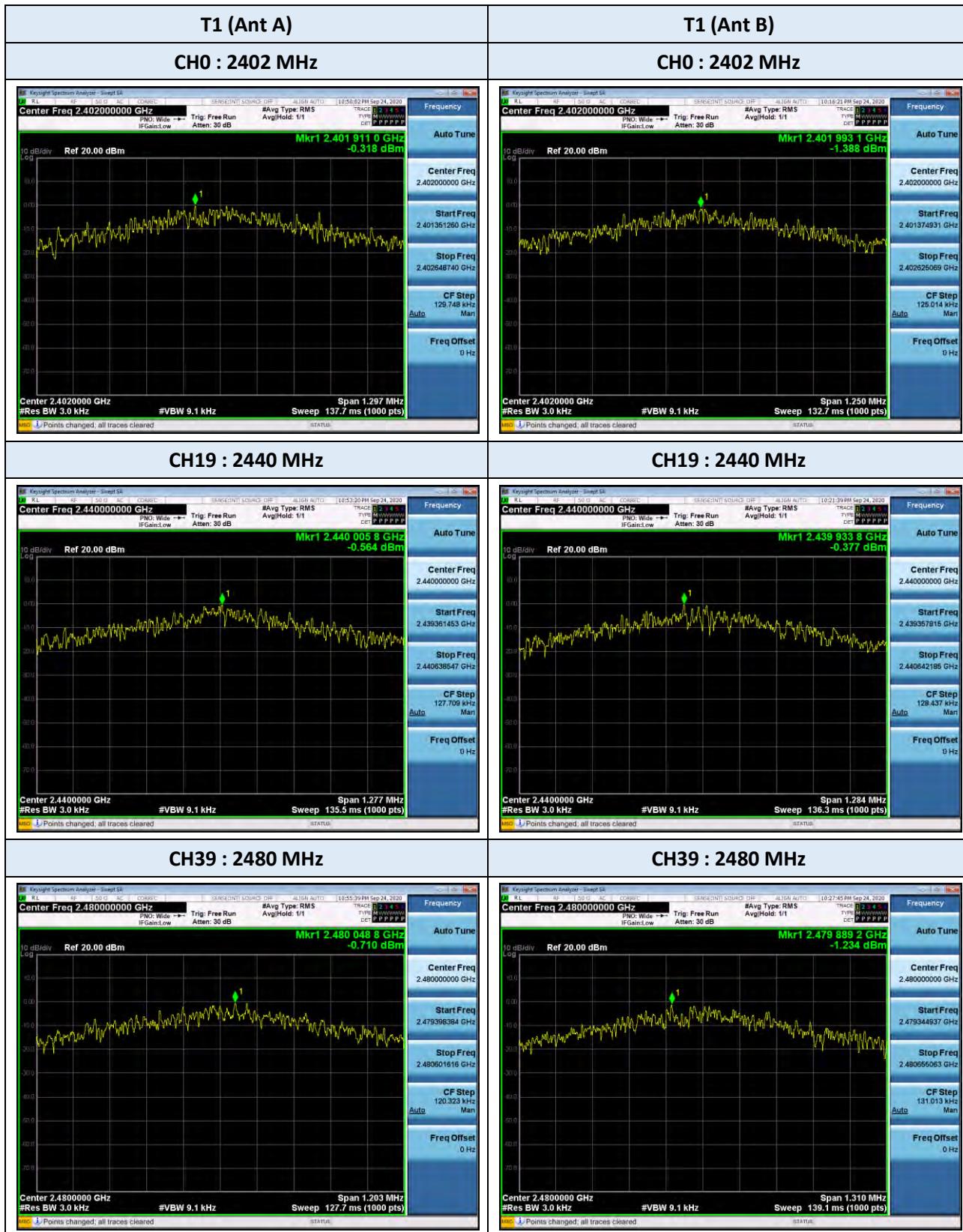
T1 (Ant B)		Test Result				
Frequency (MHz)	Channel No.	Measured Level (dBm/3kHz)	Duty Factor (dB)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Result
2402	0	-1.388	0.46	-0.925	≤ 8.000	Compliant
2440	19	-0.377	0.46	0.086	≤ 8.000	Compliant
2480	39	-1.234	0.46	-0.771	≤ 8.000	Compliant

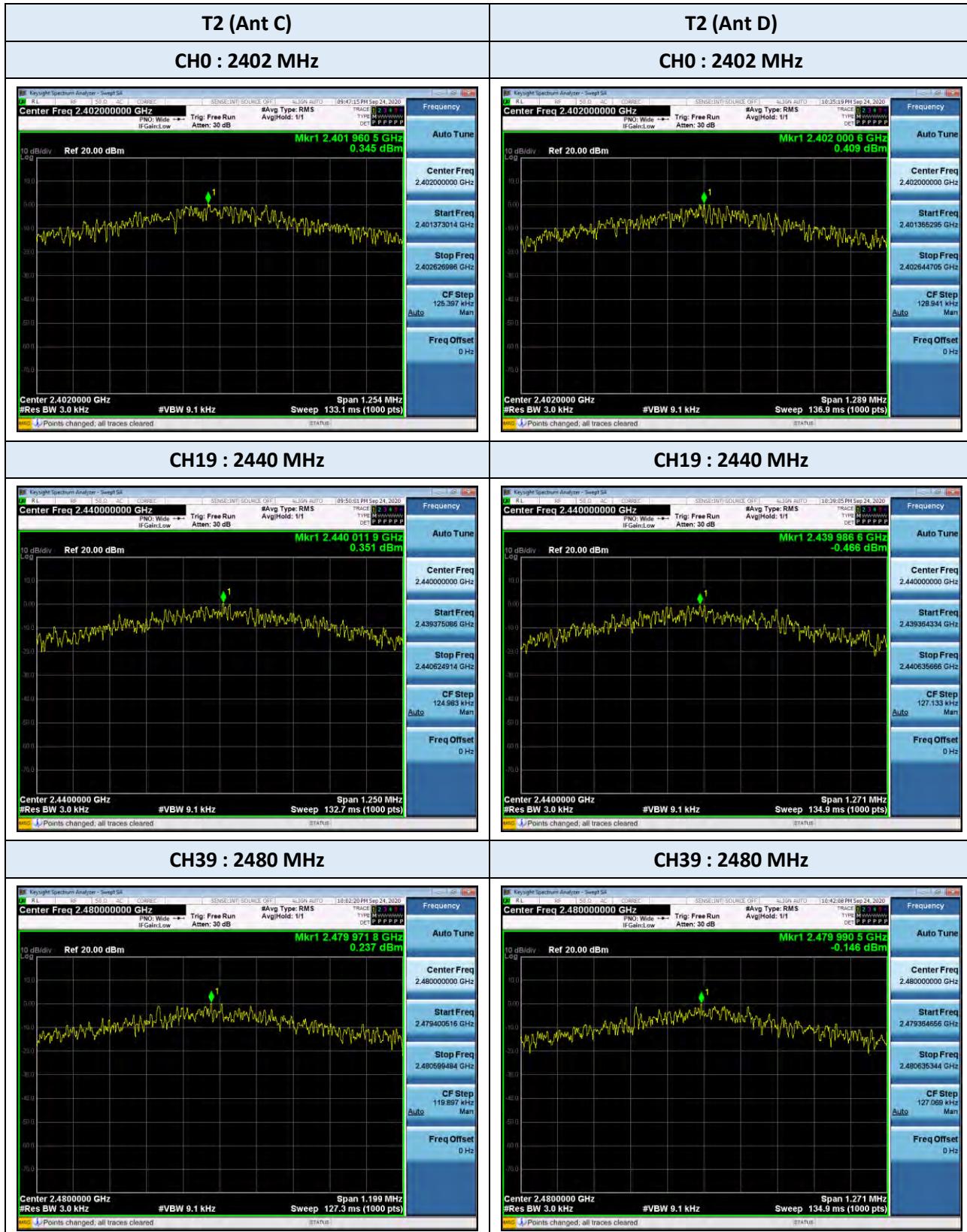
T2 (Ant C)		Test Result				
Frequency (MHz)	Channel No.	Measured Level (dBm/3kHz)	Duty Factor (dB)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Result
2402	0	0.345	0.46	0.808	≤ 8.000	Compliant
2440	19	0.351	0.46	0.814	≤ 8.000	Compliant
2480	39	0.237	0.46	0.700	≤ 8.000	Compliant

T2 (Ant D)		Test Result				
Frequency (MHz)	Channel No.	Measured Level (dBm/3kHz)	Duty Factor (dB)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Result
2402	0	0.409	0.47	0.876	≤ 8.000	Compliant
2440	19	-0.466	0.47	0.001	≤ 8.000	Compliant
2480	39	-0.146	0.47	0.321	≤ 8.000	Compliant

Note :

1. The output power results in plot include the spectrum offset, which is a combination loss of the attenuator and the cable used for testing

TEST PLOTS (PSD)


TEST PLOTS (PSD)


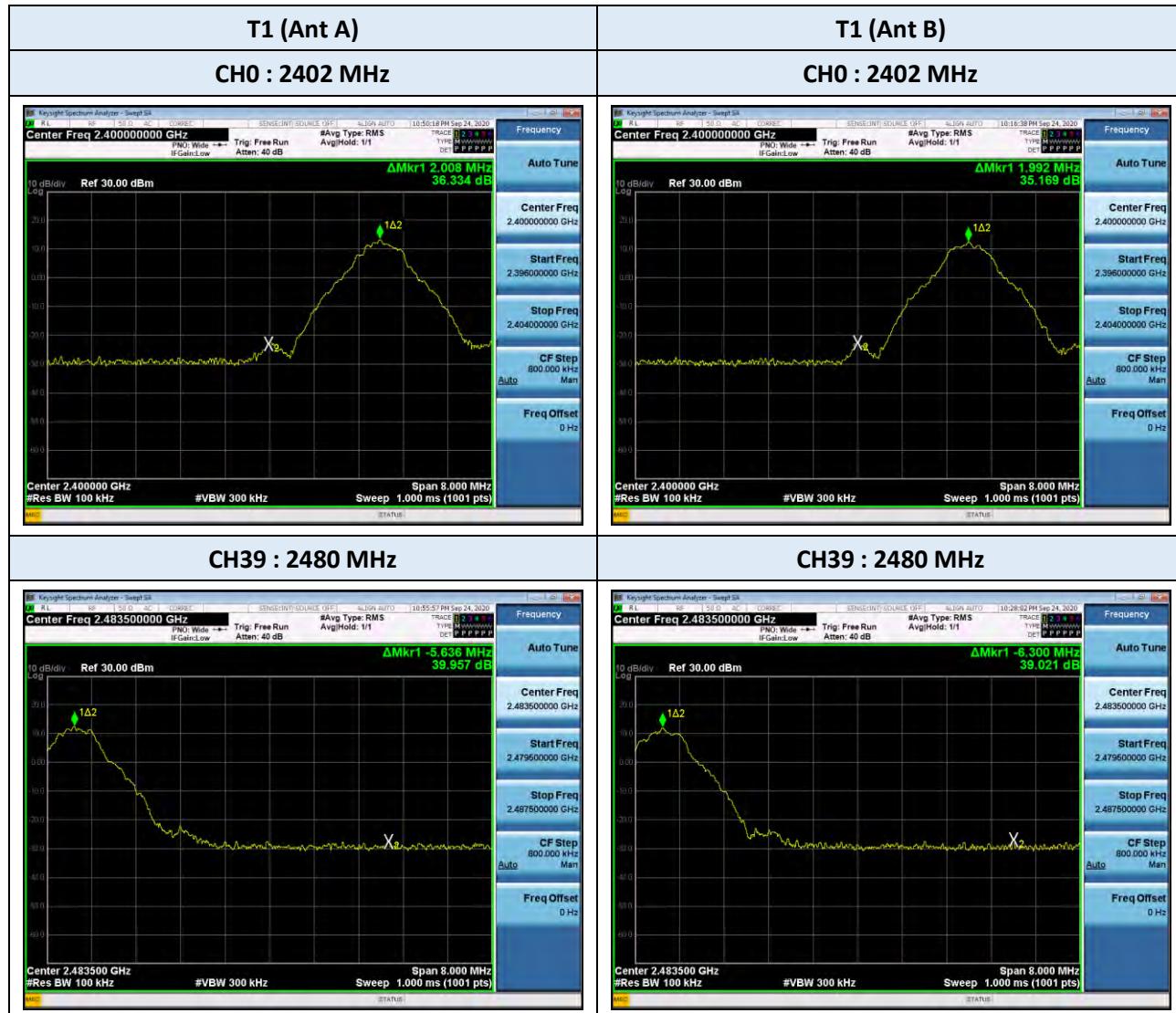
9.5. CONDUCTED BAND EDGE & SPURIOUS EMISSIONS

Out of Band Emissions at the Band Edge : T1

T1 (Ant A)			Test Result		
Frequency [MHz]	Channel No.	Position	Measured Level [dB]	Limit [dBc]	Result
2402	0	Low	36.334	≥ 20	Compliant
2480	39	High	39.957	≥ 20	Compliant

T1 (Ant B)			Test Result		
Frequency [MHz]	Channel No.	Position	Measured Level [dB]	Limit [dBc]	Result
2402	0	Low	35.169	≥ 20	Compliant
2480	39	High	39.021	≥ 20	Compliant

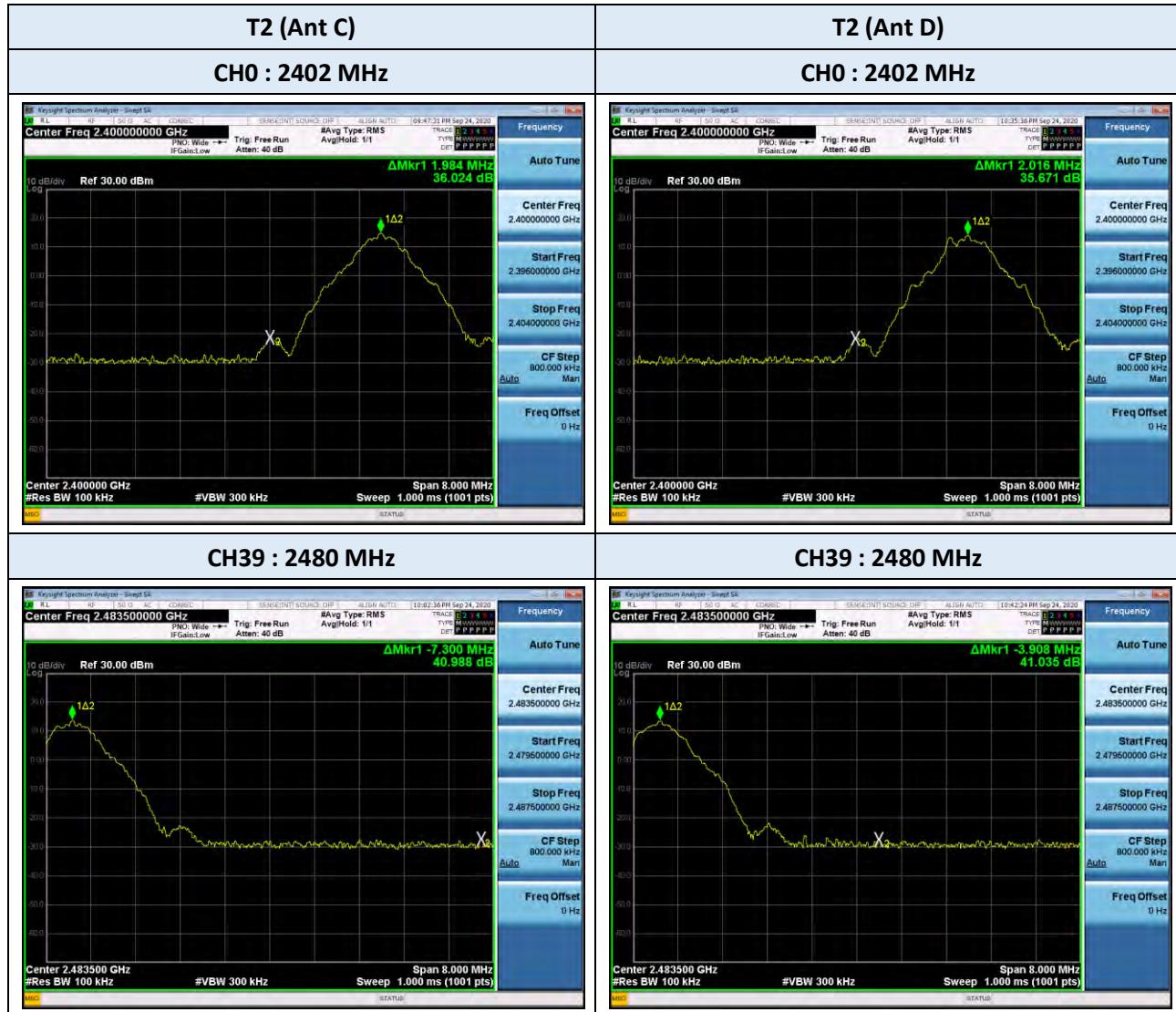
TEST PLOTS (Conducted Band Edge : T1)



Out of Band Emissions at the Band Edge : T2

T2 (Ant C)			Test Result		
Frequency [MHz]	Channel No.	Position	Measured Level [dB]	Limit [dBc]	Result
2402	0	Low	36.024	≥ 20	Compliant
2480	39	High	40.988	≥ 20	Compliant

T2 (Ant D)			Test Result		
Frequency [MHz]	Channel No.	Position	Measured Level [dB]	Limit [dBc]	Result
2402	0	Low	35.671	≥ 20	Compliant
2480	39	High	41.035	≥ 20	Compliant

TEST PLOTS (Conducted Band Edge : T1)


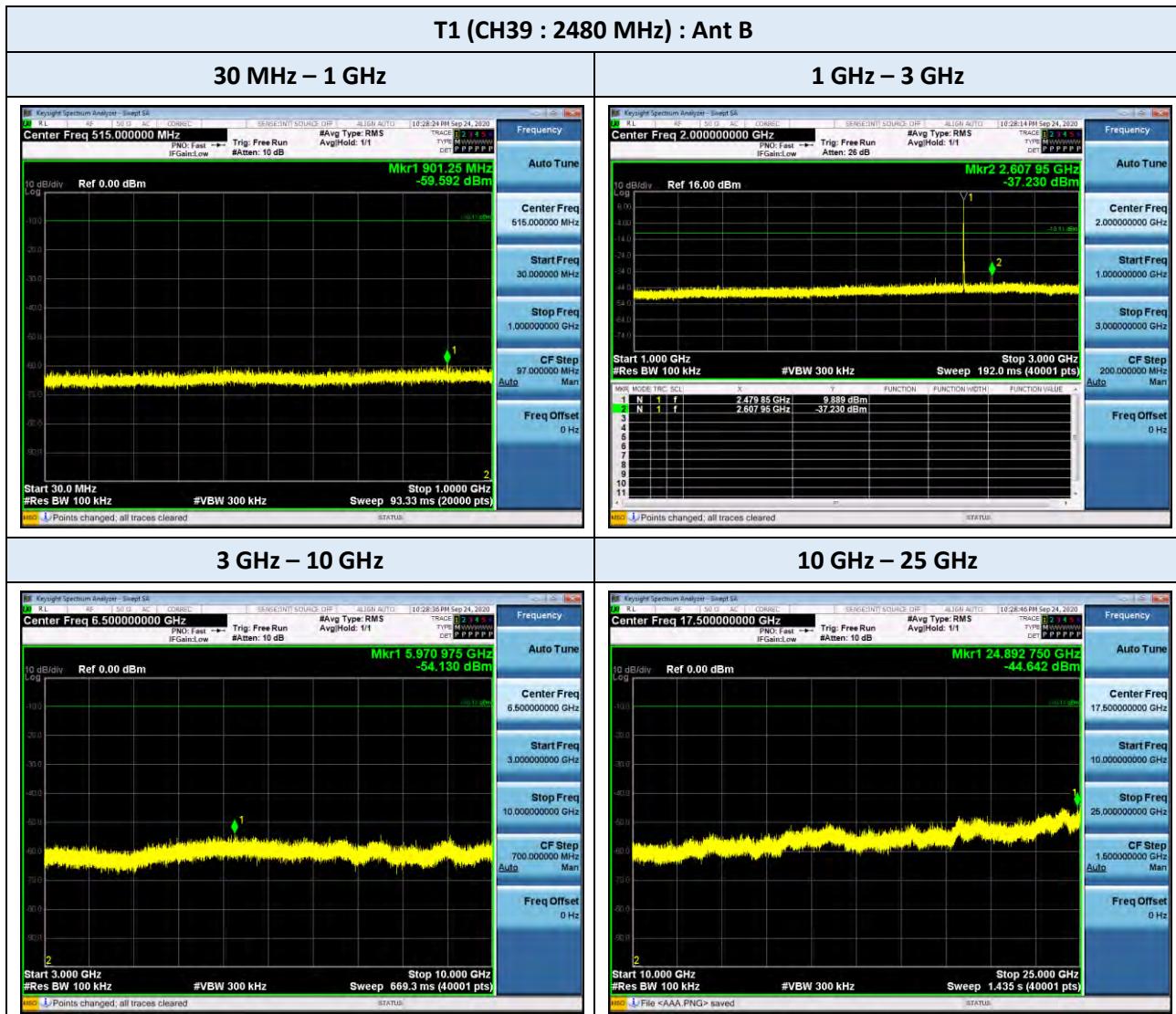
Conducted Spurious Emissions

T1 (Ant A)			Test Result		
Frequency [MHz]	Channel No.	Position	Measured Level [dBc]	Limit [dBc]	Result
2402	0	Low	50.708	≥ 20	Compliant
2440	19	Middle	50.097	≥ 20	Compliant
2480	39	High	50.681	≥ 20	Compliant

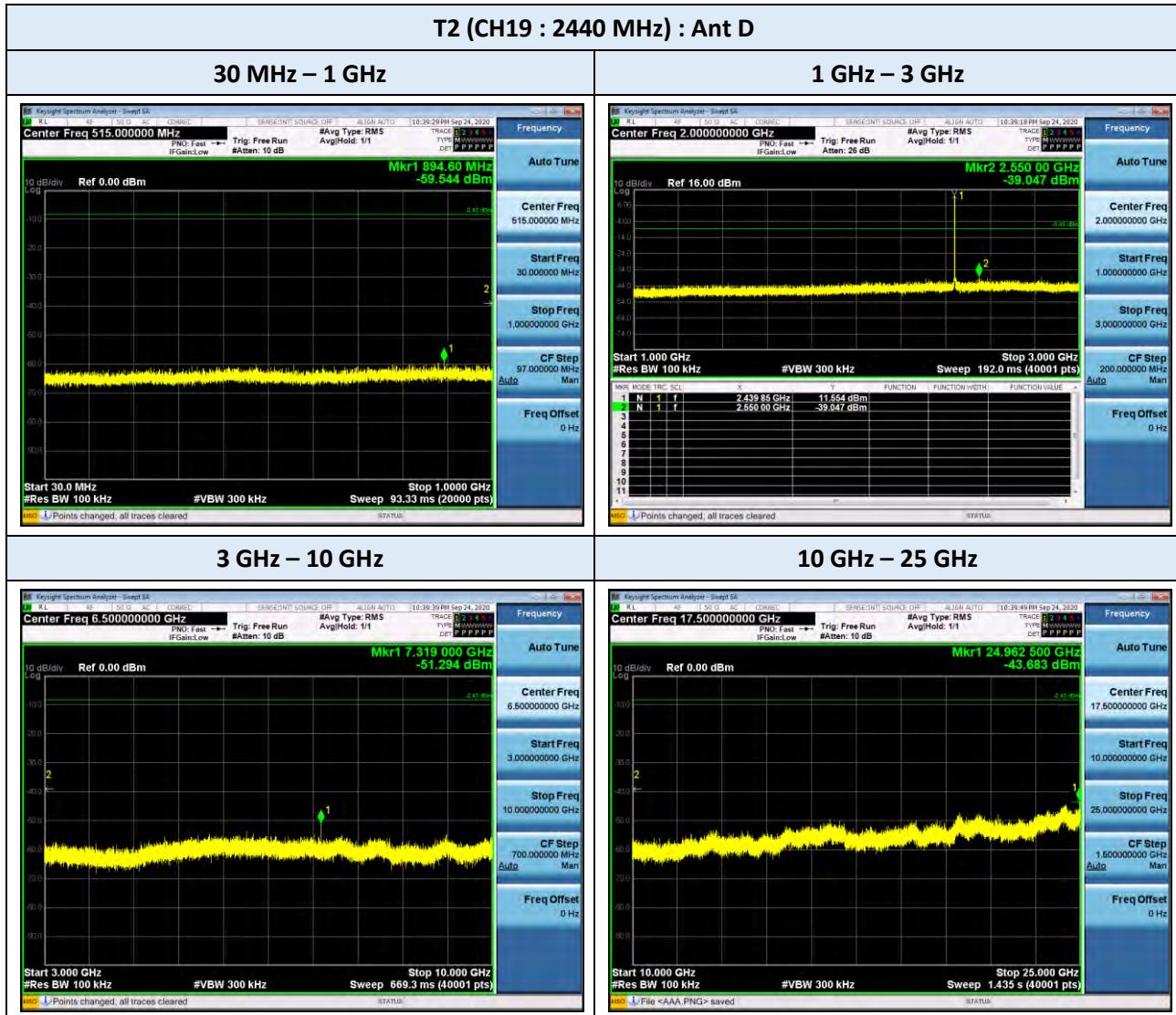
T1 (Ant B)			Test Result		
Frequency [MHz]	Channel No.	Position	Measured Level [dBc]	Limit [dBc]	Result
2402	0	Low	47.762	≥ 20	Compliant
2440	19	Middle	50.632	≥ 20	Compliant
2480	39	High	47.119	≥ 20	Compliant

T2 (Ant C)			Test Result		
Frequency [MHz]	Channel No.	Position	Measured Level [dBc]	Limit [dBc]	Result
2402	0	Low	54.006	≥ 20	Compliant
2440	19	Middle	50.891	≥ 20	Compliant
2480	39	High	51.023	≥ 20	Compliant

T2 (Ant D)			Test Result		
Frequency [MHz]	Channel No.	Position	Measured Level [dBc]	Limit [dBc]	Result
2402	0	Low	51.530	≥ 20	Compliant
2440	19	Middle	50.601	≥ 20	Compliant
2480	39	High	50.897	≥ 20	Compliant

TEST PLOTS (Conducted Spurious Emission : T1)

Note:

The plots included in this report are only at the worst-case channel and the port

TEST PLOTS (Conducted Spurious Emission : T2)

Note:

The plots included in this report are only at the worst-case channel and the port

9.6. RADIATED SPURIOUS EMISSIONS

Frequency Range : 9 kHz – 30 MHz

2402 MHz

Frequency (MHz)	Polarization	Reading (dBuV)	Corr. ¹⁾ (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement Type
0.179	H	1.5	19.8	21.3	102.5	81.2	QP
0.180	V	1.1	19.8	20.9	102.5	81.6	QP
4.072	H	2.3	20.3	22.6	69.5	46.9	QP
16.255	V	4.6	21.5	26.1	69.5	43.4	QP

Notes:

1. Correction Factor: Antenna Factor + Cable loss
2. Limit line = Specific Limits (dBuV) + Distance extrapolation factor
3. Distance extrapolation factor = $40 \log (\text{specific distance} / \text{test distance})$ (dB)
4. The measurement distance is 3 meters.
5. The worst-case result is included in this report.

Frequency Range : Below 1 GHz

T1 (Ant A) : Charging mode

2402 MHz

Frequency (MHz)	Polarization	Reading (dBuV)	Corr. ¹⁾ (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement Type
41.059	V	31.7	-7.6	24.1	40	15.9	QP
48.162	V	32.7	-12.3	20.4	40	19.6	QP
60.384	V	36.5	-13.1	23.4	40	16.6	QP
121.861	V	39.2	-6.7	32.5	43.5	11.0	QP
854.301	V	24.0	3.4	27.4	46	18.6	QP
857.000	H	24.0	3.6	27.6	46	18.4	QP

2440 MHz

Frequency (MHz)	Polarization	Reading (dBuV)	Corr. ¹⁾ (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement Type
37.402	V	29.8	-4.9	24.9	40	15.1	QP
45.944	V	30.0	-11.1	18.9	40	21.1	QP
57.970	V	37	-13.3	23.7	40	16.3	QP
121.844	V	38.7	-6.7	32.0	43.5	11.5	QP
854.253	V	24.1	3.4	27.5	46	18.5	QP
860.950	H	24.1	3.7	27.8	46	18.2	QP

2480 MHz

Frequency (MHz)	Polarization	Reading (dBuV)	Corr. ¹⁾ (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement Type
37.111	V	29.5	-4.7	24.8	40	15.2	QP
49.632	V	31.6	-12.9	18.7	40	21.3	QP
60.663	V	36.4	-13.1	23.3	40	16.7	QP
121.868	V	37.3	-6.7	30.6	43.5	12.9	QP
854.135	V	24.1	3.4	27.5	46	18.5	QP
857.324	H	24	3.6	27.6	46	18.4	QP

Notes:

1. Correction Factor: Antenna Factor + Cable loss + Preamplifier Gain

Frequency Range : Below 1 GHz

T2 (Ant C) : Charging mode

2402 MHz

Frequency (MHz)	Polarization	Reading (dBuV)	Corr. ¹⁾ (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement Type
31.563	V	25.1	-0.8	24.3	40	15.7	QP
49.324	V	34.0	-12.8	21.2	40	18.8	QP
61.619	V	29.5	-13.0	16.5	40	23.5	QP
121.853	V	35.9	-6.7	29.2	43.5	14.3	QP
854.504	V	24.1	3.4	27.5	46	18.5	QP
857.030	H	24.0	3.6	27.6	46	18.4	QP

2440 MHz

Frequency (MHz)	Polarization	Reading (dBuV)	Corr. ¹⁾ (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement Type
41.767	V	25.8	-8.1	17.7	40	22.3	QP
49.106	V	34.9	-12.7	22.2	40	17.8	QP
107.534	V	36.3	-8.3	28.0	43.5	15.5	QP
121.836	V	35.0	-6.7	28.3	43.5	15.2	QP
854.136	V	24.1	3.4	27.5	46	18.5	QP
857.122	H	24.0	3.6	27.6	46	18.4	QP

2480 MHz

Frequency (MHz)	Polarization	Reading (dBuV)	Corr. ¹⁾ (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement Type
39.988	V	25.1	-6.9	18.2	40	21.8	QP
50.090	V	35.2	-13	22.2	40	17.8	QP
107.508	V	36.1	-8.3	27.8	43.5	15.7	QP
121.849	V	35.2	-6.7	28.5	43.5	15.0	QP
885.420	H	24.2	3.6	27.8	46	18.2	QP
887.780	V	24.2	3.7	27.9	46	18.1	QP

Notes:

1. Correction Factor: Antenna Factor + Cable loss + Preamplifier Gain

Frequency Range : Below 1 GHz

T1 (Ant A) : Standalone

2402 MHz

Frequency (MHz)	Polarization	Reading (dBuV)	Corr. ¹⁾ (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement Type
57.063	V	36.4	-14.1	22.3	40	17.7	QP
107.531	H	32.8	-9.0	23.8	44	20.2	QP
843.829	H	21.0	1.5	22.5	46	23.5	QP

T2 (Ant C) : Standalone

2402 MHz

Frequency (MHz)	Polarization	Reading (dBuV)	Corr. ¹⁾ (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Measurement Type
57.334	V	37.0	-14.0	23.0	40	17.0	QP
107.544	H	31.9	-9.0	22.9	44	21.1	QP

Notes:

1. Correction Factor: Antenna Factor + Cable loss + Preamplifier Gain
2. The results for standalone mode are provided at the worst-case channels for each selective antenna ports

Frequency Range : Above 1 GHz
T1 (Ant A) : Charging mode
2402 MHz

Frequency (MHz)	Polarization	Reading (dBuV)		Factor (dB)		Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
		AV	PK	Corr. ¹⁾	Duty	AV	PK	AV	PK	AV	PK
2274.147	H	57.2	61.1	-6.2	0.47	51.5	54.9	54	74	2.6	19.1
2274.315	V	56.7	62.1	-6.2	0.47	51.0	55.9	54	74	3.1	18.1
2337.672	V	53.9	59.9	-6.1	0.47	48.3	53.8	54	74	5.8	20.2
2338.025	H	55.6	59.9	-6.1	0.47	50.0	53.8	54	74	4.1	20.2
4803.093	H	36.3	49.0	-0.2	0.47	36.6	48.8	54	74	17.5	25.2
4803.742	V	35.9	48.3	-0.2	0.47	36.2	48.1	54	74	17.9	25.9
16049.250	H	30.4	43.7	17.9	-	48.3	61.6	54	74	5.7	12.4
16525.250	V	29.3	43.1	17.8	-	47.1	60.9	54	74	6.9	13.1
19218.710	H	46.3	58.0	2.9	0.47	49.7	60.9	54	74	4.4	13.1
19218.340	V	44.0	55.2	2.9	0.47	47.4	58.1	54	74	6.7	15.9

2440 MHz

Frequency (MHz)	Polarization	Reading (dBuV)		Factor (dB)		Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
		AV	PK	Corr. ¹⁾	Duty	AV	PK	AV	PK	AV	PK
2311.921	V	56.5	61.0	-6.2	0.47	50.8	54.8	54	74	3.3	19.2
2311.822	H	55.7	60.6	-6.2	0.47	50.0	54.4	54	74	4.1	19.6
2376.329	H	53.8	60.2	-5.8	0.47	48.5	54.4	54	74	5.6	19.6
2375.605	V	52.8	59.8	-5.8	0.47	47.5	54.0	54	74	6.6	20.0
4880.241	V	39.6	50.4	-0.2	0.47	39.9	50.2	54	74	14.2	23.8
4879.720	H	38.3	49.7	-0.2	0.47	38.6	49.5	54	74	15.5	24.5
7321.003	V	42.4	52.7	5.3	0.47	48.2	58.0	54	74	5.9	16.0
7320.898	H	44.8	53.8	5.3	0.47	50.6	59.1	54	74	3.5	14.9
16523.125	V	29.1	42.2	17.8	-	46.9	60.0	54	74	7.1	14.0
16051.375	H	30.3	43.3	17.9	-	48.2	61.2	54	74	5.8	12.8
19517.040	H	41.9	54.0	2.8	0.47	45.2	56.8	54	74	8.9	17.2
19517.390	V	41.5	53.1	2.8	0.47	44.8	55.9	54	74	9.3	18.1

Notes:

1. Correction Factor: Antenna Factor + Cable loss + Preamplifier Gain
2. AV Level = Measured Power(dBm) + Correction Factor(dB) + Duty Cycle Factor(dB)

T1 (Ant A) : Charging mode
2480 MHz

Frequency (MHz)	Polarization	Reading (dBuV)		Factor (dB)		Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
		AV	PK	Corr. ¹⁾	Duty	AV	PK	AV	PK	AV	PK
2351.964	V	56.9	61.0	-6.0	0.47	51.4	55.0	54	74	2.7	19.0
2352.437	H	53.2	60.2	-6.0	0.47	47.7	54.2	54	74	6.3	19.8
4959.805	H	45.0	53.1	0.0	0.47	45.5	53.1	54	74	8.6	20.9
4960.410	V	39.5	50.7	0.0	0.47	40.0	50.7	54	74	14.1	23.3
7438.887	H	45.2	55.1	5.4	0.47	51.1	60.5	54	74	3.0	13.5
7438.977	V	38.0	49.7	5.4	0.47	43.9	55.1	54	74	10.2	18.9
15977.000	V	29.2	43.0	18.0	-	47.2	61.0	54	74	6.8	13.0
16523.125	H	29.1	42.4	17.8	-	46.9	60.2	54	74	7.1	13.8
19837.600	V	42.4	53.9	3.0	0.47	45.9	56.9	54	74	8.2	17.1
19837.530	H	42.6	54.4	3.0	0.47	46.1	57.4	54	74	8.0	16.6

Notes:

1. Correction Factor: Antenna Factor + Cable loss + Preamplifier Gain
2. AV Level = Measured Power(dBm) + Correction Factor(dB) + Duty Cycle Factor(dB)

Frequency Range : Above 1 GHz

T1 (Ant A) : Standalone mode

2402 MHz

Frequency (MHz)	Polarization	Reading (dBuV)		Factor (dB)		Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
		AV	PK	Corr. ¹⁾	Duty	AV	PK	AV	PK	AV	PK
2273.830	V	57.3	61.9	-6.2	0.47	51.6	55.7	54	74	2.5	18.3
2274.193	H	56.8	61.8	-6.2	0.47	51.1	55.6	54	74	3.0	18.4
2337.703	V	54.3	60.1	-6.1	0.47	48.7	54.0	54	74	5.4	20.0
2338.273	H	54.0	59.7	-6.1	0.47	48.4	53.6	54	74	5.7	20.4
4803.041	V	36.5	49.5	-0.2	0.47	36.8	49.3	54	74	17.3	24.7
4803.672	H	37.5	49.0	-0.2	0.47	37.8	48.8	54	74	16.3	25.2
16045.000	V	30.1	43.7	18.0	-	48.1	61.7	54	74	5.9	12.3
16538.000	H	29.2	42.5	17.8	-	47.0	60.3	54	74	7.0	13.7

Notes:

1. Correction Factor: Antenna Factor + Cable loss + Preamplifier Gain
2. AV Level = Measured Power(dBm) + Correction Factor(dB) + Duty Cycle Factor(dB)
3. The result for standalone mode is provided at the worst-case channels for each selective antenna ports

Frequency Range : Above 1 GHz

T2 (Ant C) : Charging mode

2402 MHz

Frequency (MHz)	Polarization	Reading (dBuV)		Factor (dB)		Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
		AV	PK	Corr. ¹⁾	Duty	AV	PK	AV	PK	AV	PK
2274.478	V	51.5	59.2	-6.2	0.46	45.8	53.0	54	74	8.3	21.0
2273.887	H	54.9	58.9	-6.2	0.46	49.2	52.7	54	74	4.9	21.3
4800.938	V	33.8	47.3	-0.2	0.46	34.1	47.1	54	74	20.0	26.9
4803.195	H	38.3	50.6	-0.2	0.46	38.6	50.4	54	74	15.5	23.6
15964.250	H	29.1	43.4	18.0	-	47.1	61.4	54	74	6.9	12.6
15968.500	V	29.2	42.0	18.0	-	47.2	60.0	54	74	6.8	14.0
19218.830	V	42.2	54.5	2.9	0.46	45.6	57.4	54	74	8.5	16.6
19218.580	H	44.4	56.3	2.9	0.46	47.8	59.2	54	74	6.3	14.8

2440 MHz

Frequency (MHz)	Polarization	Reading (dBuV)		Factor (dB)		Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
		AV	PK	Corr. ¹⁾	Duty	AV	PK	AV	PK	AV	PK
2311.636	V	52.9	59.4	-6.2	0.46	47.2	53.2	54	74	6.9	20.8
2312.156	H	53.6	58.4	-6.2	0.46	47.9	52.2	54	74	6.2	21.8
2376.107	V	54.1	58.7	-5.8	0.46	48.8	52.9	54	74	5.2	21.1
2376.150	H	53.4	58.3	-5.8	0.46	48.1	52.5	54	74	6.0	21.5
4879.238	V	41.3	52.7	-0.2	0.46	41.6	52.5	54	74	12.5	21.5
4880.012	H	43.4	52.5	-0.2	0.46	43.7	52.3	54	74	10.4	21.7
7319.190	H	41.4	51.7	5.3	0.46	47.2	57.0	54	74	6.9	17.0
7319.889	V	35.5	49.0	5.3	0.46	41.3	54.3	54	74	12.8	19.7
15989.750	V	28.4	41.9	18.0	-	46.4	59.9	54	74	7.6	14.1
16083.250	H	28.8	42.0	17.7	-	46.5	59.7	54	74	7.5	14.3
19518.957	V	40.9	51.8	3.0	0.46	44.4	54.8	54	74	9.7	19.2
19519.201	H	40.7	51.4	3.0	0.46	44.2	54.4	54	74	9.8	19.6

Notes:

1. Correction Factor: Antenna Factor + Cable loss + Preamplifier Gain
2. AV Level = Measured Power(dBm) + Correction Factor(dB) + Duty Cycle Factor(dB)

T2 (Ant C) : Charging mode
2480 MHz

Frequency (MHz)	Polarization	Reading (dBuV)		Factor (dB)		Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
		AV	PK	Corr. ¹⁾	Duty	AV	PK	AV	PK	AV	PK
2351.504	V	49.4	57.7	-6.0	0.46	43.9	51.7	54	74	10.2	22.3
2352.302	H	52.0	58.1	-6.0	0.46	46.5	52.1	54	74	7.6	21.9
4959.421	V	43.3	53.4	0.0	0.46	43.8	53.4	54	74	10.3	20.6
4960.284	H	43.2	52.1	0.0	0.46	43.7	52.1	54	74	10.4	21.9
7438.979	H	45.9	55.4	5.4	0.46	51.8	60.8	54	74	2.3	13.2
7439.085	V	39.3	50.3	5.4	0.46	45.2	55.7	54	74	8.9	18.3
15934.500	H	29.4	42.3	17.8	-	47.2	60.1	54	74	6.8	13.9
16064.125	V	29.9	43.6	17.9	-	47.8	61.5	54	74	6.2	12.5
19838.530	H	40.7	51.8	3.0	0.46	44.2	54.8	54	74	9.8	19.2
19838.990	V	40.4	51.4	3.0	0.46	43.9	54.4	54	74	10.2	19.6

Notes:

1. Correction Factor: Antenna Factor + Cable loss + Preamplifier Gain
2. AV Level = Measured Power(dBm) + Correction Factor(dB) + Duty Cycle Factor(dB)

Frequency Range : Above 1 GHz

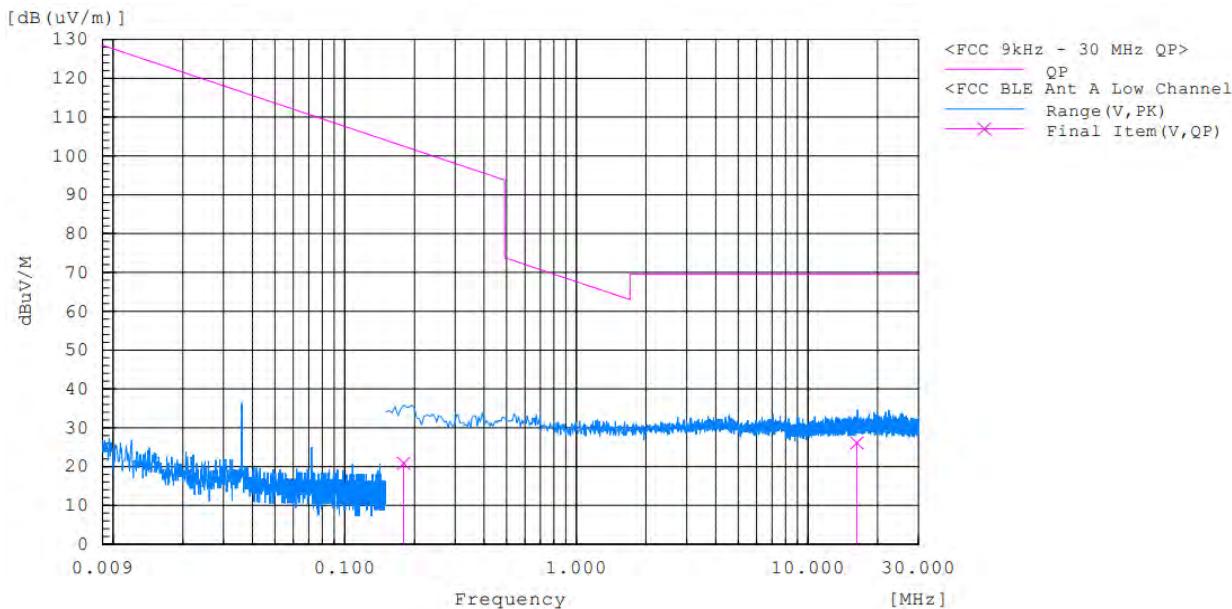
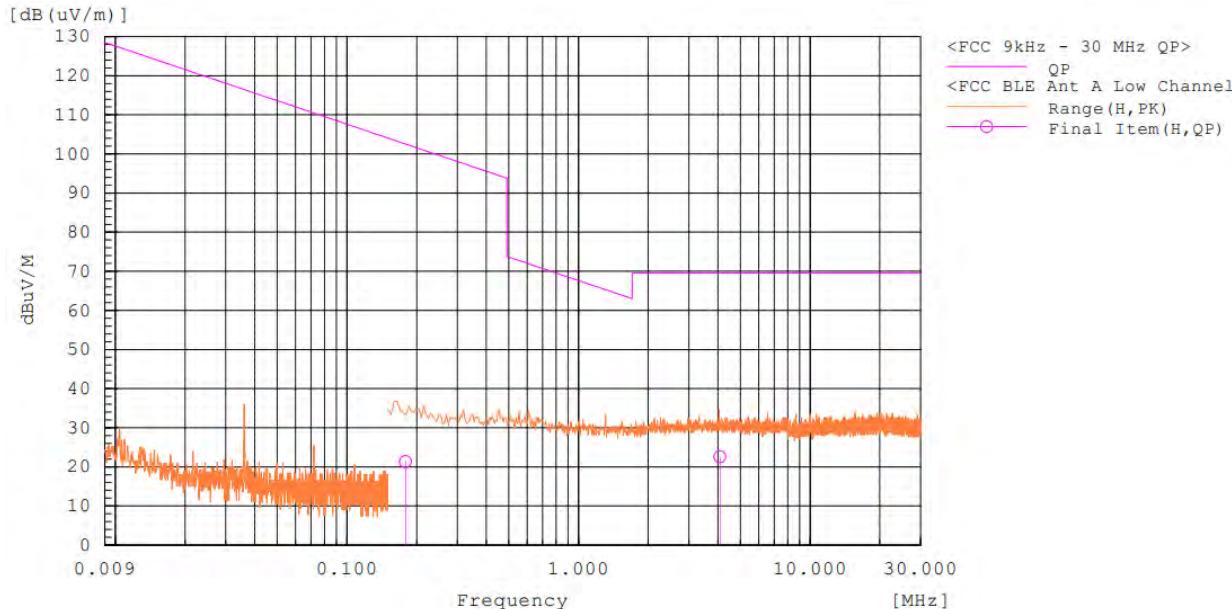
T2 (Ant C) : Standalone mode

2402 MHz

Frequency (MHz)	Polarization	Reading (dBuV)		Factor (dB)		Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
		AV	PK	Corr. ¹⁾	Duty	AV	PK	AV	PK	AV	PK
2274.192	V	54.0	58.9	-6.2	0.46	48.3	52.7	54	74	5.8	21.3
2274.310	H	53.5	59.3	-6.2	0.46	47.8	53.1	54	74	6.3	20.9
4804.515	H	38.6	50.0	-0.2	0.46	38.9	49.8	54	74	15.2	24.2
4803.383	V	35.6	48.5	-0.2	0.46	35.9	48.3	54	74	18.2	25.7
16059.875	V	30.2	43.5	17.9	-	48.1	61.4	54	74	5.9	12.6
16459.375	H	28.6	42.3	17.6	-	46.2	59.9	54	74	7.8	14.1

Notes:

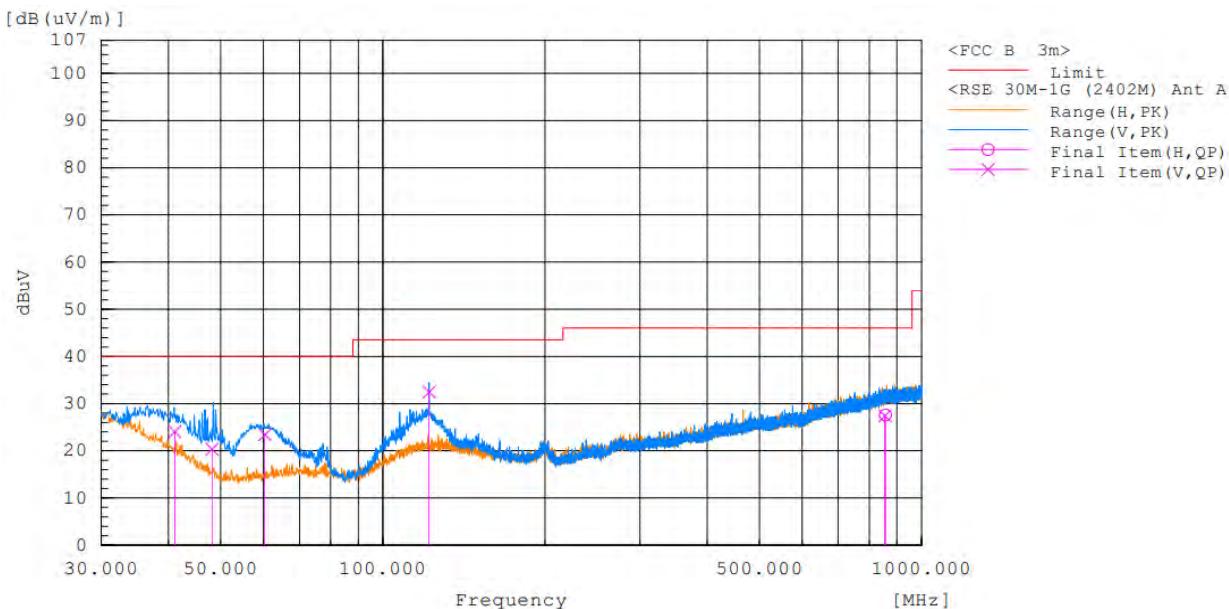
1. Correction Factor: Antenna Factor + Cable loss + Preamplifier Gain
2. AV Level = Measured Power(dBm) + Correction Factor(dB) + Duty Cycle Factor(dB)
3. The result for standalone mode provided at the worst-case channels for each selective antenna ports

TEST PLOTS
Radiated Spurious Emission 9 kHz – 30 MHz (Antenna Position 90°)

Radiated Spurious Emission 9 kHz – 30 MHz (Antenna Position 180°)

Note:

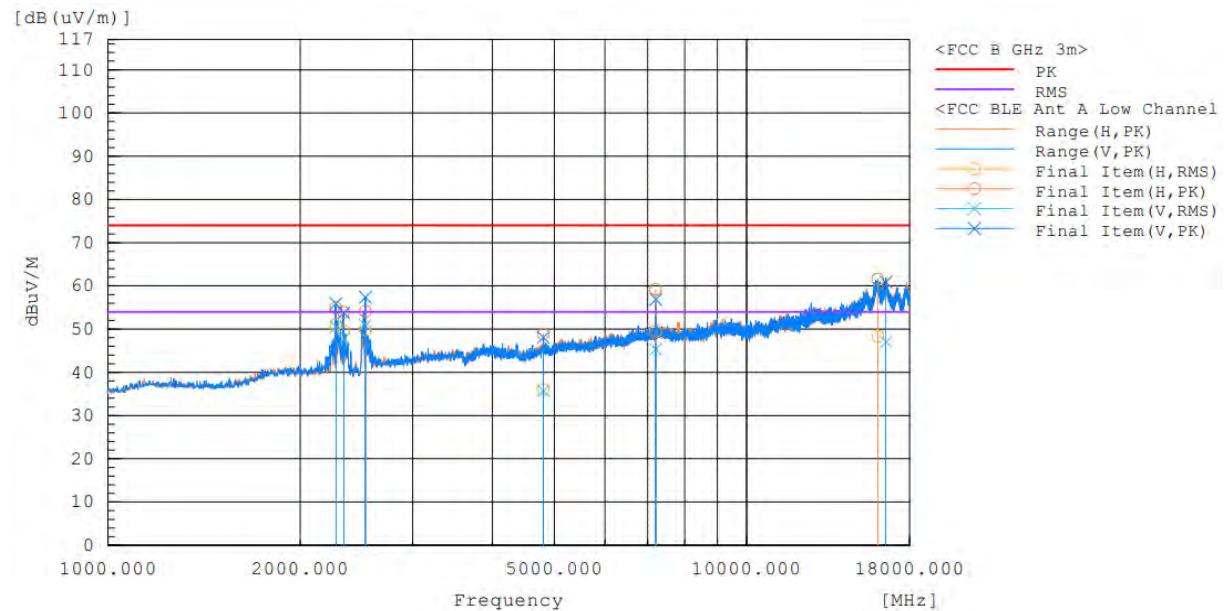
The worst-case plots are included in this report.

TEST PLOTS

Radiated Spurious Emission 30 MHz – 1 GHz : T1



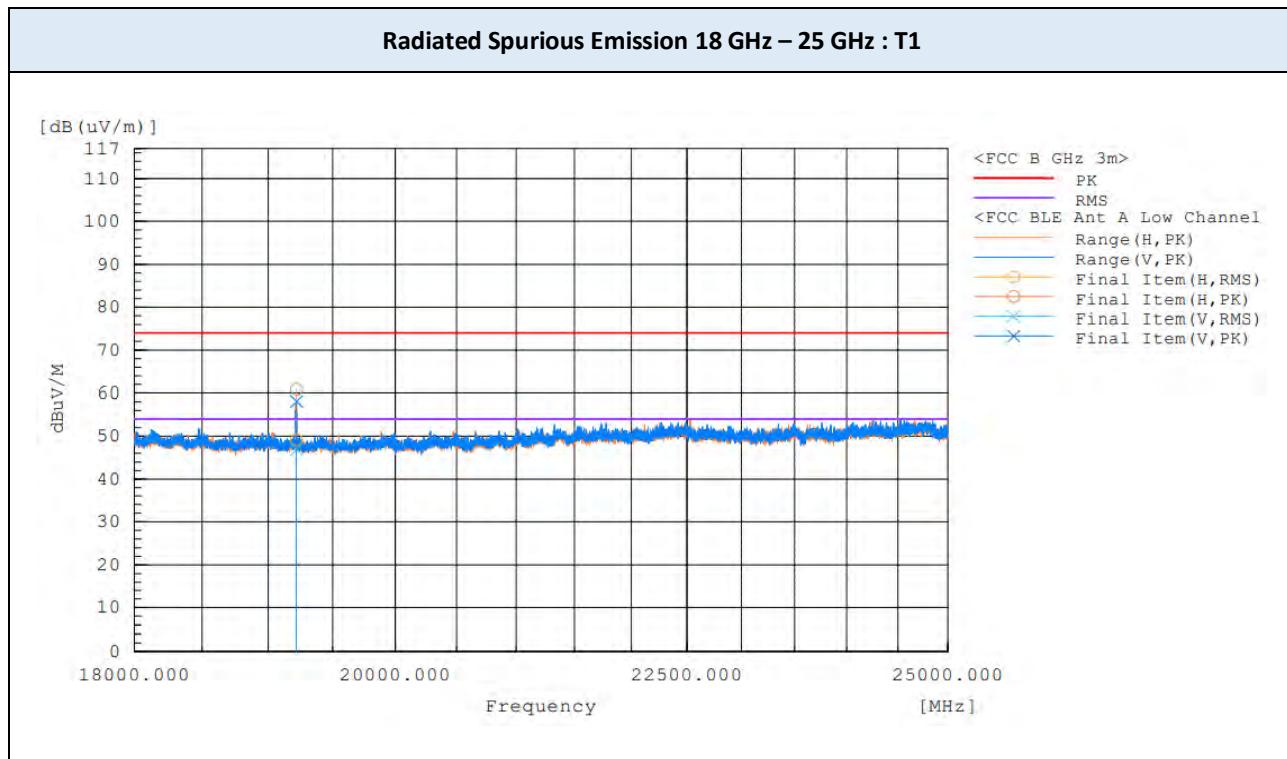
Radiated Spurious Emission 1 GHz – 18 GHz : T1



Note:

The worst-case plots are included in this report.

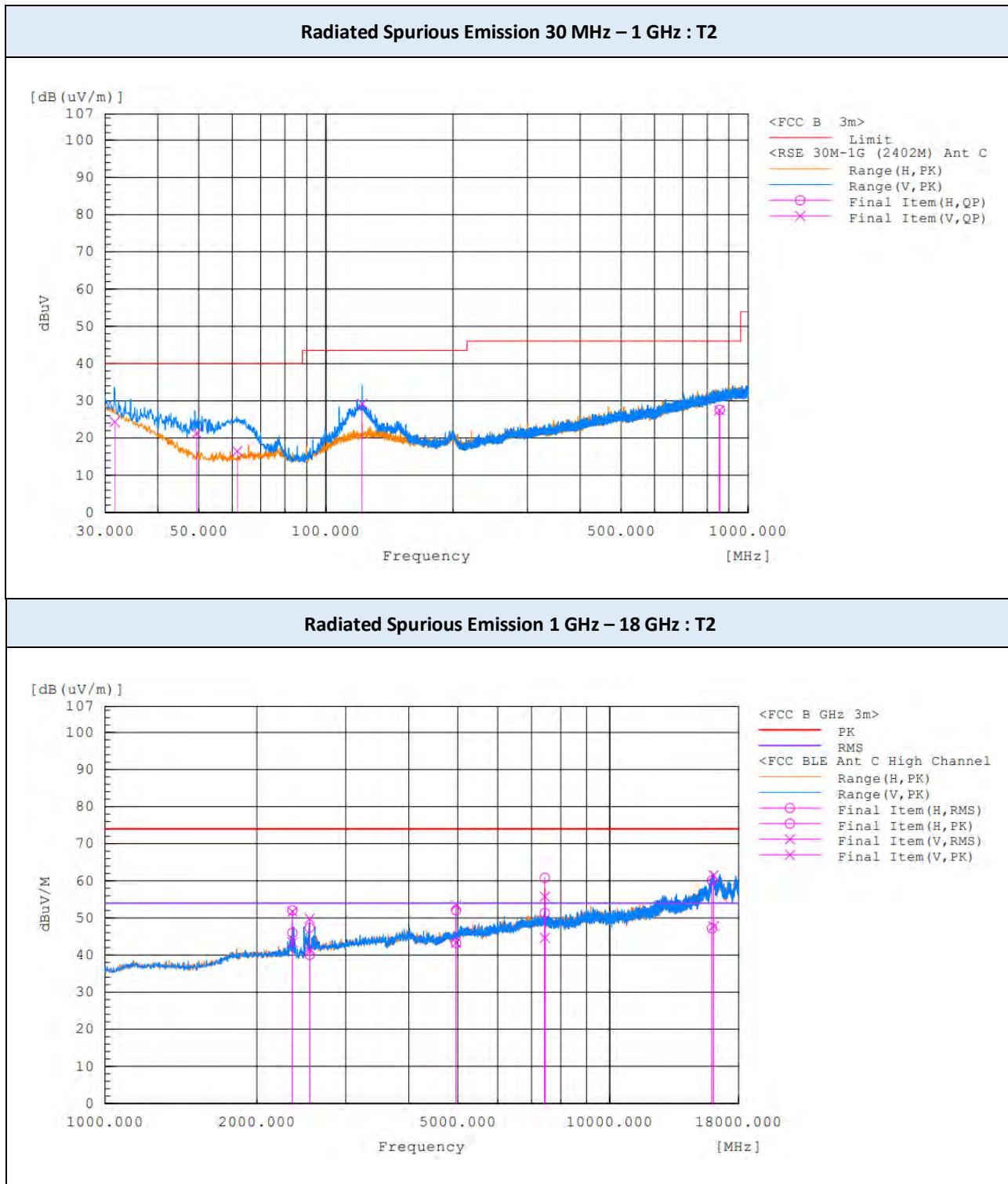
TEST PLOTS



Note:

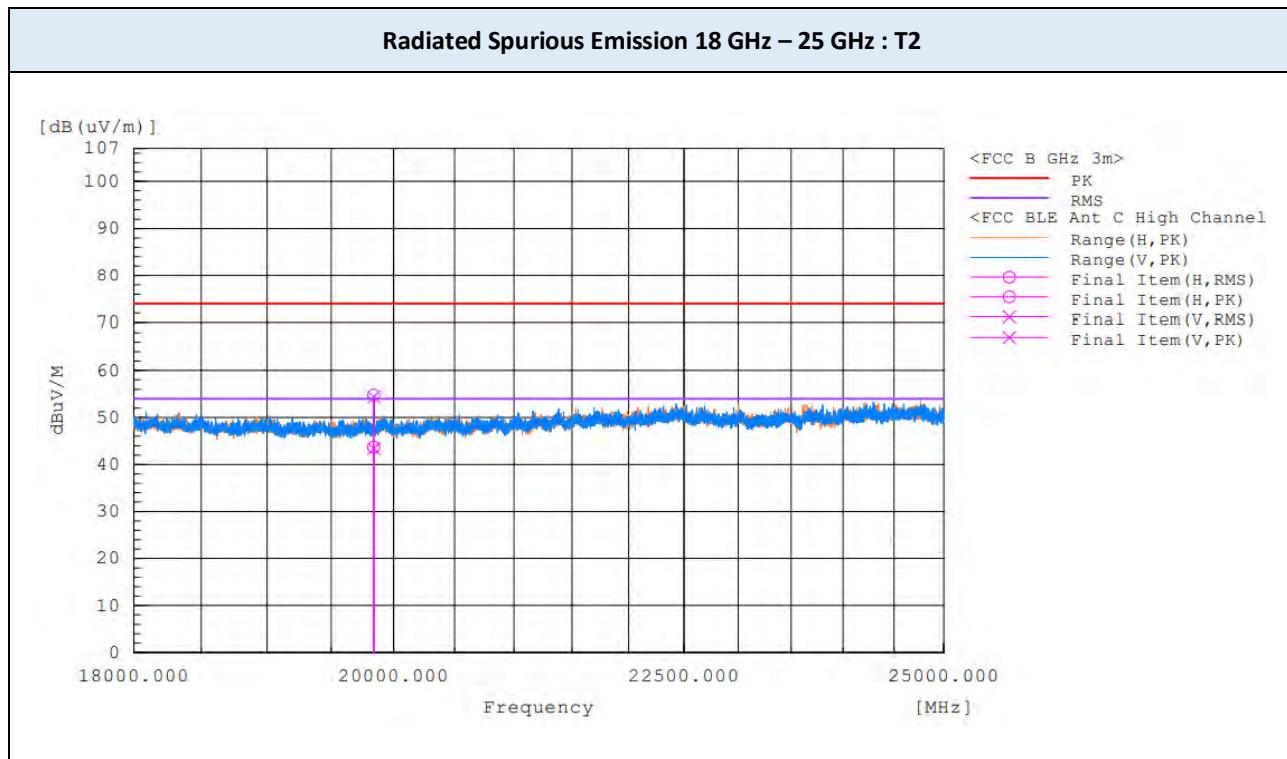
The worst-case plots are included in this report.

TEST PLOTS



Note:

The worst-case plots are included in this report.

TEST PLOTS**Note:**

The worst-case plots are included in this report.

9.7. RADIATED RESTRICTED BAND EDGES

Operating Frequency 2402 MHz
 Channel No. CH 0
 Chipset T1 (Ant A)

Frequency (MHz)	Polarization	Reading (dBuV)		Factor (dB)		Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
		AV	PK	Corr. ¹⁾	Duty	AV	PK	AV	PK	AV	PK
2377.935	V	40.4	50.7	-0.2	0.47	40.7	50.5	54	74	13.4	23.5
2377.434	H	42.1	50.9	-0.2	0.47	42.4	50.7	54	74	11.7	23.3
2389.999	V	38.9	52.1	-0.1	0.47	39.3	52.0	54	74	14.8	22.0
2389.999	H	38.1	51.9	-0.1	0.47	38.5	51.8	54	74	15.6	22.2

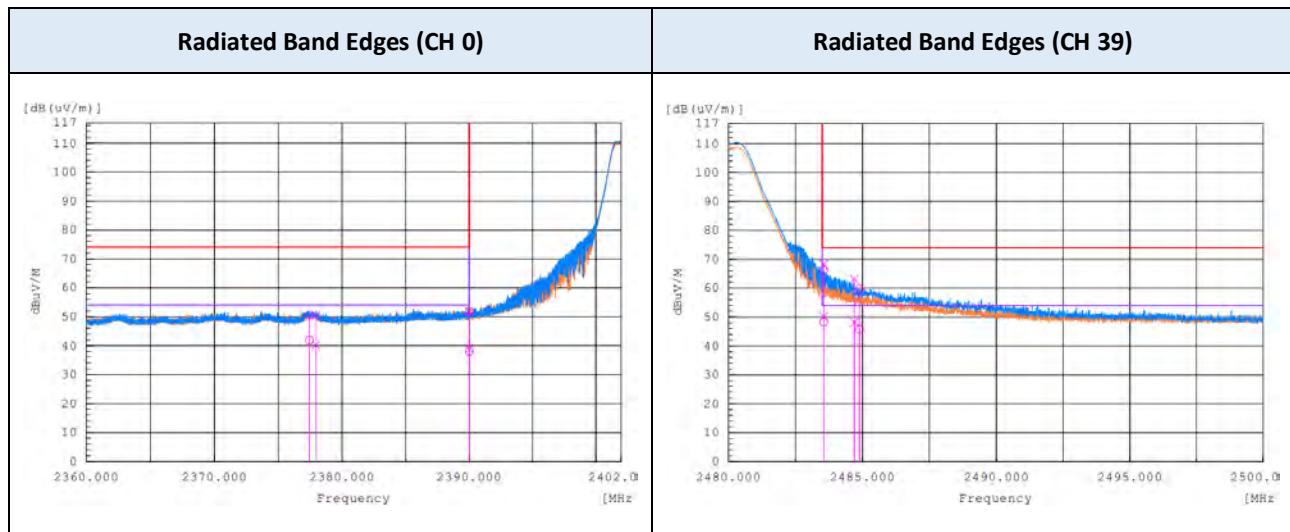
Operating Frequency 2480 MHz
 Channel No. CH 39
 Data Rate T1 (Ant A)

Frequency (MHz)	Polarization	Reading (dBuV)		Factor (dB)		Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
		AV	PK	Corr. ¹⁾	Duty	AV	PK	AV	PK	AV	PK
2483.550	H	47.9	65.8	0.4	0.47	48.8	66.2	54	74	5.3	7.8
2483.550	V	49.8	67.9	0.4	0.47	50.7	68.3	54	74	3.4	5.7
2484.694	V	47.8	62.6	0.4	0.47	48.7	63.0	54	74	5.4	11.0
2484.888	H	45.5	59.4	0.4	0.47	46.4	59.8	54	74	7.7	14.2

Notes:

1. Correction Factor: Antenna Factor + Cable loss
2. AV Level = Measured Power(dBm) + Correction Factor(dB) + Duty Cycle Factor(dB)

TEST PLOTS



Operating Frequency 2402 MHz
 Channel No. CH 0
 Chipset T2 (Ant C)

Frequency (MHz)	Polarization	Reading (dBuV)		Factor (dB)		Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
		AV	PK	Corr. ¹⁾	Duty	AV	PK	AV	PK	AV	PK
2377.404	V	37.5	48.7	-0.2	0.46	37.8	48.5	54	74	16.3	25.5
2377.404	H	37.5	48.8	-0.2	0.46	37.8	48.6	54	74	16.3	25.4
2390.000	V	34.5	47.7	-0.1	0.46	34.9	47.6	54	74	19.2	26.4
2390.000	H	35.9	49.2	-0.1	0.46	36.3	49.1	54	74	17.8	24.9

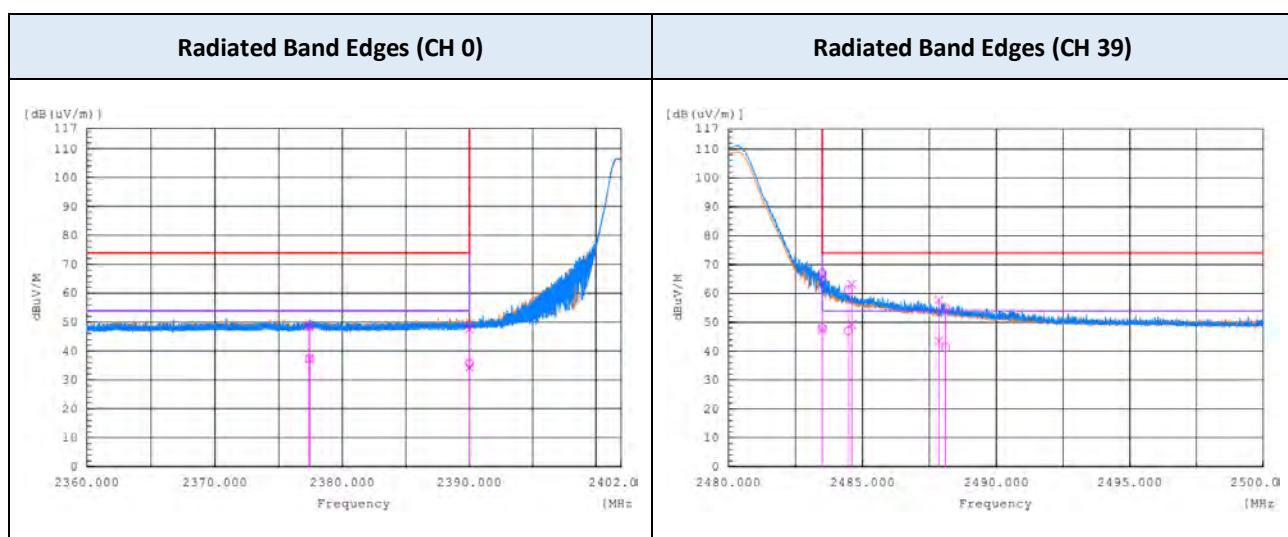
Operating Frequency 2480 MHz
 Channel No. CH 39
 Data Rate T2 (Ant C)

Frequency (MHz)	Polarization	Reading (dBuV)		Factor (dB)		Level (dBuV/m)		Limit (dBuV/m)		Margin (dB)	
		AV	PK	Corr. ¹⁾	Duty	AV	PK	AV	PK	AV	PK
2483.500	H	47.5	66.6	0.4	0.46	48.4	67.0	54	74	5.7	7.0
2483.500	V	47.2	65.5	0.4	0.46	48.1	65.9	54	74	6.0	8.1
2484.479	H	46.7	60.8	0.4	0.46	47.6	61.2	54	74	6.5	12.8
2484.598	V	48.9	62.7	0.4	0.46	49.8	63.1	54	74	4.3	10.9
2487.856	V	43.3	57.2	0.4	0.46	44.2	57.6	54	74	9.9	16.4
2488.106	H	40.9	54.5	0.4	0.46	41.8	54.9	54	74	12.3	19.1

Notes:

1. Correction Factor: Antenna Factor + Cable loss
2. AV Level = Measured Power(dBm) + Correction Factor(dB) + Duty Cycle Factor(dB)

TEST PLOTS



9.8. POWERLINE CONDUCTED EMISSIONS

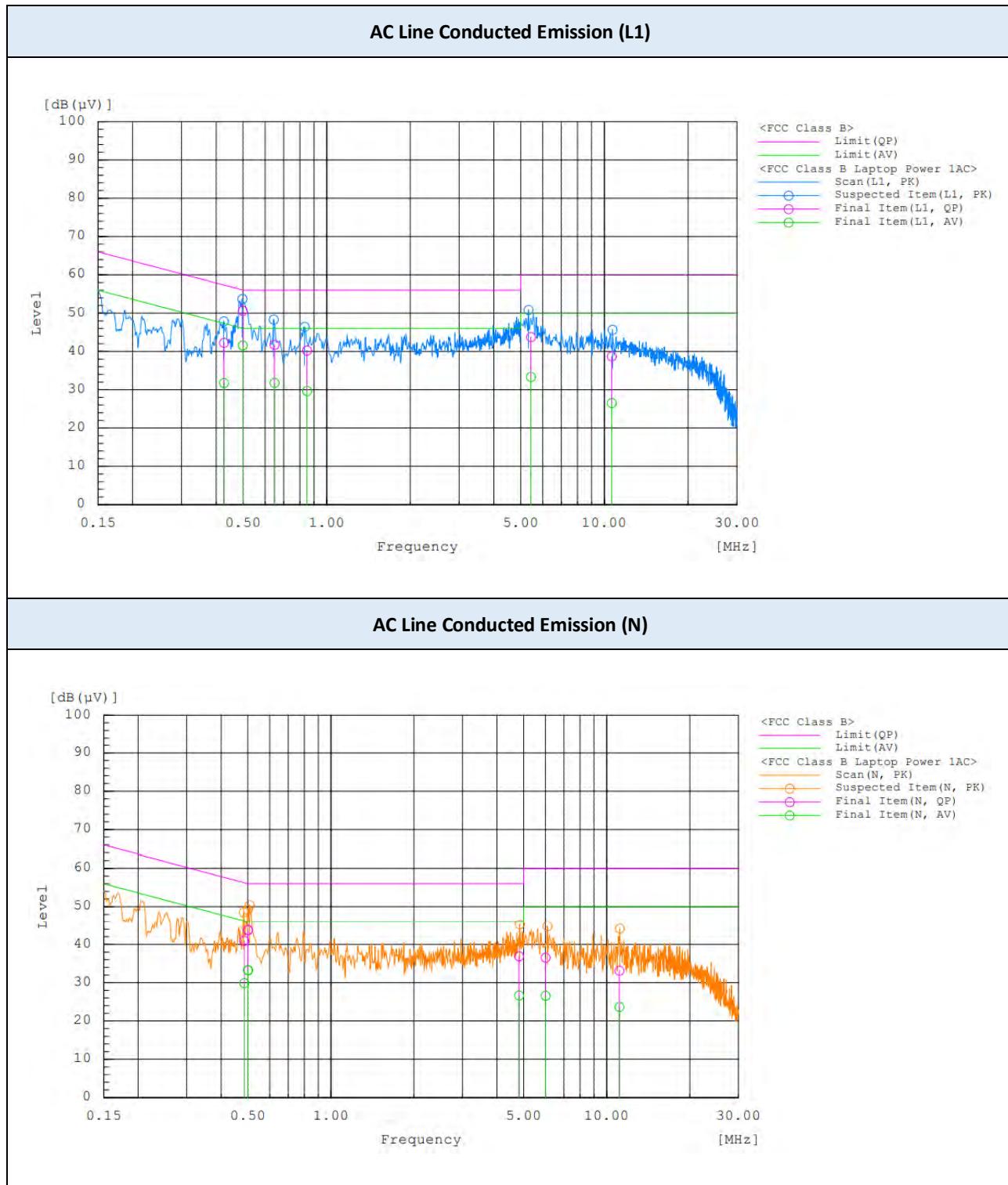
AC Main

Frequency (MHz)	Line	Reading (dB μ V)		Corr. ¹⁾ (dB)	Level (dB μ V)		Limit (dB μ V)		Margin (dB)	
		QP	CAV		QP	CAV	QP	CAV	QP	CAV
0.426	L1	32.6	22.0	9.7	42.3	31.7	57.3	47.3	15.0	15.6
0.499	L1	40.9	31.9	9.7	50.6	41.6	56	46	5.4	4.4
0.648	L1	32.1	22.1	9.7	41.8	31.8	56	46	14.2	14.2
0.849	L1	30.5	19.9	9.8	40.3	29.7	56	46	15.7	16.3
5.433	L1	33.9	23.5	9.9	43.8	33.4	60	50	16.2	16.6
10.627	L1	28.6	16.5	10.1	38.7	26.6	60	50	21.3	23.4

Frequency (MHz)	Line	Reading (dB μ V)		Corr. ¹⁾ (dB)	Level (dB μ V)		Limit (dB μ V)		Margin (dB)	
		QP	CAV		QP	CAV	QP	CAV	QP	CAV
0.484	N	31.3	20.2	9.7	41.0	29.9	56.3	46.3	15.3	16.4
0.500	N	34.1	23.6	9.7	43.8	33.3	56	46	12.2	12.7
0.500	N	34.1	23.6	9.7	43.8	33.3	56	46	12.2	12.7
4.809	N	27.0	16.8	9.9	36.9	26.7	56	46	19.1	19.3
5.998	N	26.7	16.7	9.9	36.6	26.6	60	50	23.4	23.4
11.113	N	23.1	13.6	10.1	33.2	23.7	60	50	26.8	26.3

Note :

1. Quasi-peak(Final Result) = Reading Value + Correction Factor

TEST PLOTS


10. LIST OF TEST EQUIPMENT

No.	Instrument	Model No.	Calibration Due (mm/dd/yy)	Manufacture	Serial No.
<input checked="" type="checkbox"/>	Signal Analyzer (20 Hz ~ 40.0 GHz)	ESU40	12/20/2020	ROHDE & SCHWARZ	100529
<input checked="" type="checkbox"/>	Signal Analyzer (10 Hz ~ 26.5 GHz)	N9020A	11/08/2020	Keysight	MY52091291
<input checked="" type="checkbox"/>	BI-LOG Antenna (30 MHz ~ 1 GHz)	JB1	03/27/2021	Sunol	A061416
<input checked="" type="checkbox"/>	Attenuator (20 dB, DC ~ 26.5 GHz)	8493C	12/13/2020	HP	09072
<input checked="" type="checkbox"/>	POWER AMP (1 GHz ~ 18 GHz)	PAM-118A	07/09/2021	Com-Power Corporation	18040074
<input checked="" type="checkbox"/>	POWER AMP (0.3 GHz ~ 1 GHz)	8447D	08/06/2021	HP	2443A03587
<input checked="" type="checkbox"/>	Horn Antenna (1 GHz ~ 18 GHz)	DRH-118	11/29/2020	Sunol	A061616
<input checked="" type="checkbox"/>	Loop Antenna (0.009 ~ 30 MHz)	HLA 6121	08/27/2020	TESEQ	43964
<input checked="" type="checkbox"/>	Horn Antenna (18 GHz ~ 40 GHz)	DRH-1840	02/20/2021	Sunol	17120
<input checked="" type="checkbox"/>	POWER AMP (18 GHz ~ 40 GHz)	CBL184050-45-01	02/04/2021	CERNEX, Inc.	43964
<input checked="" type="checkbox"/>	ISM Band Reject filter (2370 ~ 2400 - 2483.5 ~ 2520 MHz)	WRCJV12	01/18/2021	Wainwright	4
<input type="checkbox"/>	High Pass Filter	WHK10-2520-3000-18000-40EF	01/18/2021	Wainwright	9
<input checked="" type="checkbox"/>	EMI Test Receiver	ESR3	12/20/2020	Rohde & Schwarz	102363
<input type="checkbox"/>	LISN	3816/2SH	01/19/2021	EMCO	00205729
<input checked="" type="checkbox"/>	LISN	ENV216	01/19/2021	Rohde & Schwarz	101349

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

APPENDIX A. TEST SETUP PHOTOS

The setup photos are provided as a separate document

APPENDIX B. PHOTOGRAPHS OF EUT

B.1. EXTERNAL PHOTOS

The setup photos are provided as a separate document

B.2. INTERNAL PHOTOS

The setup photos are provided as a separate document

END OF TEST REPORT