

RADIO TEST REPORT

For

MODEL NO.: 2082 FCC ID: C3K2082 IC ID: 3048A-2082

Test Report No. R-1125-FCCISED-BTLE-2 Issue Date: May 9, 2024

FCC CFR47 Part 15 Subpart C Innovation, Science and Economic Development Canada RSS-247 Issue 3

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Record of Revisions

Revision	Date	Section	Page(s)	Summary of Changes	Author/Revised By:
1.0	03/26/2024	All	All	Version 1.0	Chian Huang
2.0	05/09/2024	All	1, 6	Updated RSS-247 references to Issue 3.	Cameron Ashbaugh
		9.2.5, 9.3.5	23-25, 27-29	Corrected order / labeling of 6-dB and 99% BW plots.	
		6, 9.9	10, 69-71	Added AC Line Emissions test results.	
		9.8	52	Added clarifying statement on use of ANSI C63.10 alternative method from 6.6.5.	
		-			
		+			

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Test Report Attestation

Microsoft Corporation Model: 2082

FCC ID: C3K2082 IC ID: 3048A-2082

Applicable Standards

Specification	Test Result
FCC 47CFR Rule Parts 15.207, 15.209, 15.247	Pass
Innovation, Science and Economic Development Canada RSS-247 Issue 3, RSS-GEN Issue 5	Pass

Microsoft EMC Laboratory attests that the product model identified in this report has been tested to and meets the requirements identified in the above standards. The test results in this report solely pertains to the specific sample tested, under the conditions and operating modes as provided by the customer.

This test report replaces the previously issued report #R-1125-FCCISED-BTLE-1 issued by Microsoft EMC Labs.

This report shall not be used to claim product certification, approval, or endorsement by A2LA or any agency of any Government. Reproduction, duplication or publication of extracts from this test report is prohibited and requires prior written approval of Microsoft EMC Laboratory.

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RF Test Engineer

Reviewed/ Issued By: Zack Gray

Sr. Manager RF/SAR Lab

Queto Dray

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Deviations from Standards

None.

Facilities and Accreditations

3.1 Test Facility

All test facilities used to collect the test data are located at Microsoft EMC Laboratory. 17760 NE 67th Ct. Redmond WA, 98052, USA

3.2 Accreditations

The lab is established and follows procedures as outlined in IEC/ISO 17025 and A2LA accreditation requirements.

A2LA Accredited Testing Certificate Number: 3472.01

FCC Registration Number: US1141

IC Site Registration Numbers: 3048A-3, 3048A-4

3.3 Test Equipment

The site and related equipment are constructed in conformance with the requirements of ANSI C63.4:2014 and other equivalent applicable standards. The test site for measurements below 30 MHz has been demonstrated to correlate with an open field site per KDB 414788. Test site requirements for measurements above 1 GHz are in accordance with ANSI C63.4:2014.

ANSI C63.10:2013 and the appropriate KDB test methods were followed.

Measurement Uncertainty

The following measurement uncertainty levels have been estimated for tests performed on the product, as specified in ETSI TR 100 028. This represents an expanded uncertainty expressed at 95% confidence level using a coverage factor k=2. These levels are for reference only and not included to determine product compliance.

Expanded uncertainty calculations are available upon request.

Test item	Uncertainty	Unit
Radiated disturbance (30 MHz to 1 GHz)	5.99	dB
Radiated disturbance (1 GHz to 18 GHz)	5.12	dB
Conducted Disturbance at Mains Port	3.31	dB
Uncertainty for Conducted Power test	1.277	dB
Uncertainty for Conducted Spurious emission test	2.742	dB
Uncertainty for Bandwidth test	4.98	kHz
Uncertainty for DC power test	0.05	%
Uncertainty for test site temperature	0.5	°C
Uncertainty for test site Humidity	3	%
Uncertainty for time	0.189	%

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5 Product Description

Company Name:	Microsoft Corporation		
. ,			
Address:	One Microsoft Way		
City, State, Zip:	Redmond, WA 98052-6399		
Customer Contact:	Mike Boucher		
Functional Description of the EUT:	I/O Accessory Device with NFC and BTLE radios		
Model:	2082		
FCC ID:	C3K2082		
IC ID:	3048A-2082		
Radio under test:	BTLE (2402- 2480 MHz)		
Modulation(s):	GFSK , 1M and 2M modes		
	Integral Antenna.		
Antenna Information:	Manufacturer declared max Antenna Gain in 2.4GHz band of operation: 5.91 dBi		
EUT Classification:	DTS		
Equipment Design State:	Prototype/Production Equivalent (DV)		
Equipment Condition:	Good		
Test Sample Details:	RF Conducted Test Sample 0E348KM24013KM RF Radiated Test Sample 0E33KCK24023KM		

5.1 Test Configurations

Test software "STM32CubeMonitor-RF" (V2.9.1) provided by the STMicroelectronics was used to program the EUT to transmit continuously.

The device can operate in only GFSK modulation. Channel numbers 0, 19 and 39 were used as Low, Mid and High Channels respectively.

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5.2 Environmental Conditions

Ambient air temperature of the test site was within the range of 10 °C to 40 °C (50 °F to 104 °F) unless the EUT specified testing over a different temperature range. Humidity levels were in the range of 10% to 90% relative humidity. Testing conditions were within tolerance, and any deviations required from the EUT are reported.

5.3 Antenna Requirements

The antennas are permanently attached and there are no provisions for connection to an external antenna.

Note: Antenna gain is provided by the customer (compliance engineer) and the accuracy of the value is the responsibility of the customer and the results where calculations involving the antenna gain can have an impact on the test results.

5.4 Equipment Modifications

No modifications were made during testing.

5.5 Test Engineer

Test Case	Test Engineer
Radiated	Vishwas
Conducted	Vishwas
AC Line Emissions	Cameron

5.6 Test Sample Details

Serial Number	Internal Lab ID	Test Cases
0E348KM24013KM	R-1125-DV-02	Conducted
0E33KCK24023KM	R-1125-DV-06	Radiated

5.7 Dates of Testing

Testing was performed from Jan 26th, 2024 to Feb 13th, 2024 and May 9,2024.

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6 Test Results Summary

Test Description	FCC CFR 47/ ISED Rule Part	Limit	Test Result
Duty Cycle	Reporting & Measurements	Reporting & Measurement Purposes only	N/A
6dB Bandwidth	15.247 (a)(2) RSS-247 [5.2]	≥ 500kHz	Pass
Occupied Bandwidth	Reporting & Measurements	Reporting & Measurement Purposes only	N/A
Output Power	15.247 (b)(3) RSS-247 [5.4]	≤ 1 Watt	Pass
Equivalent Isotropic Radiated Power	RSS-247 [5.4]	≤ 4 Watt	Pass
Power Spectral Density	15.247 (e) RSS-247 [5.2]	≤ 8dBm/3kHz	Pass
Conducted Band Edge/Unwanted Emissions	15.247 (d) RSS-247 [5.5]	At least 20dBc	Pass
Radiated Spurious Emissions/ Restricted Band Emissions	15.205, 15.209 RSS-247 [5.5] RSS-Gen [8.9]	FCC CFR 47 15.209 limits RSS-Gen [8.9]	Pass
AC Power Line Conducted Emissions	15.207 RSS-Gen [8.8]	FCC CFR 47 15.207 limits RSS-Gen [8.8]	Pass

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7 Test Equipment List

Equipment used	d for Radiated Me	easurements		
Manufacturer	Description	Model #	Asset #	Calibration Due
Rohde &	EMI Test	ESU40	RF-1331	4/3/2024
Schwarz	Receiver			
Rohde &	Open Switch	OSP230	RF-1337	12/22/2024
Schwarz	and Control			
Rohde &	Open Switch	OSP230	RF-1336	12/22/2024
Schwarz	and Control			
Rohde &	Custom Filter	SFUNIT RX	RF-322	12/22/2024
Schwarz	Bank			
Rohde &	Preamplifier	TS-PR26	RF-042	12/22/2024
Schwarz	-			
Sunol Sciences	Antenna -	JB6	RF-039	5/16/2024
	Broadband			
ETS-Lindgren	Antenna -	3117	RF-1363	3/8/2024
_	Double-Ridged			
ETS-Lindgren	Antenna -	3160-09	RF-1374	2/12/2025
	Standard Gain			
Maury	RF Cable	SP-292-MM-197	RF-1202	12/22/2024
Microwave				
Huber &	RF Cable	SucoFlex 100	RF-452	12/2/2024
Suhner				
Teledyne	RF Cable	57500	RF-1036	12/22/2024
Micro-Coax	RF Cable	A SERIES 505552-K	RF-1399	12/22/2024
		0000071		
Micro-Coax	RF Cable	142A SERIES 505508-C	RF-1398	12/22/2024
		00000856		
Pasternack	6dB Attenuator	PE7004-6	EMC-949	5/16/2024
Madge Tech	THP Meter	PRHTemp2000	SAR-091	7/18/2024

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Equipment used for Conducted Measurements								
Manufacturer	Description	Model #	Asset #	Calibration Due				
Keysight	Signal Analyzer	N9020B	RF-996	2/21/2024				
Maury Microwave	RF Cable	SB-SMA-MM-48	RF-1173	1/25/2025				
Murata	Cable	MXJA01JA1000	RF-822	1/25/2025				
Pasternack	Attenuator	PE7087-6	RF-777	1/25/2025				
Gauss	Signal Analyzer	TDEMI X1	EMC-1611	3/27/2025				
Teseq	EUT LISN	NNB 51	EMC-641	10/13/2024				
MicroCoax	Cable	UFA210A-1-1800- 50U50U	EMC-367	11/8/2024				
Chroma	AC Power Source	61602	EMC-055	NA				

Note: Items with Calibration Due data marked as N/A are characterized before test, where applicable.

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8 Test Site Description

8.1 Radiated Emissions Test Site

Radiated measurements are performed in a 3m semi-anechoic chamber, which meets NSA requirements for the frequency range of 30MHz to 1000MHz. For measurements above 1 GHz, absorbers are placed on the ground plane between the receiving antenna and the EUT to meet Site VSWR requirements in accordance with ANSI C63.4:2014.

8.1.1 Radiated Measurements in 9kHz- 30 MHz

The EUT is positioned on a turntable at a height of 80cm using a non-conducting table. A loop antenna is positioned at 3m from the EUT periphery at 1m height from the ground. The turntable is rotated 360 degrees to determine the highest emissions. This is repeated for three orientations of the measurement antenna- parallel, perpendicular, and ground-parallel. All possible orientations of the EUT were investigated for emissions and the flat orientation was identified as the worst-case configuration.

8.1.2 Radiated Measurements in 30 MHz - 1000 MHz

The EUT is positioned on a turntable at a height of 80cm using a non-conducting table. A linearly polarized broadband antenna is positioned at 3m from the EUT periphery. The turntable is rotated 360 degrees, and the antenna height varied from 1m to 4m to determine the highest emissions. This is repeated for both horizontal and vertical polarizations of the measurement antenna. All possible orientations of the EUT were investigated for emissions and the vertical standing orientation was identified as the worst-case configuration.

8.1.3 Radiated Measurements above 1GHz

The EUT is positioned on a turntable at a height of 1.5m. A linearly polarized antenna is positioned 3m from the EUT periphery. Guidelines in ANSI C63.10:2013, Section 6.6.5.1 through 6.6.5.4, were followed with respect to maximizing the emissions. The measurement antenna is set at a fixed 1.5m height while the turntable is rotated 360 degrees and the EUT elevation angle is varied from 0 to 150 degrees to determine the highest emissions. This is repeated for both horizontal and vertical polarizations of the measurement antenna. Measurements above 18GHz were performed at a 3m distance. Near field scanning is performed to identify suspect frequencies above 1GHz.

8.2 Antenna port conducted measurements

All antenna port conducted measurements were performed on a bench-top setup consisting of a spectrum analyzer, power meter (as necessary), splitters/combiners (as necessary), attenuators, and pre-characterized RF cables.

The correction factors between the EUT and the spectrum analyzer were added internally in the analyzer settings, where applicable. The plots displayed take these correction factors into account.

8.3 AC Line Conducted Emissions

The EUT is positioned on a non-conducting table at a height of 80cm over a metallic ground (reference) plane extending more than 50cm horizontally around the EUT. The EUT is setup at

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the back of the table with interconnecting cables draping off the back of table. The back of the EUT is positioned so that it is 40 cm away from a vertical ground plane. The EUT power port or power port that is indirectly connected to the EUT is terminated in 50Ω/50μH Artificial Mains Network (AMN). All other ports are terminated with equipment representing a normal use case.

8.4 Test Setup Diagrams

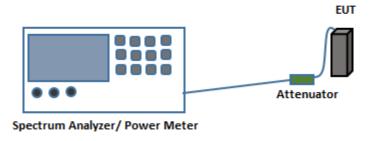


Figure 1. Test Setup for Antenna port conducted measurements

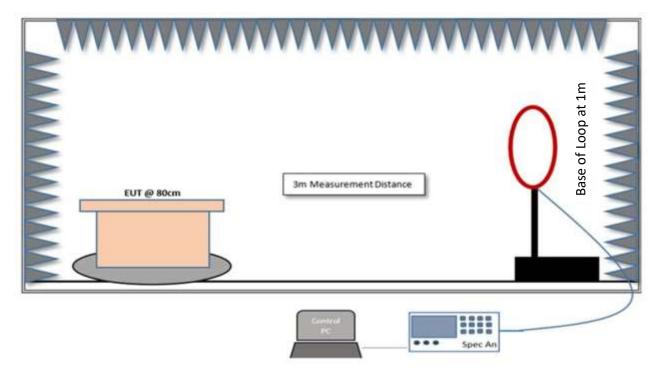


Figure 2 Test Setup for Radiated measurements in 9kHz - 30MHz Range

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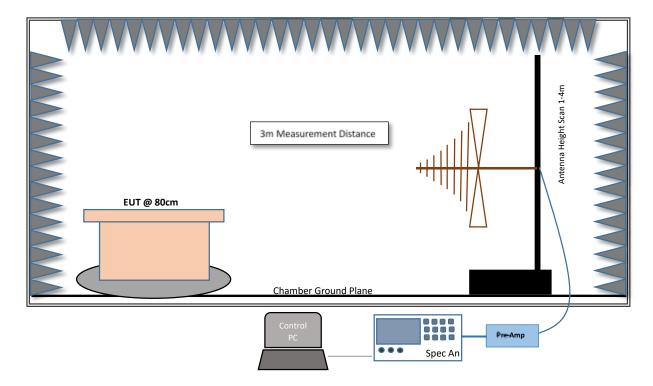


Figure 3 Test Setup for Radiated measurements in 30MHz-1GHz Range

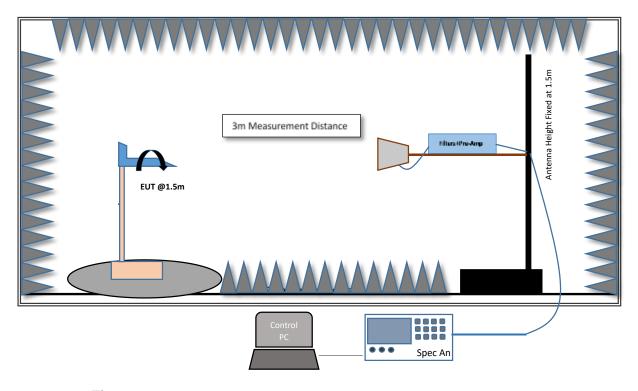


Figure 4 Test Setup for Radiated measurements in 1GHz-18GHz Range

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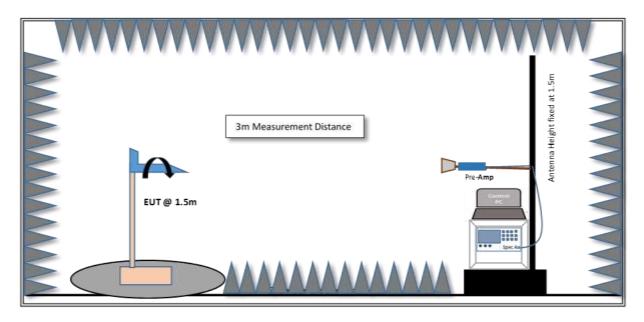


Figure 5 Test Setup for Radiated measurements >18GHz

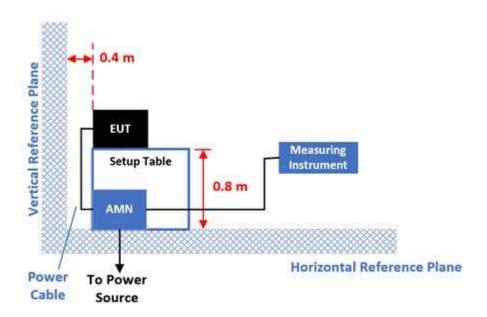


Figure 6 AC Line Conducted Emissions

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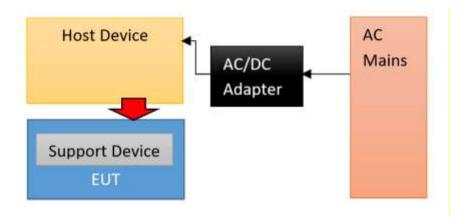


Figure 7 AC Line Conducted Emissions EUT Setup Block Diagram



9 Test Results- Conducted

9.1 Duty Cycle

9.1.1 Test Requirement:

Reporting and measurement purposes only.

9.1.2 Test Method:

Measurements were performed according to the procedure defined in ANSI C63.10: 2013.

Spectrum Analyzer Settings:

RBW ≥ Occupied Bandwidth if possible; otherwise, set RBW to the largest available value VBW ≥ RBW ≥ Signal Period

Detector = Peak

Span = 0 Hz

Sweep points > 100

Use markers to measure the Transmission Duration and Period of the signal.

Sample Calculations

i.e. Duty Cycle =
$$\frac{9ms}{10ms} \times 100 = 90\%$$

Duty Cycle Correction Factor =_10xlog (1/duty cycle) dB

Note: duty cycle is the decimal value of Duty Cycle %

i.e. Duty Cycle Correction Factor = $10 \times \log \frac{1}{0.9} = 0.46 \ dB$

9.1.3 Limits:

Reporting and measurement purposes only.

9.1.4 Test Results:

Mode	Frequency (MHz)	On Time (ms)	Period (ms)	Duty Cycle (%)	Correction Factor (dB)
1M	2402	0.414	0.628	65.924	1.81
1M	2440	0.414	0.628	65.924	1.81
1M	2480	0.414	0.628	65.924	1.81
2M	2402	0.226	0.622	36.334	4.397
2M	2440	0.226	0.622	36.334	4.397
2M	2480	0.228	0.624	36.538	4.732

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9.1.5 **Test Data:**

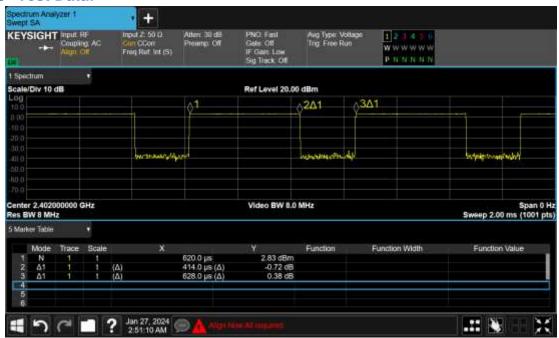


Figure 9-1 Duty Cycle 2402MHz (Ch.0) 1M.



Figure 9-2 Duty Cycle 2440MHz (Ch.19) 1M.

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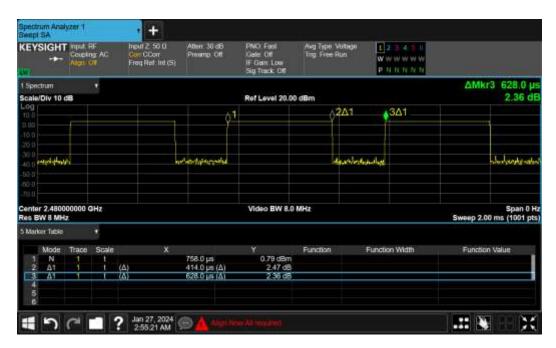


Figure 9-3 Duty Cycle 2480MHz (Ch.39) 1M.

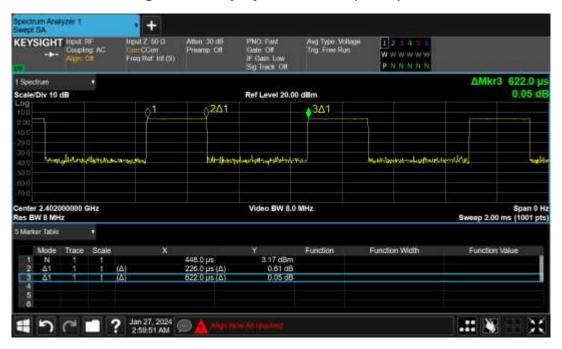


Figure 9-4 Duty Cycle 2402MHz (Ch.0) 2M.

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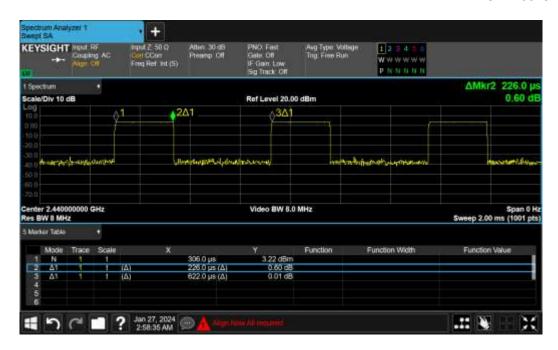


Figure 9-5 Duty Cycle 2440MHz (Ch.19) 2M.

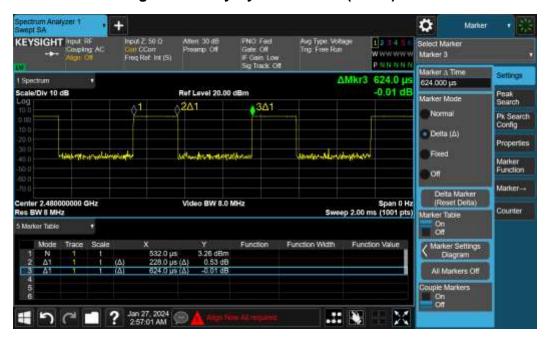


Figure 9-6 Duty Cycle 2480MHz (Ch.39) 2M.

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9.2 6-dB Bandwidth

9.2.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (a)(2)

ISED RSS-247 [5.2]

9.2.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074- Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V05 and ANSI C63.10: 2013.

Spectrum Analyzer settings:

RBW= 100 kHz

VBW \ge 3 RBW= 300 kHz.

Trace Mode= Peak Detector (Max Hold)

Sweep time= Auto Couple

The in-built functionality of the Spectrum Analyzer is used to measure the 6-dB bandwidth.

9.2.3 Limits:

The 6-dB bandwidth shall be at least 500 kHz

9.2.4 Test Results:

Frequency (MHz)	Test Mode	Channel No.	6dB Bandwidth (kHz)	Limit (kHz)	Result
2402	1M	0	685.6	>500	Pass
2440	1M	19	686.6	>500	Pass
2480	1M	39	683	>500	Pass
2402	2M	0	1143	>500	Pass
2440	2M	19	1138	>500	Pass
2480	2M	39	1137	>500	Pass

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9.2.5 **Test Data**:



Figure 9-7 6dB Bandwidth (Ch. 0) 1M.



Figure 9-8 6dB Bandwidth (Ch. 19) 1M.

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Figure 9-9 6dB Bandwidth (Ch. 39) 1M.



Figure 9-10 6dB Bandwidth (Ch. 0) 2M.

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Figure 9-11 6dB Bandwidth (Ch. 19) 2M.



Figure 9-12 6dB Bandwidth (Ch. 39) 2M.



9.3 99% Occupied Bandwidth

9.3.1 Test Requirement:

The 99% Occupied Channel Bandwidth is the bandwidth that contains 99 % of the power of the signal. This test is performed for reporting and measurement purposes only.

9.3.2 Test Method:

Measurements are performed according to ANSI C63.10: 2013.

Spectrum Analyzer settings:

Set analyzer center frequency to the nominal EUT channel frequency Span is set to between 1.5 and 5.0 times the DTS bandwidth

RBW to: 1% to 5% of the OBW= 30 kHz

VBW ≥ 3 RBW= 100 kHz

Detector = Peak

Sweep time = Auto Couple

Trace mode = max hold

Use the inbuilt 99% power bandwidth function of the instrument.

9.3.3 Limits:

For reporting purpose only.

9.3.4 Test Results:

Frequency (MHz)	Test Mode	Channel No.	99% Bandwidth (MHz)
2402	1M	0	1.0217
2440	1M	19	1.0217
2480	1M	39	1.0169
2402	2M	0	2.0389
2440	2M	19	2.0386
2480	2M	39	2.0335

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9.3.5 **Test Data**:



Figure 9-13 99% Bandwidth (Ch. 0) 1M



Figure 9-14 99% Bandwidth (Ch. 19) 1M

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Figure 9-15 99% Bandwidth (Ch. 39) 1M



Figure 9-16 99% Bandwidth (Ch. 0) 2M

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Figure 9-17 2M 99% Bandwidth (Ch. 19) 2M



Figure 9-18 99% Bandwidth (Ch. 39) 2M



9.4 Output Power

9.4.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (b)(3)

ISED RSS-247 [5.4]

9.4.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V05 and ANSI C63.10: 2013.

Spectrum Analyzer settings:

Peak Power:

RBW= 1 MHz

VBW= 3 MHz

Trace Mode= Peak Detector (Max Hold)

Sweep time= Auto Couple

Span= 3 MHz

Sample Calculation

Output power (dBm) = Raw Value (dBm) + Cable and Attenuator Loss (dB) i.e. $Output\ Power\ (dBm) = 7.3\ dBm + 11.7\ dB = 19\ dBm$

9.4.3 Limits:

15.247: The maximum permissible peak output power is 30dBm (1 W)

RSS-247: The maximum peak conducted output power shall not exceed 30dBm (1 W) and the maximum radiated output power shall not exceed 36dBm (4 W) EIRP.

9.4.4 Test Results:

Frequency (MHz)	Mode	Channel No.	Cond. Peak Power (dBm)	Cond. Peak Power (W)	Cond. Peak Limit (dBm)	Margin (dB)	Result
2402	1M	0	3.36	0.0022	30	-26.64	Pass
2440	1M	19	3.36	0.0022	30	-26.64	Pass
2480	1M	39	3.37	0.0022	30	-26.63	Pass
2402	2M	0	3.61	0.0023	30	-26.39	Pass
2440	2M	19	3.59	0.0023	30	-26.41	Pass
2480	2M	39	3.62	0.0023	30	-26.38	Pass

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Frequency (MHz)	Mode	Channel No.	Cond. Peak Power (dBm)	Max Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)	Result
2402	1M	0	3.36	5.91	9.27	36	-26.73	Pass
2440	1M	19	3.36	5.91	9.27	36	-26.73	Pass
2480	1M	39	3.37	5.91	9.28	36	-26.72	Pass
2402	2M	0	3.61	5.91	9.52	36	-26.48	Pass
2440	2M	19	3.59	5.91	9.5	36	-26.5	Pass
2480	2M	39	3.62	5.91	9.53	36	-26.47	Pass

9.4.5 **Test Data**:



Figure 9-19 Peak Power (Ch. 0) 1M.

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Figure 9-20 Peak Power (Ch. 19) 1M.



Figure 9-21 Peak Power (Ch. 39) 1M.





Figure 9-22 Peak Power (Ch. 0) 2M.



Figure 9-23 Peak Power (Ch. 19) 2M.





Figure 9-24 Peak Power (Ch. 39) 2M.



9.5 Peak Power Density

9.5.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (e)

ISED RSS-247 [5.2]

9.5.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V05 and ANSI C63.10: 2013.

Spectrum Analyzer settings:

RBW= 100 kHz

VBW= 300 kHz

Trace Mode= Peak Detector (Max Hold)

Sweep time= Auto Couple

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.

Sample Calculation

Peak Power Density dBm/3kHz = Raw Amplitude (dBm/3kHz) + Cable and Attenuator Loss (dB) i.e. $Peak\ PSD\ (dBm/3kHz) = -5.8\ dBm + 11.7\ dB = 5.9\ dBm/3kHz$

9.5.3 Limits:

The maximum permissible power density is 8dBm/3kHz.

9.5.4 Test Results:

Frequency (MHz)	Test Mode	Channel No.	Power Spectral Density (dBm/100kHz)	Limit (dBm/3kHz)	Result
2402	1M	0	3.02	8	Pass
2440	1M	19	3.05	8	Pass
2480	1M	39	3.02	8	Pass
2402	2M	0	3.03	8	Pass
2440	2M	19	3.04	8	Pass
2480	2M	39	3.02	8	Pass

The test data shows that the EUT passes the requirement using 100kHz RBW setting and hence will meet the requirement for 3kHz BW.

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9.5.5 **Test Data**:



Figure 9-2 Power Spectral Density (Ch. 0) 1M



Figure 9-26 Power Spectral Density (Ch. 19) 1M

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Figure 9-27 Power Spectral Density (Ch. 39) 1M



Figure 9-28 Power Spectral Density (Ch. 0) 2M

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Figure 9-29 Power Spectral Density (Ch. 19) 2M

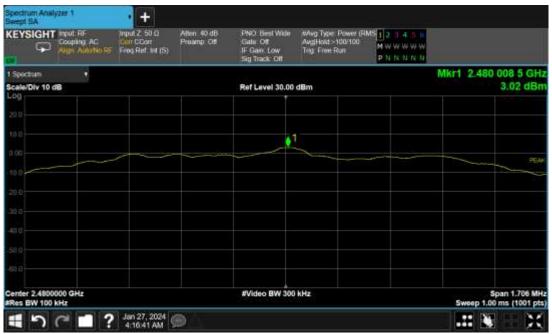


Figure 9-30 Power Spectral Density (Ch. 39) 2M



9.6 Conducted Spurious Emissions

9.6.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

ISED RSS-247 [5.5]

9.6.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V05 and ANSI C63.10: 2013.

Spectrum Analyzer settings:

Identification of Reference Level:

RBW= 100 kHz

VBW ≥ 3 x RBW

Trace Mode= Peak Detector (Max Hold)

Sweep time= Auto Couple

Span >1.5 times DTS Bandwidth

Peak Marker function to determine the max PSD level.

Conducted Spurious Emissions:

RBW= 1 MHz (100 kHz for Final Measurements)

VBW≥ 3 x RBW = 3 MHz (300 kHz for Final Measurements)

Trace Mode = Peak Detector (Max Hold)

Sweep time = Auto Couple

Span= 30 MHz- 12 GHz; 12 GHz - 25 GHz

Sweep Points = 30000

Sample Calculations

Emission Level dBm = Raw Amplitude (dBm) + Cable and Attenuator Loss (dB)

i.e. Emissions Level (dBm) = -20 dBm + 14.2 dB = -5.8 dBm

dBc level = Reference Level (dBm/100kHz) – Emission Level (dBm/100kHz)

i.e. dBc = 17 dBm - (-5.8) dB = 22.8 dBc

9.6.3 Limits:

All spurious emissions at least 20 dBc.

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9.6.4 Test Result:

Mode	Channel	Carrier Frequency (MHz)	Emission Frequency (MHz)	Emissions Amplitude (dBm/MHz)	Limit (dBm)	Margin (dB)	Result
1M	0	2402	3166.2	-37.06	-16.98	-20.08	Pass
1M	0	2402	24938.0	-37.42	-16.98	-20.44	Pass
1M	19	2440	3156.3	-36.47	-16.95	-19.52	Pass
1M	19	2440	24964.9	-36.37	-16.95	-19.42	Pass
1M	39	2480	11555.9	-36.8	-16.98	-19.82	Pass
1M	39	2480	24940.2	-36.79	-16.98	-19.81	Pass
2M	0	2402	11585.8	-36.15	-16.97	-19.18	Pass
2M	0	2402	24924.6	-36.59	-16.97	-19.62	Pass
2M	19	2440	11513.6	-36.87	-16.96	-19.91	Pass
2M	19	2440	24948.9	-38.02	-16.96	-21.06	Pass
2M	39	2480	11564.7	-36.48	-16.98	-19.50	Pass
2M	39	2480	24967.9	-37.07	-16.98	-20.09	Pass



9.6.5 **Test Data:**



Figure 9-31 Reference Level Measurement (Ch.0) 1M.

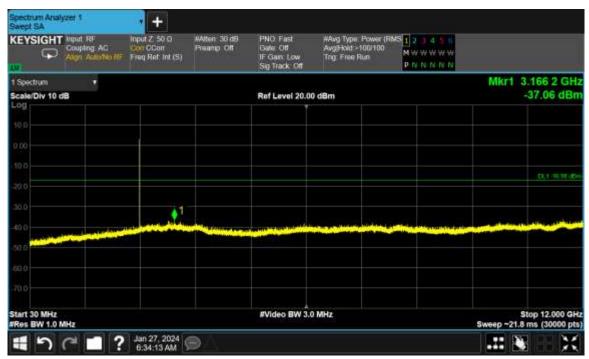


Figure 9-32 Conducted Spurious Emissions 30-12000 MHz (Ch. 0) 1M

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Figure 9-33 Conducted Spurious Emissions 12-25 GHz (Ch.0) 1M

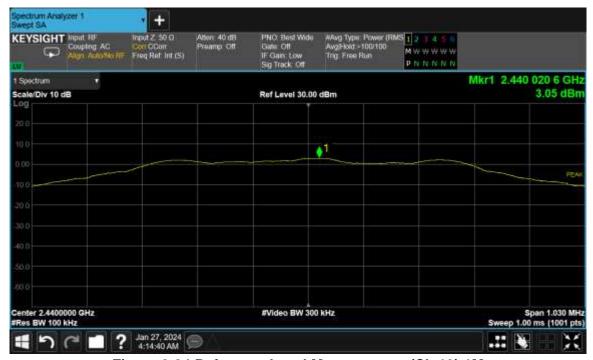


Figure 9-34 Reference Level Measurement (Ch.19) 1M





Figure 9-35 Conducted Spurious Emissions 30-12000 MHz (Ch. 19) 1M



Figure 9-36 Conducted Spurious Emissions 12-25 GHz (Ch. 19) 1M

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Figure 9-37 Reference Level Measurement (Ch.39) 1M

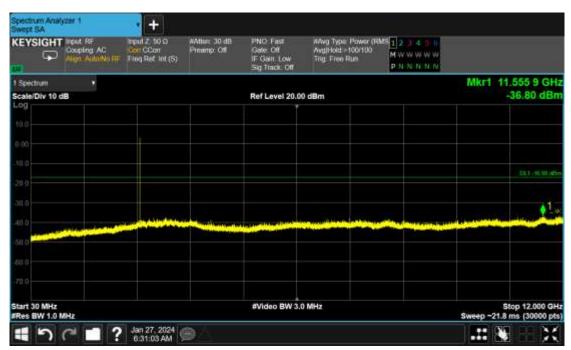


Figure 9-38 Conducted Spurious Emissions 30-12000 MHz (Ch.39) 1M





Figure 9-39 Conducted Spurious Emissions 12-25GHz (Ch.39) 1M



Figure 9-40 Reference Level Measurement (Ch.0) 2M

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Figure 9-41 Conducted Spurious Emissions 30-12000 MHz (Ch. 0) 2M



Figure 9-42 Conducted Spurious Emissions 12-25 GHz (Ch.0) 2M



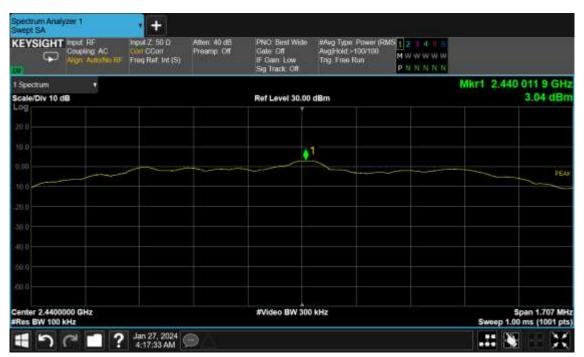


Figure 9-43 Reference Level Measurement (Ch.19) 2M

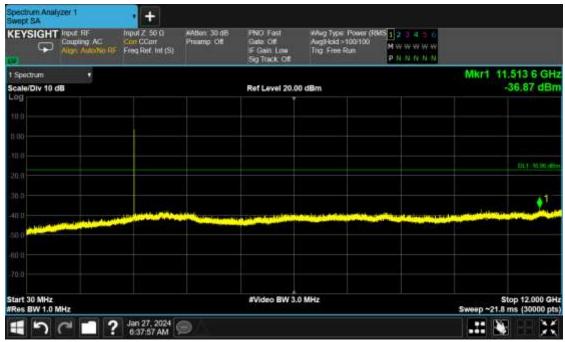


Figure 9-44 Conducted Spurious Emissions 30-12000 MHz (Ch. 19) 2M





Figure 9-45 Conducted Spurious Emissions 12-25 GHz (Ch. 19) 2M



Figure 9-46 Reference Level Measurement (Ch.39) 2M

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Figure 9-47 Conducted Spurious Emissions 30-12000 MHz (Ch.39) 2M



Figure 9-48 Conducted Spurious Emissions 12-25GHz (Ch.39) 2M

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9.7 Conducted Band Edge Emissions

9.7.1 **Test Requirement:**

FCC CFR 47 Rule Part 15.247 (d)

ISED RSS-247 [5.5]

9.7.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V05 and ANSI C63.10: 2013.

Spectrum analyzer settings:

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation

RBW = 100 kHz

VBW = 300 kHz

Sweep = Auto Couple

Detector function = Peak

Trace = Max Hold

The trace was allowed to stabilize. The marker was set on the emission at the band edge, or on the highest modulation product outside of the band if this level is greater than that at the band edge. The delta marker function was set, and the marker-to-peak function moved to the peak of the in-band emission.

Sample Calculations

```
Emission Level dBm = Raw Amplitude (dBm) + Cable and Attenuator Loss (dB)
      i.e. Emissions Level (dBm) = -20 dBm + 14.2 dB = -5.8 dBm
dBc level = Reference Level (dBm/100kHz) - Emission Level (dBm/100kHz)
      i.e. dBc = 18 dBm - (-3.4) dB = 21.4 dBc
```

9.7.3 Limits:

All spurious emissions at least 20dBc.

9.7.4 Test Result:

Pass.

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9.7.5 Test Data:



Figure 9-49 Conducted-Low Band Edge (Ch. 0) 2M

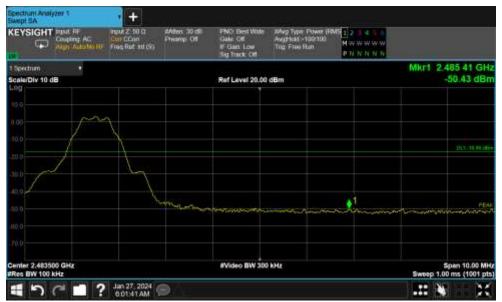


Figure 9-50 Conducted- High Band Edge (Ch. 39) 2M

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9.8 Radiated Spurious and Band Edge Emissions

9.8.1 Test Requirement:

FCC CFR 47 Rule Part 15.247 (d)

ISED RSS-247 [5.5] and RSS GEN [8.9]

9.8.2 Test Method:

Measurements were performed according to the procedure defined in KDB 558074 - Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 V05 and ANSI C63.10: 2013.

Radiated spurious measurements are made from 30MHz to the 10th harmonic of the fundamental frequency of the transmitter. Measurements below 30MHz were not performed since the radio circuitry of the EUT does not contain clocks below 30MHz. The limit for radiated spurious emissions is per 15.209 and RSS-247 [5.5]. Additionally, emissions found in the restricted bands listed in 15.205 and RSS-Gen were tested for compliance per limits in 15.209 and RSS-Gen.

The EUT was tested near the low, middle and high channels of operation. Guidelines in ANSI C63.10:2013 were followed with respect to maximizing the emissions.

A pre-amp and a high pass filter were required for this test, to provide the measuring system with sufficient sensitivity. The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength.

Both horizontal and vertical antenna polarizations were investigated. Worst-case maximized data for both polarizations is shown in this test report.

For this device, testing was performed according to the alternative method described in ANSI C63.10 6.6.5. The device meets the requirements for use of the alternative method.

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Radiated Spurious Emissions

Spectrum Analyzer Settings:

9 kHz- 30 MHz:

RBW= 1 kHz | 10kHz

VBW ≥ 3 X RBW

Trace Mode: Peak Detector (Max Hold). Final measurements performed using QP Detector and

RBW's as defined in ANSI C63.2.

Span= 9 kHz - 150 kHz and 150 kHz- 30 MHz

Sweep time= Auto

Spectrum Analyzer Settings:

30 MHz- 1 GHz:

RBW = 120 kHz

VBW ≥ 3 X RBW

Trace Mode: Peak Detector (Max Hold). Final measurements performed using QP Detector.

Span= 30 MHz - 1 GHz

Sweep time= Auto

Sweep points ≥ 2 x Span/RBW

Above 1 GHz:

RBW= 1 MHz

VBW= 3 MHz

Trace Mode: Peak Detector (Max Hold) and RMS Average Detector (Max Hold)

Span= 1 - 18 GHz and 18 - 26.5 GHz.

Sweep time= Auto

Sweep points ≥ 2 x Span/RBW

Final Measurements above 1 GHz

Peak Measurements

Spectrum Analyzer Settings:

RBW= 1 MHz

VBW= 3 MHz

Trace Mode: Peak Detector (Max Hold)

Span= wide enough to encompass the emission

Sweep Points ≥ 2 x Span/RBW

Sweep Time = Auto

RMS Average Measurements

Spectrum Analyzer Settings:

RBW = 1 MHz

VBW ≥ 3 × RBW

Detector = RMS

Span = wide enough to encompass the emission

Sweep points ≥ 2 x Span/RBW

Sweep time = auto

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Trace = Average at least 100 traces

Trace Averaging Type= power (RMS)

The duty cycle correction factor is added to the emission level.

Restricted Band-Edge Emissions

Peak Measurements

Spectrum Analyzer Settings:

RBW = 1 MHz

VBW = 3 MHz

Trace Mode: Peak Detector (Max Hold)

Span = 2310 - 2500 MHz

Sweep Points = 401

Sweep Time = Auto

Average Measurements

Spectrum Analyzer Settings:

RBW= 1 MHz

VBW= 3 MHz

VBW Mode = Linear

Trace Mode: RMS Detector (Average)

Span= 2310 - 2500 MHz

Sweep Points = 401

Sweep Time = Auto

Sweep Count = 200

Sample Calculation:

<u>Field Strength Level:</u> Amplitude (Analyzer level) + AFCL (Antenna Factor and Cable losses) – Amplifier Gain = 50dBuV + 33 dB - 25 dB = 58dBuV/m

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9.8.3 Limits:

Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (meters)	Corrected Field Strength for 3m measurement distance (dBµV/m)
0.009-0.490	2400/F (kHz)	300	48.5 - 13.8
0.490-1.705	24000/F (kHz)	30	33.8- 23.0
1.705-30	30	30	29.5
30-88	100	3	40
88-216	150	3	43.5
216-960	200	3	46
960-1000	500	3	54
Above 1000 (Restricted Frequency Bands)	500	3	54 (Average) 74 (Peak)

9.8.4 Test Result:

Pass.

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9.8.5 **Test Data**:

9.8.5.1 Radiated Restricted Band-edge emissions

	Band edge Average Data											
Carrier Frequency (MHz)	Mode	Frequency (MHz)	Raw Avg. Amplitude (dBµV)	Correction Factor (dB)	DC Correction Factor (dB)	Corrected Avg. Field Strength (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)				
2402	1M	2389.62	26.79	13.08	1.92	41.79	54	-12.21				
2480	1M	2483.5	28.36	13.49	1.92	43.77	54	-10.23				

Band edge Peak Data										
Carrier Frequency (MHz)	Mode	Frequency (MHz)	Raw Peak Amplitude (dBµV)	Correction Factor (dB)	Corrected Peak Field Strength (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)			
2402	1M	2374	43.93	13.06	56.99	74	-17.01			
2480	1M	2484	44.29	13.49	57.78	74	-16.22			

	Band edge Average Data											
Carrier Frequency (MHz)	Mode	Frequency (MHz)	Raw Avg. Amplitude (dBµV)	Correction Factor (dB)	DC Correction Factor (dB)	Corrected Avg. Field Strength (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)				
2402	2M	2387.15	25.89	13.08	4.48	43.45	54	-10.55				
2480	2M	2483.5	28.15	13.49	4.48	46.12	54	-7.88				

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	Band edge Peak Data										
Carrier Frequency (MHz)	Frequency (MHz)	Raw Peak Amplitude (dBµV)	Correction Factor (dB)	Corrected Peak Field Strength (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)					
2402	2377	44.6	13.08	57.68	74	-16.32					
2480	2484	4.33	13.49	57.82	74	-16.18					

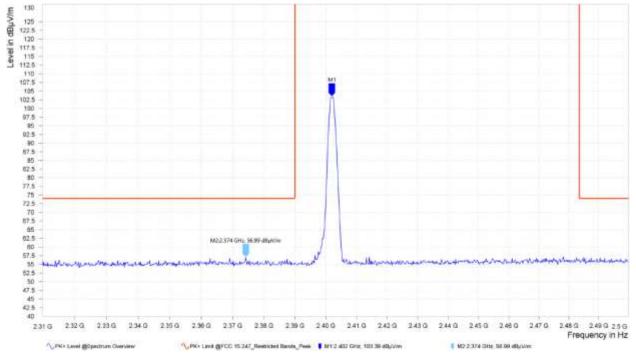


Figure 9-51 Radiated Restricted Band Edge (Ch. 0) Peak 1M



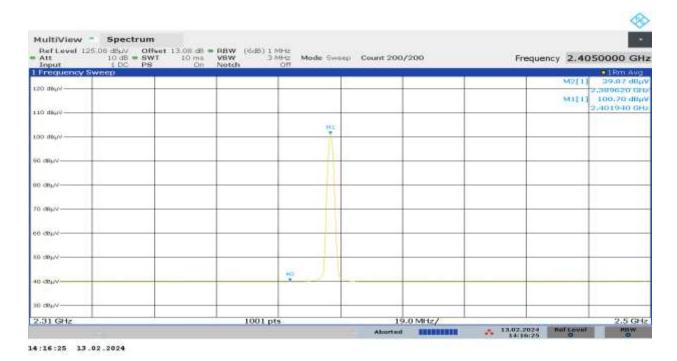


Figure 9-52 Radiated Restricted Band Edge (Ch. 0) Average 1M

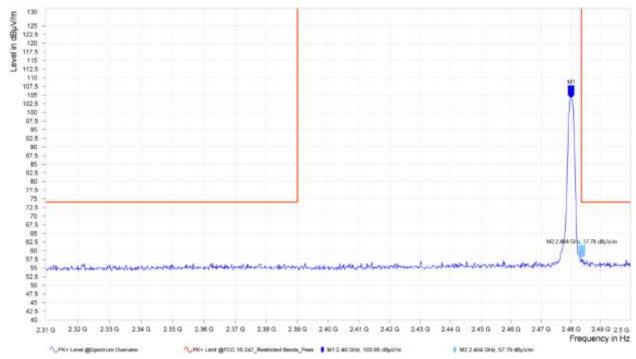


Figure 9-53 Radiated Restricted Band Edge (Ch. 39) Peak 1M





Figure 9-54 Radiated Restricted Band Edge (Ch. 39) Average 1M



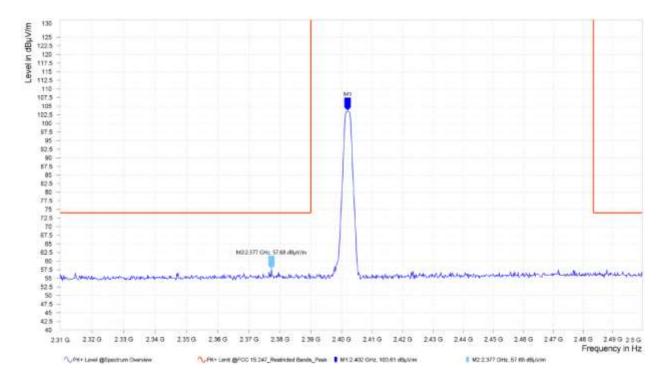


Figure 9-55 Radiated Restricted Band Edge (Ch. 0) Peak 2M

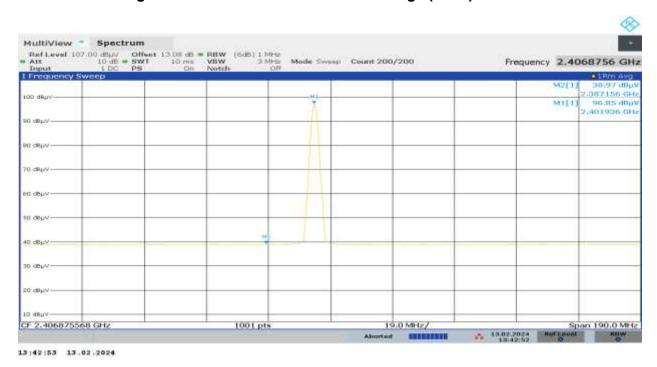


Figure 9-56 Radiated Restricted Band Edge (Ch. 0) Average 2M



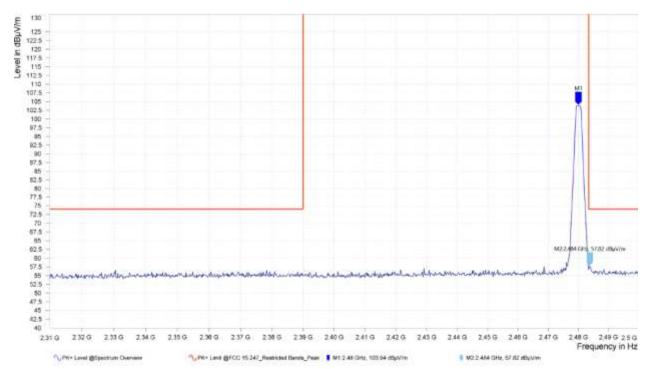


Figure 9-57 Radiated Restricted Band Edge (Ch. 39) Peak 2M



Figure 9-58 Radiated Restricted Band Edge (Ch. 39) Average 2M



9.8.5.2 Emissions in 9 kHz- 30 MHz range

No data to report since all emissions were 20dB below the limit.

9.8.5.3 Emissions in 30 MHz- 1 GHz range

All channels and EUT orientations were tested and worst-case results from channel 19, X orientation shown here.

	RSE 30-1000 MHz										
Carrier Frequency (MHz)	Emission Frequency (MHz)	Raw Quasi- Peak Amplitude (dBµV/m)	Correction Factor (dB)	Corrected Quasi- Peak Field Strength (dBµV/m)	Quasi- Peak Limit (dBµV/m)	Quasi- Peak Margin (dB)					
2440	30.18	-3.78	28.46	24.68	40.00	-15.32					
2440	39.46	-5.28	22.03	16.75	40.00	-23.25					
2440	62.49	1.72	15.92	17.64	40.00	-22.36					
2440	115.86	-5.66	21.37	15.71	43.50	-27.79					
2440	187.54	2.17	19.45	21.62	43.50	-21.88					
2440	880.73	-1.65	32.14	30.49	46.00	-15.51					

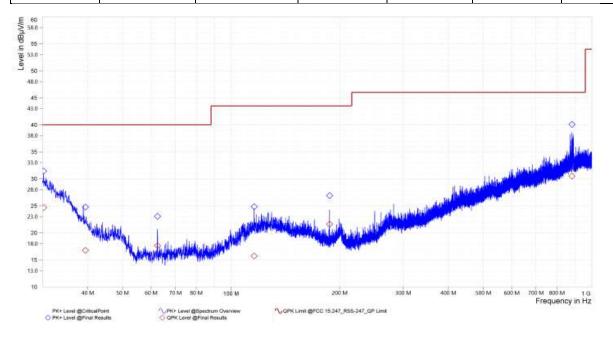


Figure 9-59 Radiated Spurious Emissions (30MHz - 1GHz) - (Ch. 39) 1M, X orientation.

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9.8.5.4 Emissions in 1-18 GHz range

	RSE 1 - 18GHz Average Data											
Carrier Frequency (MHz)	Frequency (MHz)	Raw Avg. Amplitude (dBµV)	Correction Factor (dB)	DC Correction Factor (dB)	Corrected Avg. Field Strength (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)					
2402	4803.5	26.05	8.43	2.73	37.21	54	-16.79					
2402	7206	24.03	11.64	2.73	38.4	54	-15.6					
2440	4880	27.35	8.4	2.73	.8.48	54	-15.52					
2440	7320	25.64	11.75	2.73	40.12	54	-13.88					
2480	4960	27.5	8.56	2.73	38.79	54	-15.21					
2480	7440	26	12.01	2.73	40.74	54	-13.26					

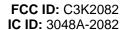
	RSE 1 - 18GHz Peak Data										
Carrier Frequency (MHz)	Frequency (MHz)	Raw Peak Amplitude (dBµV)	Correction Factor (dB)	Corrected Peak Field Strength (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)					
2402	4803.5	36.32	8.43	44.75	74	-29.25					
2402	7206	35.16	11.64	46.8	74	-27.2					
2440	4880	37.31	8.4	45.71	74	-28.29					
2440	7320	36	11.75	47.75	74	-26.25					
2480	4960	36.74	8.56	45.3	74	-28.7					
2480	7440	35.97	12.01	47.98	74	-26.02					

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	RSE 1 - 18GHz Average Data											
Carrier Frequency (MHz)	Frequency (MHz)	Raw Avg. Amplitude (dBµV)	Correction Factor (dB)	DC Correction Factor (dB)	Corrected Avg. Field Strength (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)					
2402	4804	25.33	8.3	3.49	37.25	54	-16.75					
2440	4880	24.95	8.39	3.49	36.83	54	-17.17					
2440	7320	24.58	11.75	3.49	39.82	54	-14.18					
2480	4960	24.7	8.59	3.49	36.78	54	-17.22					
2480	7440	25.23	12.01	3.49	40.73	54	-13.27					

		RSE 1	- 18GHz Peak	Data		
Carrier Frequency (MHz)	Frequency (MHz)	Raw Peak Amplitude (dBµV)	Correction Factor (dB)	Corrected Peak Field Strength (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)
2402	4804	37.19	8.3	45.62	74	-28.38
2440	4880	36.73	8.39	45.12	74	-28.88
2440	7320	34.86	11.75	46.61	74	-27.39
2480	4960	36.81	8.59	45.4	74	-28.6
2480	7440	36.72	12.01	48.73	74	-25.27





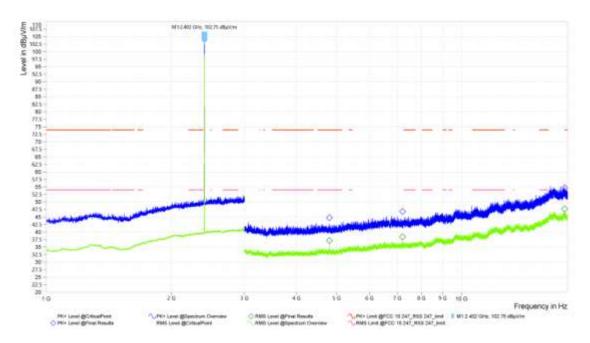


Figure 9-60 Radiated Spurious Emissions 1-18 GHz (Ch. 0) 1M

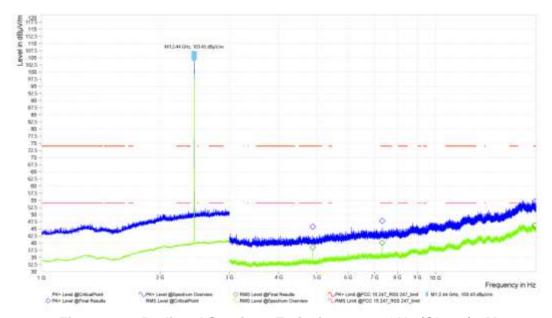


Figure 9-61 Radiated Spurious Emissions 1-18 GHz (Ch. 19) 1M



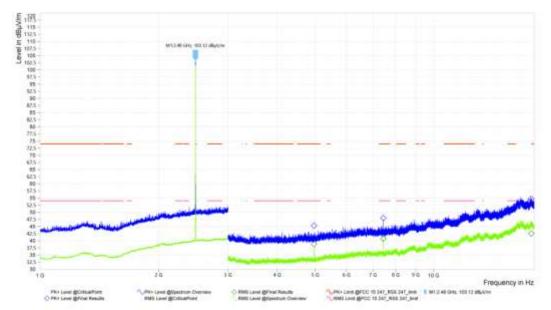


Figure 9-62 Radiated Spurious Emissions 1-18 GHz (Ch. 39) 1M

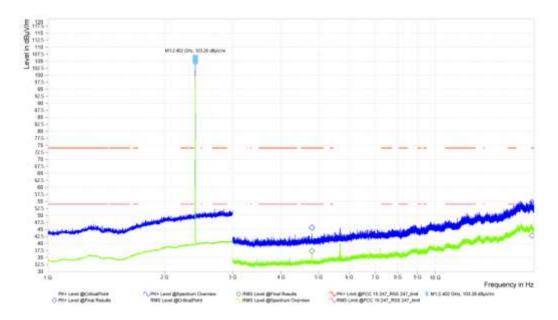


Figure 9-63 Radiated Spurious Emissions 1-18 GHz (Ch. 0) 2M

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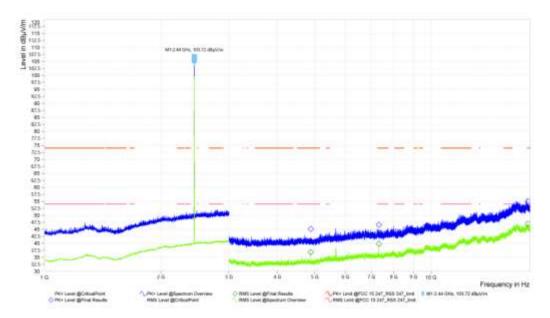


Figure 9-64 Radiated Spurious Emissions 1-18 GHz (Ch. 19) 2M

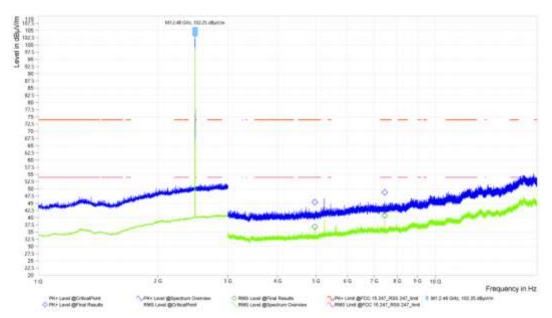


Figure 9-65 Radiated Spurious Emissions 1-18 GHz (Ch. 39) 2M



9.8.5.5 Emissions in 18-26.5 GHz range

All channels were tested and worst-case results from channel 19 (2440 MHz) shown here. No significant emissions to report above noise floor.

	RSE 18 - 40GHz Average Data										
Carrier Frequency (MHz)	Frequency (MHz)	Raw Avg. Amplitude (dBµV)	Correction Factor (dB)	DC Correction Factor (dB)	Corrected Avg. Field Strength (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)				
2440	23710.39	25.60	14.35	0	39.95	54	-14.05				

RSE 18 - 40GHz Peak Data									
Carrier Frequency (MHz)	Frequency (MHz)	Raw Peak Amplitude (dBµV)	Correction Factor (dB)	Corrected Peak Field Strength (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)			
2440	23710.39	34.60	14.35	48.95	74	-25.05			



Figure 9-66 Radiated Spurious Emissions (18 - 26.5 GHz) (Ch. 19) 1M

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9.9 AC Line Conducted Emissions

9.9.1 Test Requirements

FCC CFR 47 Rule Part 15.207 (a)

ISED RSS Gen [8.8]

9.9.2 Test Method

Conducted power line measurements are made, unless otherwise specified, over the frequency range from 150 kHz to 30 MHz to determine the Unsymmetric radio-noise voltage that is conducted from the EUT power-input terminals that are directly (or indirectly via separate transformer or power supplies) connected to a public power network. Equipment is tested with the power cords that are used under normal operating conditions. These measurements are made using a LISN (Line Impedance Stabilization Network). AC powered peripherals are attached to a second LISN with the 50-ohm measuring port terminated by a 50-ohm resistive load.

Worst case results were recorded when the EUT was transmitting continuously with a passive tag load.

EMI Receiver Settings:

150 kHz - 30 MHz:

RBW= 9 kHz VBW ≥ 3 X RBW

Trace Mode: Peak Detector (Max Hold).

Final measurements were performed using Quasi-Peak and Average Detectors.

Span= 150 kHz - 30 MHz

Sweep time= Auto

9.9.3 Limit

	Conducted	Conducted limit (dBµV)			
Frequency of emission (MHz)	Quasi-peak	Average			
0.15-0.5	66 to 56*	56 to 46*			
0.5-5	56	46			
5-30	60	50			

9.9.4 Test Result:

Pass

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9.9.5 **Test Data**:

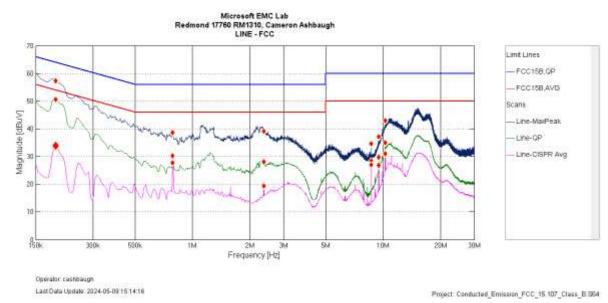


Figure 9-9 AC Line Conducted Emissions - Line (150 kHz - 30 MHz)

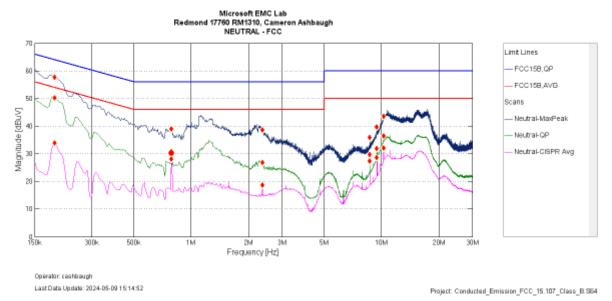


Figure 9-10 AC Line Conducted Emissions - Neutral (150 kHz - 30 MHz)

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AC Conducted Line Emissions Data – BLE										
Frequency (MHz)	QP Amplitude (dBµV)	AVG Amplitude (dBµV)	Quasi- Peak Limit (dBµV)	Average Limit (dBµV)	Line Tested (L or N)	Quasi- Peak Margin (dB)	Average Margin (dB)			
0.191719	50.42	33.86	63.96	53.96	L	-13.54	-20.1			
0.788297	30.13	27.67	56	46	L	-25.87	-18.33			
2.369	28.08	19.28	56	46	L	-27.92	-26.72			
8.686	28.4	26.95	60	50	L	-31.6	-23.05			
10.263	34.84	30.97	60	50	L	-25.16	-19.03			
9.482	29.67	26.79	60	50	L	-30.33	-23.21			
0.191719	50.2	33.86	63.96	53.96	N	-13.76	-20.1			
0.788297	30.14	28	56	46	N	-25.86	-18			
2.369	26.76	18.61	56	46	N	-29.24	-27.39			
10.267	36.42	32.05	60	50	N	-23.58	-17.95			
9.478	31.92	28.59	60	50	N	-28.08	-21.41			
8.686	29.56	27.35	60	50	N	-30.44	-22.65			

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End of Report

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