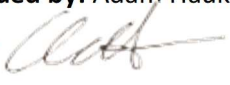
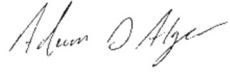


Test Report TR3768-165-BTC-FHSS

Equipment Under Test:	Module, SONA NX 611 M.2 2230, 2 MHF
Requirement(s):	eCFR 47 Part 15.247 RSS-247
Test Date(s):	01/22/2024-04/30/2024
Prepared for:	Ezurio Attn: Brian Petted W66 N220 Commerce Ct. Cedarburg, WI 53012

Report Issued by: Adam Hauke, EMC Engineer	
Signature: 	Date: 08/08/2024
Report Reviewed by: Adam Alger, Manager EMC Laboratory	
Signature: 	Date: 8/07/2024
Report Constructed by: Adam Hauke, EMC Engineer	
Signature: 	Date: 08/08/2024

This test report may not be reproduced, except in full, without approval of Ezurio

Company: Ezurio	Page 1 of 36	Name: Module, SONA NX611 M.2, 2 MHF
Report: TR3768-165-BTC-FHSS		Model: SONA NX611M
Job: C-3768		Serial: 00047

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Ezurio Test Services in Review

The Ezurio laboratory located at W66 N220 Commerce Court Cedarburg, Wisconsin, 53012 USA is recognized through the following organizations:



A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025:2017 with Electrical (EMC) Scope

A2LA Certificate Number: 1255.01

Scope of accreditation includes all test methods listed herein unless otherwise noted



Federal Communications Commission (FCC) – USA

Accredited Test Firm Registration Number: 953492

Recognition of two 3 meter Semi-Anechoic Chambers



Innovation, Science and Economic Development Canada

Accredited U.S. Identification Number: US0218

Recognition of two 3 meter Semi-Anechoic Chambers

Company: Ezurio	Page 3 of 36	Name: Module, SONA NX611 M.2 2230, 2 MHF
Report: TR3768-165-BTC-FHSS		Model: SONA NX611M
Job: C-3768		Serial: 00047

1 TEST REPORT SUMMARY

During **01/22/2024-04/30/2024** the Equipment Under Test (EUT), **Module, SONA NX611 M.2 2230, 2 MHF**, as provided by Ezurio was tested to the following requirements:

FCC 15.247 | RSS-247 – FHSS Bluetooth Classic

Requirements	Description	Method	Compliant
15.247(d) 15.209 RSS-247 Clause 5.5 RSS-GEN Clause 8.10	Spurious Radiated Emissions in Restricted Bands 30-40000 MHz	ANSI C63.10	Yes
2.1049 RSS-247 Clause 6.6	Occupied Bandwidth and 20dB DTS BW	ANSI C63.10	Yes
15.247(b)(1) RSS-247 Clause 5.4 (b)	RF Output Power	ANSI C63.10	Yes
15.247(d) RSS-247 Clause 5.5 RSS-GEN A1 Clause 8.9	Out-of-band Emissions	ANSI C63.10	Yes
15.247(a)(1) RSS-247 Clause 5.1	Channel Separation, Number of Hopping Frequencies, and Time of Occupancy	ANSI C63.10	Yes
2.1055(d) RSS-GEN 6.11	Frequency Stability	ANSI C63.10	Reported
15.207 RSS-GEN 8.8	AC Conducted Emissions	ANSI C63.10	Yes

Notice:

The results relate only to the item tested as configured and described in this report. Any additional configurations, modes of operation, or modifications made to the equipment under test after the specified test date(s) are at the decision of the client and may not apply to the data seen in this test report.

The decision rule for Pass / Fail assessment to the specification or standard listed in this test report has been agreed upon by the client and laboratory to be as follows:

Measurement Type	Rule
Emissions – Amplitude	0.1 dB below specified limit
Emissions – Frequency	1% less than the specification
Immunity	Tested at specified level

Company: Ezurio	Page 4 of 36	Name: Module, SONA NX611 M.2 2230, 2 MHF
Report: TR3768-165-BTC-FHSS		Model: SONA NX611M
Job: C-3768		Serial: 00047

2 CLIENT INFORMATION

Company Name	Ezurio
Contact Person	Brain Petted
Address	W66 N220 Commerce Ct. Cedarburg, WI 53012

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	Module, SONA NX611 M.2 2230, 2 MHF
Part Number	453-00165
Serial Number	00047
FCC ID	SQG-SONANX611M
IC ID	3147A-SONANX611M

2.2 Product Description

The NX611 is based upon NXP IW611 Wi-Fi 6 chipset. Feature-set includes 802.11 a/b/g/n/ac/ax Wi-Fi 6 and Dual-Mode Bluetooth v5.3 (BDR + EDR + BLE).

2.3 Modifications Incorporated for Compliance

None noted at time of test

2.4 Deviations and Exclusions from Test Specifications

None noted at time of test

2.5 EUT Information

Power Supply – INPUT:100-240VAC 50/60 Hz 0.3A

OUTPUT: 5VDC 2A

Firmware - sduart_nw61x_v1.bin.se

Sduart_nw61x_v1_mfg.bin.se

Company: Ezurio	Page 5 of 36	Name: Module, SONA NX611 M.2 2230, 2 MHF
Report: TR3768-165-BTC-FHSS		Model: SONA NX611M
Job: C-3768		Serial: 00047

2.6 Ancillary Equipment

Equipment used for EUT programming (not part of the EUT)

Development Kit, SU60-SOMC 6.0

P/N: 463-00138-K1 Rev 1

Power Supply: INPUT: 100-240 VAC 50/60Hz 0.7A

OUTPUT: 12VDC 2A

HP Elitebook 840G1

Labtool Version: 1.0.0.45.6

2.7 Antenna Information

Manufacturer	Model	Part Number	Dimension	Type	Peak Gain (dBi)	
					2400-2500 MHz	4900-5925 MHz
Laird Connectivity	FlexMIMO 6E	EFD2471A3S-10MH4L	39.5mm X 39.5mm X 4.7mm	PIFA	2.2	3.8
Laird Connectivity	FlexPIFA 6E	EFB2471A3S-10MH4L	16mm X 36mm X 2.5mm	PIFA	2.2	3.9
Laird Connectivity	Mini NanoBlade Flex 6E	EMF2471A3S-10MH4L	36mm X 12mm X 0.3mm	PCB Dipole	2.4	4.4
Joymax Electronics	N/A	TWX-100BR53B	137mm X 13mm	Dipole	2.0	4.0
Laird Connectivity	FlexPIFA	EFB2455A3S-16MHF1	38.5mm X 12.7 mm X 2.5mm	PIFA	2.5	3.0

2.8 Test Channels

Channel	Frequency (MHz)	Data Rates
0	2402	DH5, 2DH5, and 3DH5
39	2441	
78	2480	

2.9 Power Table and Reduced Video Bandwidth for Average Measurements

Data Rate	Minimum Average VBW (Hz)	Power Setting
DH5	360	6
2DH5	360	6
3DH5	360	6

3 WORST CASE TEST RESULTS SUMMARY

Requirement	Channel and Data Rate	Frequency (MHz)	Measurement	Limit	Margin
2.1049 RSS-247 Clause 6.6 20 dB DTS Bandwidth	0 DH5	-	956 kHz	at least 500 kHz	-
15.247 (b)(1) RSS-247 Clause 5.4 (b) Output Power	39 3DH5	-	7.9 dBm	30 dBm	22.1 dB
15.247 (d) RSS-247 Clause 5.5 Conducted	78 DH5	2483.6	58.3 dBμV/m	74.0 dBμV/m	15.7 dB
15.247(d) RSS-247 Clause 5.5 RSS-GEN Clause 8.9 Radiated	19 Basic Rate Single Channel	44.0	38.2 dBμV/m	40.0 dBμV/m	1.8 dB
15.207 RSS-GEN 8.8	37 1DH5	0.512	24.2 dBμV	46.0 dBμV	21.8 dB

4 REFERENCES

Publication	Edition	Date	AMD 1	AMD 2
FCC eCFR 47 Part 15	-	2023	-	-
ANSI C63.10	-	2020	-	-
RSS-247	3	2023	-	-
RSS-GEN	5	2018	2019	2021
KDB 558074 D01	-	2019	-	-

5 UNCERTAINTY SUMMARY

Using the guidance of the following publications the calculated measurement uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of $k = 2$.

References

CISPR 16-4-1

CISPR 16-4-2

CISPR 32

ANSI C63.23

A2LA P103

A2LA P103c

ETSI TR 100-028

Measurement Type	Configuration	Uncertainty $\pm$
Radiated Emissions	Biconical Antenna	5.0 dB
Radiated Emissions	Log Periodic Antenna	5.3 dB
Radiated Emissions	Horn Antenna	4.7 dB
AC Line Conducted Emissions	Artificial Mains Network	3.4 dB
Telecom Conducted Emissions	Asymmetric Artificial Network	4.9 dB
Disturbance Power Emissions	Absorbing Clamp	4.1 dB
Radiated Immunity	3 Volts/meter	2.2 dB
Conducted Immunity	CDN/EM/BCI	2.4/3.5/3.4 dB
EFT Burst/Surge	Peak pulse voltage	164 volts
ESD Immunity	15 kV level	1377 Volts

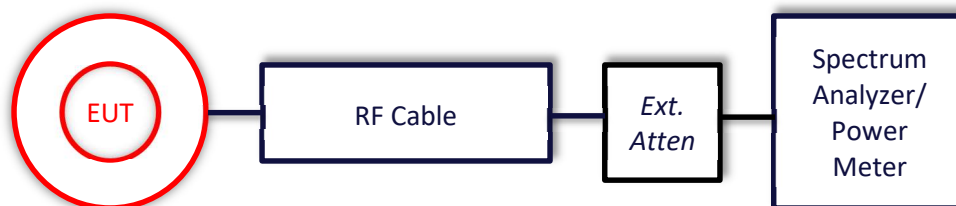
Parameter	ETSI U.C. $\pm$	U.C. $\pm$
Radio Frequency, from F0	1×10^{-7}	0.55×10^{-7}
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
Supply voltages	3 %	1 %

6 TEST DATA

6.1 Antenna Port Conducted Emissions

Description of Measurement	The direct measurement of emissions at the antenna port of the EUT is achieved by use of a RF connection to a spectrum analyzer or power meter. The cable and attenuator factors are loaded into the analyzer or power meter allowing for direct measurement readings without the need for further corrections.
Example Calculations	Measurement (dBm) + Cable factor (dB) + External Attenuator (dB) = Corrected Reading (dBm) Margin (dB) = Limit (dBm) – Corrected Reading (dBm)

Block Diagram



6.1.1 20dB DTS and 99% Occupied Bandwidth

Operator	Dylan Rosenfeldt	QA	Adam Hauke
Temperature	22.3°C	R.H. %	30.30%
Test Date	03/15/2024	Location	Conducted RF Bench
Requirement	2.1049 RSS-247 Clause 6.6	Method	ANSI C63.10 6.9

Limits: Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Test Parameters

Frequency	2400-2483.5 MHz	Setup	Antenna Port
RBW	30 kHz	VBW	300 kHz
Detector(s)	Peak	Settings	Max Hold

Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960173	Cable	A.H. Systems, Inc.	SAC-26G-1	388	6/13/2023	6/12/2024	Active Verification
EE 960085	Analyzer - EMI Receiver	Agilent	N9038A	MY51210148	4/27/2023	4/27/2024	Active Calibration

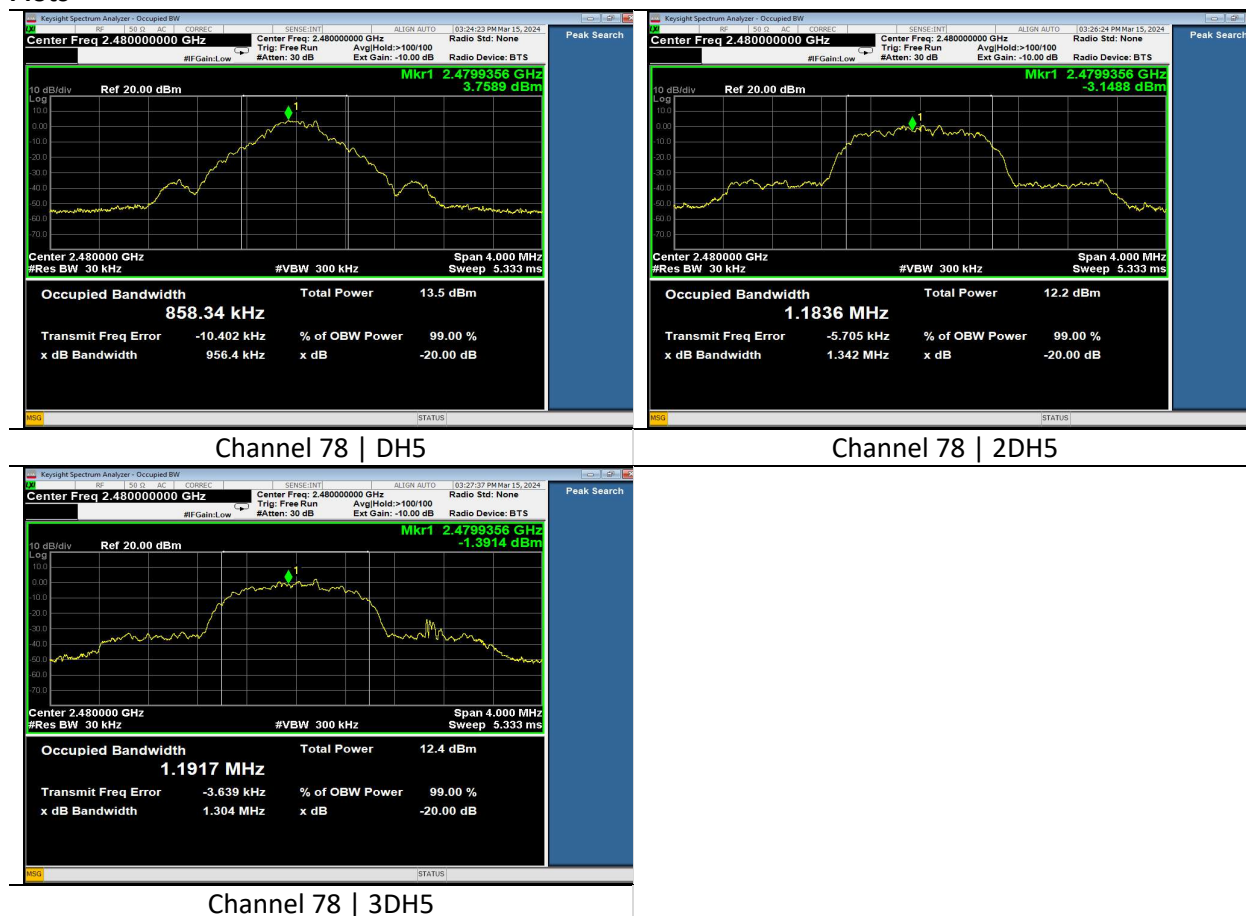
EUT Parameters

Input Power	120 VAC @ 60 Hz	Mode	BTC FHSS Tx
Frequency	2400-2483.5 MHz	Channel	See 2.9

Table

Rate	Channel	20 dB BW (kHz)	99% BW (kHz)
DH5	0	956	859
	39	958	863
	78	956	858
2DH5	0	1344	1187
	39	1343	1183
	78	1342	1184
3DH5	0	1305	1193
	39	1305	1189
	78	1304	1192

Plots



6.1.2 RF Output Power

Operator	Dylan Rosenfeldt	QA	Adam Hauke
Temperature	21.8°C	R.H. %	32.20%
Test Date	03/12/2024	Location	Conducted RF Bench
Requirement	15.247 (b)(1) RSS-247 Clause 5.4 (b)	Method	ANSI C63.10 11.9.1

Limit: For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels: 1 watt.

Test Parameters

Frequency	2400-2483.5 MHz	Setup	Antenna Port
RBW	3 MHz	VBW	50 MHz
Detector(s)	Peak	Settings	Max Hold Span: 10 MHz

Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960173	Cable	A.H. Systems, Inc.	SAC-26G-1	388	6/13/2023	6/12/2024	Active Verification
EE 960088	Analyzer - EMI Receiver	Agilent	N9038A	MY51210138	4/10/2023	4/10/2024	Active Calibration

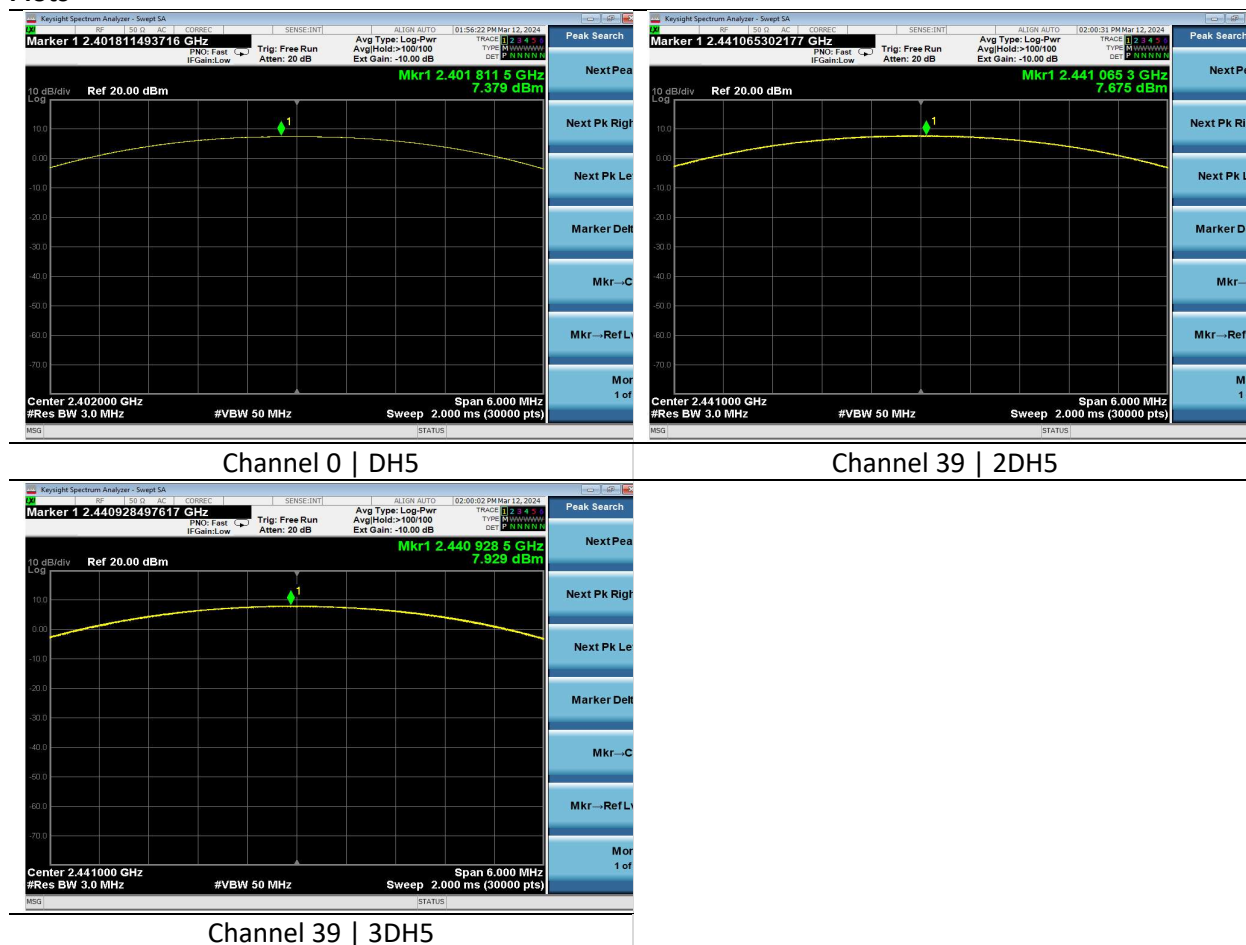
EUT Parameters

Input Power	120 VAC @ 60 Hz	Mode	BTC FHSS Tx
Frequency	2400-2483.5 MHz	Channel	See 2.9

Tables

Rate	Channel	Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
DH5	0	7.4	30.0	22.6
	39	7.3	30.0	22.7
	78	7.1	30.0	22.9
2DH5	0	7.6	30.0	22.4
	39	7.7	30.0	22.3
	78	7.7	30.0	22.3
3DH5	0	7.8	30.0	22.2
	39	7.9	30.0	22.1
	78	7.9	30.0	22.1

Plots



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Report: TR3768-165-BTC-FHSS		Model: SONA NX611M
Job: C-3768		Serial: 00047

6.1.3 Out-of-band Emissions

Operator	Dylan Rosenfeldt	QA	Adam Alger
Temperature	22.3°C 21.9°C	R.H. %	27.30% 24.50%
Test Date	03/11/2024 03/29/2024	Location	Conducted RF Bench
Requirement	15.247(d) RSS-247 Clause 5.5	Method	ANSI C63.10 11.12.2.5.2

Limits: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement provided the transmitter demonstrates compliance with the peak conducted power limits.

Reference Level (Worst Case PSD)

DH5 – 6.2 dBm/100 kHz

6.2 dBm-20 dB = -13.8 dBm Limit

Test Parameters

Frequency	30-40000 MHz	Setup	Antenna Port
RBW	100 kHz	VBW	300 kHz
Detector(s)	Peak and Average (RMS)		
Notes	Declared antenna gain for band edge – 2.5 dBi		
Example Calculations	Correction Factor = 20 log (1/D), where D is the duty cycle		

Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960172	Cable	A.H. Systems, Inc.	SAC-26G-1	387	06/13/2023	06/12/2024	Active Verification
EE 960085	Analyzer – Spectrum	Agilent	N9010A	MY53400296	04/11/2023	04/11/2024	Active Calibration
EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/11/2023	4/11/2024	Active Calibration
AA 960173	Cable	A.H. Systems, Inc.	SAC-26G-1	388	6/13/2023	6/12/2024	Active Verification

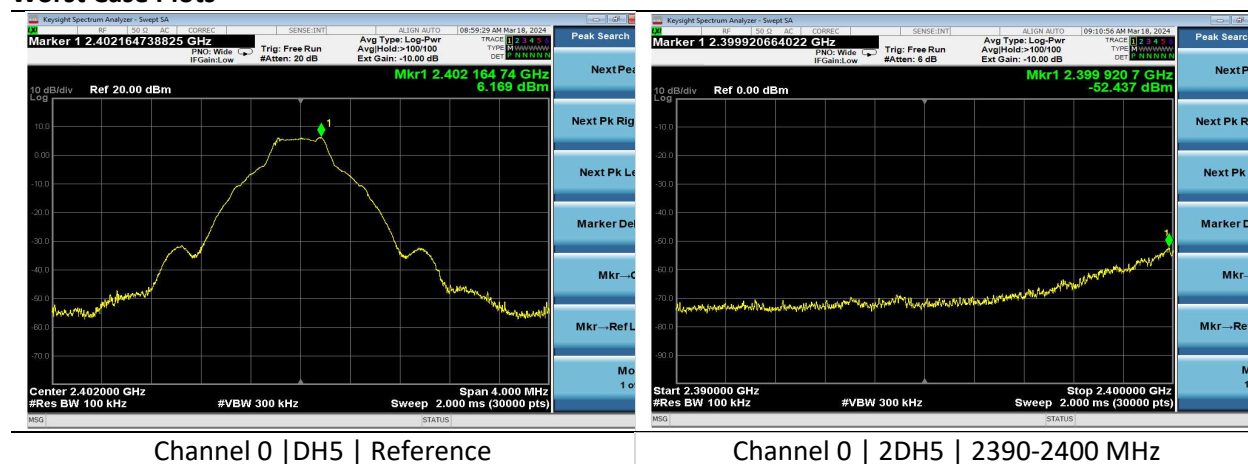
Company: Ezurio	Page 15 of 36	Name: Module, SONA NX611 M.2 2230, 2 MHF
Report: TR3768-165-BTC-FHSS		Model: SONA NX611M
Job: C-3768		Serial: 00047

Input Power	120 VAC @ 60 Hz	Mode	BTC FHSS Tx
Frequency	2400-2483.5 MHz	Channel	See 2.8

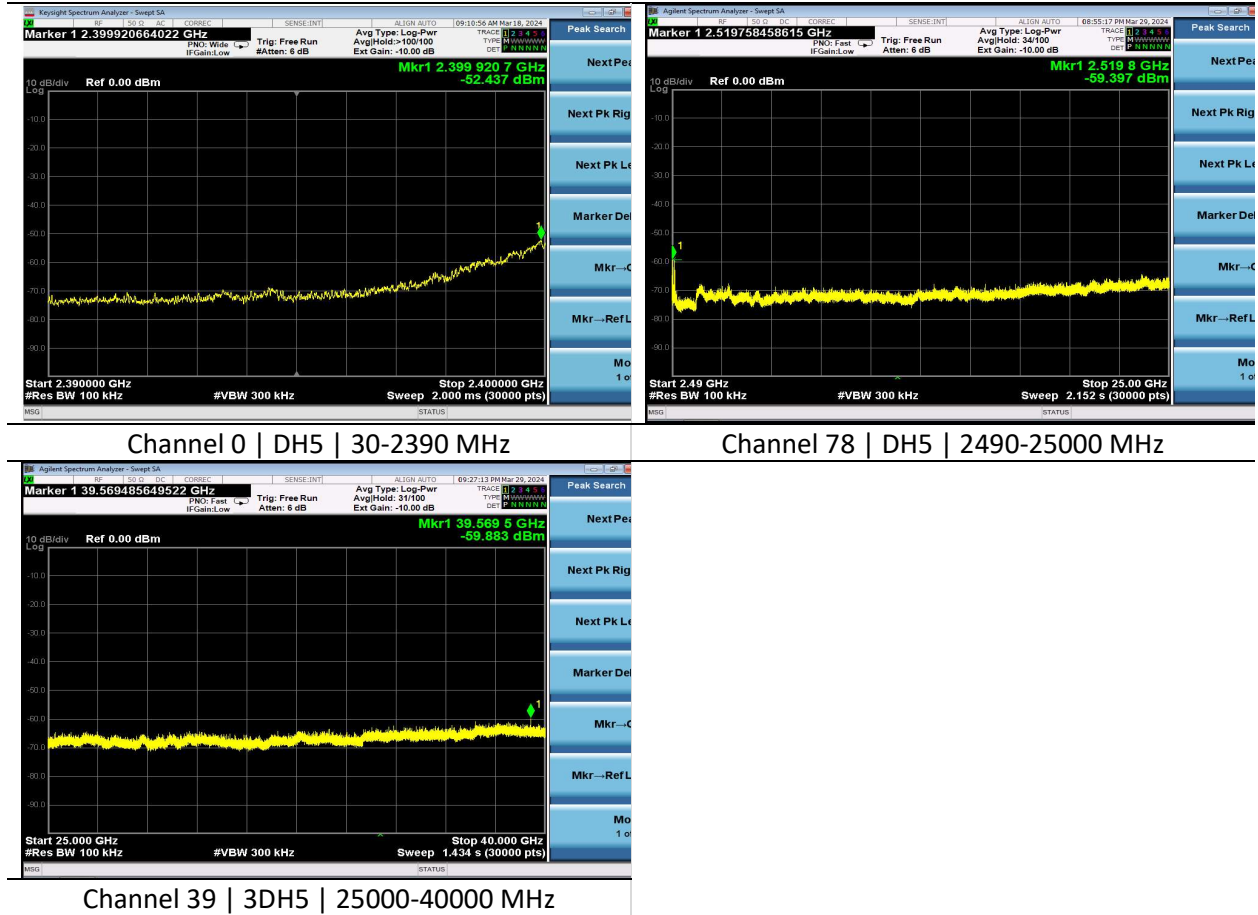
Measurements

Rate	Channel	Frequency (MHz)	Measurement (dBm)	Limit (dBm)	Margin (dB)
DH5	0	2400.0	-52.2	-13.8	38.4
	78	2493.0	-50.6	-13.8	36.8
	Hopping	2395.7	-50.2	-13.8	36.4
	Hopping	2487.0	-51.0	-13.8	37.2
2DH5	0	2399.9	-52.4	-13.8	38.6
	78	2483.7	-63.1	-13.8	49.3
	Hopping	2399.8	-53.4	-13.8	39.6
	Hopping	2483.8	-64.5	-13.8	50.7
3DH5	0	2399.9	-49.3	-13.8	35.5
	78	2483.5	-56.1	-13.8	42.3
	Hopping	2399.6	-50.6	-13.8	36.8
	Hopping	2483.5	-57.7	-13.8	43.9

Worst Case Plots



Company: Ezurio	Page 16 of 36	Name: Module, SONA NX611 M.2 2230, 2 MHF
Report: TR3768-165-BTC-FHSS		Model: SONA NX611M
Job: C-3768		Serial: 00047



6.1.4 Spurious Emissions in The Restricted Bands

Operator	Dylan Rosenfeldt	QA	Adam Alger
Temperature	22.3°C 21.9°C	R.H. %	27.30% 24.50%
Test Date	03/11/2024 03/29/2024	Location	Conducted RF Bench
Requirement	15.247(d) RSS-247 Clause 5.5	Method	ANSI C63.10 11.12.2.5.2

15.209 Limits:

Frequency (MHz)	Quasi-Peak Limit (dBμV/m)	Average Limit (dBμV/m)	Peak Limit (dBμV/m)
30-88	40.0	-	-
88-216	43.5	-	-
216-960	46.0	-	-
960-1000	54.0	-	-
1000-40000	-	54.0	74.0

Test Parameters

Frequency	30-40000 MHz	Setup	Antenna Port
RBW	100 kHz	VBW	300 kHz
Detector(s)	Peak and Average (RMS)		
Notes	Declared antenna gain for band edge – 2.5 dBi		
Example Calculations	Correction Factor = $20 \log (1/D)$, where D is the duty cycle EIRP = Measurement + Antenna Gain + Correction Factor E-Field = $EIRP - 20 \log 3 + 104.8$		

Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960172	Cable	A.H. Systems, Inc.	SAC-26G-1	387	06/13/2023	06/12/2024	Active Verification
EE 960085	Analyzer – Spectrum	Agilent	N9010A	MY53400296	04/11/2023	04/11/2024	Active Calibration
EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/11/2023	4/11/2024	Active Calibration
AA 960173	Cable	A.H. Systems, Inc.	SAC-26G-1	388	6/13/2023	6/12/2024	Active Verification

Input Power	120 VAC @ 60 Hz	Mode	BTC FHSS Tx
Frequency	2400-2483.5 MHz	Channel	See 2.8

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Report: TR3768-165-BTC-FHSS		Model: SONA NX611M
Job: C-3768		Serial: 00047

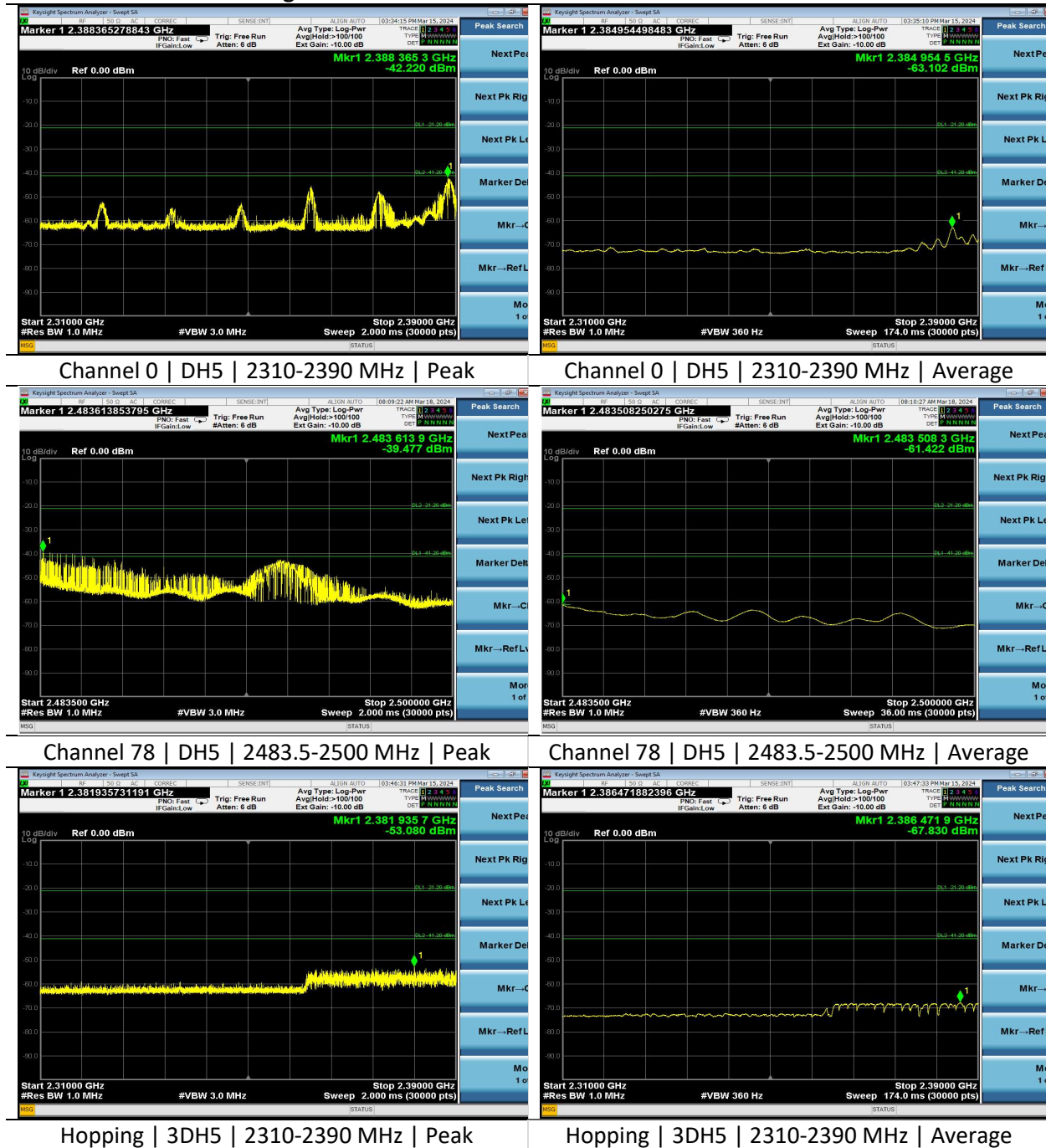
Measurements – Lower Band Edge

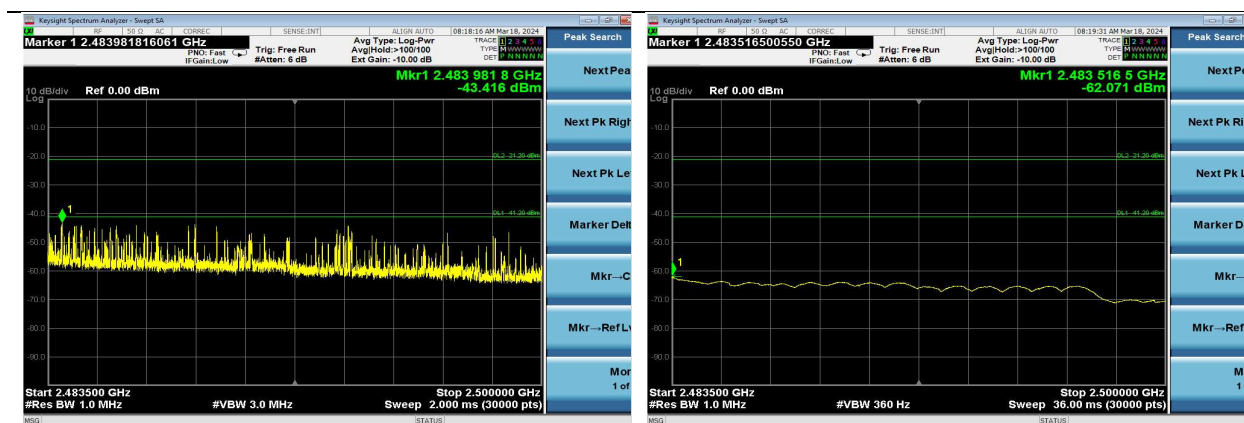
Rate	Channel	Measurement Type	Frequency (MHz)	Measurement (dBm)	EIRP (dBm)	E-Field (dBμV/m)	Limit (dBμV/m)	Margin (dB)
DH5	0	Peak	2388.4	-42.2	-39.7	55.6	74.0	18.4
		Average	2385.0	-63.1	-60.6	34.7	54.0	19.3
	Hopping	Peak	2389.0	-46.1	-43.6	51.7	74.0	22.3
		Average	2389.0	-63.1	-60.6	34.7	54.0	19.3
2DH5	0	Peak	2387.5	-54.6	-52.1	43.2	74.0	30.8
		Average	2362.4	-67.7	-65.2	30.1	54.0	23.9
	Hopping	Peak	2384.7	-55.1	-52.6	42.7	74.0	31.3
		Average	2378.6	-67.8	-65.3	30.0	54.0	24.0
3DH5	0	Peak	2361.7	-52.9	-50.4	44.9	74.0	29.1
		Average	2362.3	-67.8	-65.3	30.0	54.0	24.0
	Hopping	Peak	2381.9	-53.1	-50.6	44.7	74.0	29.3
		Average	2386.5	-67.8	-65.3	30.0	54.0	24.0

Measurements – Upper Band Edge

Rate	Channel	Measurement Type	Frequency (MHz)	Measurement (dBm)	EIRP (dBm)	E-Field (dBμV/m)	Limit (dBμV/m)	Margin (dB)
DH5	78	Peak	2483.6	-39.5	-37.0	58.3	74.0	15.7
		Average	2483.5	-61.4	-58.9	36.4	54.0	17.6
	Hopping	Peak	2484.0	-43.4	-40.9	54.4	74.0	19.6
		Average	2483.5	-62.1	-59.6	35.7	54.0	18.3
2DH5	78	Peak	2483.6	-45.9	-43.4	51.9	74.0	22.1
		Average	2483.5	-66.0	-63.5	31.8	54.0	22.2
	Hopping	Peak	2483.8	-47.1	-44.6	50.7	74.0	23.3
		Average	2483.5	-67.1	-64.6	30.7	54.0	23.3
3DH5	78	Peak	2483.5	-42.3	-39.8	55.5	74.0	18.5
		Average	2483.5	-65.3	-62.8	32.5	54.0	21.5
	Hopping	Peak	2483.5	-42.8	-40.3	55.0	74.0	19.0
		Average	2483.5	-65.7	-63.2	32.1	54.0	21.9

Worst Case Plots – Band Edge





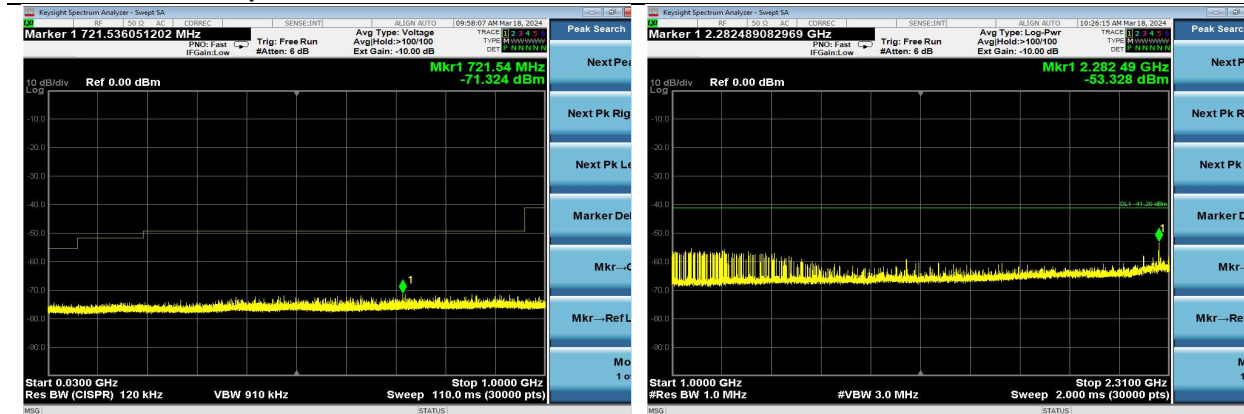
Hopping | DH5 | 2483.5-2500 MHz | Peak

Hopping | DH5 | 2483.5-2500 MHz | Average

Measurements - Spurious

Rate	Channel	Measurement Type	Frequency (MHz)	Measurement (dBm)	EIRP (dBm)	E-Field (dBμV/m)	Limit (dBμV/m)	Margin (dB)
DH5	0	Peak	2282.0	-53.6	-51.1	44.2	74.0	29.8
		Average	2292.2	-70.2	-67.7	27.6	54.0	26.4
	39	Peak	2281.2	-50.9	-48.4	46.9	74.0	27.1
		Average	2281.0	-70.4	-67.9	27.4	54.0	26.6

Worst Case Plots - Spurious



Channel 0 | DH5 | 30-1000 MHz

Channel 0 | 2DH5 | 1000-2310 MHz

Company: Ezurio

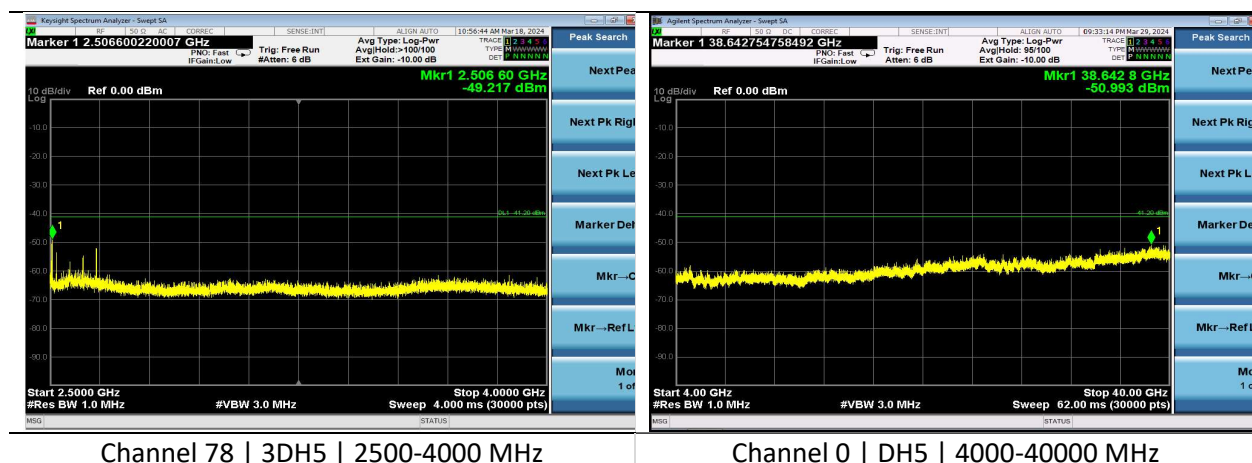
Report: TR3768-165-BTC-FHSS

Job: C-3768

Name: Module, SONA NX611 M.2 2230, 2 MHF

Model: SONA NX611M

Serial: 00047



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6.1.5 Frequency Stability | Channel Separation | Number of Hopping Frequencies | Time of Occupancy

Operator	Dylan Rosenfeldt	QA	Anthony Smith
Temperature	21.6°C 22.0°C	R.H. %	30.00% 29.10%
Test Date	04/24/2024-04/25/2024	Location	Conducted RF Bench
Requirement	15.247(a)(1) 2.1055 (d) RSS-247 Clause 5.1 RSS-GEN Clause 6.11	Method	ANSI C63.10

Test Parameters

Frequency	2402-2480 MHz	Voltage	4.3 VDC, 5 VDC, and 5.8 VDC
Detector(s)	Peak	Settings	Max Hold

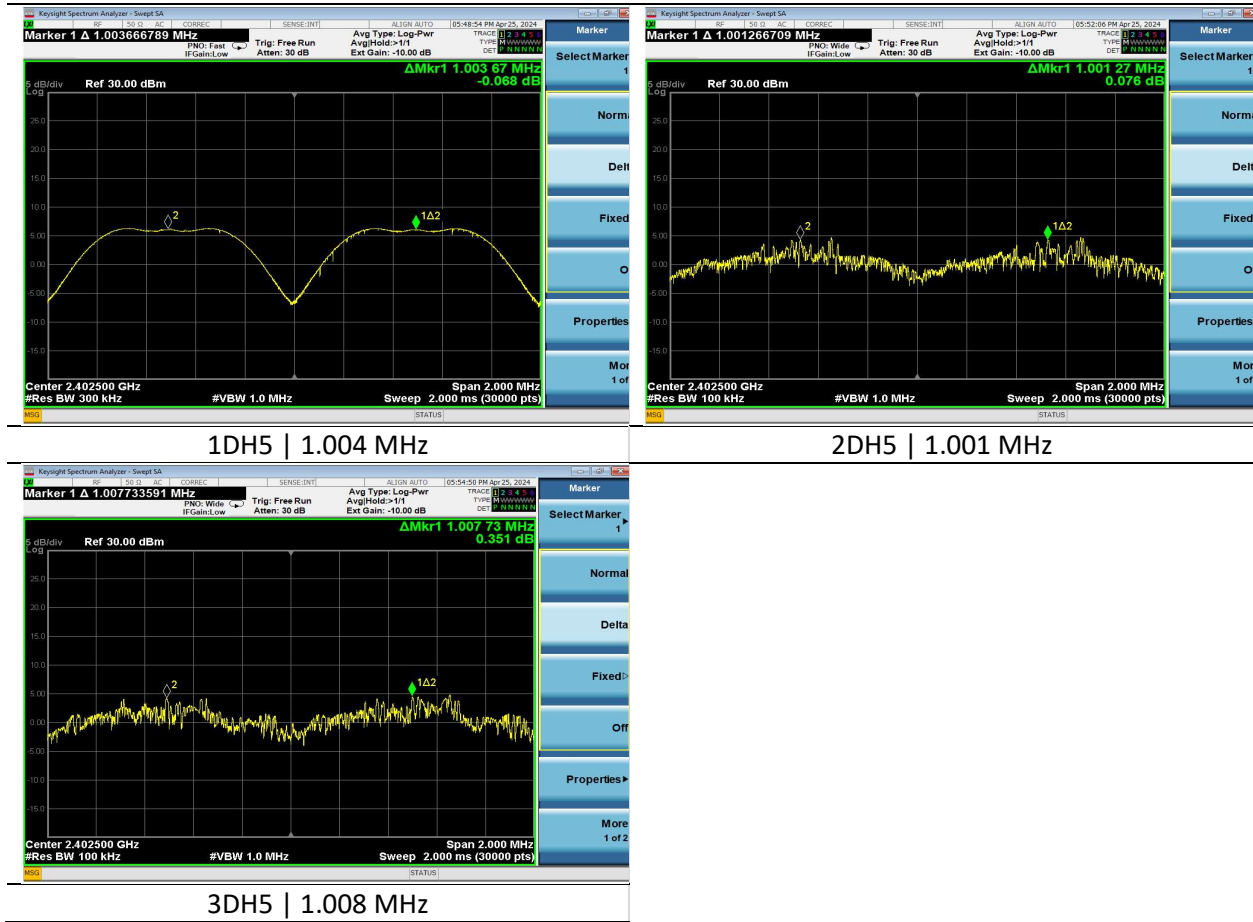
Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960173	Cable	A.H. Systems, Inc.	SAC-26G-1	387	06/13/2023	06/12/2024	Active Verification
EE 960088	Analyzer - EMI Receiver	Agilent	N9038A	MY51210138	4/10/2023	4/10/2024	Active Calibration

Frequency Stability Table

Channel	Voltage (VDC)	Center Frequency (Hz)
0	5	2401999720
	4.3	2401999739
	5.8	2402000853
39	5	2440999314
	4.3	2440999530
	5.8	2440999274
78	5	2480000349
	4.3	2479999619
	5.8	2480000092

Carrier Frequency Separation

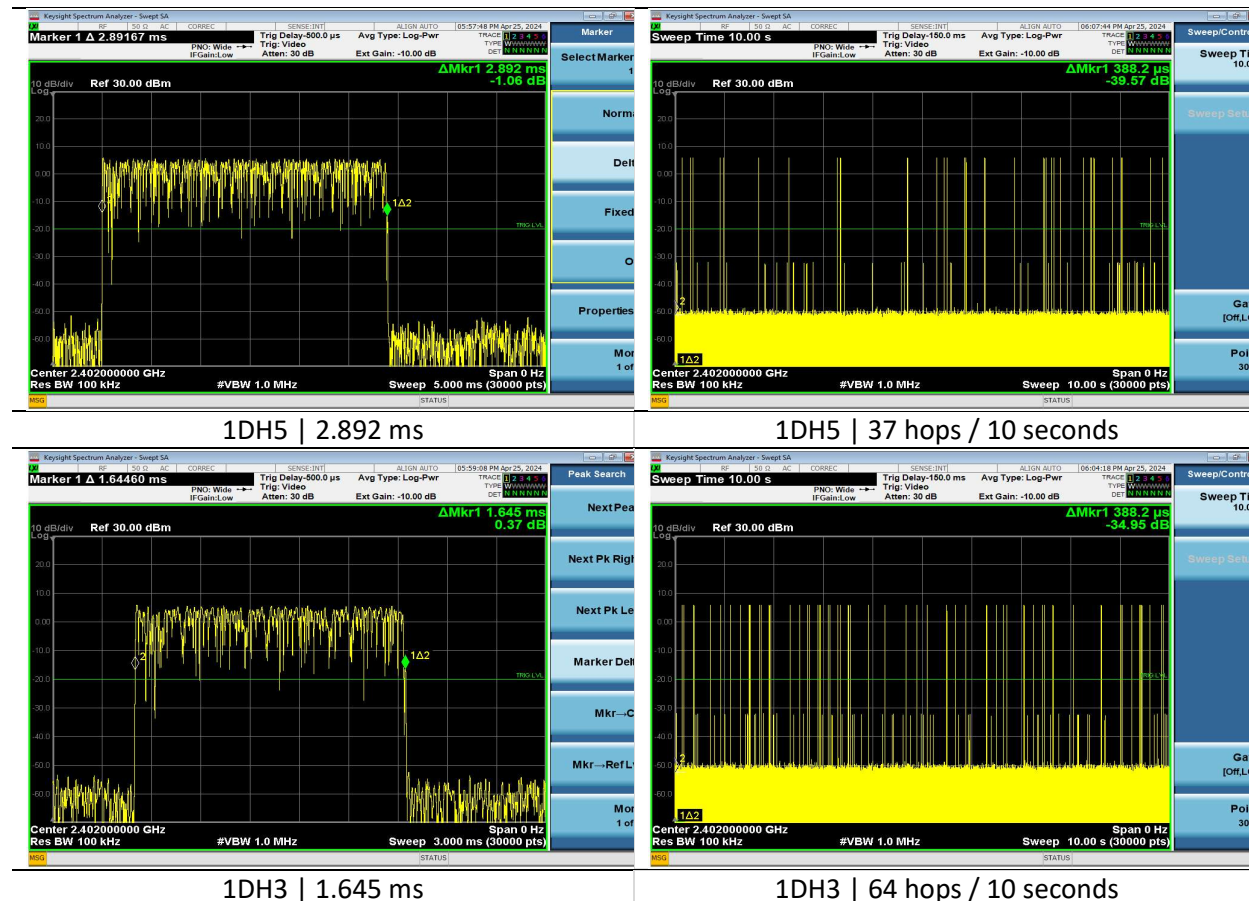


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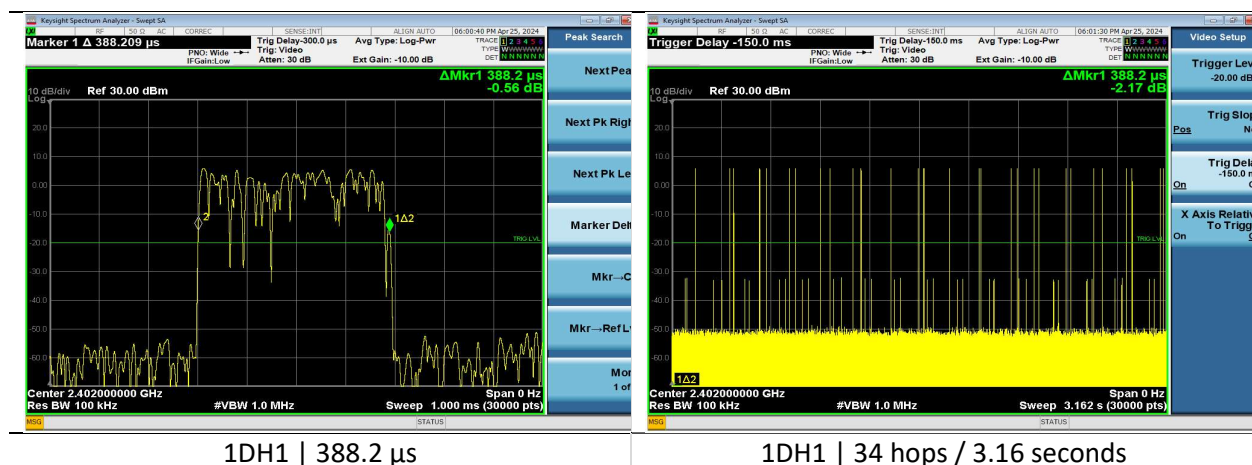
Dwell Time

Rate	Length of Transmission on Time (ms)	Number of Transmissions in 31.6s (79 Hopping *0.4)	Result (s)	Limit (s)	Margin (s)
1DH5	2.892	116.92	0.338	0.400	0.062
1DH3	1.645	202.24	0.333	0.400	0.067
1DH1	0.3882	340	0.132	0.400	0.268

Plots



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6.2 Radiated Emissions

Description of Measurement	The frequency spectrum is investigated for intentional and / or unintentional signals emanating from the EUT by use of a standardized test site and measurement antenna. The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are performed allowing the data to be gathered and reported as corrected values. The maximum emissions from the EUT are determined by turn-table azimuth rotation (360°) and scanning of the measurement antenna. Maximized levels are noted at degree values of azimuth, measurement antenna height, and measurement antenna polarity.
Example Calculations	Measurement (dBμV) + Cable factor (dB) + Other (dB) + Antenna Factor (dB/m) = Corrected Reading (dBμV/m) Margin (dB) = Limit (dBμV/m) - Corrected Reading (dBμV/m) Example at 4000 MHz: Reading = 40 dBμV + 3.4 dB + 0.9 dB + 6.5 dB/m = 50.8 dBμV/m Average Limit = 20 log (500) = 54 dBμV/m Margin = 54 dBμV/m - 50.8 dBμV/m = 3.2 dB

Block Diagram



6.2.1 Spurious Radiated Emissions in the Restricted Bands

Operator	Mitchell Freund Nicole Sedmak Jon Dilley Zachary Brown	QA	Anthony Smith Adam Alger Adam Hauke Dylan Rosenfeldt
Temperature	23.4°C-24.0°C	R.H. %	19.90%-32.40%
Test Date	03/14/2024-03/21/2024	Location	Chamber 3 Chamber 5
Requirement	15.247 (d) 15.209 RSS-247 Clause 5.5 RSS-GEN Clause 8.9	Method	ANSI C63.10

15.209 Limits:

Frequency (MHz)	Quasi-Peak Limit (dBμV/m)	Average Limit (dBμV/m)	Peak Limit (dBμV/m)
30-88	40.0	-	-
88-216	43.5	-	-
216-960	46.0	-	-
960-1000	54.0	-	-
1000-40000	-	54.0	74.0

Test Parameters

Frequency	30-40000 MHz	Distance	3 m
Detector(s)	Peak Trace Peak and Average Final	Table height	150 cm
RBW	<1000 MHz – 120 kHz >1000 – 1 MHz	VBW	<1000 – 1.2 MHz >1000 – See 2.9

Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
AA 960007	Antenna - Double Ridge Horn	EMCO	3115	9311-4138	8/10/2023	8/10/2024	Active Calibration
AA 960081	Antenna - Double Ridge Horn	EMCO	3115	6907	1/11/2024	1/11/2025	Active Calibration
AA 960154	Filter - High Pass 2.4 GHz	KWM	HPF-L-14186	7272-02	4/11/2023	4/11/2024	Active Calibration
AA 960163	Antenna - Log Periodic	A.H. Systems, Inc.	SAS-512-2	500	8/10/2023	8/10/2024	Active Calibration
AA 960217	Antenna - Biconical	A.H. Systems, Inc.	SAS-540	852	7/17/2023	7/17/2024	Active Calibration
AA 960221	Cable	A.H. Systems, Inc.	SAC-26G-6	524	6/13/2023	6/13/2024	Active Verification
EE 960085	Analyzer - EMI Receiver	Agilent	N9038A	MY51210148	4/27/2023	4/27/2024	Active Calibration

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EE 960203	Analyzer - EMI Receiver	Keysight	N9038A	MY56400072	4/11/2023	4/11/2024	Active Calibration
LSC-300	Cable	Chamber 3 Emissions	-	-	1/5/2024	1/5/2025	Active Verification
LSC-500	Cable	Chamber 5 Emissions	-	-	1/8/2024	1/8/2025	Active Verification

EUT Parameters

Input Power	120 VAC @ 60 Hz	Mode	BTC FHSS Tx
EUT	X, Y, Z Plane Orientations Antenna ports terminated with 50 Ω SMA terminators	AE	HP Elitebook 840G1 Ezurio – SOM60 Development Kit
Notes	6000 MHz Emission from auxiliary equipment. Not a function of the EUT.		

Radiated Spurious – 30-1000 MHz – Channel 19 – Basic Rate - Single

Frequency (MHz)	Antenna Polarity	Height (cm)	Azimuth (degree)	Quasi-Peak Reading (dB μ V/m)	Quasi-Peak Limit (dB μ V/m)	Margin (dB)
44.0	Horizontal	276	247	38.2	40.0	1.8
78.0	Vertical	140	55	34.3	40.0	5.7
125.0	Vertical	159	261	37.0	43.5	6.5
220.0	Horizontal	164	329	36.6	46.0	9.4
375.0	Horizontal	308	341	39.3	46.0	6.7
479.9	Vertical	135	17	40.4	46.0	5.6

*The spurious signals detected do not depend on either the operating channel or the modulation mode

1000-40000 MHz

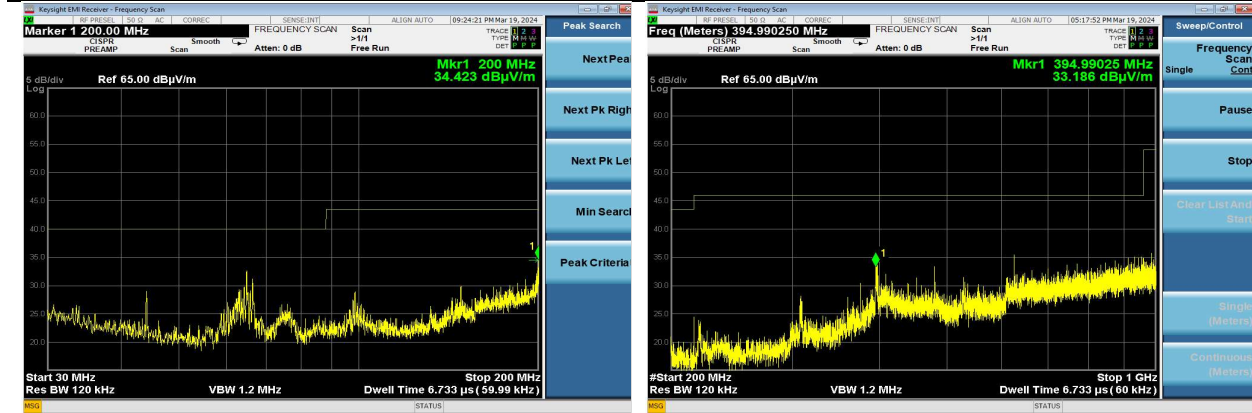
Band Edge

Channel	EUT Orientation	Data Rate	Measurement Type	Frequency (MHz)	Antenna Polarity	Measurement (dBμV/m)	Limit (dBμV/m)	Margin (dB)
0	X Plane	BR	Peak	2386.1	Vertical	47.7	68.2	20.5
		(Single)	Average	2382.5	Vertical	35.0	54.0	19.0
		BR	Peak	2340.0	Vertical	46.7	68.2	21.5
		(Hopping)	Average	2389.5	Vertical	34.9	54.0	19.1
		EDR2	Peak	2344.4	Vertical	46.7	68.2	21.5
		(Single)	Average	2388.0	Vertical	34.9	54.0	19.1
		EDR2	Peak	2370.2	Vertical	47.0	68.2	21.2
		(Hopping)	Average	2389.9	Vertical	34.9	54.0	19.1
		EDR3	Peak	2378.5	Vertical	46.6	68.2	21.6
		(Single)	Average	2389.4	Vertical	35.0	54.0	19.0
		EDR3	Peak	2355.9	Vertical	46.9	68.2	21.3
		(Hopping)	Average	2387.5	Vertical	35.0	54.0	19.0
39	Z Plane	BR	Peak	2494.3	Horizontal	47.6	68.2	20.6
		(Single)	Average	2484.5	Horizontal	35.0	54.0	19.0
		BR	Peak	2488.1	Horizontal	47.0	68.2	21.2
		(Hopping)	Average	2495.6	Horizontal	35.0	54.0	19.0
		EDR2	Peak	2487.1	Horizontal	47.8	68.2	20.4
		(Single)	Average	2486.0	Horizontal	35.0	54.0	19.0
		EDR2	Peak	2485.2	Horizontal	47.6	68.2	20.6
		(Hopping)	Average	2495.5	Horizontal	35.1	54.0	18.9
		EDR3	Peak	2485.0	Horizontal	47.3	68.2	20.9
		(Single)	Average	2490.3	Horizontal	35.1	54.0	18.9
		EDR3	Peak	2492.0	Horizontal	47.3	68.2	20.9
		(Hopping)	Average	2490.3	Horizontal	35.0	54.0	19.0

Spurious

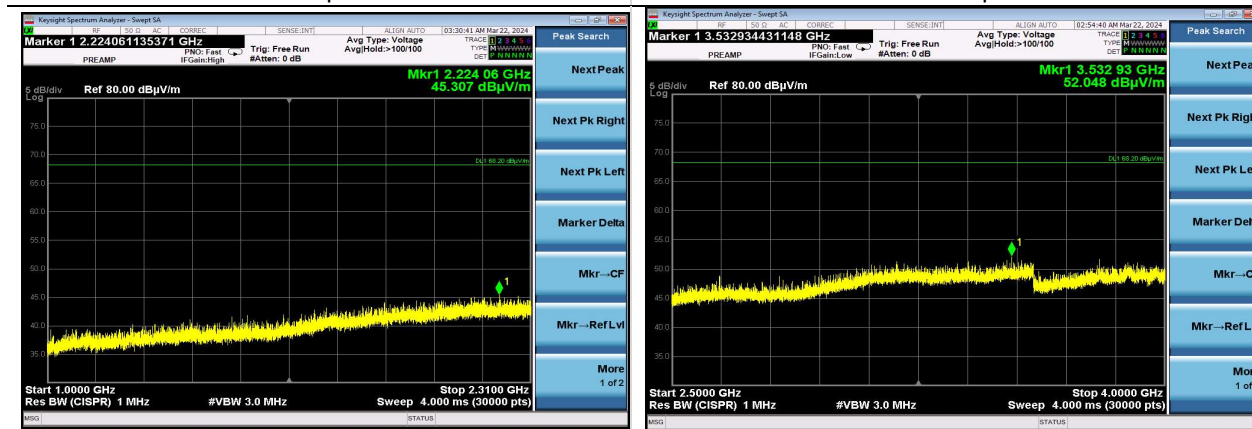
No Emissions Present

Worst Case Plots



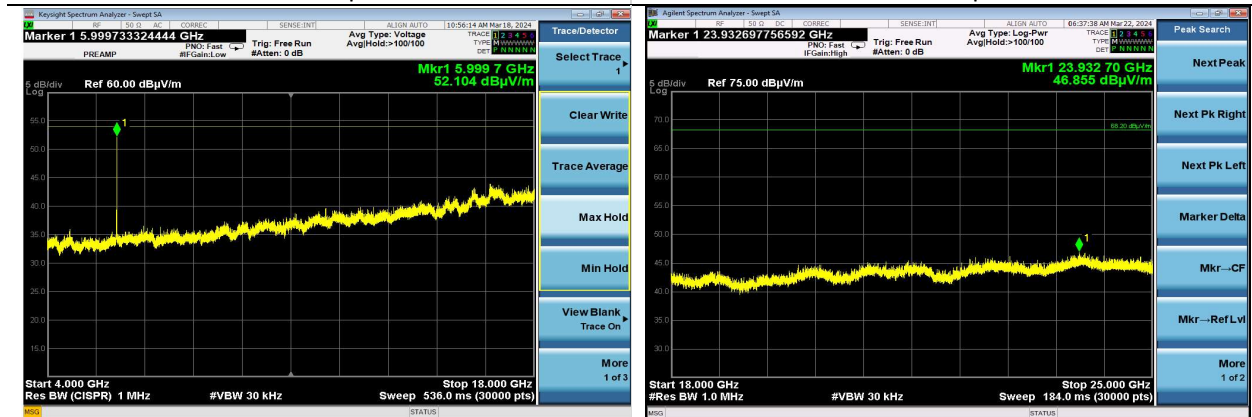
Channel 39 | Basic Rate | Single
30-200 MHz | Horizontal

Channel 39 | Basic Rate | Single
200-1000 MHz | Vertical



Channel 0 | Basic Rate | Single
1000-2310 MHz | Horizontal

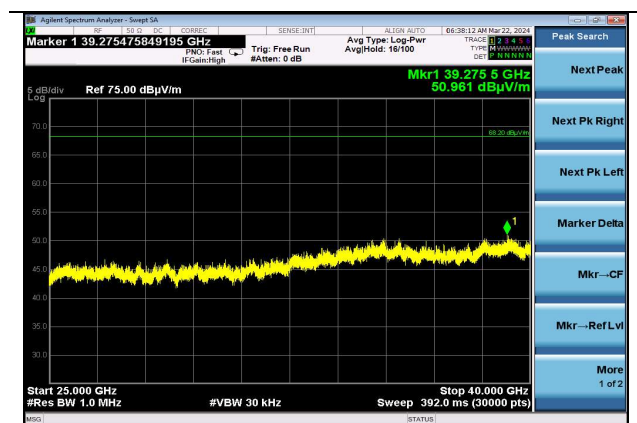
Channel 78 | Basic Rate | Single
2500-4000 MHz | Horizontal



Channel 39 | Basic Rate | Single
4000-18000 MHz | Vertical

Channel 39 | Basic Rate | Single
18000-25000 MHz | Horizontal

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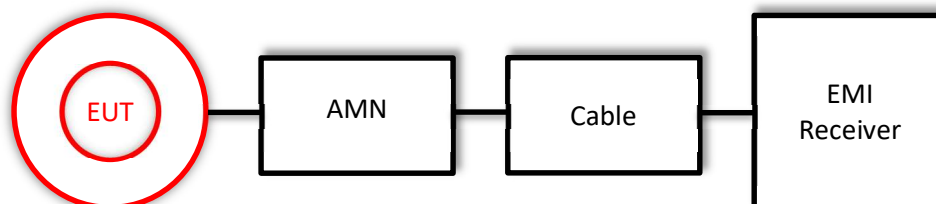
Channel 39 | Basic Rate | Single
25000-40000 MHz | Horizontal

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6.3 AC Mains Conducted Emissions

Description of Measurement	A line impedance stabilization network (LISN) or artificial mains network (AMN) allows the emissions of the power supply conductors to be measured while isolating the EUT from the supply mains. The AMN, cable, and other necessary measurement system correction factors are loaded onto the EMI receiver when the measurements are performed. The data is gathered and reported as the corrected values. Maximum emissions are determined with a peak max hold trace then measurements at a selection of the highest points are made with quasi-peak and average detectors. Results are recorded and compared to limit for each line. (e.g. line and neutral)
Example Calculations	Measurement (dBμV) + Cable factor (dB) + Other (dB) = Corrected Reading (dBμV) Margin (dB) = Limit (dBμV) - Corrected Reading (dBμV)

Block Diagram



6.3.1 AC Mains Conducted Emissions

Operator	Jon Dille	QA	Adam Hauke
Temperature	20.8°C	R.H. %	19.60%
Test Date	1/22/2024	Location	AC Conducted Bench
Requirement	15.207 RSS-GEN Clause 8.8	Method	ANSI C63.10

Limits:

Frequency (MHz)	Quasi-Peak Limit (dBμV)	Average Limit (dBμV)
0.15-0.5	66.0-56.0*	56.0-46.0*
0.5-5	56.0	46.0
5-30	60.0	50.0

*Decreases with the logarithm of the frequency.

Test Parameters

Frequency	0.15-30 MHz	Distance	40 cm from wall 80 cm from LISN
Detector(s)	Peak Trace Quasi-Peak, Average Final	Table height	80 cm
RBW	9 kHz	VBW	62 kHz
Notes	Channel has no effect on emission		

Instrumentation

Asset #	Description	Manufacturer	Model #	Serial #	Date	Due Date	Status
EE 960088	Analyzer - EMI Receiver	Agilent	N9038A	MY51210148	4/27/2023	4/27/2024	Active Calibration
EE 960089	LISN	COM-POWER	LI-215A	191943	4/10/2023	4/10/2024	Active Calibration
EE 960162	LISN	COM-POWER	LI-215A	191969	4/10/2023	4/10/2024	Active Calibration
LSC-212	Cable	Micro-Coax	UFB311A-0-1440-70U70U	64639 224071-001	1/8/2024	1/8/2025	Active Verification

EUT Parameters

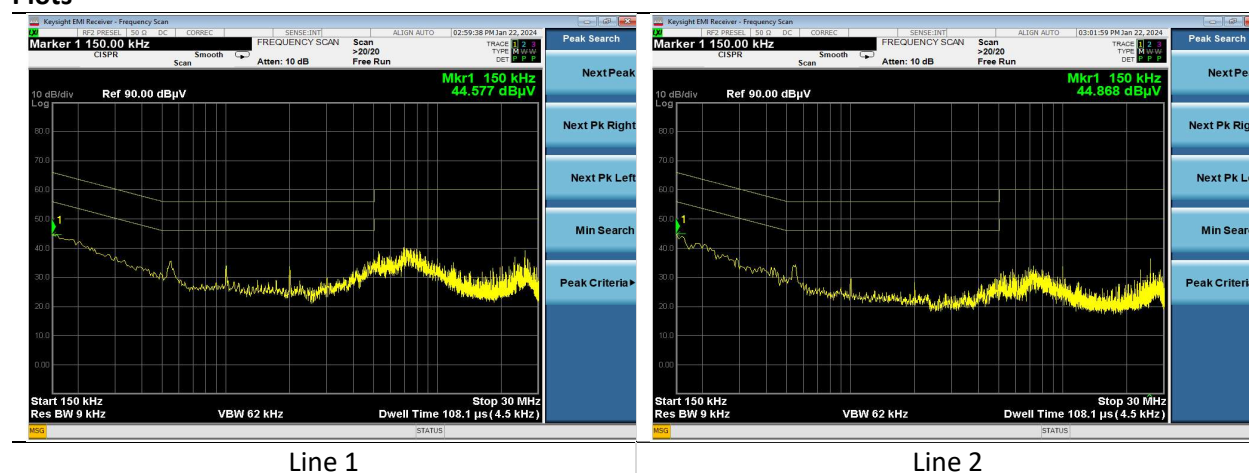
Input Power	120 VAC @ 60 Hz	Mode	BTC Tx Channel 37 1DH5
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Measurements

Line	Frequency (MHz)	Quasi Peak Reading (dBμV)	Quasi-Peak Limit (dBμV)	Quasi Peak Margin (dB)	Average Reading (dBμV)	Average Limit (dBμV)	Average Margin (dB)
1	0.155	39.3	65.8	26.5	29.6	55.8	26.2
1	0.512	30.2	56.0	25.8	24.2	46.0	21.8
1	11.760	36.0	60.0	24.0	25.1	50.0	24.9
2	0.150	39.7	66.0	26.3	30.2	56.0	25.8
2	0.517	30.8	56.0	25.2	23.6	46.0	22.4
2	11.860	30.2	60.0	29.8	18.1	50.0	31.9

Plots



7 REVISION HISTORY

Version	Date	Notes	Person
0.0	08/05/2024	Initial Draft	Adam Hauke
1.0	08/08/2024	Final Draft	Adam Hauke

END OF REPORT